Universität Hamburg

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Dissertation

zur Erlangung des akademischen Grades eines

Doktors der Wirtschaftswissenschaften (Dr. rer. pol.)

des Fachbereichs Wirtschafts- und Sozialwissenschaften,

Department Wirtschaftswissenschaften

der Universität Hamburg

vorgelegt von

Dipl.-Kfm. Wolfgang Sofka, M.A.

geboren in Ichenhausen

Hamburg, 18. Dezember 2007

Mitglieder der Promotionskommission

Vorsitzender:	Prof. Dr. Henrik Sattler
Erstgutachter:	Prof. Dr. Thorsten Teichert
Zweitgutachter:	Prof. Dr. Michel Clement

Das wissenschaftliche Gespräch fand am 26. Februar 2008 statt.

Hiermit erkläre ich an Eides statt, dass ich die vorliegende Arbeit selbstständig und ohne fremde Hilfe nur unter Verwendung der angeführten Literatur angefertigt habe.

Wolfgang Sofka

Erklärung zum Promotionsvorhaben

Hiermit erkläre ich, dass ich zuvor noch keiner Doktorprüfung unterzogen wurde sowie mich noch um keine Zulassung an der Universität Hamburg bzw. einer anderen Universität beworben habe. Weiterhin habe ich noch keiner Universität oder ähnlichen Einrichtung eine Dissertation vorgelegt.

Wolfgang Sofka

Vorwort

Diese Dissertation entstand während meiner Tätigkeit am Zentrum für Europäische Wirtschaftsforschung (ZEW) in Mannheim im Forschungsbereich Industrieökonomik und Internationale Unternehmensführung. Sie wäre ohne diese ausgezeichneten Arbeits- und Forschungsbedingungen nicht möglich gewesen. Dafür bedanke ich mich beim Präsidenten des ZEW Prof. Dr. Dr. h.c. mult. Wolfgang Franz und meinem Forschungsbereichsleiter Dr. Georg Licht.

Mein besonderer Dank gilt meinem Doktorvater Prof. Dr. Thorsten Teichert, der die Arbeit stets mit professionellem Rat und forderndem Engagement betreut hat. Prof. Dr. Michel Clement danke ich für die Übernahme des Zweitgutachtens und die bemerkenswerte Unterstützung während der Endphase der Dissertation.

Zahlreiche Kolleginnen und Kollegen am ZEW und dem Arbeitsbereich Marketing und Innovation der Universität Hamburg haben durch Diskussionen und konstruktives Feedback den Erfolg dieses Dissertationsprojekts möglich gemacht. Große Anerkennung gebührt darüber hinaus meinen Koautoren Jörg Zimmermann, Prof. Dr. Ulrich Kaiser, Ihsen Ketata und Anja Schmiele für ihren Einsatz und ihre Geduld. Besonders hervorheben möchte ich meine Wertschätzung für die Unterstützung durch Tobias Schmidt, Christop Grimpe, Christian Rammer und Bettina Peters. Sie haben es geschafft, mir vieles beizubringen und die Zusammenarbeit stets zu einem reinen Vergnügen werden zu lassen.

Dank schulde ich außerdem Heidi Halder und Heidrun Förster sowie meinem Team von studentischen Mitarbeiterinnen Oya Karatas, Tzvetana Kaicheva, Eva Anderson-Park, Jessica Csonka, Julia Metz und Magdalena Zettl.

Schließlich danke ich meiner Mutter Roswitha und meiner Schwester Monika für den unermüdlichen Zuspruch, die Aufmunterung und das Vertrauen.

Mannheim, Februar 2008 Wolfgang Sofka

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

I. Synopsis

II. Open-Innovation-Strategien und die Effekte von Auslandsnachteilen (Liability of Foreignness)

[1] Search Patterns and Absorptive Capacity: A Comparison of Low- and High-Technology Firms from Thirteen European Countries.

[Grimpe, Christoph und Wolfgang Sofka, 2007, ZEW Discussion Paper No. 07-062, Mannheim; Eingereicht auf Einladung für 25 ausgewählte Beiträge in Research Policy Special Issue „Innovation in Low-tech Sectors."]

[2] Regional Economic Stress as Moderator of Liability of Foreignness.

[Sofka, Wolfgang und Jörg Zimmermann, 2007, Max Planck Institute of Economics Papers on Entrepreneurship, Growth and Public Policy No. 12-2007 und Jena Economic Research Papers 2007-023, Jena, dritte Einreichungsrunde bei Journal of International Management, Status: Minor Revision.]

III. Internationalisierung von Innovationsimpulsen für deutsche Unternehmen

[3] Globalizing Domestic Absorptive Capacities.

[Sofka, Wolfgang, 2005, ZEW Discussion Paper No. 05-53, Mannheim, zweite Einreichungsrunde bei Management International Review (MIR), Status: Revision eingereicht.]

[4] Global Sensing and Sensibility: A Multi-Stage Matching Assessment of Competitive Advantage from Foreign Sources of Innovation.

[Sofka, Wolfgang und Thorsten Teichert, 2006, ZEW Discussion Paper No. 06-009, Mannheim, Best Paper Proceedings of the Sixty-fifth Annual Meeting of the Academy of Management 2006.]

IV. Zugang zu deutschen Innovationsquellen für ausländische Unternehmen

[5] Innovation Activities Abroad and the Effects of Liability of Foreignness: Where it Hurts.

[Sofka, Wolfgang, 2006, ZEW Discussion Paper No. 06-029, Mannheim und Georgia Tech Center for International Business Education and Research (CIBER) Working Paper 031-07/08, Atlanta, zweite Einreichungsrunde bei Management International Review (MIR), Status: Revision eingereicht.]

[6] Liability of Foreignness as a Barrier to Knowledge Spillovers: Lost in Translation?

[Schmidt, Tobias und Wolfgang Sofka, 2006, ZEW Discussion Paper No. 06-001, Mannheim, zweite Einreichungsrunde bei Journal of International Management, Status: Revision eingereicht.]

V. Abgeleitete und vertiefende Themen

[7] The Pulse of Liability of Foreignness: Dynamic Legitimacy and Experience Effects in the German Car Market.

[Kaiser, Ulrich und Wolfgang Sofka, 2006, ZEW Discussion Paper No. 06-070, Mannheim, zweite Einreichungsrunde bei Journal of World Business, Status: Revise and resubmit.]

[8] Internationalizing R&D Co-opetition: Dress for the Dance with the Devil.

[Schmiele, Anja und Wolfgang Sofka, 2007, ZEW Discussion Paper No. 07-045, Mannheim, eingereicht bei Journal of World Business.]

[9] Rapid Response Capabilities: The Importance of Speed and Flexibility for Successful Innovation.

[Grimpe, Christoph und Wolfgang Sofka, 2007, ZEW Discussion Paper No. 07-062, Mannheim, Teilergebnisse erscheinen als Buchkapitel in: Challenges in the Management of New Technologies (International Association for Management of Technology IAMOT), 2007, World Scientific Publishing Company und Contemporary Corporate Strategy: Global Perspectives, Routledge Studies in International Business and the World Economy.]

[10] Profiling Sustainable Innovators: Not Ready to Make Nice?

[Grimpe, Christoph, Ihsen Ketata und Wolfgang Sofka, 2007, Georgia Tech Center for International Business Education and Research (CIBER) Working Paper 030-07/08, Atlanta, eingereicht bei Journal of Management.]

Synopsis

Internationalisierungspotenziale von Open-Innovation-Strategien:
Chancen und Herausforderungen für das Innovationsmanagement

Wolfgang Sofka

Gliederung

1 Überblick

Die Organisation von Innovationsaktivitäten hat in den letzten Jahren bedeutende Veränderungen erfahren. Traditionell wurden unternehmensinterne Forschungs- und Entwicklungsaktivitäten als die zentrale Triebfeder für die Generierung von neuen Produkten und Prozessen betrachtet. Dieser primäre Fokus auf interne Ressourcen und Kompetenzen erweist sich zusehends als zu eng gefasst. Unternehmen profitieren davon, wenn sie interne Innovationsaktivitäten mit externem Know-how verknüpfen können. Im Vordergrund stehen in diesem Essay Innovationsimpulse von Kunden, Lieferanten und Universitäten. Dieser Trend scheint zum einen die Reaktion auf eine veränderte Wettbewerbssituation zu sein: Produktlebenszyklen werden kürzer, technologische Möglichkeiten entstehen an den Grenzen etablierter Kompetenz-/Technologiefelder, Investitionen in Innovationsprojekte steigen und der internationale Wettbewerb verschärft sich (siehe beispielsweise Calantone et al., 1997; Chatterji, 1996; Kleinschmidt und Cooper, 1988; Ojah und Monplaisir, 2003). Auf der anderen Seite steigt gleichzeitig die Verfügbarkeit wertvoller, unternehmensexterner Ressourcen. Die Mobilität von hochqualifizierten Wissenschaftlern und Ingenieuren nimmt zu, Venture Capital Finanzinvestoren erleichtern die Kommerzialisierung von neue Ideen und Erfindungen und spezialisierte Zulieferer entstehen, die spezifische Dienstleistungen, Materialien und Anlagen einbringen (Chesbrough, 2003). Dieser Trend hat sich sowohl in der praktischen als auch theoretischen Literatur niedergeschlagen. Chesbrough (2003) spricht von einem Paradigmenwechsel von geschlossenen zu offenen Innovationsaktivitäten und prägt dafür das Konzept „Open Innovation.“ Huston und Sakkab (2006) beschreiben das Phänomen als den Übergang von „Research & Develop“ zu „Connect & Develop.“

Der zentrale konzeptionelle Beitrag dieser Arbeit besteht darin, existierende Forschungsarbeiten zum Thema Open Innovation um die Chancen und Herausforderungen der zunehmenden Internationalisierung von Märkten und Wertschöpfungsketten zu erweitern. In diesem Sinne bedeutet Open Innovation nicht nur die Öffnung von Innovationsaktivitäten über Unternehmensgrenzen hinweg, sondern auch jenseits von nationalen und kulturellen Grenzen. Dies erscheint besonders relevant angesichts der zunehmenden Globalisierung, d.h. die Intensivierung von internationale Grenzen überschreitenden Güter-, Kapital- und Know-how-Strömen, die dazu führt, dass Ereignisse in geographisch weit entfernten Regionen unmittelbare Konsequenzen im Heimatland haben (Giddens, 1990; Govindarajan und Gupta, 2001). Dieser Prozess ist weitgehend getrieben von Durchbrüchen bei Informations- und Telekommunikationstechnologien sowie zunehmender politischer Unterstützung für

internationalen Freihandel und die Abkehr von staatlich gelenkten Wirtschaftssystemen in großen Märkten, insbesondere China und Indien (Govindarajan und Gupta, 2001; Gupta und Westney, 2003). Auf der einen Seite eröffnen diese Veränderungen völlig neue Möglichkeiten, von lokal gebündelter technologischer Expertise und wichtigen Marktimpulsen weltweit zu profitieren. Auf der anderen Seite steigen die Herausforderungen an das Innovationsmanagement, da der Umfang und die Komplexität potenziell wertvollen Wissens steigt und besonders aussichtsreiche Elemente über räumliche, nationale und kulturelle Grenzen hinweg identifiziert, bewertet und übermittelt werden müssen. In der Literatur zur Öffnung von Innovationsaktivitäten werden diese organisatorischen Prozesse und Fähigkeiten als absorptive Fähigkeiten zusammengefasst. Sie bestehen aus der Fähigkeit externes Wissen und dessen Quellen zu identifizieren, das Wissen aufzunehmen mit im Unternehmen existierendem zu verbinden und als neue Produkte und Prozesse zu verwerten (Cohen und Levinthal, 1989, 1990). Der Beitrag der vorliegenden Arbeit besteht darin, diesen Literaturstrang mit den besonderen Herausforderungen grenzüberschreitender Interaktionen zu verbinden.

Diese zentrale Problemstellung untersucht die vorliegende Arbeit in drei Schritten, die sich jeweils in zwei Essays aufteilen. Jedes Essay fokussiert auf einen Kernaspekt der übergeordneten Fragestellung. Allen Essays ist verfolgen das Ziel, existierende Forschungsarbeiten geeignet aufzuarbeiten und gezielt zu erweitern. Im Zentrum steht jeweils die Diskussion von Mustern und Wechselwirkungen, um daraus abgeleitete Hypothesen anschließend empirisch zu testen, so dass belastbare Ableitungen und Empfehlungen für das Innovationsmanagement geleistet werden können.

Im ersten Schritt werden die zentralen Konzepte der thematischen Fragestellung separat in die Diskussion eingeführt. Dies ist zum einen das Thema „Open Innovation“ und zum anderen die Literatur zu Nachteilen von multinationalen Unternehmen im Ausland („Liability of Foreignness“). Beide Essays erweitern die existierende Literatur. Essay 1 greift das Thema Open Innovation auf und führt den Gedanken von Suchmustern in die wissenschaftliche Diskussion zum Auffinden unternehmensexterner Innovationsimpulse ein, die bislang vor allem entlang der Dimensionen Breite (diverses Wissen) versus Tiefe (spezifisches Wissen) geführt wurde (siehe beispielsweise Katila und Ahuja, 2002; Laursen und Salter, 2006). Demgegenüber greift Essay 2 noch losgelöst vom Innovationskontext die Thematik von kulturellen Barrieren für ausländische Niederlassungen von multinationalen Unternehmungen auf. Der generelle Befund zur Existenz von diesen Auslandsnachteilen als „Liability of Foreignness“ ist in der existierenden Literatur etabliert, d.h. die mangelnde Integration von

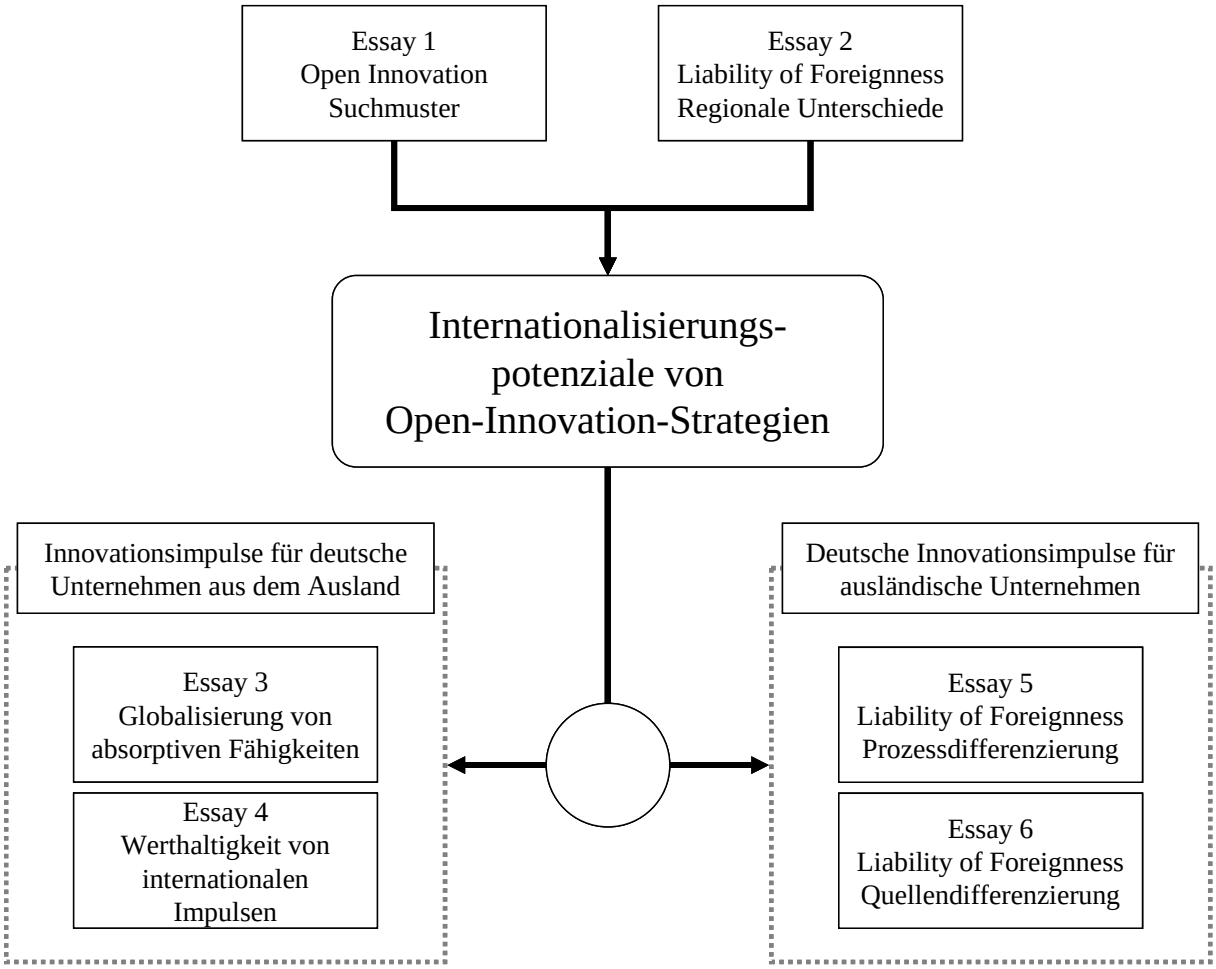
ausländischen Unternehmen in Wissensströme des Gastlandes (siehe beispielsweise Nachum, 2003; Zaheer, 1995; Zaheer und Mosakowski, 1997). Allerdings existieren bislang erst wenige Managementempfehlungen dazu, wie diesen Nachteilen begegnet werden könnte (Mezias, 2002a). Essay 2 versucht an dieser Stelle einen Beitrag zu leisten, indem es regionale Unterschiede innerhalb der wirtschaftlichen Entwicklung des Gastlandes einführt, die das Ausmaß der Liability of Foreignness verstärken bzw. abmildern können.

In den folgenden Schritten werden dann die beiden zentralen Fragestellungen „Öffnung der Innovationsprozesse“ und „Internationalisierung“ zusammengeführt. Essays 3 und 4 fokussieren auf die Internationalisierung der Nutzung von Innovationsimpulsen durch deutsche Unternehmen, während die Essays 5 und 6 die Perspektive auf die Wissensbeschaffung von ausländischen Unternehmen in Deutschland richten. Essay 3 erweitert die bestehende Literatur, indem es Mechanismen vorschlägt und empirisch testet, die dem Auf- und Ausbau von absorptiven Fähigkeiten für den internationalen Kontext zugrunde liegen. Der Schwerpunkt liegt auf der Übertragung von Impulsinformationen, die in Innovationsaktivitäten am Heimatstandort münden. In diesem Sinne ist der Ansatz eine Erweiterung der bestehenden Literatur, da er nicht den grenzüberschreitenden Transfer von kompletten Technologien unterstellt, wie das häufig in Studien basierend auf Patentstatistiken notwendig ist (siehe beispielsweise Almeida, 1996; Audretsch und Feldman, 1996) bzw. den Aufbau von ausländischen Niederlassungen voraussetzt (siehe beispielsweise Gupta und Govindarajan, 2000; Hakanson und Nobel, 2001). Essay 4 testet diese Form der Internationalisierung dann auf ihre Werthaltigkeit und kommt zu dem Ergebnis, dass sie vor allem strategische Optionen für Technologieführerschaft schafft.

Mit Essay 5 wechselt dann der Schwerpunkt zu den Innovationsaktivitäten von ausländischen Unternehmen in Deutschland und den Effekten von Liability of Foreignness. Essay 5 und 6 grenzen den Ursprung der Effekte näher ein, um somit Interventionsmöglichkeiten aufzudecken. Essay 5 verfolgt eine Prozessperspektive und erweitert die bestehende Literatur um eine differenzierte Betrachtung der Effekte von Liability of Foreignness während der Ideenfindung, Projektauswahl und dem Projektcontrolling. Es zeigt sich, dass ausländische Unternehmen in Deutschland eine signifikant höhere Wahrscheinlichkeit haben Innovationsprojekte abzubrechen bzw. zu überziehen. Essay 6 verbindet direkt die Kernthemen „Open Innovation“ und „Liability of Foreignness.“ Es wird untersucht, ob ausländische Unternehmen im selben Maße Zugang zu wertvollen Innovationsimpulsen von lokalen Kunden, Zulieferern und Universitäten bekommen wie ihre heimischen Wettbewerber. Erneut zeigt sich ein differenziertes Ergebnis, dass die Ableitung geeigneter

Management-Maßnahmen zulässt. Die negativen Effekte von Liability of Foreignness treten vor allem im Umgang mit heimischen Kunden auf. Abbildung 1 stellt das Zusammenspiel der Themen nochmals grafisch dar.

Abbildung 1: Überblick der Kernthemen



An dieses Kernthema schließen sich 4 Essays an, die abgeleitete bzw. vertiefende Themen aufgreifen. Jedes Essay ist inhaltlich bzw. methodisch mit den Kernessays verbunden, fokussiert jedoch nicht unmittelbar auf die übergeordnete Fragestellung dieser Arbeit. Essay 7 folgt analog zu Essay 2 dem Kerngedanken strategische Optionen für die Überwindung der Liability of Foreignness aufzudecken. Erfahrungseffekte werden auf Seiten der heimischen Kunden und der ausländischen Unternehmen gegenübergestellt und auf ihre Wirkung hinsichtlich einer möglichen Liability of Foreignness untersucht. Essay 8 untersucht eine spezielle Form von Open Innovation: Innovationsbezogene Kooperationen mit Wettbewerbern (Co-opetion). Im Einklang mit den Essays 1 und 3 wird untersucht, welche Firmencharakteristika Unternehmen befähigen, nicht nur mit heimischen, sondern auch mit ausländischen Wettbewerben zu kooperieren. Es zeigt sich, dass dazu eine Verschiebung beim intellektuellen Eigentumsschutz von informellen (z.B. Geheimhaltung) zu formellen

Methoden (z.B. Patenten) nötig ist. Essays 9 und 10 greifen spezifische Innovationsaktivitäten auf und verbinden sie mit der Thematik Open Innovation und absorptive Fähigkeiten. Essay 9 untersucht die Mechanismen, die es Unternehmen erlauben, die Zeit zwischen Innovationsimpuls und erfolgreicher Umsetzung zu verkürzen. Essay 10 fokussiert stattdessen auf Suchstrategien, die es Unternehmen erlauben, nachhaltige Innovationen (d.h. Innovation zur Verringerung der Umweltbelastung, Erhöhung der Sicherheit, Senkung des Energieverbrauch) zu generieren.

Der methodische Beitrag der vorliegenden Arbeit ist unmittelbar von der inhaltlichen Fragestellung abgeleitet. Im Fokus steht die Generierung differenzierter Ergebnisse, so dass geeignete Managementempfehlungen abgeleitet werden können. Auf der anderen Seite sollen Wechselwirkungen sichtbar gemacht werden, die unternehmerische Entscheidungen nicht isoliert abbilden, sondern in den relevanten Kontext einbetten. Dies wird methodisch vor allem durch die Anwendung von trivariaten Probitmodellen (Essays 3, 5, 6) und Seemingly Unrelated Regressionmodellen (Essays 2, 7) erreicht. Diese Methoden erlauben es, mehrere Entscheidungen separat abzubilden (z.B. Innovationsimpulse von Kunden versus Lieferanten), ohne dass wertvolle Informationen einer Entscheidung für die Schätzung der anderen verloren gehen. Vereinfacht gesagt, werden mehrere Gleichungen separat aber simultan geschätzt. Im Zentrum von Essay 1 steht die Erkennung von Mustern im Suchverhalten von Unternehmen. Aus diesem Grund wird in diesem Fall auf Latent Class Tobitmodelle zurückgegriffen, so dass Gruppen von Unternehmen mit ähnlichen Suchstrategien identifiziert werden können, die innerhalb der Gruppen homogen, zwischen den Gruppen jedoch heterogen sind. Überdies lassen sich mit diesem Verfahren für jede Gruppe separate Wirkungszusammenhänge aufdecken. Essay 4 ist inhaltlich unmittelbar an der ressourcen-basierten Theorie der Unternehmung angelehnt. Um deren zentrale Annahme der Firmenheterogenität geeignet abbilden zu können, kommen Propensity Score Nearest Neighbour und Kernel Matching Schätzverfahren zum Einsatz. Diese Anwendung erscheint für den angestrebten Theorietest als besonders sinnvoll, da konventionelle Regressionsanalysen kaum geeignet sind, Heterogenität zwischen Unternehmen adäquat abzubilden, da sie auf systematischen Vergleichen mit Durchschnittsunternehmen (Mittelwerten) beruhen. Matching-Verfahren weisen stattdessen basierend auf geschätzten Wahrscheinlichkeitsmaßen jedem Unternehmen individuell ein weitestgehend ähnliches Vergleichsunternehmen aus der Kontrollgruppe zu, wodurch die Annahme der Heterogenität erhalten bleibt, ohne dass die Objektivität der Schätzung verloren geht. Alle anderen Essays

basieren schließlich empirisch auf Probitmodellen (Essays 8, 9) und Regressionsanalysen (Essay 10).

Hinsichtlich der verwendeten Datengrundlage versucht die vorliegende Arbeit einen Bogen zu spannen zwischen spezifischen und detaillierten Betrachtungsweisen und abstrakteren Perspektiven, die die Generalisierbarkeit einzelner empirischer Befunde sicherstellen. Zum Einsatz kommen branchenspezifische Daten (deutscher Automobilmarkt; Essays 2, 7), deutschlandweite, branchenübergreifende Innovationserhebungen (Mannheimer Innovationspanel, Essays 3, 4, 5, 6, 8, 9, 10) und die analogen, anonymisierten Innovationsdaten für 13 europäische Länder (Essay 1). Alle theoretisch abgeleiteten Hypothesen werden empirisch getestet, wobei großzahlige Unternehmensstichproben im Mittelpunkt stehen. Abbildung 2 stellt die Verknüpfung von theoretischem und empirischem Beitrag nochmals im Überblick dar.

Abbildung 2: Theoretische und empirische Beiträge

	Theoretischer Fokus			
Empirische Analyse	*Open Innovation*	*Liability of Foreignness*	*Internatio-nalisierung von Innovation aus Deutschland*	*Internatio-nalisierung von Innovation in Deutschland*
Regressionsanalyse *Probitmodelle*	Essay 9, 10 Deutsche Innovations-daten		Essay 8 Deutsche Innovations-daten	
Seemingly Unrelated Regressionsanalysen *Trivariate Probitmodelle*		Essay 2, 7 Deutsche Automobil-daten	Essay 3 Deutsche Innovations-daten	Essay 5, 6 Deutsche Innovations-daten
Latent Class Regressionsanalyse	Essay 1 Europäische Innovations-daten			
Nearest Neighbour *Kernel Matching*			Essay 4 Deutsche Innovations-daten	

Die folgenden vier Abschnitte der Synopsis stellen die bearbeiteten Themen nochmals zusammenfassend dar. Die Synopsis endet mit einem Fazit und führt im Anhang die einzelnen Essays mit dem jeweiligen bibliographischen Status auf.

2 Chancen und Herausforderungen der Internationalisierung von Open-Innovation-Strategien

2.1 Open-Innovation-Strategien und die Effekte von Auslandsnachteilen (Liability of Foreignness)

Dieser einleitende Analyseschritt stellt zunächst die beiden Kernkonzepte der Analyse vor. Dies ist zum einen das Thema „Open Innovation“ und zum anderen „Liability of Foreignness.“ Essay 1 führt dazu das Konzept Open Innovation ein. Es geht auf Chesbrough (2003) zurück und beschreibt den Übergang von primär unternehmensinternen Innovationsaktivitäten zur verstärkten Nutzung externer Ressourcen wie z.B. von spezialisierten Zulieferern oder Universitäten. Unternehmen müssen sich dazu zu „Knowledge Brokern“ mit der Fähigkeit entwickeln, so mit externen Akteuren zu interagieren, dass das Unternehmen maximalen Nutzen aus deren Wissen und Erfindungen ziehen kann (Chesbrough, 2003). Dies erfordert den Aufbau von absorptiven Fähigkeiten, d.h. von individuellen und organisatorischen Kompetenzen und Prozesse, die es erlauben wertvolle Wissensquellen zu identifizieren, Wissen aufzunehmen und mit im Unternehmen vorhandenem Know-how zu kombinieren, so dass es schließlich in erfolgreiche Produkt- und Prozessinnovationen mündet (Cohen und Levinthal, 1989, 1990). Essay 1 versucht diesen Forschungsstrang um zwei Facetten zu erweitern: der Aufdeckung von Mustern in externen Suchstrategien und der expliziten Unterscheidung zwischen Niedrig- und Hochtechnologie-Unternehmen. Während in der Literatur bislang die Suche nach wertvollem Wissen außerhalb des Unternehmens (Suchstrategie) voranging entlang der Dimensionen Breite (diverse Innovationsquelle) versus Tiefe (spezifische Innovationquellen) beschrieben wurde (siehe beispielsweise Katila und Ahuja, 2002; Laursen und Salter, 2006), entwickelt Essay 1 die Hypothese, dass die organisatorischen Fähigkeiten und Kanäle für den Zugang und die Nutzung einer bestimmten Innovationsquelle (z.B. Kunden) nicht notwendigerweise auch in gleicher Weise für die Nutzung anderer Innovationsquellen (z.B. Universitäten) eingesetzt werden können, da Wissen aus unterschiedlichen Quellen spezifische Aufbereitungsschritte erfordert (Todorova und Durisin, 2007). Empirisch modelliert Essay 1 diese Suchmuster als Finite Mixture Modelle. Mittels Latent Class Tobitregressionen können Cluster von Unternehmen innerhalb des Datensatzes identifiziert werden, die innerhalb des Clusters sehr ähnlich sind, sich jedoch von den Unternehmen anderer Cluster deutlich unterscheiden. Diese Clusterung ist über eine latente Variable im statistischen Modell abgebildet. Dies erlaubt es, sie simultan, aber mit separaten Wirkungszusammenhängen zwischen Innovationsinputs

(FuE-Investitionen) und Outputs (Markterfolg mit neuen Produkten) für jedes Cluster zu schätzen. Die empirische Analyse von Essay 1 kann dafür auf Daten für 13 europäische Länder zurückgreifen wodurch die Ergebnisse nicht auf einzelne, nationale Kontexte begrenzt bleiben. Es handelt sich um die Ergebnisse der harmonisierten Community Innovation Survey (CIS) der Europäischen Union, die das Innovationsverhalten (einschließlich externer Innovationsquellen) der Unternehmen der Mitgliedsländer abbildet. Allerdings unterliegen die Mikrodaten sehr hohen Auflagen hinsichtlich Weitergabe und Vertraulichkeit. Insofern existieren nur äußerst wenige Studien, die von einer ähnlichen Informationsabdeckung wie Essay 1 profitieren konnten. Der Datensatz lag in anonymisierter Form für 4500 Unternehmen aus dem verarbeitenden Gewerbe und das Jahr 2001 im Rahmen des Forschungsprojekts Systematic vor. Die Verwendung von Umfrageergebnissen hat gegenüber Analysen basierend auf Patentstatistiken den Vorteil, dass Innovationsquellen (d.h. unternehmensinterne Impulse, Kunden, Zulieferer, Wettbewerber, Universitäten) und deren Bedeutung direkt bei den Leitern von FuE bzw. Innovationsabteilungen abgefragt werden können. Für Firmen aus Niedrigtechnologie-Sektoren zeigen sich drei Suchmuster, die weitgehend von Kunden und Wettbewerberquellen bestimmt werden, wobei Suchmuster, die sich auf Kundenimpulse konzentrieren, die höchste Effizienz der eingesetzten FuE-Aufwendungen bezogen auf den Markterfolg mit neuen Produkten bieten. In Unternehmen aus Hochtechnologie-Branchen zielen die Suchmuster primär auf Impulse von Zulieferern und Universitäten ab, wobei der Markterfolg bei den Unternehmen am höchsten ist, die Wissen aus Universitäten nicht primär aufbauen, sondern bereits verwerten.

Essay 2 führt im Anschluss daran die zentrale Argumentation ein, warum offene Innovationsprozesse nicht beliebig über nationale und kulturelle Grenzen hinweg ausgebreitet werden können. Noch losgelöst vom Innovationskontext stellt es dazu das Konzept von Liability of Foreignness vor. Das Konstrukt stammt aus der Institutionentheorie und basiert auf dem Grundgedanken, dass Individuen und Organisationen durch regelmäßige Interaktion mit ihrem Heimatumfeld geprägt werden und diese Prägung im Ausland zum Nachteil werden kann (Zaheer, 1995). Wesentliche Elemente dieser Prägung sind nicht eindeutig bestimmt oder kodifiziert, wodurch sie nur unzureichend auf Ressourcenmärkten erworben werden können (Jensen und Szulanski, 2004). Dies bedeutet eine Herausforderung für die ausländischen Niederlassungen multinationaler Unternehmen, die sich simultan um Konsistenz mit den Anforderungen des Gastlands und des globalen Hauptsitzes bemühen müssen. Die sichtbaren Indikatoren von Liability of Foreignness sind häufigere Fehler, Verzögerungen und unnötige Risiken verglichen mit den Handlungen von Wettbewerbern aus

dem Gastland (Lord und Ranft, 2000). Die Existenz von Liability of Foreignness wurde bereits in diversen Studien und auf vielfältigen Ebenen (z.B. Umsatzhöhe, Effizienz, Häufigkeit gerichtlicher Klagen) nachgewiesen (siehe beispielsweise DeYoung und Nolle, 1996; Mezias, 2002b; Miller und Parkhe, 2002). Essay 2 versucht, diese Forschungsarbeiten um eine regionale Perspektive innerhalb des Gastlands zu erweitern, so dass lokal zugeschnittene Gegenstrategien entwickelt werden können, die bislang in der Literatur kaum zu finden sind (Mezias, 2002a). Essay 2 entwickelt ergebnisoffene Hypothesen dazu, dass ökonomische Belastungen in einer Region des Gastlandes entweder zu patriotischeren (Erhöhung der Liability of Foreignness) oder rationaleren Kaufentscheidungen (Verringerung der Liability of Foreignness) führen. Der empirische Test für den äußerst internationalen deutschen Automobilmarkt in Ost- bzw. Westdeutschland bestätigt die zweite Hypothese. Er basiert auf einem eigens generierten Datensatz, der Preise, Umsätze, Ausstattungsmerkmale, Firmencharakteristika, Werbe- und FuE-Aufwendungen der Hersteller für fast alle Automobilmodelle (annähernd 1200) in West- und Ostdeutschland zusammenstellt. Der Datensatz erlaubt die simultane Schätzung von separaten Nachfragefunktionen (seemingly unrelated regressions) für den west- und ostdeutschen Markt. Die Konsistenz der Schätzergebnisse wird durch einen Instrumentvariablen-Ansatz sichergestellt, da Endogenität durch den engen Zusammenhang zwischen Preis und Ausstattungsmerkmalen zu erwarten ist. Auf Basis eines Likelihood Ratio Tests zeigt sich, dass west- und ostdeutsche Nachfrageverhalten nicht identisch sind, was die Modellierung in zwei separaten Gleichungen rechtfertigt. Es zeigt sich jedoch, dass ausländische Marken in beiden Märkten signifikante Nachteile haben (Liability of Foreignness), wobei dieser Nachteil in Ostdeutschland signifikant schwächer ausgeprägt ist. Essay 2 leitet daraus ab, dass der ökonomische Druck in Ostdeutschland zu rationaleren Konsumentscheidungen führt, so dass die stereotypischen Effekte von Liability of Foreignness weniger stark zum Tragen kommen.

2.2 Internationalisierung von Innovationsimpulsen für deutsche Unternehmen

Im zweiten Schritt werden die Konzepte „Open Innovation“ und „Herausforderungen der Internationalisierung“ zusammengeführt. Der Fokus liegt zunächst auf der Nutzung von ausländischen Innovationsimpulsen durch deutsche Unternehmen. Essay 3 versucht, das Konzept der absorptiven Fähigkeiten von Unternehmen um eine grenzüberschreitende Dimension zu erweitern. Der Schwerpunkt liegt auf den Triebkräften, die die Internationalisierung von absorptiven Fähigkeiten und somit von Open Innovation erklären können. Traditionell werden absorptive Fähigkeiten als Lern- und Erfahrungseffekte

resultierend aus internen Forschungs- und Entwicklungsaktivitäten verstanden (Cohen und Levinthal, 1989, 1990). Dies schließt Investitionen in Sachmittel und Kompetenzen ein. Essay 3 erweitert diesen Ansatz für den internationalen Kontext um interne Ressourcen (z.B. Internationalisierungserfahrung, Anreizsysteme) und externe Triebkräfte (z.B. Mangel an heimischen Innovationsimpulsen). Es greift den grundlegenden Ansatz von Essay 1 auf, dass nämlich unterschiedliche Mechanismen für den effektiven Umgang mit unterschiedlichen Innovationsquellen (Kunden, Zulieferer, Wettbewerber) erforderlich sind. Dieser Ansatz spiegelt sich im empirischen Teil von Essay 3 wider, der die Triebkräfte für Innovationsimpulse von Kunden, Zulieferern und Wettbewerbern aus dem Ausland simultan aber separat mittels eines trivariaten Probit Modells schätzt. Die Analyse greift auf einen umfassenden Datensatz zum Innovationsverhalten deutscher Unternehmen zurück (Mannheimer Innovationspanel), das den deutschen Beitrag zur Community Innovation Survey der Europäischen Union darstellt. Informationen zu Innovationsaktivitäten, Impulsen und Resultaten liegen für mehr als 2000 Unternehmen aus diversen Branchen (verarbeitendes Gewerbe und Dienstleistungen) vor. Essay 3 kommt zu dem Ergebnis, dass die Globalisierung von absorptiven Fähigkeiten sowohl durch unternehmensinterne Faktoren, insbesondere Anreizsysteme für Mitarbeiter und Exporterfahrung, als auch noch Defizite im heimischen Innovationsumfeld angetrieben wird. Das Gewicht dieser Faktoren unterscheidet sich im Umgang mit Kunden, Zulieferern und Wettbewerbern aus dem Ausland.

Essay 4 stellt die logische Weiterentwicklung von Essay 3 dar, indem es die Internationalisierung von Innovationsimpulsen auf ihre Werthaltigkeit untersucht. Essay 4 setzt konzeptuell direkt an der ressourcen-basierten Unternehmenstheorie an (Barney, 1991; Conner und Prahalad, 1996; Peteraf, 1993; Wernerfelt, 1984) und versucht einen methodischen Beitrag zur Literatur zu leisten, indem es ein empirisches Verfahren vorschlägt, das den Kerngedanken dieser Theorie, die Heterogenität von Unternehmen, methodisch abbildet. Die mangelnde empirische Validierung dieser Theorie war bislang ein wesentlicher Kritikpunkt an diesem Ansatz (Hoops et al., 2003; Priem und Butler, 2001). Essay 4 adressiert die Notwendigkeit zur Erhaltung von Heterogenität durch mehrstufige Propensity Score Nearest Neighbour und Kernel Matching Schätzungen, denen keine Vergleiche mit Mittelwerten (wie z.B. bei herkömmlichen Regressionen), sondern mit individuellen, möglichst ähnlichen Kontrollunternehmen zugrunde liegen. Die Zuordnung dieser Referenzunternehmen basiert auf Probitschätzungen, so dass die Objektivität des Verfahrens erhalten bleibt. Basierend auf wesentlichen Unternehmenskennziffern (z.B. Größe, Branche, Exportanteil, FuE-Ausgaben) haben die Kontrollunternehmen dieselben Voraussetzungen

(Wahrscheinlichkeiten) internationale Innovationsimpulse aufzunehmen, haben dies jedoch nicht getan. Unterschiede im Erfolg beider Unternehmen lassen sich somit auf die Internationalisierung der Innovationsimpulse zurückführen. Die Analyse nähert sich dem Thema in zwei Schritten, um die Trennschärfe des Verfahrens darzustellen. Im ersten Schritt besteht die Kontrollgruppe aus allen Unternehmen ohne internationale Innovationsimpulse; im zweiten Schritt nur aus Unternehmen mit nationalen Innovationsimpulsen. Auf diese Weise kann zwischen der generellen Werthaltigkeit von unternehmensexternen Impulsen und der spezifischen Werthaltigkeit von ausländischen Impulsen unterschieden werden. Im Ergebnis zeigt sich, dass die Öffnung des Innovationsprozesses von deutschen Unternehmen positive Effekte auf mehrere Dimensionen des Innovationserfolgs hat, wobei die ins Ausland gerichtete Facette vor allem Technologieführerschaft-Strategien ermöglicht.

2.3 Zugang zu deutschen Innovationsquellen für ausländische Unternehmen

Im dritten Schritt wechselt die vorliegende Arbeit den Fokus und untersucht ausländische Unternehmen in Deutschland und deren Erfolg im Innovationsprozess. Dieser Schritt rundet den Gesamtansatz ab, indem er unmittelbar Liability of Foreignness mit dem Innovationsprozess im Ausland verbindet. Essay 5 ergänzt bestehende Forschung auf diesem Gebiet um eine Prozessperspektive der Innovationsaktivitäten von multinationalen Unternehmen in Deutschland. Mögliche Schwachpunkte werden identifiziert, an denen die Effekte von Liability of Foreignness deutlich werden, so dass Gegenmaßnahmen gezielt getroffen werden können. Das Essay unterscheidet zwischen der frühen Ideenfindungsphase, dem Auswahlprozess und dem Controlling der Innovationsprojekte. Empirisch kommen wiederum trivariate Probitmodelle und die Daten der deutschen Innovationserhebung des Mannheim Innovationpanels (MIP) zum Einsatz. Auf dieser Basis kann jede Entscheidung separat, jedoch simultan mit allen anderen geschätzt werden. Es zeigt sich, dass multinationale Unternehmen nicht häufiger Innovationsprojekte unterlassen, jedoch eine signifikant höhere Wahrscheinlichkeit haben, sie abzubrechen oder zu überziehen. Gegenstrategien sollten somit dort lokale Expertise und Benchmarks einbeziehen, wo Innovationsprojekte bewertet, ausgewählt und gemanagt werden. Darüber hinaus zeigt die vertiefende Analyse mittels Interaktionseffekten, dass ausländische Niederlassungen diese Nachteile ebenfalls dadurch kompensieren können, wenn es ihnen gelingt, ihre einzigartigen Möglichkeiten zum Austausch von Wissen über Ländergrenzen hinweg zu aktivieren (Kogut und Zander, 1993). Das zeigt die empirische Analyse dadurch, dass die Nutzung von

ausländischen Universitäten als Innovationsimpulse die Effekte von Liability of Foreignness signifikant abmildert.

Essay 6 schließt den Themenkomplex ab, indem es unmittelbar die Konzepte „Open Innovation“ als Wissensbeschaffung im Ausland und „Liability of Foreignness“ gegenüberstellt. Im Einklang mit der Trennung nach verschiedenen Impulsquellen in anderen Essays untersucht es, ob es den Niederlassungen von multinationalen Unternehmen weniger häufig gelingt, wertvolle Innovationsimpulse von Kunden, Zulieferern und Universitäten aus Deutschland aufzunehmen. Diese Innovationsquellen unterscheiden sich dahingehend, wie eindeutig identifizierbar, kodifiziert und übertragbar das Wissen der jeweiligen Quelle ist. Die empirischen Ergebnisse einer trivariaten Probitschätzung mit den Daten des MIP zeigen, dass die Effekte von Liability of Foreignness vor allem im Umgang mit deutschen Kunden zu signifikant negativen Ergebnissen führen. Das Essay schließt mit der Folgerung, dass der Mangel an Integration im Gastland die ohnehin anspruchsvolle Aufgabe der Identifikation von Lead-Kunden mit vorausschauenden Nachfrageimpulsen zusätzlich erschwert, da Kundenwissen häufig unartikuliert, unzuverlässig und idiosynkratisch ist (Frosch, 1996).

3 Abgeleitete und vertiefende Themen

An dieses Kernthema schließen sich vier Essays an, die jeweils inhaltliche und methodische Berührungspunkte mit den Essays 1 bis 6 haben, jedoch spezifischere Themen aufgreifen. Essay 7 setzt am Thema Liability of Foreignness an, versucht jedoch, die bestehende Literatur dadurch zu erweitern, dass es die Effekte nach der Erfahrung der Käufer (Alter) und der internationaler Anbieter (Zeitpunkt des Markteintritts) differenziert. Im Zentrum steht die Frage, ob diese Erfahrungseffekte das Ausmaß der Liability of Foreignness beeinflussen. Empirisch getestet werden diese Zusammenhänge für den deutschen Automobilmarkt (Methode und Datensatz analog zu Essay 2). Interessanterweise zeigt sich, dass das Ausmaß der Liability of Foreignness bei der jüngsten Käufergruppe mit der geringsten Erfahrung am stärksten ausgeprägt ist, während sie bei der ältesten Käufergruppe nicht mehr signifikant auftritt.

Essay 8 setzt dann wieder am Gedanken der Internationalisierung von Innovationsaktivitäten an und fokussiert auf innovationsbezogene Kooperationen mit internationalen Wettbewerbern. Generell ist dieses Zusammenspiel aus Kooperation und Wettbewerb („Co-opetition“) eine ungewöhnliche Mischung mit tendenziell gegensätzlichen Interessen. Essay 8 erweitert den Forschungsstand, indem es untersucht, ob und wie deutsche Unternehmen ihre Erfahrungen bei Innovationskooperationen mit heimischen Wettbewerbern auf ausländische Wettbewerber

übertragen können. Es wird die Hypothese entwickelt, dass Unternehmen dazu nicht nur ihre eigenen absorptiven Fähigkeiten stärken, sondern auch den Abfluss von Wissen („Appropriability“) gezielt steuern müssen. Getestet wird diese Hypothese durch die Schätzung von Probitmodellen basierend auf einer aktualisierten Version des Innovationsdatensatzes für Deutschland aus Essay 3 für das Jahr 2005. Im Ergebnis zeigt sich vor allem, dass Unternehmen ihre Kompetenzen zur Aneignung neuen Wissens von informellen Methoden (z.B. Geheimhaltung) zu formellen Methoden (z.B. Patente) verschieben müssen. Außerdem erweist sich die Erfahrung aus innovationsbezogenen Kooperationen mit anderen ausländischen Partnern (Kunden, Zulieferer) als sehr hilfreich.

Essay 9 greift einen anderen Aspekt des Innovationsmanagements im Bereich „Open Innovation“ auf, die Reaktionszeit von Unternehmen zwischen der Identifikation von externen Impulsen und deren Umsetzung in erfolgreiche Innovationen. Das Essay versucht die Literatur zu „Timing“ von Innovationsaktivitäten jenseits von First-Mover- bzw. Follower-Strategien (siehe beispielsweise Lieberman und Montgomery, 1988; Shankar et al., 1998) zu erweitern. Es beschreibt die organisatorische Innovation zur Verkürzung der Reaktionszeit als ein kontinuierlich wechselndes Muster von Innovation und Imitation, bei dem der Erfolg durch Reaktionsgeschwindigkeit und Flexibilität entsteht. Die Triebfedern für den Aufbau dieser speziellen Fähigkeiten werden als Interaktion zwischen internen, absorptiven Fähigkeiten und externer Wettbewerbdynamik konzeptionell abgebildet. Der empirische Test (Probitmodelle basierend auf dem Innovationsdatensatz analog zu Essay 8) zeigt, dass die Verkürzung der Reaktionszeit primär das Ergebnis von Reaktionen auf externe Dynamiken oder die Rationalisierung von kontinuierlich aufgebauten absorptiven Fähigkeiten ist, jedoch nicht die Kombination aus beiden.

Essay 10 greift ebenfalls ein spezielles Innovationsthema auf und rückt es in den Rahmen der Literatur zu Open Innovation und absorptiven Fähigkeiten. Es fokussiert auf die Fähigkeiten, die es Unternehmen erlauben, nachhaltige Innovationen in Bezug auf ihre Umweltverträglichkeit, Material-/Energieverbrauch und Sicherheit zu entwickeln. Solche Innovationsaktivitäten verbreitern das Zielsystem von Innovation und machen sie somit komplexer und weniger berechenbar. Insofern werden Hypothesen entwickelt, die diese speziellen Eigenschaften von nachhaltigen Innovationen reflektieren, insbesondere mit Blick auf die externen Innovationsimpulse, die sie erfordern. Der empirische Test (Regressionsanalysen basierend auf dem Innovationsdatensatz aus Essays 8 und 9) zeigt, dass die Fähigkeit, nachhaltige Innovationen zu erzeugen, sowohl breit gestreute als auch

fokussierende Suchstrategien für externes Wissen erfordert, wobei die Breite des zur Verfügung stehenden Wissens wichtiger ist.

4 Fazit

Im Zentrum der vorliegenden Arbeit steht die Frage, ob und wie die Öffnung von Innovationsaktivitäten nicht nur über Unternehmens-, sondern auch nationale Grenzen hinweg gestaltet werden kann. Im Überblick bestätigen die Ergebnisse der Essays die Existenz von kulturellen Barrieren (Liability of Foreignness), die die Internationalisierung von Open-Innovation-Strategien bremsen. Gleichermaßen zeigt die Arbeit aber auch Optionen für das Management auf, wie diesen speziellen Herausforderungen begegnet werden kann. Darin besteht der zentrale, konzeptionelle Beitrag der Arbeit.

Die Fähigkeit, ausländische Innovationsimpulse aufnehmen und verwerten zu können, hängt in erheblichem Maße von der internationalen Erfahrung der Unternehmung ab (Essays 3, 8). Insofern erscheint es angebracht, Open-Innovation-Strategien, die ins Ausland zielen, nicht nur mit technologischer Expertise zu verbinden, sondern vorhandene Kompetenzen im Umgang mit internationalen Märkten aktiv mit einzubeziehen. Die Internationalisierung von Open Innovation scheint besonders dort relevant zu sein, wo das heimische Innovationsumfeld als weniger attraktiv betrachtet wird (Essay 3). Diese Wahrnehmung sollte vor allem auf Unternehmen mit aggressiven Technologiestrategien zutreffen. In dem Maße, in dem wertvolle Innovationspulse zusehends sowohl von der Technologie- als auch Marktseite global sind (Doz et al., 2001), gewinnt der Zugang zu diesen Quellen an erfolgskritischer Bedeutung. Essay 4 bestätigt diese Hypothese in dem Sinn, dass nationale Open-Innovation-Strategien ebenfalls zur Verbesserung existierender Produkte und Prozesse beitragen. Ausländische Impulse sind darüber hinaus jedoch wesentlich stärker dazu geeignet, das Unternehmen strategisch als Technologieführer zu positionieren.

Mit Blick auf die Ursachen für Liability of Foreignness im Innovationsprozess im Ausland identifiziert die vorliegende Arbeit zwei Schwerpunkte. Für ausländische Unternehmen scheint es besonders schwierig zu sein, wertvolle Innovationsimpulse von Kunden aus dem Gastland zu gewinnen (Essay 5). Wesentliche Elemente von Kundenwissen sind häufig unartikuliert, auf die eigene Situation beschränkt und wenig verlässlich (Frosch, 1996). Diese macht die Identifikation von besonders wichtigen Kunden mit zukunftsweisenden Innovationsimpulsen besonders schwierig. In diesem Umfeld scheint der Mangel an Legitimität und kultureller Einbettung in den Kontext des Gastlands besonders relevant zu werden. Luo et al. (2002) unterscheiden zwischen offensiven (verstärktes Engagement im

Gastland) und defensiven Strategien (Abzug von Kompetenzen aus dem Gastland) im Umgang mit Liability of Foreignness. Im Umgang mit kundenrelevanten Funktionen scheinen insbesondere offensive Strategien wie Investitionen in lokale Designzentren und die Übertragung von Kompetenzen an die ausländische Niederlassung angezeigt.

Ein ähnlicher Effekt von Liability of Foreignness lässt sich innerhalb des Innovationsprozesses im Ausland erkennen (Essay 5). Töchter ausländischer Unternehmen haben eine signifikant höhere Wahrscheinlichkeit, Innovationsprojekte abzubrechen oder zu überziehen, als Wettbewerber aus dem Gastland (Deutschland). Liability of Foreignness scheint keine Effekte auf die Ideenfindungsphase zu haben. Insofern werden die Nachteile erkennbar, wenn Ressourcenerfordernisse den Ideen gegenübergestellt werden müssen. Dies kann daher rühren, dass solche Bewertungen innerhalb der multinationalen Unternehmensgruppe einheitlichen Standards unterliegen, um interne Konsistenz sicherzustellen. Diese Richtlinien müssen jedoch nicht notwendigerweise in den spezifischen Kontext des jeweiligen Gastlandes passen. In diesem Sinne ist multinationalen Unternehmen anzuraten, Expertise aus dem Gastland bei der Projektauswahl zu berücksichtigen und Benchmarks nicht nur innerhalb der Unternehmensgruppe, sondern auch im lokalen Umfeld zu suchen.

Methodisch konzentriert sich die vorliegende Arbeit darauf, Entscheidungen trennscharf abzubilden, ohne sie isoliert schätzen zu müssen. Mittels trivariater Probit und seemingly unrelated Regressionsanalysen wird diese Aufgabe geleistet. Darüber hinaus kommen Matchingverfahren zum Einsatz (Essay 4), die das Potenzial haben, die theoretischen Grundlagen der ressourcen-basierten Unternehmenstheorie (Heterogenität) adäquater abzubilden als Standardschätzverfahren, die auf Mittelwertvergleichen beruhen. Schließlich greift die Arbeit auf Latent-Class-Analysen zurück, um Wechselwirkungen bzw. Muster aufzudecken (Essay 1). Jeder dieser methodischen Beiträge wird durch die Verfügbarkeit von Daten aus Innovationsbefragungen in Deutschland und Europa möglich gemacht. Sie können tiefer gehen als viele Studien in der Literatur, die auf Patentstatistiken bzw. Patentzitationen zurückgreifen müssen, um Wissensflüsse abbilden zu können (siehe beispielsweise Almeida, 1996; Jaffe et al., 1993). Patentaktivitäten bilden Wissensflüsse nur sehr selektiv ab, sind auf wenige Unternehmen konzentriert und spiegeln nicht notwendigerweise die Generierung von Innovationen wider (Criscuolo et al., 2005). Darüber hinaus ist nicht ersichtlich, in welchem Kontext der Wissensfluss stattfand (beispielsweise zwischen Kunden und Zulieferern oder unter Wettbewerbern). Die vorliegende Analyse kann die Aufdeckung dieser Strukturen leisten, so dass Managementempfehlungen abgeleitet werden können.

Alle Analysen besitzen Schwachpunkte, die zu Ansatzpunkten für neue Forschungsarbeiten werden können. Im vorliegenden Fall sind die empirischen Analysen mit Ausnahme von Essay 1 auf Deutschland begrenzt. Komparative Studien mit anderen etablierten Industrienationen, aber auch mit aufstrebenden Ländern (z.B. China, Indien) könnten interessante zusätzliche Einblicke ermöglichen. Die Potenziale der Globalisierung für das Innovationsmanagement entstehen weitgehend in diesen Ländern, die gleichzeitig eine wesentlich andere kulturelle und institutionelle Prägung aufweisen. In diesem Sinn sollten die Effekte von Liability of Foreignness stärker zum Tragen kommen. Auf der anderen Seite könnte eine zweite Facette der Effekte von „Foreignness" ins Blickfeld rücken. Nachum (2003) schlägt vor, dass im Ausland geprägte Organisationsformen und Wahrnehmungen in bestimmten Gastländern zu wertvollen Assets werden können. Aus diesem Blickwinkel liefert die vorliegende Arbeit eine solide Basis mit Analysen für Deutschland und Europa, die in weiterführenden Studien in den globalen Kontext gestellt werden sollte.

5 Literatur

Almeida, P. (1996), Knowledge Sourcing by Foreign Multinationals: Patent Citation Analysis in the U.S. Semiconductor Industry, *Strategic Management Journal* 17, 155-165.

Audretsch, D.B. und M.P. Feldman (1996), R&D Spillovers and the Geography of Innovation and Production, *American Economic Review* 86 (3), 630-640.

Barney, J.B. (1991), Firm Resources and Sustained Competitive Advantage, *Journal of Management* 17 (1), 99-120.

Calantone, R.J., J.B. Schmidt und C.A. Di Benedetto (1997), New Product Activities and Performance: The Moderating Role of Environmental Hostility., *Journal of Product Innovation Management* 14 (3), 179-189.

Chatterji, D. (1996), Accessing External Sources of Technology, *Technology Management* 39 (2), 48-57.

Chesbrough, H.W. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Boston.

Cohen, W.M. und D.A. Levinthal (1989), Innovation and Learning: The Two Faces of R&D, *The Economic Journal* 99, 569-596.

Cohen, W.M. und D.A. Levinthal (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly* 35 (1), 128-153.

Conner, K.R. und C.K. Prahalad (1996), A Resource-Based Theory of the Firm: Knowledge Versus Opportunism, *Organization Science* 7 (5), 477-501.

Criscuolo, C., J.E. Haskel und M.J. Slaughter (2005), *Global Engagement and the Innovation Activities of Firms*, NBER Working Paper No. 11479, Cambridge, MA.

DeYoung, R. und D.E. Nolle (1996), Foreign-Owned Banks in the United States: Earning Market Share or Buying It?, *Journal of Money, Credit, and Banking* 28, 622-636.

Doz, Y.L., J. Santos und P. Williamson (2001), *From Global to Metanational: How Companies Win in the Knowledge Economy*, Boston.

Frosch, R.A. (1996), The Customer for R&D Is Always Wrong!, *Research Technology Management* 39 (6), 22-25.

Giddens, A. (1990), *The Consequences of Modernity*, Stanford.

Govindarajan, V. und A.K. Gupta (2001), *The Quest for Global Dominance: Transforming Global Presence into Global Competitive Advantage*, 1, San Francisco.

Gupta, A.K. und V. Govindarajan (2000), Knowledge Flows within Multinational Corporations, *Strategic Management Journal* 21 (4), 473-496.

Gupta, A.K. und E.D. Westney (2003), Introduction, in: Gupta, A. K. und E. D. Westney (eds.), *Smart Globalization: Designing Global Strategies, Creating Global Networks*, San Francisco, 1-12.

Hakanson, L. und R. Nobel (2001), Organizational Characteristics and Reverse Technology Transfer, *Management International Review (MIR)* 41 (4), 395-420.

Hoops, D.G., T.L. Madsen und G. Walker (2003), Guest Editors' Introduction to the Special Issue: Why Is There a Resource-Based View? Toward a Theory of Competitive Heterogeneity, *Strategic Management Journal* 24 (10), 889-902.

Huston, L. und N. Sakkab (2006), Connect and Develop, *Harvard Business Review* 84 (3), 58-66.

Jaffe, A.B., M. Trajtenberg und R. Henderson (1993), Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, *The Quarterly Journal of Economics* 108 (3), 577-599.

Jensen, R. und G. Szulanski (2004), Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers, *Journal of International Business Studies* 35 (6), 508-523.

Katila, R. und G. Ahuja (2002), Someting Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction, *Academy of Management Journal* 45 (6), 1183-1194.

Kleinschmidt, E.J. und R.G. Cooper (1988), The Performance Impact of an International Orientation of Product Innovation., *European Journal of Marketing* 22 (10), 56-72.

Kogut, B. und U. Zander (1993), Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation, *Journal of International Business Studies* 24 (4), 625-645.

Laursen, K. und A. Salter (2006), Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms, *Strategic Management Journal* 27 (2), 131-150.

Lieberman, M.B. und D.B. Montgomery (1988), First-Mover Advantages, *Strategic Management Journal* 9, 41-58.

Lord, M.D. und A.L. Ranft (2000), Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge, *Journal of International Business Studies* 31 (4), 573-589.

Luo, Y., O. Shenkar und M.-K. Nyaw (2002), Mitigating Liabilities of Foreignness: Defensive Versus Offensive Approaches, *Journal of International Management* 8 (3), 283-301.

Mezias, J.M. (2002a), How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations., *Journal of International Management* 8 (3), 265-283.

Mezias, J.M. (2002b), Identifying Liabilities of Foreignness and Strategies to Minimize Their Effects: The Case of Labor Lawsuit Judgement in the United States, *Strategic Management Journal* 23, 229-244.

Miller, S.R. und A. Parkhe (2002), Is There a Liability of Foreignness in Global Banking? An Empirical Test of Banks' X-Efficiency, *Strategic Management Journal* 31 (1), 323-337.

Nachum, L. (2003), Liability of Foreignness in Global Competition? Financial Service Affiliates in the City of London, *Strategic Management Journal* 24 (12), 1187-1208.

Ojah, K. und L. Monplaisir (2003), Investors' Valuation of Global Product Design and Development, *Journal of International Business Studies* 34, 457-472.

Peteraf, M.A. (1993), The Cornerstones of Competitive Advantage: A Resource Based View, *Strategic Management Journal* 14 (3), 179-191.

Priem, R.L. und J.E. Butler (2001), Is the Resource-Based 'View' a Useful Perspective for Strategic Management Research?, *Academy of Management Review* 26 (1), 22-40.

Shankar, V., G.S. Carpenter und L. Krishnamurthi (1998), Later Mover Advantage: How Innovative Late Entrants Outsell Pioneers, *Journal of Marketing Research* 35, 54-70.

Todorova, G. und B. Durisin (2007), Absorptive Capacity: Valuing a Reconceptualization, *Academy of Management Review* 32 (3), 774-786.

Wernerfelt, B. (1984), A Resource-Based View of the Firm, *Strategic Management Journal* 5 (2), 171-180.

Zaheer, S. (1995), Overcoming the Liability of Foreignness., *Academy of Management Journal* 38 (2), 341-364.

Zaheer, S. und E. Mosakowski (1997), The Dynamics of the Liability of Foreignness: A Global Study of Survival in Financial Services, *Strategic Management Journal* 18 (6), 439-464.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Search Patterns and Absorptive Capacity: A Comparison of Low- and High-Technology Firms from Thirteen European Countries

AUTOREN: ***Christoph Grimpe***

[KU Leuven, ZEW Mannheim]

Wolfgang Sofka

[Universität Hamburg, ZEW Mannheim]

JAHR: 2007

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper No. 07-062, Mannheim
Eingereicht auf Einladung für 25 ausgewählte Beiträge in Research Policy Special Issue „Innovation in Low-tech Sectors."

Search Patterns and Absorptive Capacity: A Comparison of Low- and High-Technology Firms from Thirteen European Countries

Christoph Grimpe[1,2] and Wolfgang Sofka[1,3]

[1] Centre for European Economic Research (ZEW), Mannheim, Germany
[2] Katholieke Universiteit Leuven, Belgium
[3] University of Hamburg, Germany

Abstract

Searching for externally available knowledge has been characterised as a vital part of the innovation process. Previous research has, however, almost exclusively focused on high-technology environments, largely ignoring the substantial low- and medium-technology sectors of modern economies. We argue that low- and high-technology firms differ in their search patterns and that these moderate the relationship between innovation inputs and outputs. Based on a sample of 4,500 firms from 13 European countries we find that search patterns in low-technology industries focus on market knowledge while they are built around differences in technology sourcing activities for high-technology industries.

Keywords: Absorptive capacity, search strategies, low-, medium- and high-technology sectors, open innovation

JEL-Classification: L60, O32

Corresponding author:
Christoph Grimpe
grimpe@zew.de
Phone: +49/621/1235-381, Fax: +49/621/1235-170
Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43, D-68034 Mannheim, Germany

The authors would like to thank Christian Rammer and Edlira Shehu for their invaluable comments and discussions. This paper has been produced as part of the Systematic Innovation Watch project within the Europe Innova Initiative, sponsored by the European Commission. Financial support is gratefully acknowledged.

1 Introduction

Innovation activities have frequently been shown to be a cornerstone for increasing the market share, market value as well as the long-term survival prospects of firms (e.g. Banbury and Mitchell, 1995; Brockhoff, 1997; Brockhoff, 1999). In order to sustain the ability to successfully introduce new products to the market, many firms have shifted to a model of "open innovation" that is characterised as involving a wide range of actors from the innovation system in the innovation process and exploiting their knowledge (Chesbrough, 2003). Such innovation impulses from external sources like customers, suppliers, competitors or universities can subsequently be conceptualised as the main elements of a firm's *search strategy,* which has been shown to have a substantial impact on innovative performance (Katila, 2002; Katila and Ahuja, 2002; Laursen and Salter, 2006). The search strategy can be defined as an "organisation's problem solving activities that involve the creation and recombination of technological ideas" (Katila and Ahuja, 2002: 1184). Problem solving activities hence occur in the spectrum from exploitation to exploration (March, 1991). The definition of an appropriate search strategy, however, critically depends on the ability to recognise the potential value of external knowledge sources. This ability has been summarised as the *absorptive capacity* of firms (Cohen and Levinthal, 1990).

Interestingly, there is almost an implicit assumption in the literature that search strategies for external knowledge are particularly beneficial for firms operating in those environments where research and development (R&D) is key to overall firm strategy, i.e. in high- or medium-high-technology (HMT). Shan et al. (1994) investigate the relationship between organisational learning through cooperation and innovative output in the biotechnology industry. Interorganisational collaboration and innovation in the same industry is studied by Powell et al. (1996). Rosenkopf and Nerkar (2001a) focus on the optical disc industry to examine boundary-spanning searches. Katila (2002) and Katila and Ahuja (2002) look into the search strategies of firms in the robotics industry. Generally speaking, the studies can substantiate a positive impact of search activities on innovation performance, although there are also hints for an "over-searching" that impedes innovation. Medium-low-technology and low-technology industries (LMT), however, have been ignored so far. Exploring the search strategies of LMT firms seems even more intriguing as these firms account for by far the largest share of modern economies in terms of value added and employment (OECD, 2006).

Besides, research on the nature of these search strategies has largely focused on the dimensions of breadth and depth (see for example Katila and Ahuja, 2002; Laursen and Salter, 2006), where breadth designates the diversity and depth the intensity of search activities. Very little is known about the complementary or contradicting effects of external knowledge from various sources. This is especially relevant as effective knowledge acquisition depends heavily on a firm's ability to transform it so that combinations become possible (Todorova and Durisin, 2007). Hence, we suggest that distinctive *search patterns* can be identified that reflect a firm's technology and market environment. In that sense, we propose that these search patterns vary between HMT and LMT industries. Moreover, we assume that there is not only one uniform association with innovation success but rather that

the search patterns moderate the relationship between innovation input and output. Consequently, there are differences in the extent to which firms can appropriate external innovation impulses and hence generate returns on their absorptive capacities.

In conclusion, our research aims at extending existing literature in two ways. First, we investigate whether different patterns of search strategies exist in HMT and LMT industries respectively. Second, we analyse the link between these search patterns and the payoffs from R&D investments with regard to market success. The empirical part of this research is based on the third Community Innovation Survey (CIS-3), providing insights to the innovation processes of firms from 13 European countries using a latent class methodology. It enables us to derive targeted policy recommendations as we obtain fine-grained input-output relationships for different industries (HMT versus LMT) and under different search patterns. Our paper is organised in six sections. Section 2 provides a brief review on absorptive capacities and search strategies while section 3 presents the research questions driving the analysis. Section 4 focuses on our empirical study, outlining data, variable measurement and estimation methodology. Section 5 follows, providing the results of the quantitative analysis. Based on the results, we discuss our findings in section 6. Section 7 closes with concluding remarks.

2 A brief review on absorptive capacity and search strategies

2.1 External knowledge and absorptive capacity

Unique knowledge, be it internal or external, is the most valuable asset of a firm for achieving competitive advantage (Liebeskind, 1996). Theoretically, this perspective has emerged from the resource and capability based view of the firm (Barney, 1991; Conner, 1991; Peteraf, 1993; Wernerfelt, 1984) and culminated in a knowledge-based view of the firm (Grant, 1996). Knowledge is crucial for a firm's success as it provides a platform for decisions on what resources and capabilities to deploy, develop or discard as the environment changes (Ndofor and Levitas, 2004). However, building a competitive strategy around knowledge is challenging. Knowledge is by its very nature a public good (Jaffe, 1986) that could "spill over" to competitors and allow them to free-ride on a firm's investments in knowledge production. Hence, firms have strong incentives to keep their knowledge proprietary (Porter Liebeskind, 1997). It is therefore not surprising that the traditional approach of producing knowledge through investments in R&D has been dominated by secretive and self-contained in-house processes. However, this negative perception of knowledge spillovers between firms and their environment is fading as recent literature has pointed towards the merits of acquiring external knowledge (Tsang, 2000) and moving from "research and develop" towards "connect and develop" (Huston and Sakkab, 2006).

The "open innovation" model by Chesbrough (2003) develops this new perspective on how firms innovate. Closed innovation, i.e. firms rely solely on their own resources for the complete R&D process, appears no longer to be a superior innovation strategy as important changes in the competitive and economic environment have occurred. Shorter product life

cycles and the growing complexity of technologies and markets push firms towards using external sources of knowledge. External sources have also become more readily available, for example, information and communication technologies have improved. Chesbrough (2003) identifies four interconnected factors that propel a more open innovation process: the increasing availability and mobility of skilled workers, a venture capital market that endows entrepreneurs with the necessary capital to compete, external options for previously shelved ideas and, finally, the increased capabilities of external suppliers. Hence, firms have to reach out to actors beyond firm boundaries to maximise the benefits from inventions and ideas (Rosenkopf and Nerkar, 2001a). This openness materialises as a heightened demand for external knowledge and other external inputs in the innovation process (Fagerberg, 2005; Monjon and Waelbroeck, 2003; Peters, 2003). Several studies have identified positive performance effects from incorporating external knowledge at various levels. Such effects range from innovation success (Gemünden et al., 1992; Love and Roper, 2004) to an increased novelty of innovations (Landry and Amara, 2002) and higher returns on R&D investments (Nadiri, 1993).

External sources of knowledge need to be identified, activated and managed for success (Gottfredson et al., 2005; Stock and Tatikonda, 2004). A firm's capability to achieve this has probably best been summarised in the literature on absorptive capacity (Cohen and Levinthal, 1989, 1990). It has three major components: The identification of valuable knowledge in the environment, its assimilation with existing knowledge stocks and the final exploitation for successful innovation. These continuous learning engagements increase awareness for market and technology trends, which can be translated into pre-emptive actions. Absorptive capacities provide firms with a richer set of diverse knowledge which gives them more options for solving problems and reacting to environmental change (Bowman and Hurry, 1993; March, 1991). As a result, absorptive capacities enable firms to predict future developments more accurately (Cohen and Levinthal, 1994). This enables them to engage in exploratory innovation activities through unpredictable or rare combinations of resources (Jansen et al., 2006; Subramaniam and Youndt, 2005).

Absorptive capacities basically comprise a set of organisational routines and processes for this purpose (Zahra and George, 2002). Their roots, mechanisms and consequences have been major issues in recent scientific discussions (Lane et al. (2006) count 289 articles in their excellent review). They are generally developed as a by-product of R&D activities (Cohen and Levinthal, 1989). However, some authors have defined them more broadly as dynamic capabilities that refocus a firm's knowledge base through iterative learning processes (Szulanski, 1996; Zahra and George, 2002). In that sense, the effect of absorptive capacities varies across sources (Lane and Lubatkin, 1998) and is mediated by a firm's stable or turbulent knowledge environment (Van den Bosch et al., 1999). Absorptive capacities enable firms to find and recognise relevant external knowledge sources or require more resources to transform the knowledge so that it can be combined, i.e. assimilated, with existing knowledge stocks (Todorova and Durisin, 2007).

2.2 Search strategies

While investing in absorptive capacity is an important part of succeeding in an open innovation environment, it is not the only one. Firms need to identify the most promising external knowledge sources and align and optimise their absorptive capacities in accordingly. Hence, firms need search strategies that provide direction and priorities (Laursen and Salter, 2006). The search strategy should reflect the environment. Cohen and Levinthal (1990) have discussed the availability of technological opportunities, the turbulence of the environment as well as other firm's search activities in the industry. This means that investments in problem solving activities should result in a favourable combination and linkage of users, suppliers and other relevant actors in the innovation system (Laursen and Salter, 2006).

Laursen and Salter (2006) have developed the concepts of breadth and depth as the components of a firm's search strategy. On one hand, a broader set of external inputs reduces the risk from unforeseen development. On the other hand, it has to be considered that a company's information processing capacities are limited. There is hence a need to focus, as a vast amount of impulses would impede selection and in-depth exploitation processes (Koput, 1997). In contrast to breadth, search depth is defined as the extent to which firms draw deeply from the various external sources for innovation impulses (Laursen and Salter, 2006). Both breadth and depth can then be characterised as a firm's openness for external search processes (Chesbrough, 2003). In their study on the UK manufacturing sector, Laursen and Salter (2006) find that the relationship between searching widely and deeply and innovation performance takes on an inverted U-shape, i.e. although search efforts initially increase performance, firms may also "over-search" their environment, which in turn impedes performance.

Katila and Ahuja (2002) apply a related approach to examine how firms search and solve problems by focusing on search depth, which they define as the extent to which a firm reuses existing knowledge, and on search scope, which is how widely a firm explores external knowledge. While the latter concept largely corresponds to search breadth, the former exhibits a different focus that is more centred on exploiting the established knowledge base. They also find an inverted U-shaped relationship between a firm's search behaviour and innovation performance, indicating the negative effects of overly extensive search activities (Katila and Ahuja, 2002). Moreover, they provide evidence that the interaction of search scope and depth is positively related with innovation performance as it increases the uniqueness of recombinations: A deep understanding of firm-specific knowledge assets that is extended towards a new application (scope) creates a unique combination that serves as a basis for commercialisation. Little, however, is known about how exactly this interaction takes place. Moreover, the concepts introduced by Katila and Ahuja (2002) as well as Laursen and Salter (2006) rather nonspecificially process the counts of patent citations or external information sources regardless of their meaning and significance for the innovation process. We argue that it depends on the actual combination of different external sources as there might also be contradictions and complementarities in the use of knowledge. Such combinations hence become manifest in the *search pattern* of a firm.

3 Analytical framework

As mentioned in the preceding text, the goal of this study is to move beyond broad and/or deep search strategies and identify characteristic search patterns that prove to be beneficial in the relationship between investments in R&D and market success. Hence, it is explorative in nature. Nevertheless, we argue that such search patterns may differ between the industries. This section hence develops hypotheses on what search patterns can be expected. Commonly used methodologies group firms into the high-technology, medium-high-technology, medium-low-technology and low-technology sectors (OECD, 2006). This classification breaks up the manufacturing sector into groups that are characterised by the basic nature of their technology and innovative patterns (Hall, 1994). In the high-technology group, technical change has been rapid and (R&D) activities are a major part of the overall firm strategy. As a consequence, the levels of knowledge spillovers that a firm could benefit from are higher. In the high-medium- and medium-low-technology sectors, technologies are relatively more stable, although exploiting technical change is still an important starting point for generating competitive advantage. Finally, R&D is supposed to be a rather unimportant part of firm strategies in general in the low-technology sector which also leads to rather low levels of knowledge spillovers. Obviously, these categories are somewhat coarse and innovative firms can be found in all sectors. Nevertheless, they have provided a useful reference for studying industry differences.

We split this conceptualisation into high- and medium-high-technology (HMT) as well as low- and medium-low-technology (LMT) industries and link their typical innovation behaviour to the benefits of knowledge from various sources. Typical sources for external knowledge are customers or lead users, suppliers and universities (von Hippel, 1988). Laursen and Salter (2006) include – among others – the competitors and Katila and Ahuja (2002) stress the importance of a firm's internal knowledge. We will focus on the external sources for linking search patterns to innovation success in LMT and HMT industries respectively. Moreover, following Katila and Ahuja (2002) we include the own company as an internal source of knowledge in our analysis to reflect the generally lower munificence of the LMT environment in terms of available knowledge spillovers. Extending the description by Hall (1994) we argue that innovation success in HMT industries depends predominantly upon absorptive capacities that target technological knowledge. In contrast to this, innovation success in technologically more stable environments (LMT industries) depends much more on market inputs. Technological expertise is typically associated with university research and specialised suppliers of equipment, materials and components (Laursen and Salter, 2006). Market inputs, though, stem from custumers and competitors. Literature has identified trade-offs between these inputs along several dimensions.

While customers in their function as lead users typically generate ideas and solutions that are tightly knit to an actual application (von Hippel, 1988), there may be a much greater distance from application in case of knowledge transfers from scientific research institutes (Siegel, 2004; Link et al., 2006). Customer knowledge, though, is more tacit in nature and challenging to access and evaluate. Customer needs are often unarticulated (Von Zedtwitz and Gassmann, 2002) and determined by idiosyncratic perspectives. Frosch (1996) suggests that

customer impulses for innovation are therefore risky in the sense that they can be myopic, narrow and frequently wrong.

Furthermore, the novelty or degree of innovativeness of the knowledge obtained may vary. Knowledge from research institutes will presumably exhibit a higher degree of innovativeness than knowledge from competitors. Competitors provide rather visible impulses because of their market actions. They operate in a similar context and develop similar approaches (Dussauge et al., 2000). Reliance on knowledge from competitors would therefore hint more at an imitation strategy. Suppliers as an important source of knowledge correspond with the common perception that a large share of firms, e.g. in the automotive industry, rely on the suppliers to provide innovative components into the final product. Taking up the example of the automotive industry, the value chain is clearly dominated by high-technology or medium-high-technology firms like machinery and equipment, electrical machinery or automotive firms. In contrast to this, it is questionable whether suppliers are of equally high importance for LMT firms, particularly since LMT firms are often suppliers of high-technology components.

Synthesising these arguments we conclude that the specific characteristics of technology and market sources force firms to specialise their absorptive capacities. Absorptive capacities can be seen as learning routines that outline a stable model of organisational behaviour and reaction to internal or external stimuli. We argue that firms achieve the highest payoffs if they possess specialised search strategies, i.e. search patterns, designed for taking up technology or market knowledge. This specialisation may be superior to a general approach because external knowledge has to be transformed to fit into existing knowledge stocks (Todorova and Durisin, 2007). Hence, search patterns emerge that provide superior performance effects. We argue that these specialised patterns reflect the innovation behaviour of the industry.

Hypothesis I: Investments in R&D and subsequent absorptive capacity in LMT industries provide superior innovation success if they are combined with a search pattern that targets market knowledge (customers and competitors).

Hypothesis II: Investments in R&D and subsequent absorptive capacity in HMT industries provide superior innovation success if they are combined with a search pattern that targets technological knowledge (universities and suppliers).

4 Empirical study

4.1 Data

For the empirical part of this analysis we use cross-sectional data from the third *Community Innovation Survey* (CIS-3), a survey conducted under the coordination of Eurostat in 2001 on the innovation activities of enterprises in the EU member states (including all ascending and some neighbouring states) with at least ten employees. For the 2001 survey, data was collected on the innovation activities of enterprises during the three-year period from 1998 to 2000. CIS data represents an important source of information, since it offers representative

firm data for all EU-27 member states. Thus the CIS provides a wealth of information that is particularly relevant to the research questions covered here. Micro data contains information on the NACE 2-sector a firm belongs to and thus allows the identification of firms in LMT and HMT sectors. CIS-3 data has only recently been released by Eurostat. It is important to note that this micro data has been released in the form of anonymised data. The CIS-3 anonymisation method developed by Eurostat is based on a micro-aggregation process which modifies the firm level data in such a way that individual firms can no longer be identified, i.e. it is not possible to match a firm with its exact responses. The process is divided into several stages: pre-processing of the data, micro-aggregation, global recoding, evaluation of the disclosure risk, data suppression and release of the micro-data file (Eurostat, 2005). Nevertheless, the usefulness of CIS can be evaluated based on a comparison of anonymised and non-anonymised micro-data. A comparison using German non-anonymised micro-data yielded a satisfactory performance, so that the data can consistently be used to reveal structural relationships among the survey variables (Gottschalk and Peters, 2007).

Although CIS-3 was performed in each EU member state, country data availability is restricted. For CIS-3, micro-aggregated data is only available for 13 of the EU countries. The sample of innovating firms comprises 11,656 observations and is composed of firms from Belgium (706 firms), the Czech Republic (1,284 firms), Estonia (767 firms), Germany (1,656 firms), Greece (342 firms), Hungary (256 firms), Iceland (125 firms), Latvia (433 firms), Lithuania (585 firms), Norway (1,190 firms), Portugal (780 firms), Slovakia (363 firms) and Spain (3,169 firms). Industries were identified based on the NACE 2-digit classification and grouped according to the standard industry aggregation by technology level (OECD, 2006). Table 1 provides details on the industries represented in our analysis.

Table 1: Industry breakdown

Industry	NACE Code	Industry Group
Food and tobacco	15 – 16	Low-technology
Textiles and leather	17 – 19	Low-technology
Wood / paper / publishing	20 – 22	Low-technology
Chemicals and pharmaceuticals	24	High-/medium-high-technology
Plastics / rubber	25	Medium-low-technology
Glass / ceramics	26	Medium-low-technology
Metals	27 – 28	Medium-low-technology
Machinery and equipment	29	Medium-high-technology
Office and computing machinery	30	High-technology
Electrical machinery and apparatus	31	Medium-high-technology
Radio, TV and communication equipment	32	High-technology
Medical, precision and optical equipment	33	High-technology
Motor vehicles and trailers	34	Medium-high-technology
Transport equipment	35	Medium-high-technology
Manufacturing n.e.c. (e.g. furniture, jewellery, sports equipment and toys)	36 – 37	Low-technology

CIS surveys are self-reported and largely qualitative which raises quality issues with regard to administration, non-response and response accuracy (for a recent discussion see Criscuolo et al., 2005). However, the surveys have a number of features designed to limit possible negative effects. First, CIS-3 was administered via mail which prevents certain shortcomings and biases of telephone interviews (for a discussion see Bertrand and Mullainathan, 2001).

The multinational application of CIS adds extra layers of quality management and assurance. The survey is subject to extensive pre-testing and piloting in various countries, industries and firms with regard to interpretability, reliability and validity (Laursen and Salter, 2006). Second, the questionnaire contains detailed definitions and examples to increase response accuracy.

A major advantage of CIS data is that they provide direct, importance-weighted measures for a comprehensive set of sources (Criscuolo et al., 2005). On the downside, this information is self-reported. Heads of R&D departments or innovation management are asked directly if and how they are able to generate innovations. Overall, this immediate information on processes and outputs can complement traditional measures for innovation such as patents (Kaiser, 2002; Laursen and Salter, 2006).

4.2 Measures

Measuring innovation success

Several concepts have been discussed in the literature for capturing innovation success (for an overview see OECD, 2005). Some focus on innovation inputs (R&D expenditure), while others point towards the consequences of innovation activities, e.g. patents, new processes and products. We choose the latter perspective. While each new product may be valuable in itself, firm success heavily depends on its market acceptance. Hence, we conceptualise innovation success as the share of turnover achieved with new products. Finally, new products vary with regard to their degree of novelty. Some products may be new only to the firm while others may be new for the market as a whole. The former may be more related to imitative behaviour whereas the latter is more closely related to radical innovation success. As a result, we choose the share of turnover with market novelties[1] as our dependent variable in line with several other studies in the field (see for example Laursen and Salter, 2006).

Capturing search strategies

Measuring knowledge spillovers is a challenging task since they leave no paper trail. Therefore, several studies in the field have relied on patent statistics and subsequent citations to capture them (see for example Galunic and Rodan, 1998; Rosenkopf and Nerkar, 2001b). This approach has several disadvantages. Most importantly, "not all inventions are patentable, not all inventions are patented" (Griliches, 1979: p.1669). What is more, the distribution of patenting firms is heavily skewed. Bloom and van Reenen (2002) illustrate this, with 72 per cent of their sample of almost 60,000 patents by UK firms stemming from just 12 companies. Patenting implies the disclosure and codification of knowledge in exchange for protection (Gallini, 2002). The majority of valuable knowledge may therefore never be patented. Most importantly for this study, patent citation statistics cannot reveal the relationship between two firms (e.g. whether they are customers or competitors). Thus, the opportunities for pattern recognition are limited. Consequently, we rely on survey questions to identify the sources of external knowledge and receive importance-weighted answers on the value of their

[1] By definition this is a novelty on a firm's relevant market and not necessarily a "new to the world" innovation.

contribution. More precisely, respondents are asked to evaluate the importance of the main sources for their innovation activities on a 4-point Likert scale ranging from "not used" to "high". We use five different sources: the own company, suppliers, customers, competitors and universities. We will use these rankings to estimate search patterns.

Measuring absorptive capacity

Absorptive capacities are not a tangible construct. Managers cannot simply be surveyed to judge their existence or extent. They are typically assumed to be a by-product of performing R&D activities. In line with the literature (Cohen and Levinthal, 1990; Rothwell and Dodgson, 1991) we capture absorptive capacities through variables on the two major inputs for innovation activities: R&D expenditure (as a share of turnover) and the expertise of employees (employees with college education). Van den Bosch et al. (1999) suggest that absorptive capacities are accumulated over time as part of an iterative process. We therefore add an additional dummy variable indicating whether R&D activities are performed on a continuous basis.

Control variables

We add control variables for several other factors that may influence the estimation results. Firms may suffer from a liability of size or smallness. We capture these factors by including a firm's turnover from the start of the reporting period (1998) in logs. In addition, we control for a firm's degree of internationalisation by incorporating the ratio of exports to total turnover. Our observations stem from various European countries. It is necessary to control for the strength of each domestic innovation system. We do so by adding a variable capturing the total national R&D expenditure as a share of each country's GDP (GERD) for 2003, as provided by the European Union. Finally, we add a dummy variable to control for the fact that a firm is part of a group, which would imply that it has the possibility to spread certain functions across subsidiaries or draw from their resources.

4.3 Estimation strategy and method

Our research question has two major components. First, we suggest that subpopulations of firms with distinctive search patterns exist in our dataset. Secondly, relationships between innovation inputs and outputs differ significantly between subpopulations. While the former issue is traditionally addressed through cluster analytical methods, the latter would typically require regression analysis. We rely on latent class analysis that allows us to cover both aspects simultaneously. It was introduced by Lazarsfeld (1950) for identifying patterns in survey responses. Latent classes are unobservable (latent) subgroups or segments. The goal of latent class analysis is to identify subgroups of observations that are similar to other subgroup members, in terms of predefined variables, but dissimilar to members of other subgroups. In that sense, latent class analysis differs from other continuous latent variable approaches (like random-effects regression) in the identification of groups (or categories) as the primary goal. It therefore follows a finite mixture model rationale of disentangling a dataset into a finite mixture from a finite number of distinctly different populations. It is superior to traditional cluster analysis as it is based on a statistical model which allows for significance tests and

measurements of fit (Jensen et al., 2007; for a detailed discussion see Hagenaars and McCutcheon, 2002).

Latent class analysis can be combined with regression analysis by specifying a set of variables (so called covariates) that influence the conditional probability of a certain observation belonging to a certain class, as well as variables that influence the dependent variable (so called predictors). Put simply, the problem of assigning observations to latent classes and obtaining separate regression results for each class is solved in one optimisation step. Latent class regression analysis can therefore be considered more general than traditional regression analysis that assumes that all observations are homogeneous.

The general probability structure is:

$$f(y_i \left| z_i^{\text{cov}}, z_i^{pred} \right.) = \sum_{x=1}^{K} P(x \left| z_i^{\text{cov}} \right.) \prod_{t=1}^{T_i} f(y_{it} \left| x, z_{it}^{pred} \right.)$$

where the probability of outcome y for observation i depends upon the conditional probability of belonging to one of K latent classes (with x as the latent variable) based on a vector z of covariate variables and a vector z of predictors and T replications of a single dependent variable. This method reflects our research question perfectly. We assume that a firm's search behaviour can be condensed into a finite number of patterns (latent classes) depending upon their usage of external knowledge sources (covariates). Besides, we can test at the same time whether differences exist between the effects of the various innovation inputs (predictors) on innovation outputs given that firms follow a certain type of search pattern (i.e. are part of a particular latent class).

One more issue has to be addressed methodologically. Our dependent variable is the share of turnover with market novelties. While all firms in our sample are successful innovators, it cannot be assumed that all of their innovations were not just new to the firm but new to the market as a whole. This demanding standard for formulating the dependent variable implies that many more zeros will appear than can be expected based on a univariate normal distribution. Hence, we adjust our empirical strategy by estimating a tobit model as part of the latent class regression model. These estimations are carried out by relying on the algorithm provided by Vermunt and Magidson (2005).

5 Results

Choosing the correct number of classes is an important step of the analysis because each additional class increases the fit of the model by capturing more heterogeneity. Then again, choosing too many classes makes it difficult to achieve meaningful interpretations for each class and the system as a whole. Hence, a parsimonious approach is required that balances both interests. This decision is typically based upon two key figures: the Bayesian information criteria BIC and the Akaike information criteria AIC. Both should be minimised to indicate an appropriate number of classes. In the following, we report the results for the group of LMT firms before the results for the group of HMT firms are presented.

We report all measurements of fit for a 1 to 4 class solution in Appendix A. First of all, looking at the sharp increase in R^2 values between a 1-class and 2-class solution it becomes apparent that a conventional regression analysis assuming one homogeneous class of observations would hardly have been adequate for the available dataset. The BIC criterion reaches its minimum for the 2-class solution while AIC points towards a 3-class approach. McLachlan and Peel (2000) suggest that the BIC criteria may be too rigid whereas AIC may be too liberal. After all, it depends on the interpretability of the solution (Jensen et al., 2007). We opt for a 3-class solution.

Table 2 provides the results for the recognition of search patterns. We will present its results separately from the regression analysis in Table 3 although it should be mentioned that both were estimated simultaneously. Appendix B provides mean profiles for the 3 classes. Class 1 and class 2 are roughly equal in size, covering 39% and 37% of the sample respectively. Class 3 is smaller, with 24%. A closer look at the averages presented in Appendix B provides an indication for the appropriateness of latent class analysis. The own company is the most important source for knowledge and receives an average rating of 2 (medium) out of a maximum of 3 (high). However, Table 2 reveals that it makes no difference across companies and therefore has no significant influence on class generation. The same is true for the impulses from suppliers and universities. The former may be less surprising because suppliers may transfer most of their knowledge in the form of the supplied product or service. As this is available to all firms, it is not a differentiating factor. In a similar way, university knowledge embodied in publications may be equally available. Again, this does not imply that inputs from universities are not important. They are just not a factor that sets firms apart in their search strategies.

Table 2: Model for latent classes (LMT firms)

Model for classes	Class1	Class2	Class3	Wald (p-value)
Covariates				
Own company	-0.014	-0.095	0.109	3.984
				(0.140)
Suppliers	0.042	0.004	-0.046	0.888
				(0.640)
Customers	-0.136	-0.029	0.165	8.986
				(0.011)
Competitors	0.193	-0.060	-0.133	11.187
				(0.004)
Universities	0.054	-0.088	0.034	2.206
				(0.330)
Intercept	0.086	0.496	-0.582	8.744
				(0.013)

Customer and competitor knowledge can be shown as decisive factors for establishing search patterns. A trade-off between the two emerges. While the importance of impulses from competitors dominates class 1, customer impulses have a highly negative impact. Exactly the opposite relationship holds true for class 3. We find that both sources of external knowledge require unique approaches. Competitors provide rather visible impulses because of their

market actions. They operate in a similar context and develop similar approaches (Dussauge et al., 2000). Customer knowledge, though, is more tacit in nature and challenging to access and evaluate. Moreover, customer needs are often unarticulated (Gassmann and von Zedtwitz, 1998) and determined by idiosyncratic perspectives. Frosch (1996) suggests that customer impulses for innovation are therefore risky in the sense that they are myopic, narrow and frequently wrong. Interestingly, class 2 appears to represent the middle ground between both perspectives, being negatively influenced by both, but only very mildly. We conclude that class 1 represents competitor driven search patterns and class 3 customer driven ones. Class 2 however seems to follow a balanced pattern somewhere in between. To simplify the argumentation in subsequent parts of the analysis, we will refer to class 1 as "competitor centric", class 2 as "balanced" and class 3 as "customer centric". Hence, Hypothesis I is supported.

Using descriptive statistics based on the success of each class, measured in terms of their share of turnover with market novelties, one would be tempted to say that class 2 is the most successful, followed by class 3. However, these descriptive results do not take into account the inputs that were necessary to achieve the innovation output. The results of the tobit regression analysis presented in Table 3 provide these links between inputs and outputs under each class or search pattern.

Table 3: Tobit regression for the share of turnover with market novelties (LMT firms)

Tobit model (n=2,782)	**Class1**	**Class2**	**Class3**	**Overall**	**Comparison**
Class focus	**Competitor centric**	**Balanced**	**Customer centric**		
R-squared	0.205	0.125	0.207	0.409	
	Class1	**Class2**	**Class3**	**Wald (p-value)**	**Wald (=) (p-value)**
	Coeff.	Coeff.	Coeff.		
Intercept	-0.110	1.245	0.247	68.636 (0.000)	63.072 (0.000)
Predictors					
Continuous R&D (dummy)	0.048	0.103	0.015	40.181 (0.000)	5.516 (0.063)
R&D intensity	0.580	1.384	2.373	28.459 (0.000)	8.828 (0.012)
No of employees with graduate education (in logs)	0.017	0.032	0.001	23.049 (0.000)	5.070 (0.079)
Controls					
Export share of turnover	-0.014	0.123	-0.007	5.212 (0.160)	5.192 (0.075)
Share of total country R&D expenditures of GDP (%)	-0.010	-0.139	-0.010	27.986 (0.000)	12.402 (0.002)
Turnover 1998 (in logs)	0.002	-0.077	-0.011	44.161 (0.000)	31.792 (0.000)
Part of company group (dummy)	0.010	0.008	0.005	1.227 (0.750)	0.078 (0.960)

The "overall" column of Table 3 provides significance tests (Wald statistics and significance levels) for the overall impact of a variable on the success with market novelties given a certain search pattern (i.e. class). The "comparison" column provides equivalent significance tests on the hypothesis that the coefficients differ across classes.

Focusing on the main topic of this investigation we find that investments in R&D (as a share of turnover) have a significant, positive impact on market success and that its effect varies significantly by search pattern. It is most efficient in the customer centric class, followed by a balanced approach. Apparently, investments in R&D and subsequent absorptive capacities are most rewarding if they are distinctively directed at customer inputs. In that sense we provide empirical evidence for the merits of "market driven" organisations (Day, 1994) in an LMT environment. For a balanced search pattern investments in R&D are still highly rewarding whereas competitor centric search patterns yield the lowest return. This would indicate that the latter are generally more reactive or defensive types of absorptive capacities that are built around adaptation and imitation which makes it difficult to generate radical innovation that is new to the whole market. However, when it comes to continuous R&D engagements, it is

most rewarding in a balanced search pattern followed by competitor centric approach. It appears that customer centric patterns induce higher levels of dynamism that reward flexibility over stable routines. This relationship is also reflected in the number of skilled employees which are closely connected to continuous R&D engagements.

With regard to control variables, we find no significant effects from a company's export activity and whether it is part of a company group. Company size (measured as turnover in 1998) has a positive effect on market success under competitor centric search patterns while it is disadvantageous in the other classes. Large companies may be better prepared to sustain adaptation or imitation strategies reflected in competitor centric search patterns as they typically have a richer set of resources to compete with. Interestingly, the home country R&D intensity (share of R&D expenditures on GDP) has a negative impact across all search patterns, being most pronounced at the balanced search pattern. This may indicate that a lack of external knowledge opportunities in the domestic innovation system is most severely felt in search patterns that are not clearly defined (neither focusing on competitors or costumers).

Focusing on HMT industries we find the same trade-off between the exploratory power of our model and parsimony when it comes to choosing the number of latent classes. The BIC points towards a 2-class solution while the AIC favours a 3-class choice (see Appendix C). Again, we select the 3-class option. Appendix D provides a descriptive overview for these classes. Class 1 and 2 are roughly equal in size comprising 42% and 41% of all observations respectively. Class 3 is significantly smaller with 17%. As in the LMT case knowledge from inside the company is the most important source followed by customer knowledge. The latter is on average more important for HMT than for LMT industries. The same is true for university inputs. However, they have the lowest average importance rating within HMT firms across classes. The question remains which sources of external knowledge make a significant difference for the identification of classes (and hence search patterns) among HMT industries. Table 4 provides these results (it should be noted that the latent class analysis is simultaneously conducted with the tobit regression for which results are presented in Table 5).

Table 4: Model for latent classes (HMT firms)

Model for classes	Class1	Class2	Class3	Wald (p-value)
Covariates				
Own company	-0.135	0.081	0.054	3.308
				(0.190)
Suppliers	-0.176	0.061	0.115	4.976
				(0.083)
Customers	-0.059	-0.100	0.159	2.430
				(0.300)
Competitors	0.095	0.002	-0.097	1.399
				(0.500)
Universities	0.162	-0.176	0.015	7.279
				(0.026)
Intercept	0.721	0.382	-1.103	7.801
				(0.020)

Distinctive search patterns emerge based on supplier and university knowledge. They make a significant difference at the 92% and 97% level respectively. This does not indicate that the other sources have no merits. It indicates that they make no significant difference for search strategies of HMT firms. However, latent classes of search patterns in the HMT sector are based on significant differences in the usage of technological knowledge from suppliers and/or universities. Hence, Hypothesis II receives support.

The probability of a firm to be assigned to class 1 is determined by intensive knowledge acquisition from universities. Apparently, this search pattern is accompanied by an explicit disregard for supplier knowledge. Hence, we term this class "university centric". Class 3, though, the smallest class in our sample, shows the opposite constellation. It benefits extensively from supplier knowledge while university impulses are significant but close to zero. As a result, we call this a "supplier centric" class (and hence search pattern). Finally, class 2 exhibits the most interesting pattern. It has the highest positive impact from internal knowledge although this variable is only significant at the 81% level. Firms following this search pattern benefit from supplier knowledge but the influence is weaker than for the supplier centric class. Most strikingly, though, is the pronounced negative impact of university knowledge. In that sense, it is the only search pattern among HMT firms that neglects university impulses. We will therefore refer to it as a "university averse" search pattern. Descriptive statistics (Appendix D) point towards the university averse search pattern as the one with the highest market success, followed by the supplier centric and the university centric pattern. However, success can only be judged based on the inputs that are necessary to achieve it. Table 5 provides these estimation results.

Table 5: Tobit regression for the share of turnover with market novelties (HMT firms)

Tobit model (n=1,719)	**Class1**	**Class2**	**Class3**	**Overall**	**Comparison**
Class focus	**University centric**	**University averse**	**Supplier centric**		
R-squared	0.173	0.095	0.517	0.390	
	Class1	**Class2**	**Class3**	**Wald (p-value)**	**Wald (=) (p-value)**
	Coeff.	Coeff.	Coeff.		
Intercept	-0.114	0.694	0.359	20.110	14.808
				(0.000)	(0.001)
Predictors					
Continuous R&D (dummy)	0.065	0.101	-0.003	26.520	5.543
				(0.000)	(0.063)
R&D intensity	-0.109	1.112	0.580	9.937	8.596
				0.019	0.014
No of employees with graduate education (in logs)	0.013	0.046	-0.016	13.625	11.564
				(0.004)	(0.003)
Controls					
Export share of turnover	-0.036	0.014	0.123	14.413	13.004
				(0.002)	(0.002)
Share of total country R&D expenditures of GDP (%)	0.020	-0.142	0.027	24.117	23.412
				(0.000)	(0.000)
Turnover 1998 (in logs)	0.000	-0.040	-0.018	13.083	5.356
				(0.005)	(0.069)
Part of company group (dummy)	0.022	0.072	-0.046	8.623	8.239
				(0.035)	(0.016)

As in the LMT case, the "overall" column provides statistics on the significance of the coefficient of a particular variable while the "comparison" column provides significance tests on whether these differ between classes (and hence search patterns). In contrast to the LMT industries estimation all variables have significant impacts (at least at the 95% level) and all significant variables vary across search patterns. The coefficients on R&D intensity (R&D expenditures as a share of turnover) support the descriptive results on the merits of different search patterns. R&D expenditures in a university averse search pattern provide the highest payoffs with regard to market success and there is an additional positive effect from engaging in R&D continuously. The latter is also positive but weaker for a university centric search pattern. Most interestingly, though, R&D expenditures within a university centric search pattern have a negative impact. This seems counterintuitive at first glance. However, we use market success (turnover with market novelties) as dependent variable. Knowledge from research institutions is generally more distant from application stages (Link et al., 2006; Siegel, 2004) and one cannot expect immediate market success. We suspect that firms with a university centric search pattern are primarily interested in absorbing technological knowledge which can be exploited later on. The university averse search pattern may exactly

reflect this second phase which translates previously acquired knowledge into turnover with new products. Interestingly enough, both classes of search patterns are roughly equal in size (42%). The smaller class of supplier centric high-tech firms also achieves positive returns on their investments in R&D. However, continuous R&D engagements do not pay off. We suggest that the absorptive capacities of these firms are primarily directed at selecting and engaging specialised suppliers that trigger innovations by supplying new equipment, components or materials. Hence, the results of this search pattern reflect the "supplier dominated" classification of innovation behaviour by Pavitt (1984) and support the findings of Laursen and Salter (2006) for this particular class. The previously outlined trends are also reflected in the merits of skilled employees. They provide no additional benefits within a supplier centric search pattern and are most meaningful for university averse search patterns. A moderate positive effect emerges for university centric search patterns.

Focusing on control variables, we find that the internationalisation of turnover has a negative impact in university centric search patterns while it is positive for the two other classes. A country's R&D intensity is positively related in university and supplier centric search patterns, indicating that opportunities for knowledge sourcing may be more abundant in these environments. Less munificent environments, though, coincide with university averse search patterns. Company size has a negative effect in university averse and supplier centric search patterns while being part of a company group is positively related to market success for university centric and averse search patterns.

6 Discussion

This study is designed to connect the concepts of R&D investments and derived absorptive capacity with explicit patterns of search behaviour. We develop a conceptual argumentation that goes beyond the general assertion that firms need external knowledge to succeed in their innovation engagements and that the search for these valuable items of information should be broad and/or deep. Instead, we extend existing research that focuses on differences between various sources and the knowledge they provide (see for example Szulanski, 1996). We argue that these differences in the access, reliability and transferability of knowledge materialise as trade-offs. Search patterns emerge that reflect these complementarities and contradictions. The first goal of this study is to identify these patterns. Additionally, we propose that these search patterns are reflected in the efficiency of innovation investments with regard to their market success because different combinations of external knowledge require specific absorptive capacities to transform and combine them with existing knowledge stocks. What is more, we argue that these patterns will appear among technological sources (suppliers and universities) in HMT industries and among market sources (customers and competitors) in LMT industries. We explore both research questions empirically through separate latent class tobit regression analyses for 4,500 firms in LMT and HMT industries and their innovation activities from 13 European countries. Hence, our findings are not confined to a single country. Most strikingly, we find that search patterns in LMT industries are mostly determined by the market side while HMT industry search patterns emerge because of differences in technology sourcing. Hence, our hypotheses are supported.

Focusing on search patterns in LMT industries, internal sources for information and impulses from suppliers or universities have their merits but they are no significant source of heterogeneity in search patterns among firms. Trade-offs emerge as firms have to centre their search strategies on competitor or customer impulses. Roughly 60% of the firms in our sample settle for one or the other but not a combination of both. The rest follows a balanced search pattern. We argue that the tradeoffs between competitor and customer knowledge emerges because of the different demands they put on knowledge acquisition and transformation which leads to specialisation patterns in search behaviour. Competitor impulses are typically easier to identify and interpret because they operate in a comparable context and serve the same market (Dussauge et al., 2000). However, once they emerge the firm has very little time to react and may be forced to engage in adaptive and imitative behaviour. Customer knowledge, though, is often unarticulated, tacit and unreliable (Frosch, 1996). Then again, firms that discover unique needs early may benefit from sustained competitive advantages (Von Zedtwitz and Gassmann, 2002). These search patterns shape the payoffs from investments into R&D. R&D investments are most efficient with regard to market success of market novelties if they are combined with customer centric search patterns followed by balanced search patterns. Competitor centred search patterns, though, provide the lowest levels of efficiency as they may be limited to adaptations. Contrary to this, continuous R&D engagements are least rewarding if they coincide with customer centric search patterns. For the latter flexibility may be more important than stable trajectories.

With regard to search patterns in HMT industries, we find that all types of internal and external knowledge have their merits but the usage of university and supplier knowledge differentiates search strategies and patterns emerge. A minority of HMT firms (17%) build their search strategies around supplier knowledge which may propel their innovation engagements through new equipment, materials and components (Laursen and Salter, 2006). Apparently, this is much less reflected in long-term in-house R&D engagements (continuous R&D, high number of skilled employees) but still rewarding with regard to market success. However, absorptive capacities within a supplier centric search pattern may be concentrated on identifying specialised suppliers and integrating their inputs into the final product. The vast majority of HMT firms (roughly 80%) develop search strategies that depend upon knowledge acquisition from universities. Half of them rely heavily on university inputs (university centric) at the expense of supplier inputs, the other half moves its search pattern distinctively away from university knowledge (university averse). Interestingly, the latter is more successful with turnover of new products than the latter. We argue that university centric search patterns are primarily directed at knowledge acquisition for subsequent exploitation even if this application stage may develop the future (Link et al., 2006; Siegel, 2004). Hence, a lack of market success should not come as a surprise. Firms with university averse search patterns may have already made that step from acquisition and assimilation phases towards exploitation. At this point, absorptive capacities have shifted away from university inputs.

In conclusion, our results paint a differentiated picture for optimised search patterns in LMT and HMT industries. This needs to be reflected in tailor-made policy development. We find that LMT firms investing in R&D to develop absorptive capacity can achieve the highest returns if they direct their search behaviour towards customers. Competitor reconnaissance

may be a less risky strategy but it is also associated with lower returns. With regards to policy implications, this implies that innovation performance can be strengthened by incorporating customer interaction into R&D funding and incentive schemes for LMT industries. This may imply preferential treatment or mandatory requirements for including customers in publicly funded project consortia. Besides, public R&D support schemes targeting LMT sectors should be built around markets and customers instead of specific technologies. Moving from competitor centric search patterns to customer centred ones may be a promising but risky goal. However, even policy supported, gradual shifts towards more balanced search strategies would improve the efficiency of R&D investments with regard to market success.

In HMT industries, though, supporting supplier centric search patterns that are built around suppliers of new equipment and materials is rewarding but appears to be a niche strategy. Instead, university knowledge is the major leverage point for a firm's search pattern and hence policy intervention. Our results indicate that knowledge from universities play an important role for generating knowledge stocks inside HMT firms. However, full market success can be realised once firms move away from a myopic focus on universities for their knowledge acquisition. The differences between these stages should be reflected in public R&D support. Hence, tailor-made policy instruments should encourage HMT firms in applied, close-to-application fields to move away from a narrow focus in their search strategies on universities and develop a broader set of absorptive capacities.

7 Concluding remarks

Our analysis benefits from the unique opportunity to assemble innovation survey data across national and industry boundaries. There are, however, also some shortcomings of our study regarding country coverage and dynamic relationships. First, the availability of country data for all EU member states that participated in CIS-3 is limited. This applies particularly to large economies like France, Italy or the Netherlands. Adding observations from these countries would provide an improved basis for our reasoning. It depends on the member states to provide access to the micro-data that needs to be treated subsequently by Eurostat in order to be released. Second, it would be most interesting to study the dynamic relationship, i.e. changes in the search behaviour of firms. Although results from CIS-4 are already available in a tabulated form there is no possibility to merge two or more waves of CIS to yield a panel structure of the data without violating the data confidentiality requirements that have to be implemented by Eurostat. An alternative approach could hence be to focus just on a few countries for which micro-data is available as a panel, e.g. Germany. This could provide some interesting results regarding the evolution of search patterns in relation to certain company characteristics. Besides the focus on European countries it would also be interesting to compare results with other major economies like the U.S. or Japan. Different administrative, cultural and historical backgrounds would enhance our understanding of how firms interact with their environment and what differentiates actual from best practices.

8 Appendix

Appendix A. Model goodness of fit (LMT firms)

No. of classes	LL	BIC(LL)	AIC(LL)	No. of parameters	R^2
1-Class Regression	-1,053.827	2,179.032	2,134.654	9	0.051
2-Class Regression	-794.681	1,779.703	1,661.361	24	0.368
3-Class Regression	-750.989	1,811.283	1,618.977	39	0.409
4-Class Regression	-733.753	1,895.775	1,629.505	54	0.534

Note: AIC(LL) = LL − 3 df

Appendix B. Mean class profiles (LMT firms)

	Class1	Class2	Class3
Class size	0.388	0.368	0.244
Dependent variable			
Share of turnover with market novelties	0.016	0.178	0.099
Covariate variables			
Own company	2.061	1.932	2.172
Suppliers	1.749	1.623	1.653
Customers	1.673	1.608	1.862
Competitors	1.409	1.128	1.195
Universities	0.721	0.546	0.677

Appendix C. Model goodness of fit (HMT firms)

No. of classes	LL	BIC(LL)	AIC(LL)	No. of parameters	R^2
1-Class Regression	-591.548	1250.142	1210.097	9	0.024
2-Class Regression	-440.305	1059.397	952.609	24	0.307
3-Class Regression	-415.786	1122.103	948.572	39	0.390
4-Class Regression	-395.515	1193.304	953.031	54	0.462

Note: AIC(LL) = LL − 3 df

Appendix D. Mean class profiles (HMT firms)

	Class1	Class2	Class3
Class size	0.420	0.411	0.170
Dependent variable			
Share of turnover with market novelties	0.040	0.198	0.106
Covariate variables			
Own company	2.107	2.251	2.300
Suppliers	1.483	1.677	1.771
Customers	2.025	1.942	2.205
Competitors	1.498	1.373	1.442
Universities	1.067	0.781	0.999

9 References

Banbury, C. and W. Mitchell (1995), The Effect of Introducing Important Incremental Innovations on Market Share and Business Survival, *Strategic Management Journal* 16, 161-182.

Barney, J.B. (1991), Firm Resources and Sustained Competitive Advantage, *Journal of Management* 17 (1), 99-120.

Bertrand, M. and S. Mullainathan (2001), Do People Mean What They Say? Implications for Subjective Survey Data, *American Economic Review* 91 (2), 67-72.

Bloom, N. and J. Van Reenen (2002), Patents, Real Options and Firm Performance, *Economic Journal* 112 (478), C97-C116.

Bowman, E.H. and D. Hurry (1993), Strategy through the Option Lens: An Integrated View of Resource Investments and The, *Academy of Management Review* 18 (4), 760-782.

Brockhoff, K. (1997), *Industrial Research for Future Competitiveness*, Berlin et al.

Brockhoff, K. (1999), Technological Progress and the Market Value of Firms, *International Journal of Management Reviews* 1 (4), 485-501.

Chesbrough, H.W. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Boston.

Cohen, W.M. and D.A. Levinthal (1989), Innovation and Learning: The Two Faces of R&D, *The Economic Journal* 99 (397), 569-596.

Cohen, W.M. and D.A. Levinthal (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly* 35 (1), 128-153.

Cohen, W.M. and D.A. Levinthal (1994), Fortune Favors the Prepared Firm, *Management Science* 40 (2), 227-251.

Conner, K.R. (1991), A Historical Comparison of Resource-Based Theory and Five Schools of Thought within Industrial Organization Economics. Do We Have a New Theory of the Firm?, *Journal of Management* 17 (1), 121-154.

Criscuolo, C., J.E. Haskel and M.J. Slaughter (2005), *Global Engagement and the Innovation Activities of Firms,* NBER Working Paper No. 11479, Cambridge, MA.

Day, G.S. (1994), The Capabilities of Market-Driven Organizations, *Journal of Marketing* 58 (4), 37-52.

Dussauge, P., B. Garrette and W. Mitchell (2000), Learing from Competing Partners: Outcomes and Duration of Scale and Link Alliances in Europe, North America and Asia., *Strategic Management Journal* 21 (2), 99-126.

Eurostat (2005), *Community Innovation Survey Light (Cis Light),* http://europa.eu.int/estatref/info/sdds/de/inn/inn_cisl_sm.htm No., Luxemburg.

Fagerberg, J. (2005), Innovation: A Guide to the Literature., in: Fagerberg, J., D. Mowery and R. Nelson (eds.), *The Oxford Handbook of Innovation.*, Oxford.

Frosch, R.A. (1996), The Customer for R&D Is Always Wrong!*, Research Technology Management* 39 (6), 22-25.

Gallini, N.T. (2002), The Economics of Patents: Lessons from Recent U.S. Patent Reform*, Journal of Economic Perspectives* 16 (2), 131-154.

Galunic, C.D. and S. Rodan (1998), Resource Recombinations in the Firm: Knowledge Structures and the Potential for Schumpeterian*, Strategic Management Journal* 19 (12), 1193-1201.

Gassmann, O. and M. von Zedtwitz (1998), Organization of Industrial R&D on a Global Scale*, R&D Management* 28 (3), 147-61.

Gemünden, H., M. Heydebreck and R. Wijnberg (1992), Technological Interweavement: A Means of Achieving Innovation Success*, R&D Management* 22 (4), 359-376.

Gottfredson, M., R. Puryear and S. Phillips (2005), Strategic Sourcing: From Periphery to the Core*, Harvard Business Review* 2005 (February), 132-139.

Gottschalk, S. and B. Peters (2007), *Evaluation of the Usefulness of Anonymised Cis Iii Data, Published by Eurostat, for Econometric Analyses,* ZEW Discussion Paper No. forthcoming, Mannheim.

Grant, R.M. (1996), Toward a Knowledge-Based Theory of the Firm*, Strategic Management Journal* 17, 109-122.

Griliches, Z. (1979), Issues in Assessing the Contribution of Research and Development to Productivity Growth*, Bell Journal of Economics* 10 (1), 92-116.

Hagenaars, J.A. and A.L. McCutcheon (2002), *Applied Latent Class Analysis*, Cambridge.

Hall, B.H. (1994), Corporate Restructuring and Investment Horizons in the United States, 1976-1987*, Business History Review* 68 (1), 110-143.

Huston, L. and N. Sakkab (2006), Connect and Develop*, Harvard Business Review* 84 (3), 58-66.

Jaffe, A.B. (1986), Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Values*, American Economic Review* 76 (5), 984-1001.

Jansen, J.J.P., F.A.J. Van Den Bosch and H.W. Volberda (2006), Exploratory Innovation, Exploitative Innovation, and Performance: Effects of Organizational Antecedents and Environmental Moderators*, Management Science* 52 (11), 1661-1674.

Jensen, M.B., B. Johnson, E. Lorenz and B.A. Lundvall (2007), Forms of Knowledge and Modes of Innovation, *Research Policy* 36 (5), 680-693.

Kaiser, U. (2002), An Emprical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector, *International Journal of Industrial Organization* 20 (6), 747-774.

Katila, R. (2002), New Product Search over Time: Past Ideas in Their Prime?, *Academy of Management Journal* 45, 995-1010.

Katila, R. and G. Ahuja (2002), Someting Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction, *Academy of Management Journal* 45 (6), 1183-1194.

Koput, K.W. (1997), A Chaotic Model of Innovative Search: Some Answers, Many Questions, *Organization Science* 8 (5), 528-542.

Landry, R. and N. Amara (2002), *Effects of Sources of Information on Novelty of Innovation in Canadian Manufacturing Firms: Evidence from the 1999 Statistics Canada Innovatin Survey,* CHSFR/CIHR Department of Management Laval University No., Quebec.

Lane, P.J., B.R. Koka and S. Pathak (2006), The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct, *Academy of Management Review* 31 (4), 833-863.

Lane, P.J. and M. Lubatkin (1998), Relative Absorptive Capcity and Inter-Organizational Learning., *Strategic Management Journal* 19, 461-477.

Laursen, K. and A. Salter (2006), Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms, *Strategic Management Journal* 27, 131-150.

Lazarsfeld, P.F. (1950), The Logical and Mathematical Foundations of Latent Structure Analysis, in: Stouffer, S. A. (ed.) *Measurement and Prediction, Volume Iv of the American Soldier: Studies in Social Psychology in World War Ii*, Princeton, 362-412.

Liebeskind, J.P. (1996), Knowledge, Strategy, and the Theory of the Firm, *Strategic Management Journal* 17, 93-107.

Link, A.N., D.S. Siegel and B. Bozeman (2006), *An Empirical Analysis of the Propensity of Academics to Engage in Informal University Technology Transfer,* Available at SSRN: http://ssrn.com/abstract=902207 No.

Love, J.H. and S. Roper (2004), *Knowledge Sourcing, Innovation and Performance: A Preliminary Analysis of Irish Innovation Panel Data,* Aston Business School Working Paper No., Birmingham.

March, J.G. (1991), Exploration and Exploitation in Organizational Learning, *Organization Science* 2 (1), 71-87.

McLachlan, G. and D. Peel (2000), *Finite Mixture Models*, New York.

Monjon, S. and P. Waelbroeck (2003), Assessing Spillovers from Universities to Firms: Evidence from French Firm-Level Data, *International Journal of Industrial Organization* 21 (9), 1255-1270.

Nadiri, I.M. (1993), *Innovations and Technological Spillovers.,* NBER Working Paper No. 4423, Cambridge, MA.

Ndofor, H.A. and E. Levitas (2004), Signaling the Strategic Value of Knowledge, *Journal of Management* 30 (5), 685-702.

OECD (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, Paris.

OECD (2006), *Science, Technology and Industry Outlook*, Paris.

Pavitt, K. (1984), Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory, *Research Policy* 13 (6), 343-373.

Peteraf, M.A. (1993), The Cornerstones of Competitive Advantage: A Resource Based View, *Strategic Management Journal* 14 (3), 179-191.

Peters, M.A. (2003), Education Policy in the Age of Knowledge Capitalism, *Policy Futures in Education* 1 (2), 361-380.

Porter Liebeskind, J. (1997), Keeping Organizational Secrets: Protective Institutional Mechanisms and Their Costs, *Industrial & Corporate Change* 6 (3), 623-663.

Powell, W.W., K.W. Koput and L. Smith-Doerr (1996), Interorganizational Collaboration and the Local If Innovation: Networks of Learning in Biotechnology, *Administrative Science Quaterly* 41, 116-145.

Rosenkopf, L. and A. Nerkar (2001a), Beyond Local Research: Boundary-Spanning, Exploration, and Impact in the Optical Disk Industry, *Strategic Management Journal* 22 (4), 287-306.

Rosenkopf, L. and A. Nerkar (2001b), Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disc Industry, *Strategic Management Journal* 22 (4), 287-306.

Rothwell, R. and M. Dodgson (1991), External Linkages and Innovation in Small and Medium-Sized Enterprises, *R&D Management* 21, 125-137.

Shan, W., G. Walker and B. Kogut (1994), Interfirm Cooperation and Startup Innovation in the Biotechnology Industry, *Strategic Management Journal* 15 (5), 387-394.

Siegel, D.S. (2004), Toward a Model of the Effective Transfer of Scientific Knowledge from Academicians to Practitiones: Qualitative Evidence from the Commercialization of University Technologies, *Journal of Engineering and Technology Management* 21, 115-142.

Stock, G.N. and M.V. Tatikonda (2004), External Technology Integration in Product and Process Development, *International Journal of Operations & Production Management* 24 (7), 642-665.

Subramaniam, M. and M.A. Youndt (2005), The Influence of Intellectual Capital on the Types of Innovative Capabilities, *Academy of Management Journal* 48 (3), 450-463.

Szulanski, G. (1996), Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within the Firm, *Strategic Management Journal* 17, 27-43.

Todorova, G. and B. Durisin (2007), Absorptive Capacity: Valuing a Reconceptualization, *Academy of Management Review* 32 (3), 774-786.

Tsang, E.W.K. (2000), Transaction Cost and Resource-Based Explanations of Joint Ventures: A Comparison and Synthesis, *Organizational Studies* 21 (1), 215-242.

Van den Bosch, F.A.J., H.W. Volberda and M. de Boer (1999), Coevolution of Firm Absorptive Capacity and Knowledge Environment: Organizational Forms and Combinative Capabilities, *Organization Science* 10 (5), 551-568.

Vermunt, J.K. and J. Magidson (2005), *Technical Guide for Latent Gold 4.0: Basic and Advanced*, Belmont, Massachusetts.

von Hippel, E. (1988), *The Sources of Innovation*, New York.

Von Zedtwitz, M. and O. Gassmann (2002), Managing Customer Oriented Research, *International Journal of Technology Management* 24 (2/3), 165-193.

Wernerfelt, B. (1984), A Resource-Based View of the Firm, *Strategic Management Journal* 5 (2), 171-180.

Zahra, S.A. and G. George (2002), Absorptive Capacity: A Review, Reconceptualization, and Extension, *Academy of Management Review* 27 (2), 185-203.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Regional Economic Stress as Moderator of Liability of Foreignness

AUTOREN: ***Wolfgang Sofka***

[Universität Hamburg, ZEW Mannheim]

Jörg Zimmermann

[Max Planck Institut Jena]

JAHR: 2007

BIBLIOGRAPHISCHER STATUS: Max Planck Institute of Economics Papers on Entrepreneurship, Growth and Public Policy No. 12-2007;

Jena Economic Research Papers 2007-023, Jena

Dritte Einreichungsrunde bei Journal of International Management

Status: Minor Revision.

AUSGEWÄHLTE PRÄSENTATIONEN: Strategic Management Society San Diego, 2007

Academy of International Business Peking, 2006

Regional Economic Stress as Moderator of Liability of Foreignness

Wolfgang Sofka[1] and Jörg Zimmermann[2*]

1 Centre for European Economic Research (ZEW), Department of Industrial Economics and International Management, P.O. Box 10 34 43, 68034 Mannheim, Germany

2 Max Planck Institute of Economics; Entrepreneurship, Growth, and Public Policy Group, Kahlaische Str. 10, 07745 Jena, Germany

* Corresponding author: Tel.: +49 3641 686 737; Fax: +49 3641 686 710
Email: zimmermann@econ.mpg.de

ABSTRACT

In this paper we develop optimized localization strategies for multinational firms to overcome their liability of foreignness by adding a regional dimension within a country. We explore conceptually whether economic stress in a region has a mitigating or reinforcing effect. We test this analytical framework empirically on the highly internationalized German car market and find that intra-national regions under economic stress are more promising markets for foreign car manufacturers as the effects of liability of foreignness are significantly lower there.

Keywords: Liability of foreignness, multinational strategy, automotive market

Regional Economic Stress as Moderator of Liability of Foreignness

1 Introduction

Globalization has been an engine for growth and efficiency in almost every industry. Hence, many companies have become “multinational”, i.e. they operate procurement, production, sales and/or distribution activities abroad. These internationalization strategies have not been without fractional losses. The borderless world (Ohmae, 1990) has not materialized. Especially social and cultural borders remain sticky. The expertise and reputation of multinational corporations (MNC) is typically shaped by its home country environment. Their products and practices do not fit seamlessly in host countries with different cultural, social, economic, religious and regulatory traits and roots (Ghemawat, 2001, 2003). These stumbling blocks for MNCs materialize as more frequent mistakes and delays (Lord and Ranft, 2000). Several studies (Zaheer and Mosakowski, 1997; Mezias, 2002; Miller and Parkhe, 2002) have identified this “liability of foreignness” (Zaheer, 1995) and its effects.

We extend this existing research by focussing on countervailing strategies for practitioners to act successfully on foreign markets. More precisely, we argue that multinational firms can exploit regional differences within the host country to mitigate the effects from liability of foreignness. Mezias (2002a) and Nachum (2003) suspect such regional discrepancies. We embed their argumentation into a conceptual framework that makes regional leverage points for foreign firms predictable. We stress the importance of divergence in economic development among regions. However, our theoretical argumentation is not confined by a priori assumptions, i.e. an economic downturn in a region (e.g. high unemployment) may weaken existing customer loyalty with domestic firms but could also very well result in more narrow “patriotic” purchasing behaviour (e.g. “buy cheap” vs. “buy American”). Hence, we develop theoretical hypotheses for both lines of reasoning and test them empirically for a comprehensive sample (almost 1,200 models) of the East and West German car market in 2003. The latter is a fitting object of analysis. The automotive industry is on the forefront of globalization and Germany is a major market with deeply rooted domestic car manufacturers and established foreign competitors. Additionally, significant economic differences between both parts of the country exist even 13 years after re-unification.

This study is directed at management practitioners and scholars. Academic discussion has so far mostly focussed on the effects of liability of foreignness. We aim at deepening these insights by providing contingencies. The latter should be of interest for managers who can identify leverage points for overcoming their disadvantages from liability of foreignness.

In the following section we present a brief review on the concept of liability of foreignness. Section three further develops these fundamentals into an analytical framework. In section four we present our empirical study followed by results, and subsequently, in section six, our conclusions.

2 Liability of foreignness: Theoretical background

Liability of foreignness is a relative concept (Hymer, 1976): Enterprises doing business abroad face certain unavoidable costs that companies operating in their own home

environment do not. The main source of liability of foreignness is an interaction of social and cultural components that can create barriers for foreign companies (Granovetter, 1985; Zaheer and Mosakowski, 1997). In essence, liability of foreignness is a double-edged sword: foreign enterprises are “strangers in a strange”. An obvious point is the host consumers’ uncertainty stemming from a lack of knowledge about the foreign company and the quality of the offered product. In addition, foreign companies feel estranged because they lack the relevant tacit knowledge to interpret the daily business in the way natives do (Hymer, 1976). These disadvantages manifest themselves in more frequent errors or delayed decisions among foreign companies (Lord and Ranft, 2000; Sofka, 2006). They stem from spatial distance (e.g. travel, transportation, time zones), higher learning costs, a lack of host country reputation or legal home country export restrictions (Zaheer, 1995).

So far, research has systematically investigated and confirmed the existence of liability of foreignness, most notably Zaheer (1995), DeYoung and Nolle (1996), Hasan and Hunter (1996), Zaheer and Mosakowski (1997), and Miller and Parkhe (2002). A number of empirical studies have shown that multinational enterprises face enduring barriers in foreign countries (Hennart, 1982; Hymer, 1976) and a lack of embededness (Goshal and Bartlett, 1990; Granovetter, 1985; Zaheer and Mosakowski, 1997) compared to local firms. The most prominent sectoral studies on the topic focus on the banking industry, currency trading and labor lawsuits (DeYoung and Nolle, 1996; Mezias, 2002b; Miller and Parkhe, 2002; Miller and Richards, 2002; Zaheer and Zaheer, 1997). Still, DeYoung and Nolle (1996) add that foreign-owned enterprises may force growth more intensively than profitability.

3 Analytical framework

3.1 Sources of Liability of Foreignness

Domestic companies have an advantage over their foreign counterparts because of the intensive accumulation of tacit knowledge of their native economic, social, legal and cultural conditions. In contrast, foreign firms have problems developing a deep understanding of the host country’s sticky unwritten laws, the cultural and social regulations and their impact (Jensen and Szulanski, 2004). Natives have acquired relevant knowledge at no cost as part of their education and can therefore adopt the relevant information more easily, i.e., they know where to look (Mezias, 2002b). These capabilities are deeply rooted in continuous practice, feedback, interaction and shared experience. Foreign firms lack this form of embededness. They are not fully integrated into the local flow of information between customers and companies in the host country (Granovetter, 1985; Zaheer and Mosakowski, 1997).

Given these social and cultural roots of liability of foreignness, it is unlikely that a foreign firm could readily acquire the necessary host country assets and capabilities to compensate for its disadvantages from being foreign. There are no markets for “hybrid” resources and competencies that provide consistency within host country environments, as well as home country headquarters. Hence, these assets have to be built, developed and refined over time, interaction and experience (Dierickx and Cool, 1989). Some authors have focused on this dynamic aspect of liability of foreignness (Petersen and Pedersen, 2002; Zaheer and Mosakowski, 1997). On the one hand, foreign enterprises seem to learn and adapt to the host country environment with time. On the other hand, their perceived legitimacy in the host country increases, too. Hence, moving operations abroad is typically more of a marathon than a sprint, i.e., it takes time to compete on the same level as local enterprises (Zaheer and Mosakowski 1997).

3.2 Regional discontinuities

Most of the studies mentioned before assume at least implicitly that the country level is the relevant perspective to analyze liability of foreignness. This follows the basic assumption that the previously described sources of liability of foreignness are evenly distributed across a nation (e.g. same language, legal system etc.). Mezias (2002a), however, cautions that regional aberrations may exist and the results of Nachum (2003, 2006) could be interpreted as a first empirical hint. She finds no measurable effect for liability of foreignness for her sample of financial service firms in the city of London.

We extend this discussion by returning to its starting point. Liability of foreignness can only be measured relatively to host country competitors. While the potential factors behind liability of foreignness may be ubiquitous within a nation, environmental forces may hinder domestic competitors from realizing this "home turf advantage." We propose that this favourable strategic context for foreign firms can be identified on an intra-national level which allows multinational firms to develop targeted regional strategies within a country.

We argue that the amount of economic stress in a host country region influences the impact of liability of foreignness. Two mechanisms are possible. On the one hand, economic downturns may force host country customers to re-evaluate existing consumption patterns which provides windows of opportunities for foreign firms and their products. On the other hand, economic stress may drive customers to return to their national core believes which causes their purchasing behaviors to become more "patriotic" in effect. We explore both routes theoretically. Figure 1 summarizes our approach.

Insert Figure 1 about here

Economic stress as a mitigating factor of liability of foreignness

Dierickx and Cool (1989) argue that the degree of imitability of strategic assets, i.e. the social and cultural embeddedness of host country competitors, depends on the presence of time compression diseconomies. Put simply, the latter implies whether it is possible to take a shortcut in accumulating similar stocks of host country knowledge as domestic competitors. We argue that economic stress provides such leverage points. Given the socio-cultural nature of liability of foreignness and related deeply rooted mechanisms in a country, economic stress in a society invalidates the established social network and opens the chance for newcomers from abroad to develop local embeddedness at rates equal to domestic competitors.

These mechanisms have typically been investigated with a focus on the demand side. Consumer preferences are related to the processes, functions and structures of a social system. Preferences and preference formation are closely related to social stability and change (Zinam, 1974). Various authors show that when consumers experience disruptive events that signify transitions into new roles and create stress, they also modify their consumption patterns. Such events could have personal or social/political character (Mathur, et al., 2003; Wan, 1998). Two theoretical perspectives apply: the role transition perspective and the stress perspective. The role transition perspective suggests that as people change roles, assume new roles or relinquish old roles, their behavior changes. As people enact new roles or relinquish old ones they experience a need to redefine their self-concept (Mehta and Belk, 1991). Since

possessions are integral to the definition of self and the expression and performance of roles (e.g. Belk, 1988), role transitions are associated with disposal of products relevant to previous roles and acquisition of products relevant to new roles. Theory and research on stress provides the second perspective on behavioral changes. Stress is often defined as environmental, social or internal demands that disrupt existing psychological states and require the individual to readjust his or her usual behavior patterns (Thoits, 1995). Major life transitions are often considered to be ”stressors.” By virtue of the newness of these preferences they are relatively weak, but the weaker the preference is the more likely it is that switching can be induced (for example see Weber and Hansen, 1972). This is especially evident in markets that have experienced disruptive changes or economic stress and in untapped markets when preferences are relatively weak.

Wan (1998) illustrates this line of argument for China: Economic reforms have brought remarkable change. The economic transition in China becomes most visible in economic development and institutional transformations. The impacts on lifestyle and westernization through these channels are tremendous. Wan (1998) shows that these impacts are essentially reflected by changes in consumers' preferences for the consumption of commodities and services.

In essence, we argue that economic stress in a society forces the evaluation of existing patterns of behavior, consequently weakening the existing networks of knowledge flows (Thoits, 1995). Readjusting their preferences, consumers put domestic and foreign competitors back to the same “starting point.” They judge the importance of each product relying rather on their personal criteria and current economic situation than on their established paradigms. That opens a window of opportunity for foreign firms. Product characteristics become much more important than established procedures, paradigms and social pressure. At this time foreign firms have the same chance as domestic competitors to communicate their product advantage. This readjustment enables foreign competitors to enter host country networks. Thus, long learning engagements and the absorption of tacit knowledge is no longer a precondition to success in a foreign market. The economic stress acts as a ‘time-compressor’ for foreign companies as consumers reweigh their priorities. Such an argument would predict that the liability of foreignness decreases in regions with high levels of economic stress. Hence, we derive our first hypothesis:

> **Hypothesis 1:** Economic stress is a mitigating factor for the relative levels of liability of foreignness among host country regions.

Economic stress as a reinforcing factor of liability of foreignness

However,a contrary line of research can be found in the literature. Events such as unemployment and political and or economic upheaval often involve significant personal loss and place people in “between” stages. As stress occurs, people attempt to restore balance while relieving the frustrations and tensions accompanying disequilibrium (Lazarus and Folkman, 1984; Pearlin, 1982). Actions and thoughts that enable the individual to handle difficult situations, solve problems and reduce stress dominate (Lazarus and Folkman, 1984). At stressful times, aspects of life otherwise taken for granted may be reassessed (O'Donohoe and Turley, 1999). When people feel that they lack knowledge or the ability to process information during the crisis they rely on established patterns from the past(Earl, 1986).

For example, during the economic crisis of the winter of 1996-1997, consumer stress significantly affected the consumption practices of Bulgarian consumers. The uncertainty

about future incomes and unemployment made people more cautious about their spending. In this case, consumer preferences shifted from foreign to Bulgarian brands, particularly in the food, apparel and footwear product categories (Milanova, 1999).

Examining the impact of economic stress on consumer preferences, we argue that uncertain consumers rely more intensively on past patterns (Earl, 1986). Therefore, they prefer established home market brands compared to unknown foreign ones when economic stress occurs. We suggest that disruption and crisis actually lead to increased centralization and greater demarcation between insiders and outsiders. Such an argument predicts that the liability of foreignness actually increases during times of economic stress. Hence, we derive our second hypothesis:

> **Hypothesis 2:** Economic stress is a reinforcing factor for the relative levels of liability of foreignness among host country regions.

4 Empirical study

4.1 Empirical setting

We test our hypotheses using the German car market. Since liability of foreignness has been defined as a competitive disadvantage for foreign multinationals compared to their host country competitors, we propose that the differences in sales quantity of comparable cars between German and foreign producers can be interpreted as the degree of liability of foreignness. The German car market is an especially good setting since it features several large, domestic car manufacturers as well as established presences from almost all international car producers.

Relying on samples of different regions within the host country helps to determine if liability of foreignness is a national effect or influenced by regional characteristics (Shaver, 1998). To estimate the regional economic effect on liability of foreignness we have to control for all other liability-specific criteria (Mezias, 2002a). Moreover, as both regions, West and East Germany, belong to the same country there should be no difference in the general political and social structure that could bias the results. Thus, estimating the degree of liability of foreignness separately for West and East Germany we can compare the estimation results and interpret the difference as the outcome of the different regional economic performance. In addition, estimating separate demand functions for each region takes into account the different demand behaviors of customers between these regions. Thus, if our theoretical outline holds, the effect of liability of foreignness should be significantly different between West and East Germany.

Germany offers the opportunity to investigate the impact of a different regional economic situation on liability of foreignness. Before reunification in 1990 the East German car market was largely closed to western producers and its citizens were not directly targeted by western marketing efforts. Hence, in East Germany existed a whole regional buyer group within Germany that had little or indirect ties to West German car manufacturers. When the Berlin Wall fell, East Germany had to fulfil an economic restart. Meanwhile, West Germans relied on established patterns and experience. Thus, the West German economy had an advantage compared to East Germany. Since reunification, both parts of Germany have developed a common sense of nationality. Therefore, and because of the failure of East German

competitors (sales of the native Trabant and Wartburg models collapsed immediately after the border opening and the firms closed), West German car manufacturers became more and more established as home brands in East Germany. Furthermore, facing a 13 year time lag, East Germans have had time to handle the short term effects of the disruptive change and established their new preferences and routines. What is more, the East German states are by now fully integrated into a unified German institutional setting. This includes the legal and regulatory framework, finance system, taxation as well as the road infrastructure.

Nevertheless, while East and West Germany share historic, cultural and societal traits and similarities, significant differences in economic structure, behavior and living conditions remain. There exist significant differences in economic performance between the East and West German economies. Comparing the standard economic indicators between the regions shows a strong economic advantage for the West German states (summarized in Table 1). Relying on the German GDP, we find that the growth rate in West Germany is 160 times greater than in East Germany in 2005. Moreover, the unemployment rate in East Germany is more than 40% higher than in West Germany. Hence, we find significant lower rates of per capita consumption, saving rates and gross fixed investments in East Germany. In essence, the East German economy suffers from much more economic stress than the West German economy.

Insert Table 1 about here

To implement the empirical strategy outlined above, we rely on German car market data. This approach has several advantages. Car models are the actual item of competition in the automotive market. Automotive companies do hardly compete on individual cars but rather on lines of equally equipped car models. Market data is broadly available for all relevant competitors. It allows benchmark comparisons between foreign and domestic competitors, instead of hypothetical, normative targets. What is more, using market data enables us to judge liabilities of foreignness from the most relevant perspective: Through the eyes of the consumer. Furthermore, using market data delivers value estimations (so called shadow prices) for important company and product characteristics which can subsequently be used to validate the model.

4.2 Model and method

For estimating the effects of foreignness and various control variables, we use seemingly unrelated regression (SUR) models. The major advantage of SUR models compared to ordinary least squares (OLS) models is that car demand in West and East Germany is estimated separately for both regions but simultaneously with correlated error terms for both equations. It enables us to reflect specific differences in consumption patterns in each regional market (e.g. due to economic opportunities or preferences) through separate equations while incorporating the fact that both are part of a joint German market context. The effects of unobserved quality characteristics captured in the error term of one equation influence the error term of the other equation and vice versa. We achieve a joint variance-covariance matrix for both demand equations by applying SUR. This allows us to directly compare the effects of various factors (including foreignness) on demand in West and East Germany, which immediately reflects the hypothesis testing strategy outlined before. Moreover, we compare

the demand equations in East and West Germany to examine whether they are significant different. That would underline our assumption that regional effects exist.

Another issue needs to be addressed methodologically: Price is endogenous to demand as both consumers and producers know the unobserved (to the econometrician) quality components and producers take its value into account in their pricing decision which, in turn, induces a positive correlation between car prices and unobserved model quality. This leads to a downward bias in the estimate for the parameter corresponding to price, i.e. it is estimated "too small" in absolute value. Obviously, the impact of pricing on car purchasing behavior is too important to be neglected. Hence, we instrument the price variable. Valid instruments have to be highly correlated with the endogenous variable price while uncorrelated with unobserved car quality. Instrument variables with the combination of these particular properties are necessarily rare. We therefore rely on a technique suggested by Berry et al. (1995). It is built around the idea that the price of any car is a function of the characteristics of other cars. Consequently, these characteristics are valid instruments for car price. We use the average specification of all cars in the relevant car segment of the following quality characteristics as instrument variables: car height, cylinder capacity, power steering, brilliant varnish, all-wheel drive and convertible.

We conduct a "first stage" regression analysis with these instrument variables. The table in appendix A shows the results. These indicate that the instrument variables are highly correlated with the endogenous variable price. Most instrument variables are individually significant; all of them are jointly highly significant. We find no evidence for correlation between the unobserved quality characteristics and the instruments, as "J-tests" for over-identifying restrictions cannot reject the validity of our instruments at any conventional significance level.

In conclusion, we estimate the following formal model:

$$ln\, q_{iwest} = \beta_{0west} + \sum_{j=1}^{l} \beta_{jwest} \times X_{ij} + \beta_{jwest} \times D_i + \varepsilon_{iwest}$$

$$ln\, q_{ieast} = \beta_{0east} + \sum_{j=1}^{l} \beta_{jeast} \times X_{ij} + \beta_{jeast} \times D_i + \varepsilon_{ieast}$$

$$i = 1,..,N$$

$$cov(\varepsilon_{iwest}, \varepsilon_{ieast}) = \rho$$

where

q_{iwest} : *Quantity sold of model i to customers in West Germany*

q_{ieast} : *Quantity sold of model i to customers in East Germany*

X_{ij} : *Quality characteristic j of model i*

D_i : *Foreign producer dummy of model i*

ρ: *Correlation between the error terms* ε_{iwest} *and* ε_{iwest} *(to be estimated)*

β : *parameters to be estimated*

Finally, we use Wald tests to estimate if the degrees of liability of foreignness are significantly different between East and West Germany.

4.3 Data

We rely on a cross sectional dataset for the year 2003 which was specifically generated by combining several major data sources. Table 2 provides an overview.

Insert Table 2 about here

Our dataset is based on official new car registration statistic provided by the Federal Bureau of Motor Vehicles and Drivers. It contains information on 1,744 car models from producers with a production permit for Germany. The latter is mandated by law which implies that we can cover the complete German market. 33% of these models stem from domestic brands the rest is foreign. We combine this database with several other databases and lose some observations due to compatibility issues and resulting missing values. The two most important sources for this consolidation process should be discussed briefly. 408 car models are not ranked by German automobile assistance association ADAC with regards to their environmental friendliness and/or received no reliable pricing quote by the German car evaluation company EurotaxSchwacke (191 car models). Both issues are mostly due to the broad coverage of the official registration dataset which contains both sub-truck vehicles for commercial use (e.g., DaimlerChrysler Vito, Fiat Ducato, Ford Transit) and high-end premium cars (e.g., DaimlerChrysler Maybach, Porsche 911 GT3, Jaguar XKR). Both represent niche products which are typically not covered by the comprehensive ADAC study on the environmental friendliness of passenger cars owned by the majority of Germans. Moreover, the high-end premium products are sold in low volumes to specific customers for which reliable prices and used-car prices can hardly be estimated. As a result all models from Porsche, Jaguar and Land Rover have to be dropped from the dataset.

We derive a final dataset of 1,198 observations (37% or 439 German, and 63% or 759 foreign models) from 23 domestic and foreign car manufacturers. Hence, the share of domestic brands has increased due to data availability issues but the overall distribution is fairly in line with the initial official statistics.

4.4 Variables

Dependent variables

The dependent variables in our study are sales quantities of a particular car model (in logs) in West and East Germany respectively. By choosing the logarithmic form, we rely on the experience of several authors from hedonic price analysis. Using sales quantity as dependent variable, we can control for price. High unit sales could be the result of discount pricing or vice versa. Thus, the causal direction could be problematic. We will address this issue methodologically.

Liability of foreignness variables.

We add a dummy variable for the foreign brands under consideration as proposed by Mezias (2002a). The coefficient will be the focal point of interest in the following discussion and conclusion. Our theoretically developed research question can be tested by comparing the coefficients of this dummy variable in East and West Germany.

Zaheer and Mosakowski (1997) discuss a number of concepts that would indicate whether a company can be considered foreign: location of international headquarters, nationality of the majority of workers, share of foreign shareholders, nationality of the largest single shareholder or the perception of a company in a particular country. We chose the latter concept and define an automotive brand as domestic or foreign relying on a German point of view. Brands from companies that are born and established in Germany are treated as German and brands from firms with traditional roots in foreign markets are defined as foreign. The reference groups in all further estimations are the car models with a traditional German background: Audi, BMW, Mercedes (DaimlerChrysler), Smart and Volkswagen.[1]

We classify the following brands as foreign: Citroen, Daewoo, Chrysler, Fiat, Ford, Honda, Hyundai, Mazda, MG Rover, Nissan, General Motors (Opel), Peugeot, Renault, Saab, Seat, Skoda, Toyota, Volvo. The engagements of General Motors and Ford in Germany run deep and date back to the pre World War II era. General Motors has owned Opel since 1929 (the company was founded 1862 by German engineer Adam Opel), and the German branch of Ford was established in 1925. Hence, one could certainly argue that these companies should be considered German (i.e. domestic) instead of foreign. Still, we fear that by doing so, we would severely neglect the internalization activities and subsequently liabilities of foreignness of two of the largest car producers in the world. Nevertheless, we estimate and report an additional econometric model which includes separate dummy variables for Ford and Opel to test the consistency of the foreign effect. Ford and Opel are also the only foreign producers with manufacturing plants in Germany. Both possess production plants in West Germany, and Opel an additional one in East Germany. Thus, foreign firms that manufacture in Germany may have an advantage, and this should be controlled for. Finally, we add a dummy variable in the second econometric model for German-owned foreign brands (Skoda, Seat and Chrysler) to further test the stability of our foreign concept. German-owned foreign brands may benefit from joint development, production and distribution activities which may change the “foreignness” perception of domestic customers.

Control variables.

As suggested by Mezias (2002a), measuring liability of foreignness implies controlling for the effects of other liabilities and contextual aberrations. We address the former through a broad set of firm specific variables and the latter through model specific items.

With regards to other liabilities we capture the effects newness (time since introduction of both brands and models in Germany), distribution networks, advertising and R&D expenditures as well as size. Additionally, we control for differences in model price and quality. Specifically, we add control variables for mid- and high-end car segments that capture the different patterns of demand between in these segments. Moreover, we rely on previous findings from marketing research[2] and hedonic price analysis[3] to derive four broad quality

[1] Porsche is excluded because of data availability issues.

[2] Marketing research focuses largely on consumer preferences. Consumers have individual preferences through which they evaluate the quality of a car, which enables them to decide if and what kind of car they should buy. Hence, it is important for car manufacturers to produce cars that meet these preferences. The

factors that influence the product evaluation of prospective car buyers: performance, economic and ecological efficiency, safety and convenience/amenity. Table 3 provides a detailed overview.

Insert Table 3 about here

4.5 Description

The following section gives a brief overview of the average car characteristics and the differences between German and foreign cars. A detailed list of the means and standard deviations for the variables used in this study is provided in Table 4. Appendix C provides a correlation matrix and variance inflation factors which give no indication of collinearity concerns.

Insert Table 4 about here

The West German car market is much larger than the East German one. Roughly 1,700 units are sold from an average model in the West compared to 320 in the East. German brands outsell foreign ones in West Germany roughly 2:1 (average units sold by model) but this ratio is much smaller and almost at parity in East Germany. However, this does not account for major differences in the prices and quality characteristics. The average car from a domestic brand is more expensive (over € 34,000) compared to their foreign counterparts (above € 22,000). Domestic brands sell also much more frequently in the mid-size and upper-size segments of the market which may explain why they also posses more engine power on average. Additionally, they also have a lead when it comes to station wagon or convertible models. What is more, the average value loss after the first year is much smaller for domestic brands which may be reflected in a higher initial purchasing price. Foreign brands are not lagging with regards to their share of diesel powered or environmental friendly cars. With regards to safety features, the number of airbags is not a distinct feature but German brands sell anti skid systems much more frequently. Then again, foreign brands are better equipped with leather interior and on-board computer systems. In conclusion, the prima facie

---

prevailing methods employed to evaluate the preferences are conjoint analyses and joint stated/revealed preferences models (Berkovec and Rust, 1985; Brownstone et al., 2000; Bunch et al., 1993; Train and Sonnier, 2002). The dominant quality characteristics in these studies are price, performance, engine type, convenience and operating costs (Brownstone et al., 2000; Bunch et al., 1993).

[3] The basic idea behind hedonic price analysis lies in the assumption that changes in prices can only be correctly assessed once they have been adjusted for changes in quality. Based on the hypotheses that goods are valued for their value-creating characteristics, hedonic prices are defined as the implicit prices of these attributes (Rosen, 1974). For basic work on hedonic prices see studies of Court, 1939 and Griliches, 1961. The hedonic approach has been used in recent years in the automotive sector to investigate a variety of research topics (see for example Goldberg and Verboven, 2001, 2004; Verboven, 1998, 2002). Their prevailing goal has been to achieve segmentation in the car market largely based on performance and size.

comparison provides some trends but no clear picture on how sales, prices and quality characteristics interact. A multivariate analysis is warranted.

5 Results

Our empirical analysis yields some interesting insights. Table 5 presents the results. We find considerable degrees of correlation between the error terms of the two individual regressions (rho 0.90). Thus, our estimation procedure did in fact produce superior results compared to estimating two separate OLS regressions. Additionally, we confirm that specific regional effects in demand patterns exist. We conduct a likelihood-ratio test on whether a constrained estimation model imposing homogeneous preferences across regions would be equally suitable. This hypothesis is rejected at the 99% significance level. Therefore, we show that the demand equations of East and West Germany are significantly different. Major discussions in this section will focus on the econometric model I with a broad definition of foreign brands. Model II is primarily designed as a consistency check for potential distortions on effects of liability of foreignness from the assignments of Ford and Opel (they are no longer considered "foreign" but receive separate dummy variables) and German-owned brands. Generally, the consistency checks in model II support our overall results. We will return to its specific implications later in this section.

Insert Table 5 about here

In the conceptual part of this analysis we highlighted the dangers of misinterpreting other deficiencies as liabilities of foreignness. Thus, the control variables that have entered our estimation are important. Nevertheless, they are not the main focus of our research. We refer to a discussion of major control variable findings in appendix B.

The results for our variables of interest (i.e., foreign dummy variables) are more important. At first, foreign companies face a significant disadvantage in firm performance (measured as quantity of sales). The coefficients of the foreign variables are negative and significant in both submarkets (East and West Germany). Foreign car manufacturers face a significantly competitive disadvantage compared to their German competitors. Therefore, we identify liability of foreignness in the German car market. These results support the existing research outlined in the literature review.

More importantly, we extend this existing research by proposing that the degree of liability of foreignness differs between regions. We argue that the regional economic performance influences the consumer perception of foreign products. Comparing the coefficients of the foreignness variable in the East and West German market, we find actual differences. The coefficient in West Germany is higher than the one for the East German market. We use a Wald test to evaluate if there is a significant difference between the degree of liability of foreignness in East and West Germany and find it supported at the 99% significance level. Therefore, we conclude that foreign car manufacturers face a lower degree of liability of foreignness in East Germany than in the West German market.

To ensure that the foreign effect is not driven by a certain company, we perform several consistency checks. First, we test the significant difference of the foreign effect for the East

and West German car market excluding each single foreign brand separately from the foreign group. The results indicate that the regional effect is consistent for all foreign ventures and not a firm-specific effect. The significance levels and related regional differences of the liability of foreignness variable remain stable.[4] Secondly, we estimate an additional econometric model. Model II (see Table 5) includes separate dummy variables for Opel and Ford (we exclude them from the "foreign" status) as both firms are well established in the German market and possess production facilities in Germany. Opel shows a significant positive effect in both the West German and East German market. Ford shows no significant effect. That could be traced back to the location of their production facilities in Germany since we control for the extended time of their German market engagements. Moreover, we control for the effect of German ownership of foreign brands (Seat, Skoda and Chrysler) and their performance in the West and East German market. Its significant negative effect is limited to the West German market. The remaining foreign effect remains stable. In conclusion, all consistency checks support the existence of a liability of foreignness effect and the related regional differences remain stable.

How does this empirical finding relate to our conceptual argumentation? Following the idea of region-specific degrees of liability of foreignness (Mezias 2002a), we test two competing hypotheses. We propose that economic stress would lead either to more rational decisions by host country consumers or reinforce their patriotic sentiments. As a result, the effects of liability of foreignness would be, respectively, more or less severe. Based on our empirical findings we conclude that a lower economic performance reduces the degree of liability of foreignness. Low regional economic performance becomes reflected in individual decision making. People reconsider their habitual buying behavior. Thus, potential customers in economically depressed regions evaluate products more objectively and rely less intensively on country of origin stereotypes. They choose the product that fits best with their personal preferences and needs quite rationally. We argue that economic stress intensifies the degree of rationality in these purchasing decisions which mitigates the effects of liability of foreignness.

These results are somewhat surprising since the country affiliation of automotive brands is very visible compared to other products (Samiee et al., 2005). Hence, customers who want to make a "patriotic" statement through their purchasing behavior could achieve high visibility by "buying German." However, buying a new car is typically a large investment and a financial burden with high levels of personal involvement in terms of information gathering and comparison prior to the purchasing decision. This may reduce the necessity of host country customers to rely on country stereotypes as an indicator for expected quality (Gurhan-Canli and Maheswaran, 2000). In essence, relying on our analytical framework we can conclude that economic stress in a region may act as a reinforcing factor for making the most educated choices possible, when it comes to expensive purchases, since budgets are more restricted and economic prospects more uncertain (e.g. through unemployment).

6 Conclusions

The core of this study is to identify regional differences in the degree of liability of foreignness in a host country. We argue theoretically that economic stress in a region can have either a mitigating or reinforcing effect. We consider this a valuable contribution to the field. While the existence of liability of foreignness is very well documented, countervailing

[4] Full regression results of these additional specifications are available from the authors upon request.

strategy recommendations for practitioners remain scarce (Mezias, 2002a). Luo et al. (2002) suggest a choice between offensive and defensive strategies which multinational firms can typically only meaningfully conduct after they have entered the host market. We add a spatial dimension to this discussion and emphasize the importance of economic stress. Firms can assess these regional differences within a country based on publicly available information before their entry decision. Adding a regional contingency to the concept of liability of foreignness allows managers to develop targeted, ex-ante strategies.

During the conceptual part of this study, we explore both paths of the potential impact of economic stress on liability of foreignness, i.e. whether economically depressed regions become more or less "patriotic" in their purchasing decisions. Our empirical study allowed us to investigate the effects of economic stress under the shared cultural and institutional framework of East and West Germany. It reveals that higher levels of economic stress translate into lower levels of liability of foreignness. We conclude that customers in these regions have higher incentives to invest in information processing prior to the purchasing decision which reduces the need to rely on country-of-origin stereotypes.

We have no means to assure whether this leads to a more foreigner-friendly environment or simply reduces the home field advantage of domestic producers, since we measure only the relative disadvantage between the two. This differentiation may be more relevant for academic discussion, however. What may be more important is the argument that these economically depressed regions may be more accessible to foreign producers but also less profitable. We do not suggest that multinational firms should limit their host country engagements to areas under severe economic stress. Economically depressed regions may also be less profitable. Instead, we support the notion of using them as a starting point or attractive foothold with lower disadvantages from liability of foreignness before entering or for serving the full market.

7 Limitations and future research

Our study suffered from several limitations which may also inspire new projects. First of all, one could very easily extend our regional approach towards more fine grained concepts, like urban centres versus rural areas. We consider this a fruitful road for further research initiatives as market entry strategies especially in the automotive sector would largely focus on metropolitan areas because of agglomeration advantages. Our study hints that international firms should initially target cities in economically depressed regions but this cannot be verified based on the existing analysis.

Secondly, our empirical study is limited to German data. Given the tradition and importance of automotive production in Germany comparative studies of other countries would certainly be interesting. Foreign products may even be considered of superior quality in different country and/or product settings. Hence, foreignness becomes an asset. If this perception is related to luxury status, one would assume that the effect of our study is reversed and foreign, luxury products are especially attractive in economically prosperous regions inside a country. One could easily argue that this would hold in emerging economies. Additionally, the differences in economic performance between East and West Germany may be especially pronounced and regionally confined which also warrants comparison with other countries. What is more, the underlying concepts of economic stress, e.g. the social implications of unemployment, may be explored in more detail which may result in further contingencies for

dealing with liability of foreignness. Finally, studies with other high or low involvement purchasing decisions may strengthen our results or put them into perspective.

Acknowledgements

We appreciate comments and suggestions from Srilata Zaheer, John Mezias, Yadong Luo, Adam Lederer, Werner Bönte and two anonymous reviewers. Earlier versions of this paper were presented at the 2006 Academy of International Business in Beijing / PR China, and the 2006 Academy of Management in Atlanta / USA.

Figure 1: Moderating effect of the level of regional economic stress on the degree of liability of foreignness

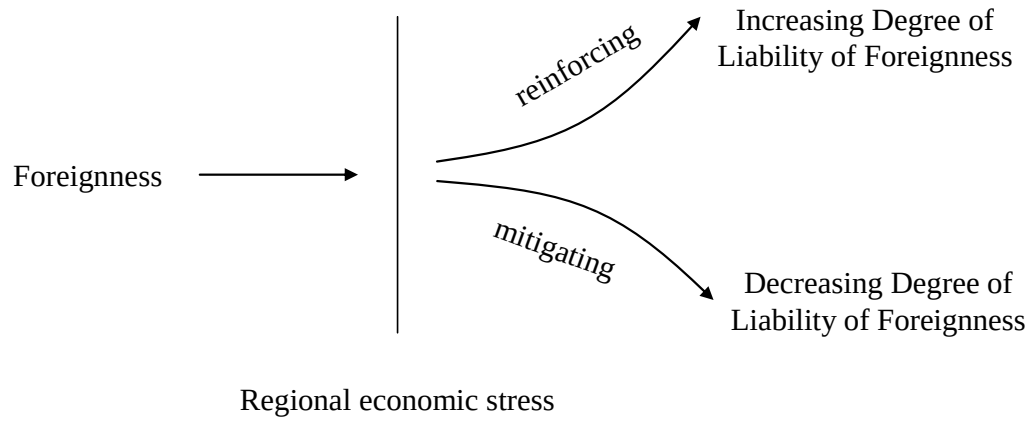


Table 1: Comparison of key economic indicators between East and West Germany

Indicator	West Germany	East Germany (incl. Berlin)
Population (as of December 31st 2005)	65,698,000	16,740,000
Unemployment rate (as of August 2006)[a]	7.7%	11.4%
Gross domestic product (2005, current prices, in billion Euro)	1,907.97	337.54
GDP growth (2005, current prices)	1.6%	0.1%
Per capita GDP (2005, current prices, in Euro)	29,045	20,117
Per capita consumption (2004, current prices, in Euro)	16,584	13,281
Savings rate	10.7%	9.3%
Gross fixed investment (2003, current prices, in million Euro)	319,081	65,299

Source: Federal Statistical Office Germany.
[a] Ratio of unemployed persons to total labor force.

Table 2: Data sources

Content	***Data source***
Sales volume and major quality features by model and region	Kraftfahrt-Bundesamt (KBA, Federal Bureau of Motor Vehicles and Drivers)
Prices and enhanced quality features	German car evaluation company EurotaxSchwacke
Advertising expenditure	Automotive intelligence provider B&D Forecast GmbH
Distribution network of licensed dealers	Central associations of German vehicle manufacturers (ZDK/VDA/VDIK)
R&D expenditures	EU industrial R&D investment scoreboard report (European Commission, 2004)
Environmental friendliness ranking EcoTest and breakdown frequency statistics	German automobile assistance association (ADAC)

Table 3: Control variables

Other liabilities	**Quality differences**				
	Basic outfit	***Performance***	***Economic/ ecolog. efficiency***	***Safety***	***Convenience/ amenity***
Months since model introduction in Germany [b] (in logs)	Price (€; in logs; instrumented)	Engine power (logs, kw)	EcoTest ranking (points) [c]	Airbags (no.)	Leather interior (dummy)
Time since brand introduction in Germany (years in logs)	Model mid-size segment (dummy)	Diesel engine (dummy)	Average value loss after first year (%)	Anti skid system	On-board computer (dummy)
Licensed dealerships per 1,000 cars sold (ratio)	Model upper-size segment (dummy)		Breakdown frequency (no. in logs)	Immobilizer (dummy)	Power windows (no.)
Advertising expenditures (%)	Station wagon (dummy)				
R&D expenditures (% of sales)	Convertible (dummy)				
Employment (no. worldwide in logs)					

[b] Companies have to apply for a general production permit at the KBA (Federal Bureau of Motor Vehicles and Drivers) if they want to sell their product on the German market. We consider the date of this production permit a reliable proxy variable for market entry (for the company as well as a specific model). Timelines refers to introduction to the German market not necessarily world-wide.

[c] The EcoTest ranking is constructed by ADAC (German Automobile Assistance Association) as a composite point score of emissions and fuel efficiency. A car model can achieve 100 points at best. Toyota achieved the highest score of 89 with its hybrid powered Prius model.

Table 4: Descriptive statistics

Variable	All brands		German brands		Foreign brands	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Sales in West Germany units	1,711.71	3,812.28	2,551.92	5,405.42	1,225.73	2,328.45
Sales in East Germany units	320.83	631.13	335.83	727.58	312.16	568.27
Price €	26,718.56	14,222.95	34,627.88	18,501.16	22,143.87	8,029.69
Months since model introduction	23.22	11.68	23.10	11.55	23.29	11.77
Years since brand introduction	45.60	11.88	51.82	9.49	41.99	11.63
Employment no., worldwide	243,623.90	106,491.20	299,241.00	88,088.31	211,455.40	102,940.80
Engine power kw	99.12	42.81	119.82	53.05	87.14	29.60
Licensed dealerships per 1, 000 cars sold	8.30	5.99	4.64	1.78	10.42	6.53
Advertising expenditures % of total	5.60	2.91	6.28	2.53	5.20	3.04
R&D expenditures % of sales	4.33	0.77	4.72	0.67	4.09	0.72
Model mid-size segment dummy	0.42	0.49	0.51	0.50	0.37	0.48
Model upper-size segment dummy	0.12	0.32	0.16	0.37	0.09	0.28
Station wagon dummy	0.18	0.38	0.20	0.40	0.16	0.37
Convertible dummy	0.06	0.24	0.09	0.29	0.04	0.21
Diesel engine dummy	0.32	0.47	0.35	0.48	0.31	0.46
Av. value loss after first year, %	22.91	160.07	9.29	3.61	30.78	200.72
EcoTest ranking points	62.93	8.63	65.08	5.52	61.69	9.79
Airbags no.	5.04	1.54	5.16	1.48	4.96	1.57
Breakdown frequency no. in logs	3.13	0.39	2.95	0.13	3.23	0.44
Anti skid system dummy	0.54	0.50	0.69	0.46	0.45	0.50
Immobilizer dummy	0.95	0.21	0.99	0.11	0.94	0.25
On-board computer dummy	0.62	0.48	0.54	0.50	0.67	0.47
Leather interior dummy	0.44	0.50	0.33	0.47	0.51	0.50
Power windows no.	3.19	1.07	3.33	1.01	3.11	1.10
Observations	1,198		439		759	

Table 5: Estimation results of sales units from seemingly unrelated regression in East and West Germany

Variable	Model I				Model II			
	West Germany		East Germany		West Germany		East Germany	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Foreign brand (dummy)	-0.94 ***	0.15	-0.32 **	0.13	-0.84 ***	0.19	-0.29 *	0.17
Brand: Opel (dummy)					0.93 ***	0.29	0.42 *	0.25
Brand: Ford (dummy)					0.03	0.25	-0.28	0.22
German owned brand (dummy)					-1.07 ***	0.31	-0.09	0.27
Control variables	YES		YES		YES		YES	
Constant	28.50 ***	2.76	25.22 ***	2.38	26.51 ***	2.95	24.27 ***	2.56
No. of Obs.	1,198		1,198		1,198		1,198	
RMSE	1.71		1.47		1.69		1.47	
R2	0.21		0.22		0.23		0.22	
chi2	326.32		329.5		354.99		336.38	
P>0	0.00		0.00		0.00		0.00	
Wald test on significant difference between foreign brand coefficients	chi2(1) = 88.13		Prob > chi2 = 0.00		chi2(1) = 48.34		Prob > chi2 = 0.00	

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors.

8 Appendix

Appendix A: Instrument regression results of car prices (in logs)

Variable	Model I		Model II	
	Coef.	SE	Coef.	SE
Foreign brand (dummy)	-0.12 ***	0.01	-0.14 ***	0.01
Brand: Opel (dummy)			0.02	0.02
Brand: Ford (dummy)			0.03	0.02
German owned brand (dummy)			0.02	0.02
Time since model introduction (months in logs)	0.00	0.01	0.00	0.01
Time since brand introduction (years in logs)	0.06 ***	0.02	0.05 ***	0.02
Licensed dealerships per 1,000 cars sold (ratio)	0.00	0.00	0.00	0.00
Advertising expenditures (% of total)	0.00 **	0.00	0.01 **	0.00
R&D expenditures (% of sales)	-0.01	0.01	-0.01	0.01
Employment (no., worldwide in logs)	0.01 *	0.01	0.01	0.01
Model from mid-size segment (dummy)	0.04 **	0.02	0.04 **	0.02
Model from upper-size segment (dummy)	0.08	0.05	0.08	0.05
Station wagon (dummy)	0.03 ***	0.01	0.03 ***	0.01
Convertible (dummy)	0.17 ***	0.02	0.18 ***	0.02
Engine power (logs, kw)	0.55 ***	0.02	0.55 ***	0.02
Diesel engine (dummy)	0.09 ***	0.01	0.09 ***	0.01
Average value loss after 1st year (normalized, %)	0.00 ***	0.00	0.00 ***	0.00
EcoTest ranking (points)	0.00	0.00	0.00	0.00
Airbags (no.)	0.01 **	0.00	0.01 ***	0.00
Breakdown frequency (no. in logs)	0.02 *	0.01	0.03 *	0.01
Anti skid system (dummy)	-0.01	0.01	-0.01	0.01
Immobilizer (dummy)	0.05 **	0.02	0.04 **	0.02
On-board computer (dummy)	0.02 *	0.01	0.02 **	0.01
Leather interior (dummy)	0.05 ***	0.01	0.05 ***	0.01
Power windows (no.)	0.03 ***	0.00	0.02 ***	0.00
Hight (cm, av. segment)	0.00	0.00	0.00	0.00
Brilliant varnish (dummy, av. segment)	0.16	0.10	0.15	0.10
Cylinder capacity (ccm, av. segment)	0.00 ***	0.00	0.00 ***	0.00
Power steering (dummy, av. segment)	-0.19 **	0.08	-0.18 **	0.08
All-wheel drive (dummy, av. segment)	-0.10 *	0.06	-0.11 *	0.06
Convertible (dummy, av. segment)	-0.16	0.11	-0.16	0.11
Constant	6.61 ***	0.36	6.66 ***	0.37
No. of Obs.		1,198		1,198
RMSE		0.13		0.13
R2		0.90		0.90
chi2		10,687.22		10,709.86
P>0		0.00		0.00
Test for instrument variables equaling zero can be rejected		F(6;1169) = 49.38 Prob > F = 0.00		F(6;1169) = 49.34 Prob > F = 0.00

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors.

Appendix B: Estimation results of sales units from seemingly unrelated regression in West and East Germany

Variable	Model I				Model II			
	West Germany		East Germany		West Germany		East Germany	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Foreign brand (dummy)	-0.94 ***	0.15	-0.32 **	0.13	-0.84 ***	0.19	-0.29 *	0.17
Brand: Opel (dummy)					0.93 ***	0.29	0.42 *	0.25
Brand: Ford (dummy)					0.03	0.25	-0.28	0.22
German owned brand (dummy)					-1.07 ***	0.31	-0.09	0.27
Time since model introduction (months in logs)	-1.19 ***	0.10	-0.82 ***	0.09	-1.15 ***	0.10	-0.82 ***	0.09
Time since brand introduction (years in logs)	1.06 ***	0.19	0.75 ***	0.16	0.98 ***	0.20	0.72 ***	0.17
Licensed dealerships per 1,000 cars sold (ratio)	-0.05 ***	0.01	-0.06 ***	0.01	-0.06 ***	0.01	-0.06 ***	0.01
Advertising expenditures (% of total)	-0.08 ***	0.02	-0.08 ***	0.02	-0.15 ***	0.03	-0.09 ***	0.03
R&D expenditures (% of sales)	-0.26 ***	0.09	-0.19 **	0.07	-0.01	0.11	-0.09	0.09
Employment (no., worldwide in logs)	-0.30 ***	0.10	-0.23 ***	0.09	-0.13	0.12	-0.17 *	0.10
Model from mid-size segment (dummy)	0.21	0.16	0.36 ***	0.14	0.19	0.16	0.36 ***	0.14
Model from upper-size segment (dummy)	0.72 ***	0.21	0.69 ***	0.18	0.78 ***	0.21	0.70 ***	0.18
Station wagon (dummy)	0.13	0.14	0.16	0.12	0.19	0.14	0.16	0.12
Convertible (dummy)	0.57 **	0.22	-0.27	0.19	0.45 **	0.22	-0.31	0.19
Engine power (logs, kw)	-1.03 ***	0.30	-1.60 ***	0.25	-1.11 ***	0.29	-1.65 ***	0.25
Diesel engine (dummy)	0.11	0.12	-0.40 ***	0.11	0.07	0.12	-0.43 ***	0.11
Average value loss after 1st year (normalized, %)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EcoTest ranking (points)	-0.01	0.01	-0.01	0.01	-0.02 **	0.01	-0.01	0.01
Airbags (no.)	0.12 ***	0.04	0.11 ***	0.04	0.10 **	0.04	0.11 ***	0.04
Breakdown frequency (no. in logs)	-0.50 ***	0.17	-0.39 ***	0.14	-0.34 **	0.17	-0.37 **	0.15
Anti skid system (dummy)	0.12	0.12	0.18 *	0.10	0.16	0.12	0.14	0.11
Immobilizer (dummy)	0.32	0.26	0.14	0.23	0.27	0.26	0.11	0.23
On-board computer (dummy)	0.26 **	0.12	0.28 ***	0.10	0.43 ***	0.13	0.29 ***	0.11
Leather interior (dummy)	0.15	0.12	0.09	0.10	0.10	0.12	0.09	0.10
Power windows (no.)	0.01	0.06	0.08	0.05	0.06	0.06	0.10 *	0.05
Price (€; in logs; instrumented)	-1.11 ***	0.33	-0.87 ***	0.28	-1.16 ***	0.33	-0.84 ***	0.28
Constant	28.50 ***	2.76	25.22 ***	2.38	26.51 ***	2.95	24.27 ***	2.56
No. of Obs.	1,198		1,198		1,198		1,198	
RMSE	1.71		1.47		1.69		1.47	
R2	0.21		0.22		0.23		0.22	
chi2	326.32		329.5		354.99		336.38	
P>0	0.00		0.00		0.00		0.00	

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors.

The variables in Table 7 are our control variables. We develop no individual a priori hypotheses on their influences and the discussion is explorative in nature. One would generally expect that better equipped car models produce larger sales numbers. Then again, customers make judgments based not just on quality but quality given the sales price. We control for the latter which means that predictions on significant coefficients and signs are much less obvious.

Most of the control variables show the same signs in both West and East Germany (see Table 7). First, we find that the time that a foreign firm has been active in the German market is positively linked to the success of its individual car models. This result is fully in line with Pedersen and Petersen (2003) and Zaheer and Mosakowski (1997). Foreign enterprises learn and adapt to the specific preferences of German customers over time. Additionally, the age of car models makes a significant difference in success. We find that customers prefer car models that are more up to date and consequently reflect their expectations for a modern car more adequately. An announcement of a new model propels sales once the new model finally arrives. Interestingly enough, the overall advertising expenditures of a producer influence the quantity of sales negatively. We cannot observe advertising for a particular car model and it would therefore be farfetched to conclude that ad campaigns are per se useless or even counterproductive. Besides, an important argument for increased advertising expenditures is to balance weaknesses in sales. Considering the negative effect of R&D investments on model turnover we argue that these expenditures are necessary investments into the future and tie up resources in the short run while providing long term competitive potentials. The number of worldwide employees per car manufacturer shows a negative impact on sales performance

Not surprisingly, price elasticities for cars in West and East Germany are negative and significant. We find a significant negative impact of engine power on sales units in West and East Germany (see Table 7). Given that we already control for car price and segment, the room for variation in engine power is limited. We argue that average engine power within a certain price and size segment is sufficient for daily use. Cars with an engine power above this threshold are more likely for exclusive driving behavior (like sports cars). We argue that these high powered cars are for niche markets with lower volumes. Thus, the overall effect of engine power on sales units is negative. Dealership network shows a significant negative effect. Some industry studies have indicated that the brand exclusive dealership network in Germany is too extensive and our results may also point in this direction (see Cleff et al., 2005). Then again, customers are willing to buy reliable car models with superior safety features (as captured by the breakdown frequency and the number of airbags). On-board computer systems make a significant positive difference when it comes to convenience. All other amenities may be considered standard given a certain price and size segment.

Few quality feature differences between the two German markets remain. West Germans are attracted by convertibles while there is no preference in East Germany. A diesel powered engine makes a car less attractive in East Germans while an anti-skid system has a positive impact there. Cars of the mid-size segment are more attractive for East German customers than West German ones.

Generally spoken, we find no strong differences in purchasing patterns between East and West Germany. This may reflect the homogeneity of legal, tax and infrastructure environments in both sub-markets. However, the various significant results indicate that they are valuable control variables for the core theme of this study.

Appendix C: Correlation matrix and variance inflation factors

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	Foreign brand	1.00												
(2)	Brand Opel	0.20	1.00											
(3)	Brand Ford	0.22	-0.07	1.00										
(4)	German owend brand	0.23	-0.07	-0.08	1.00									
(5)	Time since model introd.	0.00	0.01	-0.13	0.00	1.00								
(6)	Time since brand introd.	-0.27	0.14	0.15	-0.07	0.05	1.00							
(7)	Licensed dealerships	0.48	-0.05	0.07	0.00	-0.05	-0.23	1.00						
(8)	Advertising expenditures	-0.19	0.27	0.02	-0.40	0.05	0.49	-0.42	1.00					
(9)	R&D expenditures	-0.39	-0.42	0.08	0.12	-0.07	0.35	-0.24	0.06	1.00				
(10)	Employment	-0.35	0.16	0.18	0.18	-0.02	0.29	-0.55	0.34	-0.05	1.00			
(11)	Mid-size segment	-0.14	-0.03	-0.06	-0.09	-0.06	0.09	-0.05	-0.16	0.11	-0.12	1.00		
(12)	Upper size segment	-0.16	-0.10	-0.11	-0.08	-0.03	0.07	0.00	0.05	0.04	-0.03	-0.32	1.00	
(13)	Station wagon	-0.04	-0.11	-0.12	0.05	0.05	0.04	-0.01	0.02	0.14	-0.08	0.19	-0.15	1.00
(14)	Convertible	-0.11	0.03	-0.06	-0.05	0.00	-0.10	0.01	-0.07	0.02	-0.01	-0.07	0.16	-0.12
(15)	Engine power	-0.36	-0.04	-0.14	-0.13	-0.08	0.26	-0.15	-0.02	0.16	0.00	0.41	0.28	0.02
(16)	Diesel engine	-0.01	0.00	0.01	0.05	-0.08	0.07	-0.03	0.05	0.05	0.02	0.03	-0.03	0.06
(17)	Average value loss	0.07	-0.02	-0.02	0.25	0.05	-0.05	0.05	-0.10	-0.02	0.06	-0.06	0.11	-0.03
(18)	EcoTest ranking	-0.18	0.23	-0.03	-0.08	0.01	0.15	-0.21	0.10	0.06	0.14	0.49	-0.13	0.09
(19)	Airbags	0.02	0.01	-0.05	-0.11	-0.10	0.21	0.00	0.11	0.08	-0.06	0.28	-0.08	0.17
(20)	Breakdown frequency	0.34	0.03	-0.04	0.24	0.06	0.05	0.40	-0.21	-0.23	-0.18	-0.02	-0.01	0.01
(21)	Anti skid system	-0.19	0.04	-0.19	0.06	-0.11	0.13	-0.06	0.08	0.21	-0.04	0.15	0.03	0.22
(22)	Immobilizer	0.00	0.07	0.07	0.09	0.04	-0.09	0.07	-0.14	0.01	0.04	0.09	-0.13	0.03
(23)	On-board computer	0.15	-0.03	-0.13	0.18	-0.04	0.08	-0.09	0.11	-0.03	0.02	0.11	-0.02	0.11
(24)	Leather interior	0.20	0.09	0.00	-0.08	-0.01	0.05	0.09	0.13	-0.08	-0.14	0.06	0.09	0.00
(25)	Power windows (no.)	-0.01	-0.11	0.00	-0.01	-0.05	0.01	0.01	0.05	0.05	-0.05	0.32	0.00	0.14
	Variance Inflation Factor (VIF)	3.28	1.96	1.79	2.94	1.15	2.65	2.39	3.22	2.65	2.97	2.34	1.59	1.17

	Variable	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
(14)	Convertible	1.00											
(15)	Engine power	0.11	1.00										
(16)	Diesel engine	-0.15	-0.17	1.00									
(17)	Average value loss	0.07	0.02	-0.05	1.00								
(18)	EcoTest ranking	0.08	0.39	-0.20	0.05	1.00							
(19)	Airbags	-0.17	0.23	0.11	-0.06	0.21	1.00						
(20)	Breakdown frequency	0.00	-0.07	0.02	0.19	-0.07	0.04	1.00					
(21)	Anti skid system	-0.03	0.30	0.04	-0.07	0.22	0.37	0.04	1.00				
(22)	Immobilizer	0.02	-0.03	0.09	0.02	0.02	0.30	-0.08	0.07	1.00			
(23)	On-board computer	-0.07	0.18	0.12	-0.01	0.10	0.39	0.12	0.25	0.11	1.00		
(24)	Leather interior	0.03	0.16	0.02	0.04	0.08	0.17	0.25	0.19	0.04	0.29	1.00	
(25)	Power windows	-0.03	0.27	0.16	0.02	0.14	0.55	-0.04	0.26	0.36	0.41	0.27	1.00
	VIF	1.17	2.27	1.23	1.17	1.84	2.15	1.72	1.55	1.44	1.65	1.39	2.16
	Mean VIF	1.99											

9 Literature

ADAC, 2004. Ecotest. ADAC: http://www.adac.de/images/22930_tcm8-117022.pdf.

Belk, R., 1988. Possession and the Extended Self. Journal of Consumer Research 15(2), 139-168.

Berkovec, J., Rust, J., 1985. A Nested Logit Model of Automobile Holdings for One Vehicle Households. Transportation Research Part B: Methodological 19 (4), 275-285.

Berry, S., Levinsohn, J., Pakes, A., 1995. Automobile Prices in Market Equilibrium. Econometrica 63 (4), 841-890.

Brownstone, D., Bunch, D.S., Train, K., 2000. Joint Mixed Logit Models of Stated and Revealed Preferences for Alternative Fuel Vehicles. Transport Research Part B: Methodological 34 (5), 315-338.

Bunch, D.S., Bradley, M., Golob, T.F., Kitmura, R., 1993. Demand for Clean-Fuel Vehicles in California – a Discrete Choice Stated Preference Pilot Project. Transportation Research Part A: Policy and Practice 27 (3), 237-253.

Chao, P., Gupta, P.B., 1995. Information Search and Efficiency of Consumer Choices of New Cars: Country-of-Origin Effects. International Marketing Review 12 (6): 47-59.

Cleff, T., Heneric, O., Spielkamp, A., 2005. Regulation and Industrial Policy, in: Heneric O, Licht G, Sofka W. (Eds.). Europe's Automotive Industry on the Move: Competitiveness in a Changing World. Heidelberg, pp. 157-190.

Court, A.T., 1939. Hedonic Price Indexes. General Motors Corporation. in: Court AT. (Eds.), The Dynamics of Automobile Demand. New York, pp. 99-117.

DeYoung, R., Nolle, D.E., 1996. Foreign-Owned Banks in the United States: Earning Market Share or Buying It? Journal of Money, Credit, and Banking 28, 622-636.

Dierickx, I., Cool, K., 1989. Assett Stock Accumulation and Sustainability of Competitive Advantage. Management Science 35 (12), 1504-1511.

European Commission, 2004. EU Industrial R&D Investment Scoreboard. Brussels.

Ghemawat, P., 2001. Distance Still Matters: The Hard Reality of Global Expansion. Harvard Business Review 79 (8), 137-146.

Ghemawat, P., 2003. The Forgotten Strategy. Harvard Business Review 81 (11). 76-84.

Goldberg, P.K., Verboven, F., 2001. The Evolution of Price Dispersion in the European Car Market. Review of Economic Studies 68 (4), 811-849.

Goldberg, P.K., Verboven, F., 2004. Cross-Country Price Dispersion in the Euro Era: A Case Study of the European Car Market. Economic Policy 19 (40), 484-522.

Goshal, S., Bartlett, C., 1990. The Multinational Corporation as an Interorganizational Network. Academy of Management Review 15, 603-625.

Granovetter, M., 1985. Economic Action and Social Structure: The Problem of Embeddedness. American Journal of Sociology 91 (3), 481-510.

Griliches, Z., 1961. Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change. The Price Statistics of the Federal Government. NBER General Series 73 (3), 173-196.

Gurhan-Canli, Z., Maheswaran, D., 2000. Determinants of Country-of-Origin Evaluations. Journal of Consumer Research 27 (1), 96-108.

Hasan, I., Hunter, W.C., 1996. Efficiency of Japanese Multinational Banks in the United States, in: Chen AH. (Eds.) Research in Finance. Greenwich and London, pp. 157-173.

Hennart, J.F., 1982. A Theory of Multinational Enterprise, Michigan.

Hymer, S.H., 1976. The International Operations of National Firms: A Study of Direct Investment, Cambridge.

Jensen, R., Szulanski, G., 2004. Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers. Journal of International Business Studies 35 (6), 508-523.

Lord, M.D., Ranft, A.L., 2000. Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge. Journal of International Business Studies 31 (4), 573-589.

Luo, Y., Shenkar, O., Nyaw, M.K., 2002. Mitigating Liabilities of Foreignness: Defensive Versus Offensive Approaches. Journal of International Management 8 (3), 283-301.

Mathur, A., Moschis, G.P., Lee, E., 2003. Life Events and Brand Preference Changes. Journal of Consumer Behaviour 3 (2), 129-141.

Mehta, R., Belk, R., 1991. Artifacts, Identity, and Transitions: Favourite Possessions of Indians and Indian Immigrants to the US, Journal of Consumer Research 17 (4), 398-411.

Mezias, J.M., 2002a. How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations. Journal of International Management 8 (3), 265-283.

Mezias, J.M., 2002b. Identifying Liabilities of Foreignness and Strategies to Minimize Their Effects: The Case of Labor Lawsuit Judgement in the United States. Strategic Management Journal 23, 229-244.

Miller, S.R., Parkhe, A., 2002. Is There a Liability of Foreignness in Global Banking? An Empirical Test of Banks' X-Efficiency. Strategic Management Journal 31 (1), 323-337.

Miller, S.R., Richards, M., 2002. Liability of Foreignness and Membership in a Regional Economic Group: Analysis of the European Union. Journal of International Management 8 (3), 323-337.

Nachum, L., 2003. Liability of Foreignness in Global Competition? Financial Service Affiliates in the City of London. Strategic Management Journal 24 (12), 1187-1208.

Nachum, L., 2006. What Constitutes the Liability of Foreignness? Proceedings of Academy of Management. Atlanta.

Ohmae, K., 1990. The Borderless World: Power and Strategy in the Interlinked Economy. New York.

Petersen, B., Pedersen, T., 2002. Coping with Liability of Foreignness: Different Learning Engagements of Entrant Firms. Journal of International Management 8(3), 339-350.

Rosen, S., 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. The Journal of Political Economy 82 (1), 34-55.

Samiee, S., Shimp, T.A., Sharma, S., 2005. Brand Origin Recognition Accuracy: Its Antecedents and Consumers' Cognitive Limitations. Journal of International Business Studies 36 (4), 379-397.

Sofka, W., 2006. Innovation Activities Abroad and the Effects of Liability of Foreignness: Where It Hurts. ZEW Discussion Paper No. 06-029, Mannheim.

Thoits, P., 1995. Stress, Coping, and Social Support Processes: Where Are We? What Next? Journal of Health and Social Behaviour 35(Extra Issue: Forty Years of Medical Sociology: The State of The Art and Directions for the Future), 53-79.

Train, K., Sonnier, G., 2002. Mixed Logit with Bounded Distribution of Correlated Pathworks. University of California Berkeley Working Paper. http://elsa.berkeley.edu/wp/train1202b.pdf.

VDA, 2004. Auto Jahresbericht, Frankfurt.

Verboven, F., 1998. Testing for 'Monopoly' Market Power When Products Are Differentiated in Quality. Manchester School 70 (1), 115-134.

Verboven, F., 2002. Quality-Based Price Discrimination and Tax Incidence: Evidence from Gasoline and Diesel Cars. RAND Journal of Economics 33 (2): 275-298.

Wan, G., 1998. Nonparametric Measurement of Preference Changes: The Case of Food Demand in Rural China. Applied Econometrics Letters 5, 433-436.

Weber, J., Hansen, R., 1972. The Majority Effect and Brand Choice. Journal of Marketing Research 9 (3), 320-323.

Zaheer, S., 1995. Overcoming the Liability of Foreignness. Academy of Management Journal 38 (2), 341-364.

Zaheer, S., Mosakowski, E., 1997. The Dynamics of the Liability of Foreignness: A Global Study of Survival in Financial Services. Strategic Management Journal 18 (6), 439-464.

Zaheer, S., Zaheer, A., 1997. Country Effects on Information Seeking in Global Electronic Networks. Journal of International Business Studies 28 (1), 77-100.

Zinam, O., 1974. Role of Consumer Preferences in an Economic System. The American Journal of Economics and Sociology 33 (4), 337-350.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Globalizing Domestic Absorptive Capacities

AUTOREN: ***Wolfgang Sofka***

[Universität Hamburg, ZEW Mannheim]

JAHR: 2005

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper
No. 05-53, Mannheim
Zweite Einreichungsrunde bei
Management International Review (MIR)
Status: Revision eingereicht.

AUSGEWÄHLTE PRÄSENTATIONEN: Technology Transfer Society
Kansas City, 2005

R&D Management
Pisa, 2005

Danish Research Unit for Industrial
Dynamics (DRUID)
Kopenhagen, 2005

Wolfgang Sofka

Globalizing Domestic Absorptive Capacities

Abstract

- The literature on the internationalization of innovation activities has largely focused on the role of foreign subsidiaries and their R&D engagements. We extend this stream of research by focusing on how firms globalize their absorptive capacities by sourcing impulses from international customers, suppliers and competitors which trigger domestic innovation activities.

- We identify three factors conceptually: Investments into absorptive capacities, international exposure and experience as well as the relevance of international knowledge compared to the domestic environment. Besides, we draw distinctions between knowledge from foreign customers, suppliers and competitors. We test these hypotheses empirically by means of a survey of more than 2,200 German firms.

Key Results

- We find that the globalization of absorptive capacities is a combination of investments into absorptive capacities (most importantly through ambitious incentive systems), export experience and shortcomings of the domestic innovation environment.

- These results differ with regards to whether the knowledge stems from foreign customers, suppliers or competitors.

Author

Wolfgang Sofka, Research Fellow, Centre for European Economic Research, Department Industrial Economics and International Management, P.O. Box 10 34 43, D-68034 Mannheim, Germany

Introduction

Establishing "pipelines" to valuable technological expertise and market intelligence around the world has become a major theme of modern innovation management (Malmberg/Maskell 2005). Political and economic changes in large, unexplored markets combined with technological breakthroughs (internet, telecommunications) in easy, affordable communication provide exciting opportunities. Important research has been conducted into multinational firms and how they tap into international knowledge pools through subsidiaries and foreign direct investments (see for example Anand/Kogut 1997, Kuemmerle 1999, Von Zedtwitz/Gassmann/Boutellier 2004) or based on patent statistics (see for example Almeida/Phene 2004, Jaffe/Trajtenberg/Henderson 1993). We extend this line of research by focusing on the transfer of impulses across national borders that may trigger domestic innovation activities.

To do so, we draw arguments from the literature on firms' absorptive capacity, i.e. their ability to identify, assimilate and exploit knowledge from their environment (Cohen/Levinthal 1989, 1990). More precisely, we explore the specific challenges in an international environment stemming from national and cultural borders. We ask: What factors lead firms to source innovation impulses abroad so that they can globalize their absorptive capacities? We develop these factors conceptually and derive distinctions between the specifics of different knowledge sources (foreign customers, suppliers and competitors). We test these hypotheses empirically using a survey of more than 2,200 German firms and their innovation activities.

Our analysis is structured as follows: The following section provides a theoretical background followed by the development of hypotheses. The subsequent sections provide an overview of the empirical study (data, methods, measures) and its results. We conclude with a discussion of these.

Theory Section

Several studies have outlined the rationale (competitive pressure, shorter product lifecycles, high investments, available external expertise) for companies to leverage external sources of innovation (Chatterji 1996, Chesbrough 2003, Kleinschmidt/Cooper 1988). These sources need to be identified, activated and managed for success (Gottfredson/Puryear/Phillips 2005, Stock/Tatikonda 2004). The capability to achieve this has been conceptualized as a firm's absorptive capacity (Cohen/Levinthal 1989, 1990). It has three major components: The identification of valuable knowledge in the environment, its assimilation with existing knowledge stocks and finally its exploitation for successful innovation. Absorptive capacities, their roots, mechanisms and consequences have been major issues of recent scientific discussion (Lane/Koka/Pathak 2006 count 289 papers in their excellent review). Absorptive capacities link a company's innovation system with its environment. Hence, they cannot remain static as the environment changes (Szulanski 1996, Van den Bosch/Volberda/de Boer 1999). They allow firms to reinforce, complement or refocus their knowledge base (Lane/Koka/Pathak 2006). Zahara/George (2002) introduce the distinction between

potential and realized absorptive capacity. Put simply, they envision absorptive capacity as a funnel with a large opening for taking in a broad variety of diverse ideas with potential value. These have to be narrowed down, prioritized and codified to facilitate efficient assimilation and exploitation processes (Jansen/Van den Bosch/Volberda 2005). We build upon this concept by introducing the effects of globalization to this basic notion of "valuable knowledge from the environment" and how firms readjust their absorptive capacities to deal with a much larger pool of potential ideas which are also more diverse. We define the globalization of absorptive capacities as a set of organzational processes that enable domestic companies to use international innovation impulses in their domestic innovation processes.

Breakthroughs in information and telecommunications technology as well as the opening of large, dynamic markets, most notably in China and India, are amplifying the scope of promising ideas and impulses (Govindarajan/Gupta 2001, Gupta/Westney 2003). The benefits of internationalizing innovation activities are well documented: responsiveness to foreign market conditions (e.g., tastes, regulations) (Craig/Douglas 2000), learning from localized, country-specific expertise (Kuemmerle 1999, Rugman/Verbeke 2003) and increasing efficiency by leveraging comparative cost advantages abroad (e.g., large supply of scientific personnel, 24/7 lab activities) (Von Zedtwitz 2004). Conversely, the risks from missing important technological or market trends (Rugman/Verbeke 2004) as well as resource commitments for the wrong ones are increasing, as pockets of valuable expertise are becoming more globally diverse and dispersed (Doz/Santos/Williamson 2001). Competitive advantage can be achieved if companies have the competencies and processes in place to identify market and technology opportunities that are unarticulated, overlooked or underestimated (Von Zedtwitz/Gassmann 2002a). The challenge for any innovation management system is to absorb and prioritize prospective innovation signals (Lloyd 1995). This is especially difficult as the information that has to be transferred is often subtle, complex and difficult to transfer (Doz/Santos/Williamson 2001). Moreover, transnational knowledge flows represent a challenge because a significant border effect exists (Branstetter 2001, Jaffe/Trajtenberg 1999, Jaffe/Trajtenberg/Henderson 1993, Peri 2005, Porter/Stern 2000).

Hypotheses Development

Szulanski (1996, 2000) provides a process perspective on knowledge transfers. We utilize this framework and envision the sourcing of innovation impulses as a form of knowledge transfer. The knowledge transfer model has four distinctive stages. It starts with an initiation stage which largely consists in identifying and evaluating relevant knowledge and its sources, followed by the implementation stage, in which the knowledge should be captured as completely as possible and transferred from its source to the recipient. The transfer concludes with an initial "ramp up" stage for the recipient including trial and test activities. The final stage is one of integration into the recipient's knowledge base. The recipient's absorptive capacities are an important factor for the success of this multistage knowledge transfer (Szulanski 2000). We argue that knowledge sourcing in a globalized environment adds new challenges to this process at the early stages, i.e. initiation and implementation, when the potential knowledge sources have to be identified and their knowledge captured and codified

comprehensively. Doz/Santos/Williamson (2001) conceptualize these early stages as "sensing" for new competencies, innovative technologies and lead market knowledge. This is seen as the basic layer of internationalizing innovation activities; the mobilization of resources and their execution follow.

Searching for valuable innovation impulses around the globe adds the additional dimension of cultural and social borders. Knowledge cannot be separated from the commitments and belief patterns of its holders (Nonaka 1994). Frictional losses in cross-border situations have been summarized as liabilities of foreignness (Zaheer 1995). Language barriers and differences in communication patterns are an important element of these cultural obstacles (West/Graham 2004). They are typically related back to institution theory. Environmental pressure and opportunities in the domestic market shape the skills, structures, practices and routines of companies and their staff over time. A firm's constant exposure to its environment and the interaction between the two leads to an organizational entity that reflects its domestic social, cultural, economic and legal environment. Many of the rules in the environment are causally ambiguous or unwritten (Jensen/Szulanski 2004) which makes them difficult to codify and transfer. We argue that a firm's ability to absorb foreign knowledge impulses will depend upon investments in absorptive capacities, the exposure it has to international markets and the relevance that international knowledge has compared to the domestic environment.

Investments in Absorptive Capacities

Foreign knowledge is embedded in an unfamiliar cultural context. Transferring and absorbing tacit and complex knowledge is difficult (Garud/Nayyar 1994, Szulanski 1996). The ambiguity induced by tacitness makes the process less effective, while the additional knowledge needed to understand complex items makes it less efficient. As firms move away from the certainties of their home market environment into the uncertainties of international markets, they are subject to cognitive uncertainty, i.e. a reduced ability to predict and explain the behavior of others (Harvey/Novicevic 2000). This results in more frequent mistakes and delays (Lord/Ranft 2000). Hence, identifying and absorbing foreign knowledge requires additional transformation layers before this knowledge can be assimilated with existing knowledge stocks. A basic element of this transformation process is language translation. Besides, the relevant knowledge has to be detached from idiosyncratic elements of the institutional, technological and market context abroad. Todorova/Durisin (2007) identify this transformation of external knowledge as a key element of a firm's absorptive capacity. Hence, firms need superior absorptive capacities to extend their reach to foreign knowledge sources. We argue that these additional challenges need to be reflected in the investments into their development. This leads to our first hypothesis:

> Hypothesis I: Globalized knowledge sourcing becomes more likely as firms extend their investments in absorptive capacities.

Exposure to International Markets

Existing literature on a firm's absorptive capacity has largely focused on its development as a by-product of technological R&D engagements (see for example

Cohen/Levinthal 1989). We suggest that valuable competences and capabilities for identifying and absorbing foreign knowledge may also stem from internationalization experience. Firms may benefit from complementary resources and capabilities developed in related internationalization activities. In that sense, we extend the concept of Dyer/Singh (1998), who find that absorptive capacities are not just the result of in-house R&D engagements but also generated through interactions and collaborations with other firms. These interchanges establish communication channels and mutual understanding which can subsequently be exploited for transferring knowledge (Laursen/Salter 2006). Hence, we argue that a firm's exposure to international markets generates richer transmission channels which facilitate knowledge flows (Gupta/Govindarajan 2000). Furthermore, if this international experience is missing firms may suffer from global organizational ignorance (Harvey/Novicevic 2000), i.e. managers' lack of awareness of important foreign information or the inability to interpret it correctly. In such a case, they are more likely to rely on knowledge from their home market when making decisions, even when it does not fit into the foreign context. Home market knowledge is typically more readily available, can be related back to a class of previous experiences and provides consistency with previous convictions (Harvey/Novicevic 2000). As a result, we hypothesize:

> Hypothesis II: Firms with high degrees of internationalization are more likely to globalize their absorptive capacities.

Relevance of International Knowledge

Search strategies depend upon the opportunities in the environment (Levinthal/March 1993) and the levels of motivation for both knowledge sources and recipients (Szulanski 1996). Knowledge from the domestic environment may be easier and less costly for firms to access. However, the home country may not provide sufficient impulses. Almeida/Phene (2004) find that multinational firms select host countries for their R&D engagements based on the expected benefits from superior factor endowments and knowledge spillovers from competitor R&D investments. Superior innovation inputs found outside their home borders can therefore incite a firm to globalize its knowledge sourcing (Le Bas/Sierra 2002). Certain domestic paucities might also be based on the fact that important sources for innovation in the value chain have moved abroad (suppliers, customers) or that competitors from abroad are threatening established market positions (Doz/Santos/Williamson 2001). Consequently, a firm's decision to globalize its knowledge sourcing may not be limited to internal resources and capabilities like investments in absorptive capacities and experience in international markets. Instead, the relative abundance of valuable knowledge abroad compared to the home market may force firms to develop globalized absorptive capacities.

> Hypothesis III: A scarcity of valuable domestic knowledge increases the likelihood for globalized absorptive capacities.

Besides, we suspect that the relationships described in hypotheses I to III differ with regards to the nature of the source, i.e. whether the impulse stems from a foreign customer, supplier or competitor. The channels for promising knowledge sources vary significantly in terms of the norms, routines and habits of knowledge carriers

(Laursen/Salter 2006). The effectiveness of knowledge transfers depends upon how effectively knowledge can be articulated, captured and codified (Zander/Kogut 1995). Knowledge embodied in products or codified in manuals or training is generally easier to transfer (Pittaway/Robertson/Munir/Denyer/Neely 2004). These attributes apply more typically to knowledge flows from suppliers (new materials, intermediate products, machines and equipment) or competitors (opportunities for reverse engineering). Acquiring valuable knowledge from customers holds other challenges. Their impulses have been found to be often unarticulated, narrow and unreliable (Frosch 1996, Sandberg 2007). As a result, we add an exploratory layer to this analysis and investigate the hypotheses developed above separately for impulses from foreign customers, suppliers and competitors.

Data and Methods

For the empirical part of this paper we use cross section data from a survey on the innovation behavior of German enterprises called the "Mannheim Innovation Panel" (MIP). The survey is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry for Education and Research. The methodology and questionnaire of the survey are the same as those used in the Community Innovation Survey (CIS), conducted every four years under the co-ordination of Eurostat. For our analysis we use the 2003 survey. About 4,500 firms in manufacturing and services responded to the survey and provided information on their innovation activities. We utilized this data to operationalize the concepts presented above. Using CIS data has two major advantages. First, heads of R&D departments or innovation management are asked directly if and how they have been able to generate innovations. This leads to the production of direct measures for processes and outputs which can complement traditional measures for innovation such as patents (Kaiser 2002, Laursen/Salter 2006). Secondly, the multinational application of CIS surveys adds extra layers of quality management and assurance. CIS surveys are subject to extensive pre-testing and piloting in various countries, industries and firms with regard to interpretability, reliability and validity (Laursen/Salter 2006).

Additionally, we complement this firm-specific dataset with international trade data provided by the OECD (ITCS – International Trade by Commodity Statistics 2003 and TIS – Trade in Services 2004) and data on business R&D expenditures (ANBERD - R&D Expenditure in Industry 2003). Both additional datasets are available, and hence merged, at the industry level.

Measures

Dependent Variable

We focus on systematic activities that enable domestic companies to use international innovation impulses in their domestic innovation processes. This sourcing of innovation impulses from abroad may result from active screening or could be the by-product of other activities. We use three individual dependent variables to capture these transfers of knowledge impulses. These were generated from three direct questions on the country of origin of customers, suppliers or competitors which were used as essential

sources for domestic innovation.[1] Each of these three dependent variables is in binary format. It was possible for a respondent to report using any combination of these sources at one time, or none.

Independent Variables

We test our hypotheses by incorporating each of the theoretical concepts (absorptive capacity, exposure to international markets, relevance of international knowledge) through multiple independent variables in our empirical model.

Absorptive capacities are not a tangible concept but rather a combination of different competencies and capabilities. Hence, companies cannot be easily surveyed to estimate the degree to which they possess these absorptive capacities. Cohen/Levinthal (1989, 1990) follow the rationale that absorptive capacities are developed by performing R&D activities. We follow their suggestion and introduce R&D intensity (share of R&D expenditures of sales lagged by one year) to our model. Other studies have extended this concept and point towards absorptive capacities at the level of individual employees and their educational attainments (Rothwell/Dodgson 1991). Consequently, we incorporate the employees' level of education into the empirical model through the share of employees with graduate education. Besides, absorptive capacities have been shown to depend upon organizational motivation and incentive systems to activate these assets (Lane/Lubatkin 1998a, Lord/Ranft 2000). We utilize information on the importance of management strategies for stimulating innovation activities. Respondents indicated on a four point Likert scale how important the following measures are for their company: monetary incentives, non-monetary incentives, target agreements, identification/development of key personnel, recruitment/training, empowerment of line managers, creativity circles, groupwork, union involvement. A principal component factor analysis was performed on these nine categories, yielding a single factor with an eigenvalue larger than one (5.94). We score an index-variable (after Varimax rotation, rescaled between 0 and 1) to capture the effect of management stimulation for innovation.

We measure a firm’s exposure to international markets through the share of sales that are exports (lagged values for 2001). Lu/Beamish (2004) suggest that the relationship between exporting and performance is not necessarily a linear one. It is therefore important to capture the effect of firms with exceedingly high shares of exports. We incorporate this effect by adding the squared share of exports to the model, which in turn tests for a u-shaped relationship between export activity and the globalization of absorptive capacities. Exports may be a sub-optimal measure to capture the exposure to international markets for multinational firms, i.e. firms that possess subsidiaries abroad (Sullivan 1994). Hence, we follow Veugelers/Cassiman (1999) and add two dummy variables indicating whether the firm is part of a multinational group and, if so, whether its headquarters are in Germany or abroad. Both factors may provide firms with richer channels to transfer knowledge (see for example Hakanson/Nobel 2001).

To capture the “relevance of international knowledge” component outlined above, we add variables for the richness of the domestic innovation landscape at the industry level and firm specific variables on shortages perceived as particularly important. For the former we introduce Germany's revealed comparative advantage (RCA)[2] among OECD

countries in 2002 at the industry level as a measure for competitive performance/specialization, and the German share of OECD business R&D expenditures (BERD) by industry in 1999[3] as a measure for competitive potential. This reflects the findings by Almeida/Phene (2004) that the attractiveness of foreign locations depends upon the quality of their factor endowments and spillovers from competitor R&D investments. However, firms' decisions to globalize absorptive capacities may stem to a lesser degree from objective assessments of their domestic environment but rather from subjectively perceived shortcomings (Hellriegel/Slocum Jr 1974). The latter may stem from a lack of technological information, high risks or unfavorable regulatory environments (Buckley/Casson 1998) which increase the relative attractiveness of foreign knowledge. Perceived shortages at the firm level are captured through three dummy variables accounting for firms' evaluations of obstacles to their innovation activities which might, in turn, trigger a search process for external innovation sources from abroad. The variables are high risks and the closely related high costs of innovation projects, a lack of technological information and unfavorable conditions in regulation or governmental bureaucracy. Firms rate the importance of these obstacles to them on a four point Likert scale (not relevant to high). The dummy variables take a value of one if the importance of the obstacle was perceived as high.

Finally, we add several variables to control for other potentially influencing effects. These are firm size (logarithm of the number of employees) and regional effects (whether a company is located in the eastern part of Germany or not). Again, we add the squared term of the number of employees (in logs) to the model to control for a u-shaped relationship and particular effects from exceedingly large firms. Furthermore, border effects have been found to be less pronounced in certain industries, such as semiconductors (Irwin/Klenow 1994). Hence, six additional, instrumental industry group variables have been introduced to capture industry-specific aspects that would distort the explanatory power of our other exogenous variables.[4] The comparison group in all further analytical steps is "other manufacturing."

Model

The decisions to use a foreign customer, supplier or competitor as a key source for innovation are not independent of one another. It is quite conceivable that firms choose multiple sources at the same time, for example when they are operating in multiple industries. To model this link between the three decisions adequately, we use a trivariate probit model instead of estimating the equations for each source separately. Within our empirical framework, the trivariate probit is superior to multinomial logit models since it allows us to reflect simultaneous multiple-source usage and use the available information completely (Greene 1993). Firms may choose any combination of foreign innovation impulses (customers, suppliers, competitors) or none. Hence, we model the decision for each impulse separately but estimate the complete system through a trivariate probit model. The trivariate probit model is directly derived from the standard probit model, but allows more than one equation with correlated disturbances. This technique is quite comparable to the seemingly unrelated regressions model. Estimating three equations simultaneously allows us to improve the estimated sampling precision and consequently facilitates a more complete usage of the available information. In essence, each probit equation holds information on factors that influenced the decisions

on all three possible foreign sources. Estimating these equations simultaneously utilizes this information for the complete system. The specification for our three-equation model is

$$customersource^* = \beta_1' x + \varepsilon_1,\ \ customersource = 1\ if\ customersource^* > 0, 0\ otherwise,$$
$$suppliersource^* = \beta_2' x + \varepsilon_2,\ \ suppliersource = 1\ if\ suppliersource^* > 0, 0\ otherwise,$$
$$competitorsource^* = \beta_3' x + \varepsilon_3,\ \ competitorsource = 1\ if\ competitorsource^* > 0, 0\ otherwise.$$
$$Cov(\varepsilon_1, \varepsilon_2) = \rho_1$$
$$Cov(\varepsilon_1, \varepsilon_3) = \rho_2$$
$$Cov(\varepsilon_2, \varepsilon_3) = \rho_3$$

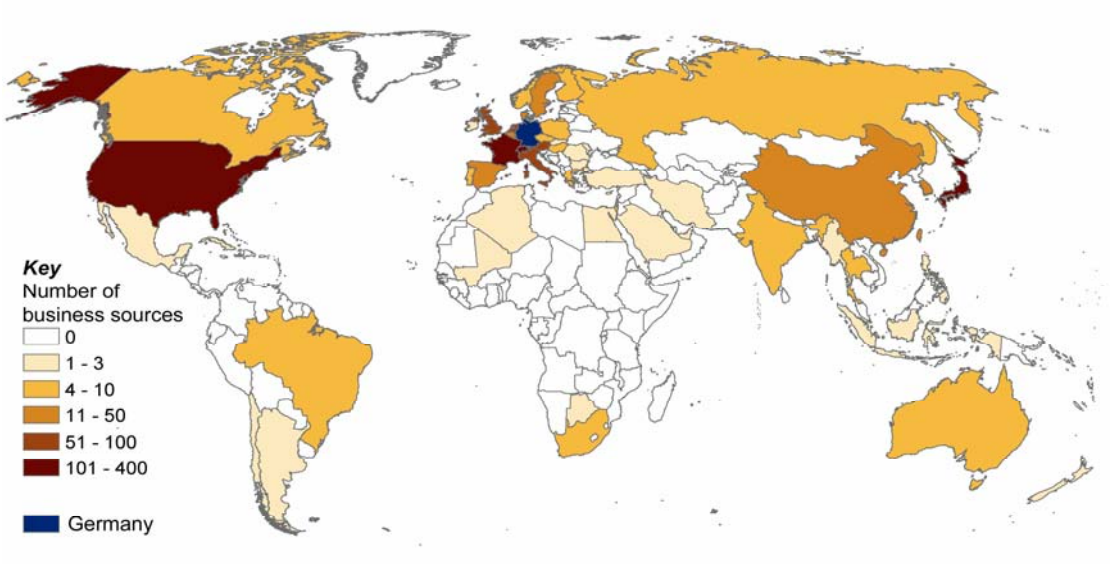
where x is the vector of explanatory variables.

Estimating trivariate or more generally multivariate probit regression models using maximum likelihood methods involves some unique challenges. Normal probability distribution functions have to be calculated in the evaluation of probit-model likelihood functions. While algorithms for the bivariate case exist, more highly dimensional normal distributions still pose a problem. Hence, we turn to a simulation-based technique: the Geweke-Hajivassiliou-Keane (GHK) simulator. This simulator relies on sequentially conditioned, univariate normal distribution functions, through which multivariate normal distribution functions can be expressed.

Results

Complete data for the variables described above is available for 2,276 companies. This is the basis for all of the following elaborations. Foreign customers (326 observations) are apparently the most promising foreign innovation impulses. Suppliers (119) or competitors (139) are chosen less frequently. Figure 1 puts their origins on a map. While we use only a narrow dimension (domestic/foreign) for this particular analysis it becomes apparent that our observations are not limited to a few neighboring or triad countries but are truly “global.”

Figure 1: Map of innovation impulses



Source: ZEW Mannheim Innovation Panel 2003.
Note: Multiple country responses possible.

There are no indications on multicollinearity in the dataset. Table 3 of the appendix presents details on correlation coefficients and variance inflation factors. Table 1 provides descriptive statistics. They indicate that firms using international innovation impulses are distinctively and broadly different from the full sample of firms. Across individual variables they report higher levels of absorptive capacities (higher levels of R&D expenditures, employees with graduate education as well as the management stimulation for innovation) and degrees of internationalization (exports as a share of sales as well as the likelihood of being part of a multinational group). With regards to the "relevance" factor, differences become especially visible in the firm-specific intensity of perceived shortages but not necessarily in the industry wide factors. International knowledge sourcing appears to be especially relevant for firms with high cost and risk innovation activities as well as firms under regulatory pressures. Finally, these firms are generally larger, but spread out over a wide array of industries. The more detailed discussion below focuses on the estimation results.

Table 1: Descriptive statistics: Means and standard errors (in parentheses)

Definitions	*Full sample*	*Foreign customer impulse*	*Foreign supplier impulse*	*Foreign competitor impulse*
Absorptive capacity				
Share of graduates among employees	23.18	31.07	27.43	31.88
	(26.89)	(26.37)	(25.66)	(25.92)
R&D expenditures as a share of sales 2001	2.98	8.01	6.25	8.13
	(8.48)	(11.90)	(11.68)	(12.96)
Index value of management stimulation for innovation	0.35	0.51	0.50	0.53
	(0.18)	(0.18)	(0.18)	(0.17)
International exposure				
Exports as a share of sales, 2001	13.92	35.71	23.18	32.66
	(22.70)	(26.92)	(27.87)	(28.78)

Definitions	*Full sample*	*Foreign customer impulse*	*Foreign supplier impulse*	*Foreign competitor impulse*
Company is part of multinational group with foreign headquarters (Dummy)	0.07	0.13	0.15	0.16
	(0.26)	(0.34)	(0.36)	(0.37)
Company is part of multinational group with German headquarters (Dummy)	0.10	0.21	0.17	0.24
	(0.30)	(0.41)	(0.38)	(0.43)
Relevance				
Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	10.25	18.06	7.06	18.45
	(65.47)	(40.11)	(55.23)	(36.40)
German share of global business R&D in industry, 1999	10.19	9.54	8.00	9.31
	(6.63)	(4.98)	(5.55)	(5.14)
Obstacle lack of technological information (Dummy)	0.06	0.14	0.14	0.17
	(0.24)	(0.35)	(0.35)	(0.37)
Obstacle innovation costs or risk (Dummy)	0.24	0.46	0.59	0.49
	(0.43)	(0.50)	(0.49)	(0.50)
Obstacle regulation or bureaucracy (Dummy)	0.12	0.23	0.31	0.29
	(0.33)	(0.42)	(0.46)	(0.46)
Control variables				
Company is located in Eastern Germany (Dummy)	0.35	0.34	0.33	0.39
	(0.48)	(0.48)	(0.47)	(0.49)
Number of employees	574.69	1,125.53	1,386.83	1,566.27
	(9,453.78)	(6,869.41)	(9,581.26)	(6,259.61)
Industry group other manufacturing (Dummy)	0.35	0.25	0.31	0.22
	(0.48)	(0.43)	(0.46)	(0.42)
Industry group medium high-tech manufacturing (Dummy)	0.16	0.34	0.16	0.30
	(0.36)	(0.48)	(0.37)	(0.46)
Industry group high-tech manufacturing (Dummy)	0.07	0.20	0.16	0.20
	(0.26)	(0.40)	(0.37)	(0.40)
Industry group distributive services (Dummy)	0.14	0.04	0.13	0.02
	(0.35)	(0.20)	(0.34)	(0.15)
Industry group knowledge-intensive services (Dummy)	0.13	0.02	0.03	0.06
	(0.33)	(0.15)	(0.16)	(0.23)
Industry group technological services (Dummy)	0.15	0.15	0.21	0.19
	(0.36)	(0.35)	(0.41)	(0.40)
Observations	2276	326	119	139

Table 2 provides the results of our trivariate probit estimation. The choice of a trivariate probit setup instead of three separate probit estimations is justified. The correlation among all individual error terms is both positive and highly significant. Additionally, we conduct pairwise likelihood ratio tests on constrained model specifications assuming equality of coefficients between customer, supplier and competitor impulses. All of these tests are rejected with a 99% significance level. In conclusion, the driving forces behind the globalization of absorptive capacities directed

at customers, suppliers and competitors are related (significant, positive correlation of error terms) but not homogeneous (rejected likelihood ratio tests).

Table 2: Results for trivariate probit estimations of probability of using a foreign customer, supplier or competitor as a source for innovation

Definitions	*Foreign customer impulse*	*Foreign supplier impulse*	*Foreign competitor impulse*
Absorptive capacity			
Share of graduates among employees	0.01***	0.00	0.00
	(0.00)	(0.00)	(0.00)
R&D expenditures as a share of sales 2001	0.01***	0.00	0.01***
	(0.00)	(0.00)	(0.00)
Index value of management stimulation for innovation	1.80***	1.35***	1.52***
	(0.23)	(0.28)	(0.25)
International exposure			
Exports as a share of sales, 2001	0.04***	0.00	0.02**
	(0.01)	(0.01)	(0.01)
Exports as a share of sales, squared, 2001	-0.0003***	0.00	0.00
	(0.00)	(0.00)	(0.00)
Company is part of multinational group with foreign headquarters (Dummy)	-0.07	0.20	0.05
	(0.13)	(0.16)	(0.16)
Company is part of multinational group with German headquarters (Dummy)	0.11	0.01	0.06
	(0.12)	(0.16)	(0.15)
Relevance			
Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
German share of global business R&D in industry, 1999	-0.02***	-0.03***	-0.02**
	(0.01)	(0.01)	(0.01)
Obstacle lack of technological information (Dummy)	0.25*	0.03	0.32**
	(0.13)	(0.16)	(0.14)
Obstacle innovation costs or risk (Dummy)	0.23***	0.56***	0.18*
	(0.09)	0.10	(0.11)
Obstacle regulation or bureaucracy (Dummy)	0.22**	0.32***	0.34***
	(0.11)	(0.12)	(0.12)
Control variables			
Company is located in Eastern Germany (Dummy)	0.19**	0.09	0.31***
	(0.09)	(0.10)	(0.11)
Number of employees (log)	0.08	0.05	0.12
	(0.09)	(0.10)	(0.11)
Squared number of employees (log)	-0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)
Industry group medium high-tech manufacturing (Dummy)	0.38***	-0.03	0.34**
	(0.12)	(0.16)	(0.15)
Industry group high-tech manufacturing	0.29**	0.16	0.37**

Definitions	*Foreign customer impulse*	*Foreign supplier impulse*	*Foreign competitor impulse*
(Dummy)			
	(0.14)	(0.17)	(0.17)
Industry group distributive services (Dummy)	-0.07	0.27*	-0.40
	(0.16)	(0.16)	(0.26)
Industry group knowledge-intensive services (Dummy)	-0.51**	-0.59*	0.17
	(0.21)	(0.30)	(0.22)
Industry group technological services (Dummy)	-0.12	0.27	0.37*
	(0.17)	(0.18)	(0.20)
Constant	-2.79***	-2.59***	-3.35***
	(0.23)	(0.30)	(0.32)
Observations		2,276	
Wald chi2(60)		730.66	
Prob > chi2		0.00	
Log-likelihood		-1,419.55	
Aldrich Nelson Pseudo R2		0.44	
Rho	(1/2) 0.35 ***	(1/3) 0.51 ***	(2/3) 0.49 ***

* significant at 10%; ** significant at 5%; ***; significant at 1%;
Robust standard errors in parentheses

Hypothesis I suggests a positive relationship between investments in absorptive capacities and the internationalization of a firm's knowledge sourcing. We find this hypothesis generally supported when we focus the motivational aspects of absorptive capacity. As firms increase their stimulation of innovation activities employees are more likely to search for valuable impulses outside of the domestic environment. This effect is most pronounced for foreign customers, followed by foreign competitors and suppliers. Formal employee education levels, however, are only relevant when it comes to targeting customer knowledge from abroad. This may indicate that impulses from foreign suppliers and competitors are easier to access, as important parts of the knowledge are embodied in products and services. Finally, the most traditional measure of absorptive capacities (Cohen/Levinthal 1989), R&D expenditures as a percentage of sales, has the expected positive and significant coefficient although only with regards to foreign customers and competitors. Interestingly, there is no significant effect for foreign supplier impulses.

We find no (in the case of foreign suppliers) or only weak support for the complementary channels to foreign knowledge through international market exposure as elaborated in hypothesis II. Structural forms of internationalization from being a multinational group show no significant effect. Export intensity is the only factor that makes a significant difference. We identify a linear relationship with the likelihood of impulse sourcing from foreign competitors, indicating that they become easier to track and at the same time more relevant sources as foreign markets become more important. Impulses from foreign customers, however, follow an inverted u-shaped trend. The benefits of global innovation impulses increase up to a certain threshold of internationalization (58% export share of sales) and decline afterwards. We suspected that companies may opt for host country subsidiaries instead of direct exporting when

certain foreign markets become crucial for economic success and that our dummy variables on whether a firm is part of a multinational group are not fine-grained enough to capture this effect.

The "relevance of international knowledge" rationale for globalizing absorptive capacities as conceptualized in hypothesis III is also confirmed. However, the current industry position with regards to specialization and international competitiveness (revealed comparative advantage) has no significant impact. More interestingly, we find that globalizing absorptive capacities is propelled both by objective measures for domestic scarcity of innovation impulses (domestic share of worldwide industry R&D expenditure) and by firm-specific, perceived paucities. Focusing on the former factor, we support the findings of Feinberg/Gupta (2004) on the relationship between industry R&D expenditures in a country and its attractiveness for international knowledge sourcing. As the domestic (i.e. German) share of global business R&D expenditures in an industry decreases, international knowledge sourcing from foreign customers, suppliers and competitors becomes more likely. Looking at firm-specific obstacles to innovation activities we find that globalizing absorptive capacities becomes more likely for firms under pressure from high costs and risks as well as regulation and bureaucracy. Firms that indicate that their innovation activities suffer from a lack of technological information are significantly more likely to source knowledge from foreign customers and competitors but not suppliers.

With regard to the control variables, the absence of a significant effect of size is certainly surprising. Apparently, the degree of internationalization is a more important factor than firm size itself. We find a regional effect for East Germany with regard to inputs from foreign customers or competitors. This is largely in line with the tendency for risk reduction and catching-up "follower" strategies that have been found in the former Communist part of Germany (Sofka/Schmidt 2004). Industry effects indicate that international knowledge sourcing appears more appealing in manufacturing and directed at foreign customers and competitors. This holds in both medium high-tech (e.g. automotive) and high-tech sectors (e.g. electronics). There are significant negative effects in knowledge-intensive services (e.g. banking) in which direct interaction and tailor-made offerings for local customers may limit the merits of international knowledge spillovers.

Discussion

Internationalizing innovation activities has largely been considered in the context of foreign direct investment. Research has typically focused on large, multinational firms that place R&D centers or at least "listening posts" abroad (see for example Al-Laham/Amburgey 2005, Almeida/Phene 2004, Birkinshaw/Hood 1998, Von Zedtwitz/Gassmann 2002b). Others have modeled international knowledge flows through patent data (see for example Jaffe/Trajtenberg 1999, Porter/Stern 2000), reflecting the end of an innovation process more than its beginning. We add the dimension of firms capitalizing on globalization. They do this by acting upon international impulses to globalize their existing absorptive capacities. Our findings suggest that the impact of globalization on firms' international knowledge sourcing is

not limited to foreign direct investment. Furthermore, we find no significant effect of firm size.

We identify conceptually three major components of the globalization of absorptive capacities. These are investments into their development, international exposure and related experience, and the relevance of international knowledge. We also suggest that these relationships vary with regards to the knowledge sources, i.e. whether it stems from a foreign customer, supplier or competitor. Our empirical results, based on a comprehensive dataset of more than 2,200 German firms and their innovation activities, provide a differentiated picture.

Globalized absorptive capacities are positively linked to ambitions management stimulation and incentive systems. This stresses the motivational aspect of absorptive capacities (Lane/Lubatkin 1998b, Szulanski 1996). Adequate incentive systems propel employees to look across borders for promising innovation impulses. Apparently, this mechanism is not limited to specific channels or sources but applies to foreign customers, suppliers and competitors alike. Investments in R&D and qualified personnel do not show such a general positive relationship. The former increase the likelihood of impulse generation from foreign customers and competitors while the effect of the latter is narrowly focused on customers. This is surprising, as higher levels of academic achievement should also increase the chances of more elaborate language skills which, in turn, should make international communication easier. A broader spectrum of these particular competencies provides companies with higher potential absorptive capacities. We argue that such broad interfaces are most successful when dealing with diverse customers, where singling out promising sources is especially difficult (Frosch 1996). Identifying promising suppliers and competitors may be easier because their knowledge is typically embodied and traceable in the products they offer.

Besides, we find that complementary channels established through exposure to international markets are only selectively beneficial to the globalization of absorptive capacities. There is no significant effect at all for impulses from foreign suppliers. We suggest that this is the result of more tangible, unambiguous knowledge flows embodied in the supplied product or service itself. There are positive effects on the likelihood of globalizing absorptive capacities directed at foreign customers and competitors as they become more important for economic success. Interestingly, this is a linear relationship for foreign competitors and an inverted u-shaped one for foreign customers. We argue that the difference stems from the necessity to provide responsiveness for foreign customers as they become exceedingly important for firm success (Bartlett/Goshal 1987). In such a situation (our empirical results point towards a peak at 58% export share of sales) exporting may be an inferior option to dedicated subsidiaries in the most important foreign markets.

Our results suggest that the globalization of absorptive capacities is most promising if the potential from domestic R&D expenditures in the industry is relatively limited. This supports the findings from Feinberg/Gupta (2004) on the signaling effects of both local factor endowments and competitors' R&D investments. Furthermore, we find strong support for the notion that the globalization of absorptive capacities is not only related to objective paucities, but also by the firm-specific perception of these domestic shortcomings. Hence, firms which are especially sensitive to technological deficits, face

substantial risks and deal with a less supportive regulatory environment, react by globalizing their absorptive capacities.

Major Contribution

We believe that our work contributes to existing streams of literature by investigating international knowledge flows that are not based on physical investments abroad but on a firm's ability to find and exploit it from afar. Furthermore, we do not focus on the complete transfer of complex concepts or technologies, but on the ideas and impulses that may trigger subsequent domestic innovation activities. We embed this conceptual line of reasoning into the literature on a firm's absorptive capacity. We explore factors that enable or propel firms to source knowledge from abroad and therefore globalize their absorptive capacities. These are the investments into absorptive capacities, international market exposure and related experience as well as the relevance of international knowledge compared to domestic knowledge. We distinguish between foreign customers, suppliers and competitors as sources for innovation impulses. Our analysis benefits from the opportunity to test these intangible constructs empirically for a comprehensive sample of more than 2,200 German firms. Our major result is the realisation that the globalization of absorptive capacities is in fact a combination of investments into absorptive capacities, international experience and domestic scarcities. However, the nature and extent of these relationships differ dependent on whether the impulses stem from foreign customers, suppliers or competitors.

Limits and Future Research

Several limitations constrained our analysis. These should be acknowledged and may provide paths for further fruitful research projects. While we were fortunate enough to work with a comprehensive, high quality dataset, it was not specifically designed for this analysis. First, one of the most obvious shortcomings lies in a lack of information on innovation impulses from foreign universities or research institutes. There is no doubt that these are important knowledge sources and that specific absorptive capacities are required to activate and utilize them (Schmidt 2005). Secondly, our measures of the degree of internationalization are rather crude and can only be considered proxies for more precise ones (Sullivan 1994). Third, since most of the literature on international innovation activities deals with foreign subsidiaries and knowledge flows internal to multinational firms, impulses from foreign subsidiaries should be considered simultaneously with external impulses (e.g. customers) so that differences and similarities become visible and closer links to existing MNC theory can be established. Fourth, we track only "actual" not "best" practices, although global innovation impulses have been linked to superior firm performance (Sofka/Teichert 2006). Furthermore, measures for the importance of innovation impulses should be included. It may be the case that a few impulses have a very high impact on innovation performance while a large number of impulses provide limited benefits. Fifth, both the theoretical and empirical model could be extended by going beyond a simple distinction between domestic and foreign. Measures for physical and psychological distance may provide additional new insights. Finally, our empirical setting is limited to Germany, with its unique cultural and institutional characteristics. Comparative studies should produce important new insights.

Appenix

Table 3: Correlation Coefficients and Variance Inflation Factors

	Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
(1)	Share of graduates among employees	1.00								
(2)	R&D expenditures as a share of sales 2001	0.35	1.00							
(3)	Index value of management stimulation for innovation	0.15	0.23	1.00						
(4)	Exports as a share of sales, 2001	0.00	0.11	0.32	1.00					
(5)	Company is part of multinational group with foreign headquarters (Dummy)	-0.01	-0.01	0.14	0.25	1.00				
(6)	Company is part of multinational group with German headquarters (Dummy)	0.01	0.00	0.19	0.23	-0.09	1.00			
(7)	Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	0.14	0.05	0.07	0.05	0.03	0.06	1.00		
(8)	German share of global business R&D in industry, 1999	0.09	-0.05	-0.04	0.02	-0.01	0.01	0.18	1.00	
(9)	Obstacle lack of technological information (Dummy)	0.02	0.03	0.17	0.14	0.08	0.06	0.04	-0.01	1.00
(10)	Obstacle innovation costs or risk (Dummy)	0.10	0.18	0.28	0.17	0.07	0.10	0.03	-0.02	0.24
(11)	Obstacle regulation or bureaucracy (Dummy)	0.13	0.16	0.18	0.04	0.00	0.01	0.02	0.00	0.17
(12)	Company is located in Eastern Germany (Dummy)	0.16	0.09	-0.08	-0.14	-0.05	-0.12	-0.03	0.05	-0.10
(13)	Number of employees	-0.23	-0.08	0.31	0.34	0.23	0.38	0.03	-0.02	0.10
(14)	Industry group medium high-tech manufacturing (Dummy)	-0.04	0.04	0.15	0.35	0.12	0.14	0.23	0.24	0.09
(15)	Industry group high-tech manufacturing (Dummy)	0.11	0.18	0.19	0.17	0.06	0.01	0.00	-0.14	0.01
(16)	Industry group distributive services (Dummy)	-0.20	-0.13	-0.17	-0.18	-0.07	-0.02	-0.10	0.04	-0.07
(17)	Industry group knowledge-intensive services (Dummy)	0.08	-0.09	-0.08	-0.20	-0.04	-0.05	0.20	0.16	-0.02
(18)	Industry group technological services (Dummy)	0.56	0.27	0.05	-0.12	-0.08	-0.04	0.08	0.08	0.01
	Variance Inflation Factor (VIF)	1.90	1.28	1.37	1.50	1.17	1.29	1.18	1.21	1.10

		(10)	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
(10)	Obstacle innovation costs or risk (Dummy)	1.00								
(11)	Obstacle regulation or bureaucracy (Dummy)	0.34	1.00							
(12)	Company is located in Eastern Germany (Dummy)	-0.08	-0.02	1.00						
(13)	Number of employees	0.14	0.05	-0.18	1.00					
(14)	Industry group medium high-tech manufacturing (Dummy)	0.10	0.02	-0.05	0.19	1.00				
(15)	Industry group high-tech manufacturing (Dummy)	0.09	0.08	0.01	0.05	-0.12	1.00			
(16)	Industry group distributive services (Dummy)	-0.11	-0.08	-0.01	-0.08	-0.18	-0.12	1.00		
(17)	Industry group knowledge-intensive services (Dummy)	-0.07	-0.01	0.00	-0.06	-0.16	-0.11	-0.16	1.00	
(18)	Industry group technological services (Dummy)	0.06	0.09	0.08	-0.22	-0.18	-0.12	-0.17	-0.16	1.00
	Variance Inflation Factor (VIF)	1.26	1.17	1.09	1.56	1.64	1.30	1.30	1.54	2.13
	Mean VIF	1.39								

References

Al-Laham, A./Amburgey, T.L., Knowledge Sourcing in Foreign Direct Investments: An Empirical Examination of Target Profiles, *Management International Review*, 45, 3, 2005, pp. 247-275.

Almeida, P./Phene, A., Subsidiaries and Knowledge Creation: The Influence of the Mnc and Host Country on Innovation, *Strategic Management Journal*, 25, 8/9, 2004, pp. 847-864.

Anand, J./Kogut, B., Technological Capabilities of Countries, Firm Rivalry and Foreign Direct Investment, *Journal of International Business Studies*, 28, 3, 1997, pp. 445-465.

Bartlett, C.A./Goshal, S., Managing across Borders: New Organizational Responses, *Sloan Management Review*, 29, 1, 1987, pp. 43-54.

Birkinshaw, J./Hood, N., Multinational Subsidiary Evolution: Capability and Charter Change in Foreign-Owned Subsidiary Companies, *Academy of Management Review*, 23, 4, 1998, pp. 773-795.

Branstetter, L.G., Are Knowledge Spillovers International or Intranational in Scope?, *Journal of International Economics*, 53, 1, 2001, pp. 53-80.

Buckley, P.J./Casson, M.C., Analyzing Foreign Market Entry Strategies: Extending the Internalization Approach, *Journal of International Business Studies*, 29, 3, 1998, pp. 539-562.

Chatterji, D., Accessing External Sources of Technology, *Technology Management*, 39, 2, 1996, pp. 48-57.

Chesbrough, H.W., *Open Innovation - the New Imperative for Creating and Profiting from Technology*, Boston, USA: Harvard Business School Press 2003.

Cohen, W.M./Levinthal, D.A., Innovation and Learning: The Two Faces of R&D, *The Economic Journal*, 99, 1989, pp. 569-596.

Cohen, W.M./Levinthal, D.A., Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, 35, 1, 1990, pp. 128-153.

Craig, C.S./Douglas, S.P., Configural Advantage in Global Markets, *Journal of International Marketing*, 8, 1, 2000, pp. 6-26.

Doz, Y.L./Santos, J./Williamson, P., *From Global to Metanational: How Companies Win in the Knowledge Economy*, Boston: Harvard Business School Press 2001.

Dyer, J.H./Singh, H., The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage, *Academy of Management Review*, 23, 4, 1998, pp. 660-679.

Feinberg, S.E./Gupta, A.K., Knowledge Spillovers and the Assignment of R&D Responsibilities to Foreign Subsidiaries, *Strategic Management Journal*, 25, 8/9, 2004, pp. 823-845.

Frosch, R.A., The Customer for R&D Is Always Wrong!, *Research Technology Management*, 39, 6, 1996, pp. 22-25.

Garud, R./Nayyar, P.R., Transformative Capacity: Continual Structuring by Intertemporal Technology Transfer, *Strategic Management Journal*, 15, 5, 1994, pp. 365-385.

Gottfredson, M./Puryear, R./Phillips, S., Strategic Sourcing: From Periphery to the Core, *Harvard Business Review*, 2005, February, 2005, pp. 132-139.
Govindarajan, V./Gupta, A.K., *The Quest for Global Dominance: Transforming Global Presence into Global Competitive Advantage* 1, San Francisco: Jossey-Bass 2001.
Greene, W.H., *Econometric Analysis*, New York: Macmillan Publishing Company 1993.
Gupta, A.K./Govindarajan, V., Knowledge Flows within Multinational Corporations, *Strategic Management Journal*, 21, 4, 2000, pp. 473-496.
Gupta, A.K./Westney, E.D., Introduction, in Gupta, A. K./Westney, E. D. (eds.), *Smart Globalization: Designing Global Strategies, Creating Global Networks*: San Francisco 2003, pp. 1-12.
Hakanson, L./Nobel, R., Organizational Characteristics and Reverse Technology Transfer, *Management International Review (MIR)*, 41, 4, 2001, pp. 395-420.
Harvey, M./Novicevic, M.M., Staffing Global Marketing Positions: What We Don't Know Can Make a Difference, *Journal of World Business*, 35, 1, 2000, pp. 80-94.
Hellriegel, D./Slocum Jr, J.W., Organizational Climate: Measures, Research and Contingencies, *Academy of Management Journal*, 17, 2, 1974, pp. 255-280.
Irwin, D.A./Klenow, P.J., Learning-by-Doing Spillovers in the Semiconductor Industry., *Journal of Political Economy*, 102, 6, 1994, pp. 1200-1227.
Jaffe, A.B./Trajtenberg, M., International Knowledge Flows: Evidence from Patent Citations, *Economics of Innovation & New Technology*, 8, 1/2, 1999, pp. 105-137.
Jaffe, A.B./Trajtenberg, M./Henderson, R., Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, *The Quarterly Journal of Economics*, 108, 3, 1993, pp. 577-599.
Jansen, J.J.P./Van den Bosch, F.A.J./Volberda, H.W., Managing Potential and Realized Absorptive Capacity: How Do Organizational Antecendents Matter?, *Academy of Management Journal*, 48, 6, 2005, pp. 999-1015.
Jensen, R./Szulanski, G., Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers, *Journal of International Business Studies*, 35, 6, 2004, pp. 508-523.
Kaiser, U., An Emprical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector, *International Journal of Industrial Organization*, 20, 6, 2002, pp. 747-774.
Kleinschmidt, E.J./Cooper, R.G., The Performance Impact of an International Orientation of Product Innovation., *European Journal of Marketing*, 22, 10, 1988, pp. 56-72.
Kuemmerle, W., The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation., *Journal of International Business Studies*, 30, 1, 1999, pp. 1-25.
Lane, P.J./Koka, B.R./Pathak, S., The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct, *Academy of Management Review*, 31, 4, 2006, pp. 833-863.
Lane, P.J./Lubatkin, M., Relative Absorptive Capacity and Interorganizational Learning, *Strategic Management Journal*, 19, 1998a, pp. 461-477.

Lane, P.J./Lubatkin, M., Relative Absorptive Capcity and Inter-Organizational Learning., *Strategic Management Journal*, 19, 1998b, pp. 461-477.
Laursen, K./Salter, A., Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms, *Strategic Management Journal*, 27, 2, 2006, pp. 131-150.
Le Bas, C./Sierra, C., 'Location Versus Home Country Advantages in R&D Activities: Some Further Results on Multinationals' Locational Strategies., *Research Policy*, 31, 4, 2002, pp. 589-609.
Levinthal, D.A./March, J.G., The Myopia of Learning, *Strategic Management Journal*, 14, 8, 1993, pp. 95-112.
Lloyd, T., A Little Bat Sense, *Journal of Business Strategy*, 16, 5, 1995, pp. 9-10.
Lord, M.D./Ranft, A.L., Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge, *Journal of International Business Studies*, 31, 4, 2000, pp. 573-589.
Lu, J.W./Beamish, P.W., International Diversification and Firm Performance: The S-Curve Hypothesis, *Academy of Management Journal*, 47, 4, 2004, pp. 589-609.
Malmberg, A./Maskell, P., *Localized Learning Revisited*, DRUID Working Paper No. 05-19, 2005.
Nonaka, I., A Dynamic Theory of Organizational Knowledge Creation, *Organization Science*, 5, 1, 1994, pp. 14-37.
Peri, G., Determinants of Knowledge Flows and Their Effect on Innovation, *Review of Economics and Statistics*, 87, 2, 2005, pp. 308-322.
Pittaway, L./Robertson, M./Munir, K./Denyer, D./Neely, A.D., Networking and Innovation: A Systematic Review of the Evidence, *International Journal of Management Review*, 5-6, 3-4, 2004, pp. 37-168.
Porter, M.E./Stern, S., *Measuring The "Ideas" Production Function: Evidence from International Patent Output*, NBER Working Paper No. 7891, 2000.
Rothwell, R./Dodgson, M., External Linkages and Innovation in Small and Medium-Sized Enterprises, *R&D Management*, 21, 1991, pp. 125-137.
Rugman, A.M./Verbeke, A., Extending the Theory of the Multinational Enterprise: Internalization and Strategic Management Perspectives, *Journal of International Business Studies*, 34, 2, 2003, pp. 125-137.
Rugman, A.M./Verbeke, A., A Perspective on Regional and Global Strategies of Multinational Enterprises, *Journal of International Business Studies*, 35, 1, 2004, pp. 3-18.
Sandberg, B., Customer-Related Proactiveness in the Radical Innovation Development Process, *European Journal of Innovation Management*, 10, 2, 2007, pp. 252-267.
Schmidt, T., *Absorptive Capacity – One Size Fits All? A Firm-Level Analysis of Absorptive Capacity for Different Kinds of Knowledge*, ZEW Discussion Paper No. 05-72, Mannheim, 2005.
Sofka, W./Schmidt, T., *I Like the Way You Move: An Empirical Investigation into the Mechanisms Behind First Mover and Follower Strategies*, ZEW Discussion Paper No. 04-87, Mannheim, 2004.
Sofka, W./Teichert, T., *Global Sensing and Sensibility - a Multi-Stage Matching Assessment of Competitive Advantage from Foreign Sources of Innovation*, Proceedings of Academy of Management, Atlanta, 2006.

Stock, G.N./Tatikonda, M.V., External Technology Integration in Product and Process Development, *International Journal of Operations & Production Management*, 24, 7, 2004, pp. 642-665.
Sullivan, D., Measuring the Degree of Internationalization of a Firm, *Journal of International Business Studies*, 25, 2, 1994, pp. 325-42.
Szulanski, G., Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within the Firm, *Strategic Management Journal*, 17, Special issue, 1996, pp. 27-43.
Szulanski, G., The Process of Knowledge Transfer: A Diachronic Analysis of Stickiness, *Organizational Behavior & Human Decision Processes*, 82, 1, 2000, pp. 9-27.
Todorova, G./Durisin, B., Absorptive Capacity: Valuing a Reconceptualization, *Academy of Management Review*, 32, 3, 2007, pp. 774-786.
Van den Bosch, F.A.J./Volberda, H.W./de Boer, M., Coevolution of Firm Absorptive Capacity and Knowledge Environment: Organizational Forms and Combinative Capabilities, *Organization Science*, 10, 5, 1999, pp. 551-568.
Veugelers, R./Cassiman, B., *Importance of International Linkages for Local Know-How Flows: Some Econometric Evidence from Belgium*, CEPR Discussion Paper No. 2337, London, 1999.
Von Zedtwitz, M., Managing Foreign R&D Laboratories in China, *R&D Management*, 34, 4, 2004, pp. 439-452.
Von Zedtwitz, M./Gassmann, O., Managing Customer Oriented Research, *International Journal of Technology Management*, 24, 2/3, 2002a, pp. 165-193.
Von Zedtwitz, M./Gassmann, O., Market Versus Technology Drive in R&D Internationalization: Four Different Patterns of Managing Research and Development, *Research Policy*, 31, 4, 2002b, pp. 569-588.
Von Zedtwitz, M./Gassmann, O./Boutellier, R., Organizing Global R&D: Challenges and Dilemmas, *Journal of International Management*, 10, 1, 2004, pp. 21-49.
West, J./Graham, J.L., A Linguistic-Based Measure of Cultural Distance and Its Relationship to Managerial Values, *Management International Review*, 44, 2, 2004, pp. 239-260.
Wolter, F., *Factor Proportions, Technology and West-German Industry's International Trade Patterns*, Weltwirtschaftliches Archiv No. 113, Tübingen, 1977.
Zahara, S.A./George, G., Absorptive Capacity: A Review, Reconceptualization and Extension, *Academy of Management Journal*, 27, 2, 2002, pp. 185-203.
Zaheer, S., Overcoming the Liability of Foreignness., *Academy of Management Journal*, 38, 2, 1995, pp. 341-364.
Zander, U./Kogut, B., Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test, *Organization Science*, 6, 1, 1995, pp. 76-92.

Endnotes

[1] The question is part of a section that initially defines external sources for innovation as impulses that were indispensable for the firm's new products, services or processes. The exact question is: "Have you introduced significantly improved products or processes between 2000 and 2002 because specific customers asked for them or demanded them directly? If yes, from which country did they come? The supplier and competitor questions are identical, but with the ending " … were only made possible through new innovations by suppliers/competitors." We consider an important German knowledge flow as established when the respondent wrote a country other than Germany into the country field of the customer, supplier or competitor question.

[22] The quotient of industry exports and imports divided by the overall country export-import-quotient. Values larger than one indicate firms in a particular industry were not only more successful on foreign markets than foreign competitors at home but also compared to the overall country trade performance (specialization). For a detailed discussion see Wolter (1977).

[3] The year 1999 provides the best compromise in terms of country and industry wide data availability. Subsequent limitations through explicitly assumed time persistence in country R&D engagements are acknowledged.

[4]

Industry	**NACE Code**	**Industry Group**
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.2	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Global Sensing and Sensibility: A Multi-Stage Matching Assessment of Competitive Advantage from Foreign Sources of Innovation

AUTOREN: ***Wolfgang Sofka***

[Universität Hamburg, ZEW Mannheim]

Thorsten Teichert

[Universität Hamburg]

JAHR: 2006

AUSZEICHNUNGEN: Academy of Management
Best Paper International Management:
24 ausgewählte Papiere aus 319
Einreichungen

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper
No. 06-009, Mannheim
Best Paper Proceedings of the Sixty-fifth
Annual Meeting of the Academy of
Management 2006

AUSGEWÄHLTE PRÄSENTATIONEN: Academy of Management
Atlanta, 2006

Academy of International Business
Peking, 2006

Global Sensing and Sensibility

A Multi-Stage Matching Assessment of Competitive Advantage from Foreign Sources of Innovation

Wolfgang Sofka[1,2] and Thorsten Teichert[2]

Abstract

The ability to deliver successful innovations in a globalized environment can be regarded as a core competitive capability of modern firms. Companies literally find themselves confronted with a world of ideas. The challenge remains to decide which impulses should be on top of the list and which at the bottom. Given limited resources and substantial investments, betting on the wrong horse can be risky and costly. We investigate firms' capabilities to assimilate, identify and prioritize valuable knowledge across national, cultural and social borders - a competence we call global sensing. We establish an analytical framework to examine whether global sensing activities generate competitive advantage. Consequently, we develop an empirical, multistage evaluation procedure. This procedure rests on a matching approach for a recent, broad sample of almost 1,700 German companies from both services and manufacturing. We find the strongest and most consistent support for global sensing as a strategic enabler for technological leadership. Against prima facie indications we observe that foreign external sources of innovation are generally not superior to domestic ones. Implications for methodological issues of theory testing are drawn.

Keywords: Global innovation, global sensing, capability based view

JEL-Classification: F23, O31, O32

[1] Centre for European Economic Research (ZEW), Department of Industrial Economics and International Management, P.O. Box 10 34 43, D-68034 Mannheim, Germany

[2] Professor at Hamburg University, Institute of Retailing and Marketing, Chair for Marketing and Innovation, Von-Melle-Park 5, D-20146 Hamburg, Germany

Corresponding author: Wolfgang Sofka, sofka@zew.de, Tel.:+49-621-1235-181, Fax: +49-621-1235-170

The authors thank Dr. Georg Licht, Dr. Christian Rammer and Tobias Schmidt for invaluable comments and discussions.

1 Introduction

Globalization has not led to a borderless world (as suggested by Ohmae, 1990) with universally homogeneous customers (as suggested by Levitt, 1983). Market demands and technological opportunities remain globally heterogeneous and country specific. There is thus a need for efficient knowledge management since the basic sources of global competitive advantage remain local, sticky, diverse and dispersed (Doz et al., 2001).

The intensified exchange of products, services, capital and – most important to our analysis – know-how has created strong economic ties between geographically dispersed countries (Archibugi and Iammarino, 2002; Govindarajan and Gupta, 2001). Doz et al. (2001) identify three levels of competition in this global knowledge economy: Sensing (identifying and accessing new competencies, innovative technologies, and lead-market knowledge), mobilizing (integrating scattered capabilities and emerging market opportunities to pioneer new products and services) and operations (optimizing the size and configuration of operations for efficiency, flexibility, and financial discipline).

The mobilizing and operations aspects of this framework have received relatively more attention in the literature so far.[1] We focus on the sensing aspect: the ability of a firm to sense leading technological and market trends globally. The driving forces behind globalization (information technology and open market ideology) enable firms to source localized expertise in technology and demand (Govindarajan and Gupta, 2001; Gupta and Westney, 2003). On the one hand, this makes the accessible pool of global innovation sources large and deep. On the other hand, it requires special expertise to pick the most promising fishing grounds and land the largest catch amid intensified global competition. Companies need an "early warning radar system" that enables them to keep track of recent technological and market trends worldwide as well as to distinguish between crucial signals and secondary noise. We investigate this global sensing capability and extend existing research on the theoretical and methodological side.

From a theoretical perspective we draw arguments from the capability based view of the firm and test whether global sensing is actually a competitive advantage generating capability of a firm. This is not clear from the outset. Global sensing implies identifying, synthesizing and combining knowledge across national, cultural and social borders. It is easier today to transfer information across borders, yet putting it into the right context to get the most out of it remains challenging. Hence, these capabilities have the potential to generate competitive

[1] Major topics include the sources of advantage for multinational enterprises (MNEs) (Dunning, 1981), their organizational structure (Bartlett and Goshal, 1989), balanced configurations between headquarters and subsidiaries (Doz and Prahalad, 1984; Prahalad and Doz, 1987), knowledge flows between them (Birkinshaw and Fry, 1998) and the management of globally dispersed teams (Boutellier et al., 1998; Maznevski and Chudoba, 2000).

advantage. This question is at the very heart of this paper: does global sensing produce measurable competitive advantage?

On the methodological side we introduce the novel technique of matching estimators to management studies which address a major shortcoming of the resource/capability based view of the firm: the lack of an empirical basis (Priem and Butler, 2001). In essence, matching estimators rely on a straightforward idea. If each global sensing firm can be matched with an almost perfect twin firm (e.g. same size, industry, region) from a control group, the remaining performance differences can be attributed to global sensing. On this basis, we develop a multistage evaluation framework that preserves the heterogeneity among firms and disentangles the effects of global sensing while controlling for context specific factors. Subsequently, we achieve an undisguised view of the strategic effects of global sensing. We test our evaluation framework empirically for a broad sample of more than 1,600 German companies from both manufacturing and services.

This paper follows an integrated design. The section subsequent to this introduction conceptually embeds global sensing in the capability based view of the firm. Section 3 condenses this argumentation into an analytical framework that can be tested. In section 4 we introduce the empirical tools to actually conduct these tests. Accordingly, section 5 discusses our results and is followed by our conclusions in section 6.

2 Conceptual Framework

2.1 The nature of global sensing

Literature identifies a number of reasons why companies have to think beyond their own boundaries and search for external sources for innovation: Competitive pressure, shorter product lifecycles, high investments, available external expertise (see for example Chesbrough, 2003). Firms need a knowledge management system that picks the right sources, synthesizes the inputs and combines them with existing expertise (Gottfredson et al., 2005; Stock and Tatikonda, 2004). In a globalized world modern information and communications technology as well as changing ideology increase the potentials from these external innovation inputs, most notably in China and India (Govindarajan and Gupta, 2001; Gupta and Westney, 2003). At the same time, the pockets of valuable expertise are becoming more globally diverse and dispersed (Doz et al., 2001). The immense scope of potential knowledge increases the peril from strategic blind spots (Rugman and Verbeke, 2004) or betting on the wrong horse. Competitive advantage can be achieved if companies have the competencies and capabilities to identify, combine and develop market and technology opportunities that are unarticulated, overlooked or underestimated (Von Zedtwitz and Gassmann, 2002a). We call this capability “global sensing.” It includes sifting through the enormous amounts of prospective innovation signals from worldwide customers, competitors and suppliers, absorbing and prioritizing them and triggering an adequate organizational response.

2.2 Global sensing as a strategic capability

We suggested in the previous section that global sensing capabilities are a source of competitive advantage. We substantiate this claim by integrating it in the literature on the resource and capability based view of the firm (Barney, 1991; Conner, 1991; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984). Competitive advantage stems from internal resources and capabilities and subsequent proactive strategic choices to create and grasp market opportunities (Lado et al., 1992). We argue that global sensing fits the criteria for a strategic capability because of the special kind of knowledge that has to be transferred and the capacities needed to synthesize and integrate them (i.e. component and architectural competence (Henderson and Cockburn, 1994)). Firstly, impulses from foreign customers, suppliers and competitors are valuable, specific and difficult to imitate or substitute. These resources are valuable because they generate three types of performance potentials (Bartlett and Goshal, 1987; Dunning, 1981, 1992). These are responsiveness to foreign market conditions (e.g., tastes, regulations), learning from localized, country-specific expertise (Rugman and Verbeke, 2003) and efficiency through comparative cost advantages abroad (e.g., large supply of scientific personnel, 24/7 lab activities) (Von Zedtwitz, 2004). They are specific because the particular configuration of foreign customers, suppliers and competitors is unique for a firms' value chain and difficult to imitate because the information that has to be transferred is often subtle, complex and sticky (Doz et al., 2001).

Secondly, we argue that competitive advantage through global sensing stems not only from the knowledge transferred but also from firms' capabilities to establish "pipelines to knowledge sources around the globe" (Malmberg and Maskell, 2005). These potentials have to be identified, activated and managed to generate competitive advantage. Competitive capabilities imply the targeted deployment and combination of resources through organizational processes (Amit and Schoemaker, 1993). Eisenhardt and Martin (2000) similarly use the concept of dynamic capabilities to describe the organizational and strategic routines through which companies trigger or adapt to market changes. Capabilities are cultivated in practice over time which makes them causally ambiguous and socially complex (Dierickx and Cool, 1989). This embeddedness makes them hard to acquire or imitate and therefore generates competitive advantage (Brush and Artz, 1999). Identifying, sharing and exploiting valuable knowledge assets has been identified as such a source of competitive advantage (Zander and Kogut, 1995). We extend this argument to global sensing by stressing the particularities of cross-border relationships. Synthesizing and applying existing and sensed knowledge (i.e. combinative capabilities, Kogut and Zander, 1992) across national, cultural and social borders requires intelligent processes and competencies that are built up over time. This includes identifying impulses from abroad and putting them in a fitting context to trigger an adequate response. Knowledge transfers across national borders have been found to be difficult and subject to losses (Branstetter, 2001; Jaffe and Trajtenberg, 1999). In particular, tacit knowledge often associated with face-to-face contact and shared experiences is of crucial importance but difficult to transfer across cultural barriers (Al-Laham and Amburgey, 2005; Liesch and Knight, 1999). Frictional losses stem from increased transaction costs and principal-agent problems (Rugman and Verbeke, 2003; Von Zedtwitz and Gassmann, 2002b). These frequent mistakes and delays in cross-border situations have been summarized as

liabilities of foreignness (Hymer, 1976; Zaheer, 1995). Their prime drivers are costs related to spatial distance (travel, transportation, time zones), higher learning costs in the new environment due to a lack of roots, higher reputation costs due to a lack of perceived legitimacy in the host country and legal restrictions in the home country (Zaheer, 1995). These liabilities of foreignness can be overcome through superior firm specific advantages and learning from foreign affiliates (Caves, 1971; Mezias, 2002).

In conclusion, we argue that impulses from foreign customers, suppliers and competitors are a strategic resource. Moreover, firms which can identify and transfer these inputs across national and cultural borders and combine them with existing knowledge can achieve competitive advantage. Hence we hypothesize that global sensing is a strategic capability.

3 Analytical framework

3.1 Capturing capabilities through matching estimators

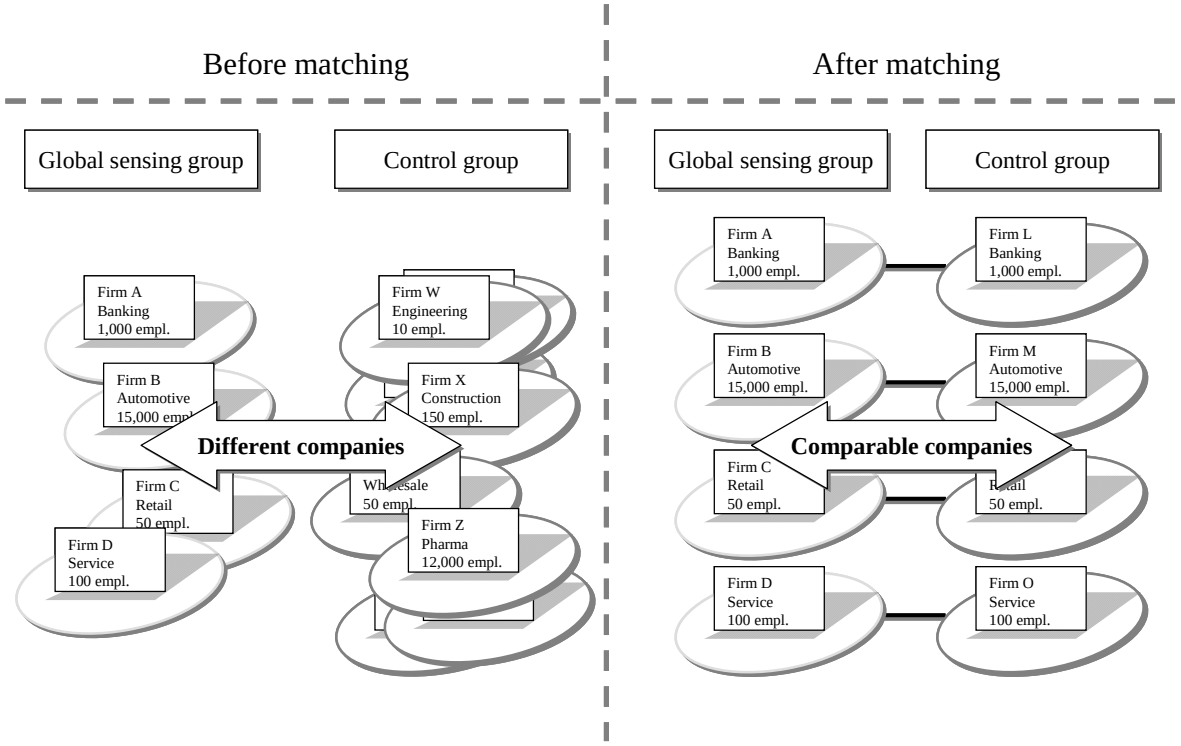
The resource based view of the firm has come under criticism for lacking specificity and neglecting dynamics in the firm environment and empirical validation (Hoops, et al., 2003; Priem and Butler, 2001). Priem and Butler (2001) suspect that “virtually anything” can be a resource. Hence, a methodology is required that empirically validates the effects from strategic resources and capabilities. This implies separating their contributions from other factors in the environment (e.g. industry). Conventional regression-based methods achieve this goal by comparing average firms. These comparisons of “averages” run counter to the central resource based concepts of uniqueness, heterogeneity and equifinality (Rouse and Daellenbach, 1999; Rouse and Daellenbach, 2002).

A logical way out of this dilemma would be to find an individual benchmark for each company instead of the average one for all. This benchmarking technique is directly related to the concept developed in business engineering which implies that companies should choose the “best in class” as the relevant standard to assess their own performance. Such an approach preserves heterogeneity among firms. Choosing the relevant benchmark, though, remains difficult. Massini, et al. (2005) show that there is no generally accepted, objective procedure for picking a relevant reference group; e.g. aggressive firm strategies may lead to frontier benchmark targets while complacent firms may just settle for comparisons with industry averages. Hence, benchmarking introduces a subjective element into comparisons which impairs its usefulness as an analytical tool for empirical verification.

We suggest an optimized procedure that combines the advantages of regression and benchmarking techniques by allowing both context sensitivity and objective, empirical verification: matching estimation. Put simply, the matching procedure extends the simple idea of comparing mean differences between global sensing firms and the rest (control group). Instead of comparing apples and oranges it aims at identifying almost perfect twin companies from both groups. These twin companies are objectively assigned based on propensity scores estimated from predefined context variables (e.g., same size, industry). The differences in

firm performance between these twins can subsequently be attributed to global sensing. Global sensing can be considered a strategic capability if these effects are positive and significant. Figure 1 summarizes the matching rationale.

Figure 1: Rationale behind matching estimation



Matching approaches have been predominantly developed and discussed in labour market research (Heckman, et al., 1998b; Heckman, et al., 1999; Lechner, 2000). The technique has also made inroads in industrial economics, most prominently through studies on the effects of public R&D subsidies (Almus and Czarnitzki, 2001; Czarnitzki, et al., 2004). We consider this approach especially fitting for empirical tests of the resource and capability based view of the firm for two reasons. Firstly, it compares firms with similar contexts and dynamics in their environment. Secondly, it preserves the heterogeneity among firms, which is a central pillar of the resource based view; i.e. firms are not compared to an average firm but to a firm that is relatively similar. Table 1 summarizes the theoretical arguments in favour of matching estimation. Section 5 illustrates its usefulness based on a multi-stage empirical application.

Table 1: Advantages of matching estimation

Quality requirements	***Direct group comparisons (apples and oranges)***	***Regression based techniques***	***Benchmarking***	***Matching estimation***
Objective controls for relevant context	No	Yes	No; subjective benchmark identification	Yes; objective propensity scores
Preserve firm heterogeneity	No	No; comparison of averages	Yes; individual benchmarks	Yes; comparison of twin companies

3.2 Relevant context and performance measures

The context of global sensing

Amit and Schoemaker (1993) suggest that the resource based view of the firm complements traditional industry analysis and that internal and external factors have to be considered to understand the sources of competitive advantage. Along these lines several studies have argued that capabilities cannot be separated from their relevant context (Atuahene-Gima and Haiyang, 2004; Brush and Artz, 1999). In line with Priem and Butler (2001) we define the relevant context as the "when, where and how" resources and capabilities translate into competitive advantage. We suggest that these context factors can be captured at three levels: the company's degree of internationalization (access and opportunity), the relevance of knowledge from abroad (need) and the competencies and processes the company has to leverage impulses from abroad (absorptive capacity). We shall now elaborate this categorization briefly.

Global sensing systems are naturally linked to the absorptive capacities of organizations: (Cohen and Levinthal, 1989, 1990): The ability to identify, assimilate and exploit knowledge from the environment, which is developed while performing R&D activities. Therefore R&D not only generates innovations by itself, it also supports the building-up process of knowledge within a company and its personnel (Engelbrecht, 1996). We suggest that organizations develop certain skills and competencies when interacting with foreign customers, suppliers and competitors that enable them to establish channels across borders which subsequently serve as pipelines for valuable knowledge from abroad. Through this embeddedness they find it easier to transform these foreign impulses into inputs that can be injected in the company's innovation system. Therefore, we argue that global sensing activities are more efficiently conducted if the company and its employees possess previous experience in internationalization since the existence and richness of transmission channels propel knowledge flows (Gupta and Govindarajan, 2000). Hence a company's degree of internationalization should propel global sensing activities. Besides, cultural barriers to knowledge flows have proven to be rather entrenched and persistent in society (Ghemawat, 2001, 2003). There is a need to address them organizationally, e.g., by recruiting managers from abroad or with foreign experience (O'Grady and Lane, 1996).

Moreover, we suggest that global sensing activities are targeted. They focus on compensating an - at least perceived - shortage in the quality or quantity of suitable domestic sources. These relative shortcomings can originate at the country, industry or firm level. Push factors might propel domestic companies to exploit their firm-specific advantages abroad but they might also experience pull factors from superior foreign inputs (Le Bas and Sierra, 2002). These drivers could be structural (e.g., barriers to competition) or cognitive (e.g., high information costs) in nature (Dunning, 1981). This process is dynamic. It can be stimulated through intensified international competition or offshoring activities from important customers or suppliers (Doz et al., 2001). Additionally, the development stage within the innovation process is important. As Pearce (1989) and Dunning (1992) suggest, applied R&D activities should more likely be decentralized, while fundamental basic research is better conducted domestically.

In conclusion, firms need access to relevant knowledge that fits their needs and adequate absorptive capacities to leverage these inputs. Hence in line with Sofka (2005) we conceptualize the mechanisms behind global sensing as a combination of three factors: access, need and absorptive capacity.

Performance effects of global sensing

Global sensing can only be considered a strategic capability if it generates competitive advantage through superior firm performance. Hence there is an obvious need to define the latter. The performance potentials from global sensing have been outlined before: responsiveness, learning and efficiency (Bartlett and Goshal, 1987). We break these concepts down in line with the literature on innovation controlling (Hauschildt, 2004; Klomp and van Leeuwen, 2001). Additionally, we distinguish between strategic outcomes (i.e. a firm's cost and quality position from global sensing) and strategic potentials (i.e. whether global sensing enables firms to choose a cost or quality leadership strategy for the future).

Following this line we suggest measurement constructs which will guide our subsequent empirical study. As operative effects of global sensing (strategic outcomes) we suggest the share of turnover a company can achieve through market novelties, the sales increase it can achieve through quality improvements and the cost reductions it can generate through innovative processes. Obviously, strategic potentials are a less tangible construct. Hence, we suggest surveyed management ratings for certain strategies. These strategies are industry leadership with new products, technological leadership and cost leadership. Table 2 summarizes the operationalization and emphasizes its integration in the conceptual framework.

Table 2: Dimensions of global sensing

Benefits from global sensing	***Key drivers for global sensing***	***Strategic outcomes: Operative effects from global sensing***	***Strategic potentials generated by global sensing***
Efficiency	Competition and society driven	Cost reduction	Cost leadership
Responsiveness	Market requirements	Turnover with market novelties	New product leadership
Learning	Technological opportunities	Quality improvement	Technological leadership

4 Estimation strategy

4.1 Data and variables

For the empirical part of this paper we use cross section data from a survey on the innovation behavior of German enterprises called the "Mannheim Innovation Panel" (MIP) The survey is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry for Education and Research. The methodology and questionnaire of the survey, which is targeted at enterprises with at least five employees, are the same as those used in the Community Innovation Survey (CIS), conducted every four

years by Eurostat. For our analysis we use the 2003 survey, in which data was collected on the innovation behavior of enterprises during the three-year period 2000-2002. About 4,500 firms in manufacturing and services responded to the survey and provided information on their innovation activities.[2] We utilized this data to operationalize the concepts presented above. Additionally, we complemented this dataset with international trade data provided by the OECD (ITCS – International Trade by Commodity Statistics 2003 and TIS – Trade in Services 2004) and data on business R&D expenditures (ANBERD - R&D Expenditure in Industry 2003).

Our dataset of observations without any missing values consists of 1,664 companies. 324 of those indicated that they had used at least one foreign customer, supplier or competitor as a source of innovation (global sensing). Non-innovating firms are excluded. This is the full sample which we will use at the first and second stage of our evaluation scheme. For step three (net potential from global sensing) we restrict our dataset to firms which used external business sources (foreign or domestic). To achieve a more homogeneous sample we exclude companies from Eastern Germany. This leaves us with 405 observations. 209 of those had used a foreign business source for innovation. This relatively high portion has methodological implications. We will return to this issue at stage three of our evaluation scheme.

Naturally, global sensing activities cannot be readily observed. Some employee might read a foreign newspaper or receive an e-mail from a foreign friend that would serve as an impulse for in-house innovation activities. Still, we do not consider it helpful to draw too broad a spectrum of potential global sensing activities. We therefore focus on major activities that let domestic companies feed relevant technological or market information into their innovation processes. These sensing activities may result from active screening or could be the by-product of other activities. We want to judge the utilization of these particular sources on its merits. Therefore, we conclude that a company is conducting global sensing activities once it has indicated that it has used innovation impulses from foreign[3] customers, suppliers or competitors.[4] A detailed description of all variables can be found in section 7.3 of the annex. The industry classification is based on grouped NACE 2 and is detailed in section 7.4 of the annex.

---

[2] The sample was drawn using the stratified random sample technique. A non-response analysis showed no distortions. For a more detailed description of the dataset and the survey see Janz et al. (2001) and Rammer et al. (2005).

[3] To be precise, respondents were asked to name the country of origin of their innovation impulse. Thus, the term foreign implies that they named a country other than Germany.

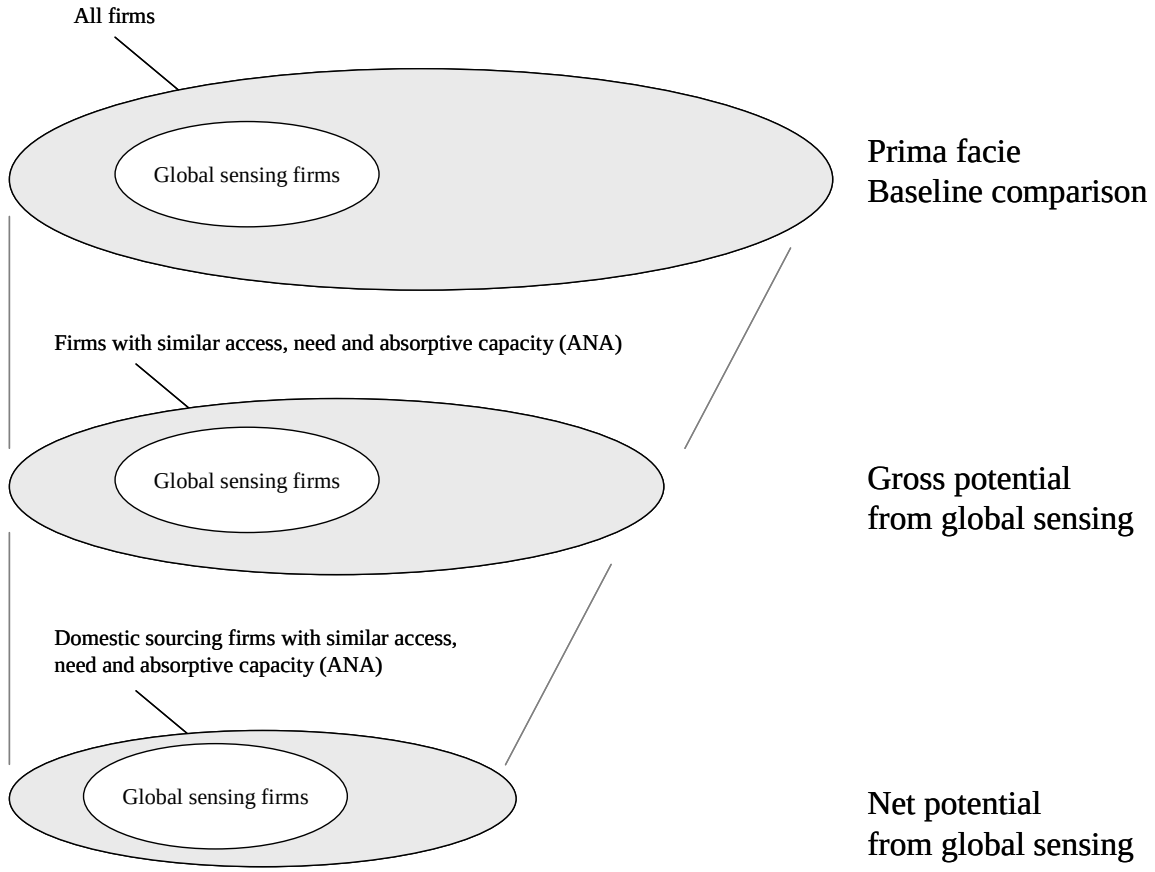
[4] Our survey framework tracks only those sensing activities that led to successful innovations. One the one hand, this enables us to capture the sensing process within the company comprehensively (from impulse reconnaissance through the final innovation). On the other hand, it has to be acknowledged that we underestimate the scope of global sensing activities since we cover successful innovations only.

4.2 Evaluation scheme

Based on the foundations presented so far we suggest a three layer evaluation design. At all levels of the evaluation we will judge the strategic effects of global sensing based on the comparison of actual strategic outcomes. For this we initially divide our sample into two sub samples: those enterprises that have conducted global sensing and a comparison group that has not. We will refine this comparison group step by step. The three evaluation layers are briefly outlined.

As a baseline case we conduct a prima facie comparison between the global sensing firms and all other companies. That is, we ignore the firm context to generate a benchmark case for all subsequent steps of the analysis. Secondly, we restrict the comparison group to companies that closely resemble our global sensing firms based on the contextual factors presented above. The differences in strategic outcomes can now be attributed to the global sensing activities since we have controlled for other sources of heterogeneity. We call the resulting differences in strategic outcomes between the two groups "gross potential of global sensing." Third, we restrict our comparison group to companies that have sensed for external innovation sources domestically and again construct a homogeneous sample based on context factors. We will interpret the remaining differences in strategic outcomes as the "net potential from global sensing." This implies that we investigate the extra effect a firm can achieve from extending its search for external sources across national borders. Figure 2 summarizes our approach.

Figure 2: Evaluation scheme for the strategic effects of global sensing



4.3 Matching procedure

Our analytical setting is typical for evaluation analyses. Since we can easily distinguish between our two groups of companies and their choice to sense globally or not, this is clearly not random, we operate in a non-experimental setting. This allows us to utilize the estimation strategies offered by the literature on the econometrics of evaluation. We opt for the matching procedure (additional methodological considerations can be found in section 7.1 of the annex). It controls for observed heterogeneity and necessitates no assumptions on the functional form of the outcome equations or the distribution of the error terms of the selection or outcome equations (Czarnitzki et al., 2004).

The procedure works as follows (Czarnitzki et al., 2004; Gerfin and Lechner, 2002). All companies are divided in two groups: global sensing companies and the remaining control group. Matching is based on the idea that the counterfactual situation of the controls can be estimated from the global sensing firms. The matching estimator generates a sample of global sensing firms which are comparable to the control firms. This comparability is based on a set of a priori defined characteristics (context factors). These characteristics would typically translate into same size or same industry. This produces matched control firms. As comparability with respect to this predefined criteria is achieved between global sensing companies and matched control firms the differences between them in the outcome variables can be explained exclusively through global sensing activities[5].

There is an obvious necessity to identify a suitable vector of context variables that defines these criteria of comparability. One would be tempted to develop a vector as large as possible to achieve a high degree of comparability. This endeavour has a downside. One runs into the curse of dimensionality (Czarnitzki et al., 2004): as the number of matching criteria increases it becomes harder to identify control observations. Rosenbaum and Rubin (1983, 1985) solve this problem by reasoning that it is sufficient to balance the samples based on an equal propensity score (or probability) for global sensing. We use the previously introduced framework of access, need and absorptive capacity (ANA) to identify comparable context factors. The operationalization of these ANA-components follows Sofka (2005). More details can be found in section 7.2 of the annex. A probit estimation based on these components will provide the propensity scores for all subsequent analytical steps.

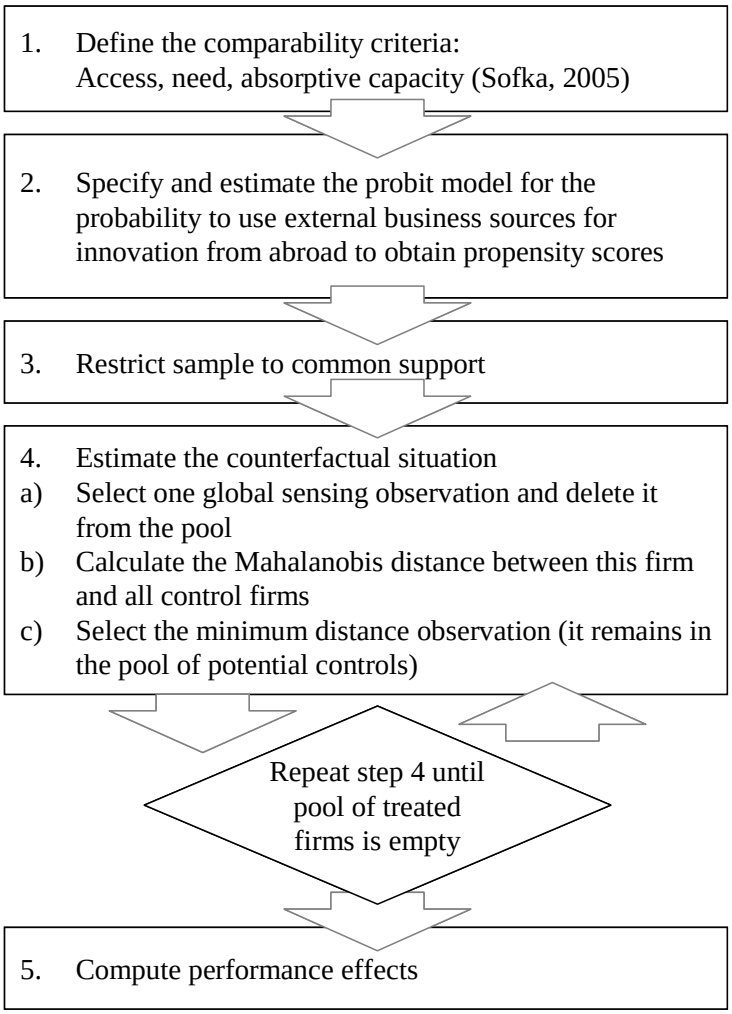
We introduce two additional modifications to our estimation strategy to enhance the quality of the results. First, we complement the propensity score matching with additional conditions to guarantee a proper threshold of comparability. Lechner (1998) suggests this so-called “hybrid matching”. In our study this implies that propensity score matching will only be applied to companies which are roughly equal in terms of size (number of employees),

[5] These differences are usually termed “average treatment effect on the treated (ATT).” The terminology follows matching labor market studies which evaluate the effects of training programs on the unemployed. Those programs are considered a “treatment” and the program participants are the “treated.” In our context global sensing is the treatment and global sensing firms are the treated. We consider these terms confusing for our research question and will henceforth avoid them.

industry and regional location (West or East Germany).[6] Secondly, concentrating on properly matched pairs of companies improves the quality of our analysis. Hence, we focus on matched pairs with "common support", i.e. observations with propensity scores above the smallest maximum and below the highest minimum of all sub-samples are eliminated (Czarnitzki et al., 2004).

In conclusion, the matching protocol in Figure 3 summarizes our matching approach.[7]

Figure 3: Matching protocol



Source: Own illustration based on Czarnitzki et al. (2004).

[6] We use Mahalanobis distance measures for the conditioning of these variables.

[7] This approach was implemented through psmatch2 by Leuven and Sianesi (2003).

5 Content analysis

5.1 Baseline case: Prima facie comparison

In essence, our estimation strategy attempts to provide an answer to the core question of this paper: How does the strategic performance of a company change if it uses global sensing? The hypothetical nature of this question already points towards the challenges in tackling it empirically. The counterfactual situation cannot be observed. One might intuitively suggest comparing the average outcomes between companies that did use these particular sources of innovation with those who did not (prima facie comparison). This procedure would most likely be subject to a selection bias, i.e. the companies in the two groups differ in important characteristics. Thus differences in the outcome variables could not only be attributed to different patterns for using external sources but they could also be explained by differences in size, location or industry effects, to name a few. With this in mind we conduct a prima facie comparison to generate a baseline benchmark for the subsequent stages of analysis. Table 3

Table 3: Results of prima facie comparison

Definition	*Variable*	*Mean*		*t-test*
		Global sensing	*Control*	*t*
Strategic outcomes				
Share of turnover with market novelties	novel	11.350	3.436	9.54***
Sales increase due to quality improvement in per cent	qual	2.637	1.051	4.65***
Cost reduction due to process innovation in per cent	costred	3.776	0.826	9.82***
Strategic potentials				
Innovation strategy industry leader with new products	stratfirstprod	2.179	0.659	23.31***
Innovation strategy technological leadership	strattechleader	2.352	0.655	25.17***
Innovation strategy cost leadership	stratcostleader	1.855	0.613	20.36***

* significant at 10%; ** significant at 5%; *** significant at 1%

With this very basic tool one would be tempted to conclude that global sensing firms are better off on all accounts and companies should rush to establish international sensing capabilities because these will guarantee them competitive advantage. This conclusion would be dangerously myopic. Global sensing firms and the control group differ on a variety of items and each of these mitigating factors could explain large portions of the differences in competitive performance. Section 7.5 gives a full descriptive comparison, so we shall restrict ourselves here to briefly outlining the major differences.

Global sensing companies have roughly six times more employees than the average control firm. Global sensing firms are much more internationalized. Almost every third Euro of their turnover stems from exports while this is only one out of ten for the control group. They are also much more frequently part of a multinational group. While global sensing companies operate in industries in which Germany has a relatively strong international competitiveness (RCAs), the German shares of business expenditures on R&D are roughly equal for both groups. Global sensing firms are both more self-reliant in their innovation activities and more R&D intensive than the control group. They are also much more sensitive to obstacles to

innovations than the control firms across the board. Finally, global sensing firms have higher absorptive capacities on average, indicated by the share of college educated employees, relative R&D expenditures and management programs for stimulating innovativeness. In conclusion, a technique needs to be found that addresses these mitigating factors and allows a more unbiased assessment of the strategic value of global sensing.

5.2 Gross potential of global sensing

We apply our empirical matching strategy as outlined in the protocol. As a first step we conduct a probit estimation (our dependent variable is binary in nature: global sensing firm or not) with the ANA variables. Table 11 of the annex outlines the results.[8] The coefficients of the probit estimation support the results from Sofka (2005). We refer to this paper for a discussion of the various effects. At this point we want to focus on performance effects and merely use the probit estimation as a vehicle to achieve meaningful propensity scores.

To enhance the quality of our matching estimation we exclude observations with extreme propensity scores since these are unlikely to produce meaningful benchmark comparisons.[9] The effect of this so-called common support conditioning on our sample is rather limited. Two global sensing observations have to be dropped, leaving us with 322 global sensing companies for further investigation. Subsequently, we conduct the matching for these firms. We add an additional quality check by investigating whether global sensing companies and their matched controls are still significantly different with regard to the variables from the probit estimation. For the vast majority of our variables this is not the case. We can assure that our matched pairs are similar with regard to their industry, size, degree of internationalization and regional location (West/East Germany). For full disclosure we present the mean differences before and after matching in Table 12 of the annex.

Finally, we focus on the outcome variables to compute the treatment effects. Table 4 displays the results. We start the discussion by outlining the merits of our matching procedure based on the first variable: share of turnover with market novelties. In an unmatched state comparing means among the two groups would have suggested that global sensing does in fact increase success with market novelties. After the matching, we know that this result is misleading, as it is effectively based on a comparison of apples and oranges. The matching tells us that when we compare similar companies between the groups, there is no significant difference in turnover with market novelties.

Table 4: Gross potential from global sensing

[8] The estimation performs well with a fit of 0.54 (Aldrich Nelson Pseudo R^2). This makes us confident that we have achieved an adequate foundation for all subsequent steps of our matching procedure.

[9] Observations larger than the smallest maximum and smaller than the largest minimum of both groups are eliminated.

Definition	*Variable*	*Mean*		*t-test*
		Global sensing	*Control*	*t*
Strategic outcome				
Share of turnover with market novelties	novel	11.343	9.292	1.55
Sales increase due to quality improvement in per cent	qual	2.654	1.876	1.81*
Cost reduction due to process innovation in per cent	costred	3.613	1.624	4.45***
Strategic potentials				
Innovation strategy industry leader with new products	stratfirstprod	2.180	1.789	4.97***
Innovation strategy technological leadership	strattechleader	2.348	1.978	4.48***
Innovation strategy cost leadership	stratcostleader	1.848	1.711	1.94*

* significant at 10%; ** significant at 5%; *** significant at 1%

When focusing on the results we find that global sensing does still generate competitive advantage. The internationalization in source usage does not readily translate into a higher share of turnover with market novelties but it does help to refine products (services) and processes. While success is still created within the company and its domestic competitive environment (Porter, 1990), responsiveness and efficiency can be achieved by learning from the foreign parts of the value chain (Bartlett and Goshal, 1987). What is more, this input generates strategic potentials across the board, in technology, costs and timing. While economic efficiency might be achieved in the home market (Porter, 1996), sustainable competitive advantage requires access to the scarce, regional pockets of competitive excellence across the globe (Doz et al., 2001; Porter, 1990). Hence, we can actually identify configurational, metanational advantages (Craig and Douglas, 2000; Doz et al., 2001) from using foreign business sources for innovation.

5.3 Net potential of global sensing

At this point of the analysis one might argue that our analytical approach measures sensing capabilities in general but not global sensing exclusively. We address this issue by fine-tuning our empirical approach. Instead of benchmarking global sensing firms against matched controls from all other firms we constrict this potential control group to firms with domestic sensing activities. This reconfiguration emphasizes the ‘global’ aspect in global sensing and therefore provides additional insight. On the downside, limiting the pool of potential benchmark firms reduces the a priori probability of producing effective matches. We refine our matching procedure accordingly.

To be precise, we have previously outlined a matching procedure that finds the best matching control company for any given global sensing company. This technique is called “nearest neighbor” matching and is the general backbone of the matching analysis. However, in this second step of our investigation we will apply a different matching procedure to a sub-sample. In this sub-sample the number of global sensing and control firms is fairly equal. While it would still be possible to find a suitable control for every firm (a firm can serve as a control for more than one global sensing company) the danger of using a single control firm too often increases. Hence, for the sub sample we choose a different algorithm from the methods surveyed by Heckman et al. (1999). The matching protocol laid out in Figure 3 still

applies with a notable exception in step 4. Instead of choosing one particular control firm we construct a weighted match from all control firms. The weights are derived from the differences in propensity scores. An exact match gets a large weight; a poor match has a small weight. The function to generate these weighted matches is called kernel. We utilize the widely-used Epanechnikov kernel (Mueser et al., 2003). Therefore, this procedure is called Epanechnikov kernel matching.

As indicated before, we investigate our net potential from global sensing by narrowing our sample to companies from Western Germany that had used an external business source for innovation (domestic or foreign). For these 405 observations we conduct a probit estimation with the same parameters as before. The results of this estimation are presented in Table 13 of the annex. The fit of this probit estimation is not as good as the previous one but still acceptable (Aldrich Nelson Pseudo R^2 0.28). This might be due to the significantly reduced sample size and the fact that there are no companies in our sample that use foreign business sources exclusively. This leads ultimately to a more homogeneous sample with less variance, which explains the lower fit of this probit model. Nevertheless, we are confident that our Epanechnikow kernel matching strategy delivers high quality results. We base this certainty on the fact that there are no significant differences between the variables of our probit estimation after matching (six observations were dropped due to common support; the full set of unmatched and matched mean differences is presented in Table 14 of the annex). Therefore, we compute the following effects.

Table 5: Net potential from global sensing (Sub sample: external source using companies located in Western Germany)

Definition	*Variable*	*Mean*		*t-test*
		Global sensing	*Control*	*t*
Strategic outcome				
Share of turnover with market novelties	novel	10.825	9.661	0.67
Sales increase due to quality improvement in per cent	qual	2.594	2.177	0.570
Cost reduction due to process innovation in per cent	costred	4.224	3.364	1.160
Strategic potentials				
Innovation strategy, industry leader with new products	stratfirstprod	2.230	2.215	1.190
Innovation strategy, technology leadership in the industry	strattechleader	2.517	2.333	2.030**
Innovation strategy, cost leadership	stratcostleader	1.897	1.975	-0.730

* significant at 10%; ** significant at 5%; *** significant at 1%

Even at first glance, it becomes visible that the special benefit from using foreign business sources for innovation stems from the learning leverage point (Bartlett and Goshal, 1987). For all other performance aspects the merits derived can hardly outweigh the increased costs from crossing physical and cultural borders. Still, when it comes to leading technology, companies need to source this input wherever it occurs on the globe. If these inputs can be leveraged through the value chain instead of foreign direct investments the risks from betting on the wrong horse in a volatile environment can be severely reduced (Doz et al., 2001). Therefore, we find our argumentation from the previous section condensed but substantiated.

6 Conclusion

Our study was designed to thoroughly investigate whether global sensing is a strategic capability. We incorporate several features in our evaluation scheme to ensure that our findings are of a proper quality. On the methodological side, we find the matching approach a very suitable tool for this kind of in-depth evaluation of strategic resources and capabilities. From our experience its unique positive features are twofold: first and most obviously, it controls for contextual factors in the environment while preserving heterogeneity. Secondly, the technique of choosing an almost ideal twin company and assessing the outcome effects based on remaining observable differences makes the matching procedure more accessible and comprehensible for practitioners. They find it easier to relate to the results if the procedure on which it is based intuitively makes sense to them and do not require going into too much empirical detail.

These methodological aspects aside, we find the strongest and most consistent support for global sensing as a strategic enabler for technological leadership. Companies that plan to build their competitive advantage around their technologically unique processes and competencies are more likely to search and find creative sparring partners outside of their home countries. We suggest that these reconnaissance activities are also more targeted and hence cost efficient for them. Pockets of elite technological expertise are less likely to be randomly scattered across the globe. Instead they need substantial physical investments (e.g. specialized labs) and, more importantly, a proven knowledge stock to arise. Hence they can be tracked and traced much more easily.

Secondly, we find no support for the notion that global sensing would provide companies with more success when bringing novel products and services to the market. We argue that global sensing delivers the best results at the beginning and the end of the innovation process. At initial levels new technological opportunities trigger projects, while market inputs at the final stages benefit customizing and debugging activities. At the intermediate stages of the innovation process firms may be more reliant on other competencies and capabilities. We suggest that these unique internal capabilities are still the prime sources of market success with new products while global sensing allows fine tuning and streamlining of products and processes. The results for cost reductions and quality improvements at the gross potential level of analysis support this argument. Nevertheless, longitudinal data would be required for more robust explanations.

We benefited from a large database across many industries, both from manufacturing and services. Still, at this point we can only empirically map the German perspective. We suggest that comparative international studies would yield some additional insights. It would be very interesting to see whether global sensing in the US and Japan has similar results. What is more, we expect a generally different attitude towards global sensing from developing countries.

In conclusion, the purpose of this study was to bring sensibility to the issue of global sensing. While we recommend companies to harvest the benefits of globalization through the access to exciting ideas worldwide, we also caution that global sensing is no magic wand.

What is more, our results also highlight the fact that foreign external sources of innovation are generally not superior to domestic sources for competitive advantage. Hence, neglecting this domestic innovation environment just because “global sounds better” would be ill-advised. Just because globalization has opened up space for new branches on the company tree, there is no need to axe or drain local roots.

7 Annex

7.1 Methodological matching issues

Heckman et al. (1999) and Heckman et al. (1997) present a comprehensive survey of techniques to correct for selection biases. There is no universally superior estimation strategy. The method of choice has to be the most appropriate one for a given dataset (Heckman et al., 1998a). The difference-in-difference estimator for instance requires panel data which is not available to us. For cross-section data, instrumental variables (IV) estimators are a frequent choice. IV estimators are an option in our setting. Still, they require at least one variable that is related with the decision to sense globally but otherwise unrelated to the strategic outcome (Blundell and Costa Dias, 2000, 2002). Hence, the requirements for such a perfect instrumental variable are high. Given the limitations of our dataset and the previous conceptual discussion on relevant context factors, we find it difficult to identify an instrumental variable which would not ultimately impair our results. Hence, we opt for the matching procedure.

The matching procedure basically rests upon two central conditions: the conditional independence assumption (CIA) and the stable unit treatment value condition (SUTVA). Rubin (1977) introduced the conditional independence assumption. It implies that treatment and potential outcomes are independent for observations with the same set of matching characteristics (Almus and Czarnitzki, 2001). The validity of CIA cannot be tested empirically (Almus et al., 1999). Given the broad range of variables in our dataset and the fact that the Mannheim Innovation Panel data has been used in the past for several matching studies (Almus and Czarnitzki, 2001; Czarnitzki et al., 2004) as well as with respect to internationalisation activities (Arnold and Hussinger, 2004), we are confident that the CIA makes a reasonable approximation. Angrist et al. (1996) demand that the treatment status of a particular firm must not influence the outcomes of others. Since the usage of foreign suppliers, customers or competitors as a source for innovation (treatment) can not be observed by other firms, we consider it more than unlikely that this fact would influence their outcome variables. Therefore, SUTVA holds for our empirical investigation.

7.2 Operationalization of the ANA framework

Access

Access is captured as a firms' degree of internationalization. We use export intensity[10] as a measurement for internationalization performance and being part of a multinational group[11]

[10] We use the lagged values for 2001 in this case to achieve clarity in interpretation; for the 2002 data it would be unclear whether an increased export intensity was the result of source usage from abroad or its cause (endogeneity).

for structural internationalization (Sullivan, 1994). To incorporate the supposed curved-linear relationship between the degree of internationalization and derived utility from using external sources from abroad, we additionally introduced the squared export intensity as a separate variable. To account for firm size we introduce the logarithm of the number of employees and for regional effects whether a company is located in the eastern part of Germany or not. For the effect of exceedingly large co-operations the squared values of firm size is added, too.

Need

This item operationalizes actual or perceived deficits within a company or its domestic environment. Shortcomings could be due to country-, industry- or firm-specific factors. We therefore introduce Germany's revealed comparative advantage (RCA)[12] among OECD countries in 2002 at the industry level as a measure for competitive performance and the German share of OECD business R&D expenditures (BERD) by industry in 1999[13] as a measure of competitive potential (Buckley et al., 1988). Openness to new products on domestic markets and domestic market dynamics are measured by the share of turnover with market novelties in the industry.

At a firm level we introduce self-reliance in innovation activities which suggests a pronounced need for external sources. Additionally, the share of turnover taken up by R&D expenditure[14] is a proxy for the importance of innovation activities for the company. By including the squared value of this variable in the model we address companies operating with an extreme degree of R&D intensity. This follows the idea that applied R&D is better decentralized while more fundamental R&D is better performed centrally at home (Dunning, 1992). While high R&D intensity alone can certainly not provide convincing evidence of basic R&D, it should (carefully) be treated as a reasonable indication in that direction. Finally, three firm-level dummy variables are introduced to the model to account for obstacles to innovation which might in turn trigger a search process for external innovation sources from abroad: high risks and the closely related high costs of innovation projects, a lack of technological information and unfavorable conditions in regulation or governmental bureaucracy (Buckley and Casson, 1998).

---

11 In line with Veugelers and Cassiman (1999) we distinguish between multinational groups with headquarters in Germany and abroad to account for different levels of international exposure.

12 The strength of the RCA analysis stems from the opportunity to assess how successful a country has been on foreign markets (exports) in comparison to the foothold foreign competitors were able to gain in that country's domestic market (imports). Additionally, this ratio is compared to the overall export/import ratio of a particular country to the world as a whole. To be precise, this concept measures not only whether exports of a specific product have outweighed imports, but also whether the trade position for this particular product has been stronger than the overall trade performance of the country considered. At the same time, its formulation in logarithmic terms yields continuous, unbound and symmetric results (Wolter, 1977).

13 1999 is the most recent year featuring a high level of data availability.

14 As stated before, at this point it is not totally clear whether an increased R&D intensity is the result of the usage of foreign sources or its cause (endogeniety). To clarify this casual relationship with R&D intensity as the cause we rely on lagged values for 2001.

Absorptive capacity

Absorptive capacities are not a tangible concept but rather a combination of different competencies and capabilities. Hence companies cannot be easily surveyed to estimate the degree to which they possess these absorptive capacities. We use the employees' level of education and academic achievement (Rothwell and Dodgson, 1991), companies' relative strength in R&D[15] compared to the industry average(Cohen and Levinthal, 1989, 1990) and a variable for the importance management attributes to stimulating innovation (Lane and Lubatkin, 1998; Lord and Ranft, 2000).

Furthermore, border effects have been found to be less pronounced in certain industries, such as semiconductors (Irwin and Klenow, 1994). Hence, six additional, instrumental industry group[16] variables have been introduced to capture industry-specific aspects that would distort the explanatory power of our other exogenous variables.

7.3 Variables

Table 6: Definition of outcome variables

Variable	***Definition***
novel	Share of turnover with market novelties in per cent
qual	Sales increase due to quality improvement in per cent
costred	Cost reduction due to process innovation in per cent
stratfirstprod	Importance of innovation strategy, industry leader with new products on a four point Likert scale (3 equals “high”)
strattechleader	Importance of innovation strategy, technology leadership in the industry on a four point Likert scale (3 equals “high”)
stratcostleader	Importance of innovation strategy, cost leadership on a four point Likert scale (3 equals “high”)

Table 7: Definition of dependent variables

Variable	***Definition***
Foreign business source	Dummy variable is 1 if the company indicated that it used at least one customer, supplier or competitor as a source for innovation from a country other than Germany.

Table 8: Definition of exogenous variables

Variable	***Definition***
east	Dummy variable is 1 if the company is located in Eastern Germany.
lnempl	Natural logarithm of number of employees in the year 2002.
sqlnempl	Squared natural logarithm of number of employees in the year 2002.
exonturn01	Share of exports in turnover, 2001.
sqexonturn01	Squared share of exports in turnover, 2001.
fullforeigngroup	Dummy variable is 1 if the company is part of multinational group with foreign headquarters.
nationalintgroup	Dummy variable is 1 if the company is part of multinational group with German headquarters.
fulllrca	The quotient between exports and imports in an industry (NACE2) divided by

[15] Measured as a firm’s R&D expenditures divided by the industry average.

[16] These industry groups are more broadly defined as “other”, “medium high-tech” manufacturing, and “distributive”, “knowledge-intensive” and “technological” services. The base group in all cases is “other” manufacturing.

Variable	*Definition*
	the quotient between overall German exports and imports in 2002; in logs, multiplied by 100.
worldsharernd	German share of business expenditures on R&D among reporting OECD countries in current PPP USD in 1999 by industry (NACE2).
indumnove	Industry (NACE2) share of turnover with market novelties, 2002.
intdev	Dummy variable is 1 if the company develops its innovations predominantly internally.
mdontum01	Share of R&D expenditures in turnover, 2001.
sqrndonturn01	Squared share of R&D expenditures in turnover 2001.
hemyestechnologicalinfo	Dummy variable is 1 if the company indicated that a lack of technological information obstructed its innovation projects.
hemyescostrisk	Dummy variable is 1 if the company indicated that high economic risks or costs obstructed its innovation projects.
hemyesgov	Dummy variable is 1 if the company indicated that regulation or government bureaucracy obstructed its innovation projects.
grads	Share of employees who are graduates 2002.
quotmd01	The quotient between the firm's R&D expenditures and the industry (NACE2) average in 2001.
stimindex	Index value of management stimulation for innovation. The index was derived as follows: Companies indicated on a four-point scale according to what importance their company assigned to nine different measures of stimulating innovation, ranging from targeted recruiting to immaterial incentives and monetary bonuses. A principal component factor analysis was performed on these nine categories, yielding a single factor with an eigenvalue larger than one (5.94). The index represents these factor loadings after Varimax rotation rescaled between 0 and 1.

Table 9: Definition of instrument variables

Variable	*Definition*
Indugroup1	Dummy variable is 1 if company operates in other manufacturing.
Indugroup2	Dummy variable is 1 if company operates in medium high-tech manufacturing.
Indugroup3	Dummy variable is 1 if company operates in high-tech manufacturing.
Indugroup4	Dummy variable is 1 if company operates in distributive services.
Indugroup5	Dummy variable is 1 if company operates in knowledge-intensive services.
Indugroup6	Dummy variable is 1 if company operates in technological services.

7.4 Industry breakdown

Industry	**NACE Code**	**Industry Group**
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery,	36 – 37	Other manufacturing

Industry	NACE Code	Industry Group
sports equipment and toys		
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.2	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

7.5 Descriptive statistics

Table 10: Descriptive statistics: means, standard errors in parentheses

Definition	*Complete sample*	*Global sensing firms*	*Rest*
Access			
Company is located in Eastern Germany (Dummy)	0.35	0.35	0.35
	(0.48)	(0.48)	(0.48)
Number of employees	429.64	1,336.62	210.34
	(3,589.78)	(7,437.40)	(1,553.77)
Number of employees (log)	3.93	4.77	3.73
	(1.72)	(1.91)	(1.61)
Squared number of employees (log)	18.42	26.40	16.49
	(15.83)	(21.04)	(13.62)
Share of exports in turnover 2001	14.21	31.35	10.07
	(22.84)	(27.20)	(19.53)
Squared share of exports in turnover 2001	723.46	1,720.20	482.46
	(1,635.64)	(2,211.80)	(1,357.96)
Company is part of multinational group with foreign headquarters (Dummy)	0.07	0.13	0.06
	(0.25)	(0.34)	(0.23)
Company is part of multinational group with German headquarters (Dummy)	0.10	0.20	0.07
	(0.30)	(0.40)	(0.30)
Need			
Revealed comparative advantage in industry 2002 (NACE2; in logs; multiplied by 100)	10.05	17.00	8.37
	(67.09)	(42.29)	(71.72)
German share of global, business R&D in industry 1999	10.12	9.42	10.29
	(6.62)	(5.08)	(6.94)
Industry share of turnover with market novelties	3.15	4.37	2.86
	(3.59)	(3.81)	(3.47)
Company develops innovations primarily internally (Dummy)	0.36	0.76	0.26
	(0.48)	(0.43)	(0.44)
Share of R&D expenditures on turnover,	2.90	7.54	1.78

Definition	*Complete sample*	*Global sensing firms*	*Rest*
2001			
	(8.05)	(11.70)	(6.41)
Squared share of R&D expenditures in turnover, 2001	73.24	193.43	44.17
	(383.75)	(590.47)	(307.34)
Obstacle - lack of technological information (Dummy)	0.06	0.14	0.04
	(0.23)	(0.34)	(0.19)
Obstacle - innovation costs or risk (Dummy)	0.23	0.48	0.17
	(0.42)	(0.50)	(0.37)
Obstacle - regulation or bureaucratic red tape (Dummy)	0.12	0.25	0.08
	(0.32)	(0.44)	(0.27)
Absorptive capacity			
Share of graduates among employees	23.10	31.11	21.16
	(26.69)	(26.46)	(26.39)
Relative position to industry average in R&D, 2001	0.64	1.95	0.32
	(4.72)	(8.45)	(3.14)
Index value of management stimulation for innovation	0.35	0.51	0.31
	(0.17)	(0.18)	(0.15)
Number of observations	1,664	324	1,340

7.6 Results of the matching procedure for gross potential from global sensing

Table 11: Results from probit estimation of nearest neighbor matching for gross potential from global sensing

Definitions	*Coeff.*	*Robust SE*
Access		
Company is located in Eastern Germany (Dummy)	0.258***	(0.098)
Number of employees (log)	-0.002	(0.101)
Squared number of employess (log)	0.009	(0.010)
Share of exports in turnover, 2001	0.030***	(0.005)
Squared share of exports in turnover, 2001	-0.001***	(0.001)
Company is part of multinational group with foreign headquarters (Dummy)	-0.100	(0.158)
Company is part of multinational group with German headquarters (Dummy)	-0.022	(0.143)
Need		
Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	0.001	(0.001)
German share of global, business R&D in industry, 1999	-0.022**	(0.009)
Industry share of turnover with market novelties	-0.014	(0.014)
Company develops innovations primarily internally (Dummy)	0.479***	(0.107)
Share of R&D expenditures in turnover 2001	0.041***	(0.012)
Squared share of R&D expenditures in turnover 2001	-0.001**	(0.001)
Obstacle lack of technological information (Dummy)	0.273*	0.149
Obstacle innovation costs or risk (Dummy)	0.360***	(0.102)
Obstacle regulation or bureaucratic red tape (Dummy)	0.373***	(0.127)
Absorptive capacity		

Definitions	*Coeff.*	*Robust SE*
Share of graduates among employees	0.005**	(0.002)
Relative position to industry average in R&D, 2001	0.001	(0.008)
Index value of management stimulation for innovation	1.728***	(0.284)
Instruments		
Industry group medium high-tech manufacturing	0.378**	(0.149)
Industry group high-tech manufacturing	0.199	(0.175)
Industry group distributive services	-0.119	(0.171)
Industry group knowledge-intensive services	-0.329	(0.220)
Industry group technological services	-0.085	(0.187)
Constant	-2.621***	(0.283)
Observations	1,664	
Wald chi2(75)	484.53	
Prob > chi2	0.000	
Log-likelihood	-516.173	
Aldrich Nelson Pseudo R2	0.539	

* significant at 10%; ** significant at 5%; *** significant at 1%, robust standard errors in parentheses.

Table 12: Mean differences before and after matching for the ANA-variables of the full sample

Variable	*Sample*	*Mean*		*t-test*
		Treated	*Control*	*t*
Access				
Company is located in Eastern Germany (Dummy)	Unmatched	0.349	0.351	-0.07
	Matched	0.348	0.329	0.52
Number of employees (log)	Unmatched	4.770	3.730	10.07***
	Matched	4.749	4.599	1.18
Squared number of employess (log)	Unmatched	26.4	16.49	10.43***
	Matched	26.135	24.332	1.32
Share of exports in turnover, 2001	Unmatched	31.346	10.067	16.18***
	Matched	31.175	28.762	1.23
Squared share of exports in turnover, 2001	Unmatched	1720.2	482.46	12.81***
	Matched	1709	1513.9	1.23
Company is part of multinational group with foreign headquarters (Dummy)	Unmatched	0.130	0.055	4.75***
	Matched	0.130	0.127	0.09
Company is part of multinational group with German headquarters (Dummy)	Unmatched	0.197	0.072	6.93***
	Matched	0.193	0.168	0.98
Need				
Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	Unmatched	17.001	8.365	2.08**
	Matched	17.088	19.66	-0.77
German share of global, business R&D in industry, 1999	Unmatched	9.422	10.289	-2.12**
	Matched	9.438	9.633	-0.52
Industry share of turnover with market novelties	Unmatched	4.368	2.860	6.88***
	Matched	4.372	4.267	0.34
Company develops innovations primarily	Unmatched	0.762	0.260	18.61***

Variable	*Sample*	*Mean*		*t-test*
		Treated	*Control*	*t*
internally (Dummy)				
	Matched	0.761	0.767	-0.14
Share of R&D expenditures in turnover 2001	Unmatched	7.540	1.78	12.04***
	Matched	7.500	6.979	0.62
Squared share of R&D expenditures in turnover 2001	Unmatched	193.43	44.173	6.36***
	Matched	193.32	174.69	0.38
Obstacle lack of technological information (Dummy)	Unmatched	0.136	0.037	7.08***
	Matched	0.134	0.090	1.84*
Obstacle innovation costs or risk (Dummy)	Unmatched	0.481	0.167	12.66***
	Matched	0.478	0.404	1.99**
Obstacle regulation or bureaucratic red tape (Dummy)	Unmatched	0.253	0.082	8.84***
	Matched	0.252	0.183	2.15**
Absorptive capacity				
Share of graduates among employees	Unmatched	31.11	21.161	6.09***
	Matched	31.08	29.716	0.66
Relative position to industry average in R&D, 2001	Unmatched	1.947	0.323	5.62***
	Matched	1.868	1.654	0.45
Index value of management stimulation for innovation	Unmatched	0.506	0.307	20.78***
	Matched	0.505	0.483	1.66*
Instruments				
Industry group medium high-tech manufacturing	Unmatched	0.330	0.125	9.12***
	Matched	0.329	0.292	1.05
Industry group high-tech manufacturing	Unmatched	0.173	0.049	7.87***
	Matched	0.171	0.177	-0.14
Industry group distributive services	Unmatched	0.043	0.172	-5.95***
	Matched	0.043	0.043	-0.02
Industry group knowledge-intensive services	Unmatched	0.037	0.149	-5.48***
	Matched	0.037	0.053	-0.97
Industry group technological services	Unmatched	0.157	0.147	0.47
	Matched	0.158	0.146	0.40

* significant at 10%; ** significant at 5%; *** significant at 1%

7.7 Results of the matching procedure for net potential from global sensing

Table 13: Results from probit estimation for net potential from global sensing

Definitions	*Coeff.*	*Robust SE*
Access		
Number of employees (log)	0.097	(0.149)
Squared number of employees (log)	0.001	(0.014)
Share of exports in turnover, 2001	0.017	(0.009)
Squared share of exports in turnover, 2001	-0.001	(0.001)
Company is part of multinational group with foreign headquarters (Dummy)	0.036*	(0.233)
Company is part of multinational group with German headquarters (Dummy)	-0.075	(0.195)

Definitions	*Coeff.*	*Robust SE*
Need		
Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	-0.001	(0.001)
German share of global, business R&D in industry, 1999	-0.017	(0.013)
Industry share of turnover with market novelties	0.021	(0.023)
Company develops innovations primarily internally (Dummy)	0.008	(0.163)
Share of R&D expenditures in turnover 2001	0.028	(0.019)
	(0.019)	-0.001
Squared share of R&D expenditures in turnover 2001	-0.001	(0.001)
Obstacle lack of technological information (Dummy)	0.188	(0.196)
Obstacle innovation costs or risk (Dummy)	0.222	(0.141)
Obstacle regulation or bureaucratic red tape (Dummy)	0.198	(0.179)
Absorptive capacity		
Share of graduates among employees	0.008**	(0.004)
Relative position to industry average in R&D, 2001	0.001	(0.009)
Index value of management stimulation for innovation	0.445	(0.394)
Instruments		
Industry group medium high-tech manufacturing	0.326	(0.205)
Industry group high-tech manufacturing	-0.072	(0.267)
Industry group distributive services	0.120	(0.299)
Industry group knowledge-intensive services	-0.561*	(0.323)
Industry group technological services	-0.112	(0.267)
Constant	-1.314***	(0.470)
Observations	405	
Wald chi2(23)	72.75	
Prob > chi2	0.000	
Log-pseudolikelihood	-240.996	
Aldrich Nelson Pseudo R2	0.281	

* significant at 10%; ** significant at 5%; *** significant at 1%, robust standard errors in parentheses

Table 14: Mean differences before and after matching for the ANA-variables of the net potential from global sensing

Variable	*Sample*	*Mean*		*t-test*
		Global sensing	*Control*	*t*
Access				
Number of employees (log)	Unmatched	5.132	4.342	4.230***
	Matched	5.013	4.982	0.800
Squared number of employess (log)	Unmatched	30.232	21.960	4.180***
	Matched	28.532	27.872	1.170
Share of exports in turnover, 2001	Unmatched	33.370	17.119	6.560***
	Matched	32.337	32.832	0.200
Squared share of exports in turnover, 2001	Unmatched	1862.7	770.580	5.780***
	Matched	1774.3	1828.9	0.150
Company is part of multinational group with foreign headquarters (Dummy)	Unmatched	0.139	0.082	1.830*
	Matched	0.133	0.144	-0.150
Company is part of multinational group with German headquarters (Dummy)	Unmatched	0.239	0.153	2.180**

Variable	*Sample*	*Mean*		*t-test*
		Global sensing	*Control*	*t*
	Matched	0.232	0.210	0.700
Need				
Revealed comparative advantage in industry, 2002 (NACE2; in logs; multiplied by 100)	Unmatched	17.705	22.118	-0.840
	Matched	17.696	16.289	0.280
German share of global, business R&D in industry, 1999	Unmatched	9.640	9.791	-0.260
	Matched	9.688	9.741	-0.180
Industry share of turnover with market novelties	Unmatched	4.637	3.484	3.080***
	Matched	4.497	4.679	-0.100
Company develops innovations primarily internally (Dummy)	Unmatched	0.770	0.709	1.400
	Matched	0.768	0.760	0.25
Share of R&D expenditures in turnover 2001	Unmatched	5.899	3.677	2.470**
	Matched	5.651	5.703	0.200
Squared share of R&D expenditures in turnover 2001	Unmatched	129.090	81.070	1.090
	Matched	124.370	136.210	-0.150
Obstacle lack of technological information (Dummy)	Unmatched	0.177	0.102	2.180**
	Matched	0.177	0.166	0.300
Obstacle innovation costs or risk (Dummy)	Unmatched	0.512	0.408	2.100**
	Matched	0.502	0.494	0.370
Obstacle regulation or bureaucratic red tape (Dummy)	Unmatched	0.230	0.163	1.680*
	Matched	0.222	0.216	0.330
Absorptive capacity				
Share of graduates among employees	Unmatched	27.288	25.123	0.810
	Matched	26.730	26.793	0.190
Relative position to industry average in R&D, 2001	Unmatched	2.734	1.189	1.850*
	Matched	1.901	1.895	0.950
Index value of management stimulation for innovation	Unmatched	0.525	0.468	3.200***
	Matched	0.522	0.519	0.300
Instruments				
Industry group medium high-tech manufacturing	Unmatched	0.349	0.189	3.680***
	Matched	0.345	0.332	0.380
Industry group high-tech manufacturing	Unmatched	0.134	0.082	1.690*
	Matched	0.128	0.129	0.140
Industry group distributive services	Unmatched	0.053	0.071	-0.780
	Matched	0.054	0.051	0.070
Industry group knowledge-intensive services	Unmatched	0.043	0.143	-3.530***
	Matched	0.044	0.044	-0.02
Industry group technological services	Unmatched	0.153	0.194	-1.080
	Matched	0.153	0.168	-0.410

* significant at 10%; ** significant at 5%; *** significant at 1%

8 References

Al-Laham, A. and T.L. Amburgey (2005), Knowledge Sourcing in Foreign Direct Investments: An Empirical Examination of Target Profiles, *Management International Review* 45 (3), 247-275.

Almus, M. and D. Czarnitzki (2001), *The Effects of Public R&D Subsidies on Firms' Innovation Activities: The Case of Eastern Germany,* ZEW Discussion Paper No. 01-10, Mannheim.

Almus, M., J. Egeln, M. Lechner, F. Pfeiffer and H. Spengler (1999), *Wirkungen Gemeinnütziger Arbeitnehmerüberlassung in Rheinland-Pfalz*, Beiträge Zur Arbeitsmarkt- Und Berufsforschung 225, Nürnberg.

Amit, R. and P.J.H. Schoemaker (1993), Strategic Assets and Organizational Rent, *Strategic Management Journal* 14 (1), 33-46.

Angrist, J.D., G.W. Imbens and D.B. Rubin (1996), Identification of Causal Effects Using Instrumental Variables, *Journal of the American Statistical Association* 91 (434), 444-455.

Archibugi, D. and S. Iammarino (2002), The Globalization of Technological Innovation: Definition and Evidence, *Review of International Political Economy* 9 (1), 98-122.

Arnold, J.M. and K. Hussinger (2004), *Export Behavior and Firm Productivity in German Manufacturing,* ZEW Discussion Paper No. 04-12, Mannheim.

Atuahene-Gima, K. and L. Haiyang (2004), Strategic Decision Comprehensiveness and New Product Development Outcomes in New Technology Ventures, *Academy of Management Journal* 47 (4), 583-597.

Barney, J.B. (1991), Firm Resources and Sustained Competitive Advantage, *Journal of Management* 17 (1), 99-120.

Bartlett, C. and S. Goshal (1989), *Managing across Borders: The Transnational Solution*, Cambridge.

Bartlett, C.A. and S. Goshal (1987), Managing across Borders: New Organizational Responses, *Sloan Management Review* 29 (1), 43-54.

Birkinshaw, J. and N. Fry (1998), Subsidiary Initiatives to Develop New Markets., *Sloan Management Review* 39 (3), 51-62.

Blundell, R. and M. Costa Dias (2000), Evaluation Methods for Non-Experimental Data, *Fiscal Studies* 21 (4), 427-468.

Blundell, R. and M. Costa Dias (2002), *Alternative Approaches to Evaluation in Empirical Microeconomics,* cemmap Working Paper No. 02-10.

Boutellier, R., O. Gassmann, H. Macho and M. Roux (1998), Management of Dispersed Product Development Teams: The Role of Information Technologies, *R&D Management* 28 (1), 13-25.

Branstetter, L.G. (2001), Are Knowledge Spillovers International or Intranational in Scope? *Journal of International Economics* 53 (1), 53-80.

Brush, T.H. and K.W. Artz (1999), Toward a Contingent Resource-Based Theory: The Impact of Information Asymmetry on the Value of Capabilities in Veterinary Medicine, *Strategic Management Journal* 20 (3), 223-250.

Buckley, P.J. and M.C. Casson (1998), Models of the Multinational Enterprise, *Journal of International Business Studies* 29 (1), 21-44.

Buckley, P.J., C.L. Pass and K. Prescott (1988), Measures of International Competitiveness: A Critical Survey., *Journal of Marketing Management* 4 (2), 175-200.

Caves, R.E. (1971), International Corporations: The Industrial Economics of Foreign Investment, *Economica* 38 (149), 1-27.

Chesbrough, H.W. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Boston.

Cohen, W.M. and D.A. Levinthal (1989), Innovation and Learning: The Two Faces of R&D, *The Economic Journal* 99, 569-596.

Cohen, W.M. and D.A. Levinthal (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly* 35 (1), 128-153.

Conner, K.R. (1991), A Historical Comparison of Resource-Based Theory and Five Schools of Thought within Industrial Organization Economics: Do We Have a New Theory of the Firm? *Journal of Management* 17 (1), 121-154.

Craig, C.S. and S.P. Douglas (2000), Configural Advantage in Global Markets, *Journal of International Marketing* 8 (1), 6-26.

Czarnitzki, D., B. Ebersberger and A. Fier (2004), *The Relationship between R&D Collaboration, Subsidies and Patenting Activity: Empirical Evidence from Finland and Germany*, ZEW Discussion Paper No. 04-37, Mannheim.

Dierickx, I. and K. Cool (1989), Assett Stock Accumulation and Sustainability of Competitive Advantage, *Management Science* 35 (12), 1504-1511.

Doz, Y.L. and C.K. Prahalad (1984), Patterns of Strategic Control within Multinational Corporations, *Journal of International Business Studies* 15 (2), 55-72.

Doz, Y.L., J. Santos and P. Williamson (2001), *From Global to Metanational: How Companies Win in the Knowledge Economy*, Boston.

Dunning, J.H. (1981), *International Production and the Multinational Enterprise*, London.

Dunning, J.H. (1992), Multinational Enterprises and the Globalization of Innovatory Capacity, in: Granstrand, O., L. Hakanson and S. Sjölander (eds.), *Internationalization of R&D and Technology*, New York.

Eisenhardt, K.M. and J.A. Martin (2000), Dynamic Capabilities: What Are They? *Strategic Management Journal* 21 (10/11), 1105-1121.

Engelbrecht, H.-J. (1996), International R&D Spillovers, Human Capital and Productivity in Oecd Economies: An Empirical Investigation, *European Economic Review* 41, 1479-1488.

Gerfin, M. and M. Lechner (2002), A Microeconometric Evaluation of the Active Labour Market Policy in Switzerland, *Economic Journal* 112 (482), 854-893.

Ghemawat, P. (2001), Distance Still Matters: The Hard Reality of Global Expansion, *Harvard Business Review* 79 (8), 137-146.

Ghemawat, P. (2003), The Forgotton Strategy, *Harvard Business Review* 81 (11), 76-84.

Gottfredson, M., R. Puryear and S. Phillips (2005), Strategic Sourcing: From Periphery to the Core, *Harvard Business Review* 2005 (February), 132-139.

Govindarajan, V. and A.K. Gupta (2001), *The Quest for Global Dominance: Transforming Global Presence into Global Competitive Advantage* 1, San Francisco.

Gupta, A.K. and V. Govindarajan (2000), Knowledge Flows within Multinational Corporations, *Strategic Management Journal* 21 (4), 473-496.

Gupta, A.K. and E.D. Westney (2003), Introduction, in: Gupta, A. K. and E. D. Westney (eds.), *Smart Globalization: Designing Global Strategies, Creating Global Networks*, San Francisco, 1-12.

Hauschildt, J. (2004), *Innovationsmanagement* 3, Munich.

Heckman, J.J., H. Ichimura, J.A. Smith and P. Todd (1998a), Charaterizing Selection Bias Using Experimental Data, *Econometrica* 66 (5), 1017-1098.

Heckman, J.J., H. Ichimura and P. Todd (1998b), Matching as an Econometric Evaluation Estimator., *Review of Economic Studies* 65 (223), 261.

Heckman, J.J., R.J. Lalonde and J.A. Smith (1999), The Economics and Econometrics of Active Labour Market Programs, in: Ashenfelter, A. and D. Card (eds.), *Handbook of Labour Economics*, Amsterdam, 1866-2097.

Heckman, J.J., J.A. Smith and N. Clements (1997), Making the Most out of Program Evaluations and Social Experiments: Accounting for Heterogeneity in Program Impacts, *Review of Economic Studies* 64 (221), 487-536.

Henderson, R. and I. Cockburn (1994), Measuring Competence? Exploring Firm Effects in Pharmaceutical Research, *Strategic Management Journal* 15 (Special Issue Winter), 63-84.

Hoops, D.G., T.L. Madsen and G. Walker (2003), Guest Editors' Introduction to the Special Issue: Why Is There a Resource-Based View? Toward a Theory of Competitive Heterogeneity, *Strategic Management Journal* 24 (10), 889-902.

Hymer, S.H. (1976), *The International Operations of National Firms: A Study of Direct Investment*, Cambridge.

Irwin, D.A. and P.J. Klenow (1994), Learning-by-Doing Spillovers in the Semiconductor Industry., *Journal of Political Economy* 102 (6), 1200-1227.

Jaffe, A.B. and M. Trajtenberg (1999), International Knowledge Flows: Evidence from Patent Citations, *Economics of Innovation & New Technology* 8 (1/2), 105-137.

Janz, N., G. Ebling, S. Gottschalk and H. Niggemann (2001), The Mannheim Innovation Panels (Mip and Mip-S) of the Centre for European Economic Research (Zew), *Journal of Applied Social Science Studies* 121 (1), 123-129.

Klomp, L. and G. van Leeuwen (2001), Linking Innovation and Firm Performance: A New Approach, *International Journal of the Economics of Business* 8 (3), 343-364.

Kogut, B. and U. Zander (1992), Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology, *Organization Science* 3 (3), 383-397.

Lado, A.A., N.G. Boyd and P. Wright (1992), A Competency-Based Model of Sustainable Competitive Advantage: Toward a Conceptual Integration, *Journal of Management* 18 (1), 77-91.

Lane, P.J. and M. Lubatkin (1998), Relative Absorptive Capacity and Interorganizational Learning, *Strategic Management Journal* 19, 461-477.

Le Bas, C. and C. Sierra (2002), 'Location Versus Home Country Advantages in R&D Activities: Some Further Results on Multinationals' Locational Strategies., *Research Policy* 31 (4), 589-609.

Lechner, M. (1998), *Training the East German Labour Force: Microeconometric Evaluations of Continuous Vocational Training after Unification*, Studies in Contemporary Economics, Heidelberg.

Lechner, M. (2000), An Evaluation of Public-Sector-Sponsored Continuous Vocational Training Programs in East Germany, *Journal of Human Resources* 35 (2), 347-375.

Leuven, E. and B. Sianesi (2003), Psmatch2: Stata Module to Perform Full Mahalanobis and Propensity Score Matching, Common Support Graphing, and Covariate Imbalance Testing, http://ideas.repec.org/c/boc/bocode/s432001.html.

Levitt, T. (1983), The Globalization of Markets, *Harvard Business Review* 67, 152-61.

Liesch, P.W. and G.A. Knight (1999), Information Internalization and Hurdle Rates in Small and Medium Enterprise Internationalization, *Journal of International Business Studies* 30 (1), 383-394.

Lord, M.D. and A.L. Ranft (2000), Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge, *Journal of International Business Studies* 31 (4), 573-589.

Malmberg, A. and P. Maskell (2005), *Localized Learning Revisited*, DRUID Working Paper No. 05-19.

Maznevski, M.L. and K.M. Chudoba (2000), Bridging Space over Time: Global Virtual Team Dynamics and Effectiveness., *Organization Science: A Journal of the Institute of Management Sciences* 11 (5), 473-493.

Mezias, J.M. (2002), How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations., *Journal of International Management* 8 (3), 265-283.

Mueser, P., K.R. Troske and A. Gorislavsky (2003), *Using State Administrative Data to Measure Program Performance*, IZA Discussion Paper No. 786.

O'Grady, S. and H.W. Lane (1996), The Psychic Distance Paradox, *Journal of International Business Studies* 27 (2), 309-334.

Ohmae, K. (1990), *The Borderless World: Power and Strategy in the Interlinked Economy*, New York.

Pearce, R.D. (1989), *The Internationalization of Research and Development by Multinational Enterprises*, New York.

Penrose, E.T. (1959), *The Theory of the Growth of the Firm*, New York.

Peteraf, M.A. (1993), The Cornerstones of Competitive Advantage: A Resource Based View, *Strategic Management Journal* 14 (3), 179-191.

Porter, M.E. (1990), *The Competitive Advantage of Nations*, New York.

Porter, M.E. (1996), What Is Strategy? *Harvard Business Review* 74 (6), 61-88.

Prahalad, C.K. and Y.L. Doz (1987), *The Multinational Mission: Balancing Local Demands and Global Vision* 1, New York.

Priem, R.L. and J.E. Butler (2001), Is the Resource-Based 'View" a Useful Perspective for Strategic Management Research? *Academy of Management Review* 26 (1), 22-40.

Rammer, C., B. Peters, T. Schmidt, B. Aschhoff, T. Doherr and H. Niggemann (2005), *Innovationen in Deutschland - Ergebnisse Der Innovationserhebung 2003 in Der Deutschen Wirtschaft*, Zew Wirtschaftsanalysen 78, Baden-Baden.

Rosenbaum, P.R. and D.B. Rubin (1983), The Central Role of the Propensity Score in Observational Studies for Causal Effects, *Biometrika* 70 (1), 41-55.

Rosenbaum, P.R. and D.B. Rubin (1985), Constructing a Control Group Using Multivariate Matched Sampling Methods That Incorporate the Propensity Score, *The American Statistician* 39 (1), 33-38.

Rothwell, R. and M. Dodgson (1991), External Linkages and Innovation in Small and Medium-Sized Enterprises, *R&D Management* 21, 125-137.

Rouse, M.J. and U.S. Daellenbach (1999), Rethinking Research Methods for the Resource-Based Perspective: Isolating Sources of Sustainable, *Strategic Management Journal* 20 (5), 487-494.

Rouse, M.J. and U.S. Daellenbach (2002), More Thinking on Research Methods for the Resource-Based Perspective, *Strategic Management Journal* 23 (10), 963-967.

Rubin, D.B. (1977), Assignment to Treatment Group on the Basis of a Covariate, *Journal of Educational Statistics* 2, 1-26.

Rugman, A.M. and A. Verbeke (2003), Extending the Theory of the Multinational Enterprise: Internalization and Strategic Management Perspectives, *Journal of International Business Studies* 34 (2), 125-137.

Rugman, A.M. and A. Verbeke (2004), A Perspective on Regional and Global Strategies of Multinational Enterprises, *Journal of International Business Studies* 35 (1), 3-18.

Sofka, W. (2005), *Global Idea Sourcing: An Empirical Investigation into the Mechanisms Behind the Usage of Foreign Business Sources for Innovation*, ZEW Discussion Paper No. 05-53, Mannheim.

Stock, G.N. and M.V. Tatikonda (2004), External Technology Integration in Product and Process Development, *International Journal of Operations & Production Management* 24 (7), 642-665.

Veugelers, R. and B. Cassiman (1999), *Importance of International Linkages for Local Know-How Flows: Some Econometric Evidence from Belgium*, CEPR Discussion Paper No. 2337, London.

Von Zedtwitz, M. (2004), Managing Foreign R&D Laboratories in China, *R&D Management* 34 (4), 439-452.

Von Zedtwitz, M. and O. Gassmann (2002a), Managing Customer Oriented Research, *International Journal of Technology Management* 24 (2/3), 165-193.

Von Zedtwitz, M. and O. Gassmann (2002b), Market Versus Technology Drive in R&D Internationalization: Four Different Patterns of Managing Research and Development, *Research Policy* 31 (4), 569-588.

Wernerfelt, B. (1984), A Resource-Based View of the Firm, *Strategic Management Journal* 5 (2), 171-180.

Wolter, F. (1977), *Factor Proportions, Technology and West-German Industry's International Trade Patterns*, Weltwirtschaftliches Archiv No. 113, Tübingen.

Zaheer, S. (1995), Overcoming the Liability of Foreignness., *Academy of Management Journal* 38 (2), 341-364.

Zander, U. and B. Kogut (1995), Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test, *Organization Science* 6 (1), 76-92.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Innovation Activities Abroad and the Effects of Liability of Foreignness: Where it Hurts

---

AUTOREN: ***Wolfgang Sofka***

[Universität Hamburg, ZEW Mannheim]

JAHR: 2006

AUSZEICHNUNGEN: International Association for Management of Technology Miami 2007
Best Student Paper

Academy of International Business
Indianapolis 2007
Finalist Haynes Prize
Most Promising Scholar

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper
No. 06-029, Mannheim
Georgia Tech Center for International Business Education and Research
Working Paper 031-07/08, Atlanta
Zweite Einreichungsrunde bei
Management International Review (MIR)
Status: Revision eingereicht

AUSGEWÄHLTE PRÄSENTATIONEN: Academy of Management
Philadelphia, 2007

Wolfgang Sofka

Innovation Activities Abroad and the Effects of Liability of Foreignness: Where it Hurts

Abstract

- The innovation activities of foreign subsidiaries have been identified as an important source of competitive advantage for multinational corporations. The success of these engagements depends heavily on tapping host country pools of localized expertise. To achieve this, foreign subsidiaries have to overcome cultural and social barriers (liability of foreignness).
- We derive potential stumbling blocks in the innovation process theoretically and argue that these materialize as neglected projects, cancellations or budget overruns. We test these hypotheses empirically for more than 1,000 firms from various sectors with innovation activities in Germany.

Key Results

- We find that foreign-controlled firms are not challenged by liability of foreignness at the idea generation stage. The lack of local embeddedness becomes more problematic as projects have to be prioritized and managed. We identify these problems by the more frequent mistakes and delays that accompany them.
- We argue that this is the result of shared practices within the multinational firm that do not readily fit into the local context. However, multinational firms that can leverage their unique capability of transferring scientific knowledge across borders are significantly less prone to suffer from liability of foreignness.

Author

Wolfgang Sofka, Research fellow, Centre for European Economic Research (ZEW), Mannheim, Germany

Introduction

So far the effects of globalization have been mostly experienced in the production and procurement segments of the value chain (Rugman/Verbeke 2004). Now there appears to be a shift towards the companies' innovation activities and the opportunities from outsourcing and/or offshoring them. The World Investment Report (UNCTAD 2005) features this trend of internationalizing R&D activities. At the same time there is a growing stream of literature that stresses the importance of harvesting creativity across the globe, which typically requires "being there." Foreign subsidiaries evolve through their innovation engagements from home-base exploiting towards increasingly home-base augmenting mandates (Birkinshaw/Hood 1998, Kuemmerle 1999). They tap local pools of expertise and make them accessible for the multinational company (MNC). Hence, these innovation engagements of foreign subsidiaries can generate competitive advantage for the MNC as a whole.

To achieve this ambitious goal they need to become embedded in flows of valuable knowledge in the host country. While spatial proximity is almost a precondition, important cultural and social barriers remain. The literature has identified these frictional losses from operating outside of the home market environment as "liability of foreignness" (Hymer 1976, Zaheer 1995). In this analysis we focus on these "stranger in a strange land" effects on the innovation activities of multinational corporations abroad. More precisely, we derive potential stumbling blocks during the innovation process conceptually, so that targeted management recommendations can be derived. We suggest that liability of foreignness may stifle innovation projects and lead to the wrong project choices and/or budget overruns.

The existing research has largely relied on large MNCs or patent data[1] which only documents successful innovations. We extend this literature by testing our conceptual framework on barriers to foreign innovation through survey data on more than 1,000 German firms and their innovation activities. Roughly ten percent of the firms are subsidiaries of foreign companies; within this setting we devise a trivariate probit estimation.

The analysis is structured as follows: Following this introduction, section 2 provides the conceptual framework which we develop further in the analytical section 3 to form hypotheses. Section 4 outlines the empirical study. The results of the estimation procedures are presented and discussed in section 5 while section 6 provides conclusions and management recommendations.

Conceptual framework

The traditional view on the innovation activities of multinational corporations regards the global headquarters as the centre of gravity for developing new technologies, with subsidiaries providing adaptation and cost efficiency (see for example Vernon 1966). More recent research streams indicate that foreign R&D units have differentiated roles within modern MNC networks, ranging from adaptation to host country tastes and support of production to more creative roles, which involve tapping into localized pools of expertise (Nobel/Birkinshaw 1998). Especially the latter subsidiary role, often described as a mandate for home-base augmenting (Kuemmerle 1999) or competence-creating (Cantwell/Mudambi

2005), has received much attention as it empowers subsidiaries to generate competitive advantage for the MNC as a whole (Birkinshaw/Hood 1998). It depends not only on headquarters assignment but also subsidiary choices and the host country environment, such as the infrastructure, science-base and skilled workforce (Birkinshaw/Hood 1998, Cantwell/Mudambi 2005).

Feinberg/Gupta 2004 show that the prospects of knowledge spillovers, from both host country factor endowments and competitors' R&D investments, increase the attractiveness of foreign locations for R&D. While this host country environment is important, it is not sufficient to generate competitive advantage. Foreign subsidiaries need to evolve over time and develop the necessary absorptive capacities to translate these external impulses into successful innovation (Birkinshaw/Hood 1998). Foreign subsidiaries enable multinational companies to develop these competencies by engaging in local networks (Gulati/Nohria/Zaheer 2000) and benefiting from the regional mobility of skilled personnel (Almeida/Kogut 1999). Hence, developing and strengthening interfirm and interpersonal relationships is a major part of firms' foreign R&D engagements (Birkinshaw/Hood 1998). The success of these engagements, in turn, is crucial for generating competitive advantage.

Becoming integrated in host country knowledge flows is therefore a crucial aspect. Investing in foreign subsidiaries with R&D responsibilities reduces the hampering effects from spatial distance but social, cultural, cognitive, administrative, institutional and organisational differences remain (Boschma 2005, Ghemawat 2001, 2003). The effects of the latter are especially challenging in the innovation process, which relies heavily on tacit knowledge and face-to-face communication (Feinberg/Gupta 2004). However, international subsidiaries face additional challenges compared to host country competitors in their R&D activities, as achieving local embeddedness needs to be balanced with intra MNC integration (Rosenzweig/Singh 1991). The latter is a prerequisite for transferring knowledge back from the subsidiary to international headquarters or other subsidiaries (Hakanson/Nobel 2001). This forces subsidiary managers to develop dual identities with the subsidiary and parent organization to advocate, communicate and coordinate successfully back and forth (Vora/Kostova/Roth 2007). Our goal is to extend existing research by investigating frictional losses from a lack of embeddedness in the host country compared to local firms. We scrutinize their importance at different stages of the innovation process.

Relative disadvantages of international firms operating outside of their home country have been summarized as liability of foreignness (Hymer 1976, Zaheer 1995). The concept implies that firms operating abroad encounter inevitable impediments that host country competitors do not. Hence, liability of foreignness is a relative concept. It comprises additional or disproportionably high cost as well as neglected revenue opportunities (Mezias 2002a). These disadvantages have four major drivers (Zaheer 1995): Spatial distance (i.e. logistics, coordination, communication and monitoring across large distances and time zones), a lack of host country roots (i.e. higher learning costs), a perceived lack of host country legitimacy[2] (i.e. higher reputation-building costs) and restrictions from the home country (e.g. export constraints for high technology). Liabilities of foreignness have been identified at various firm performance layers (e.g. profitability, growth, efficiency, exposure to labour lawsuits) and in several sectors (e.g. currency trading, banking, automobiles) (DeYoung/Nolle 1996,

Hasan/Hunter 1996, Mezias 2002b, Miller/Richards 2002, Zaheer 1995, Zaheer/Mosakowski 1997, Zaheer/Zaheer 1997).

The forces behind liability of foreignness are sociological in nature[3] and have structural, relational and legitimacy dimensions (Zaheer 2002). Differences in languages and hence understanding are a major but not exclusive factor (West/Graham 2004). As firms grow and develop within their home market, both the organization and its employees develop and refine certain skills, structures, practices and routines that reflect their social, cultural, economic and legal environment. Put simply, long-lasting exposure, experience and interaction produce a tailor-made entity that can function effectively and efficiently in the home market. This knowledge is largely acquired automatically at minimal extra cost. Substantial parts of host countries' social and cultural laws are causally ambiguous and not codified (Jensen/Szulanski 2004). These factors make it difficult for foreign competitors to buy, imitate or substitute these specific capabilities on factor markets. Hence, their liability of foreignness prevents them from achieving the same levels of local embeddedness as their host country rivals. These "rough edges" translate into relative deficits in efficiency and effectiveness (Mezias 2002a). The visible symptoms of these challenges are more frequent errors, unnecessary risks and delays (Lord/Ranft 2000). A heavy reliance on host country management, staff and resources is not enough to eradicate the problem. The foreign company always has to put additional energy into balancing host country integration with intra-MNC consistency when communicating, coordinating and monitoring across national and cultural borders (Mezias 2002a, b).

However, liabilities of foreignness are not the inevitable fate of every foreign engagement. Multinational firms can win these uphill battles through firm-specific advantages (Caves 1971). What is more, continuous host country exposure and experience allows foreign companies to adjust and adapt while, at the same time, the host country environment gets used to the firm's presence (Petersen/Pedersen 2002, Zaheer/Mosakowski 1997). Still, management recommendations on how to overcome liabilities of foreignness remain scarce (Mezias 2002a). We connect the roots of liability of foreignness with a procedural perspective on the innovation process. In essence, we investigate at what stages of the process the effects of liability of foreignness are most prevalent, so that countervailing strategies can be targeted at these weak spots.

Analytical framework

Stages of the innovation process

We build upon a basic model of the innovation process as presented by Bessant/Tidd (2007, pp. 3-37). It distinguishes between three distinct stages:

- Generating innovation possibilities
  This stage primarily consists of searching and scanning internal and external signals of new technological opportunities, changes in market demands, new legislation or competitor moves.

- Strategically selecting from these options
  At this stage resource commitments need to be balanced with expected outcomes, strategic goals and resource availability.
- Implementation
  This stage entails the management of selected projects including the effective and efficient provision of necessary funds, skills and knowledge with the goal of delivering new products or services.

We explore each stage to identify potential effects from liability of foreignness that differentiate subsidiaries' innovation processes from those of their host country counterparts.

Liability of foreignness at the idea generation stage

Idea generation is the earliest stage of the innovation process. Other authors have called it a discovery stage (Cooper/Edgett/Kleinschmidt 2002a) or fuzzy front end (Boeddrich 2004). All of these conceptualizations have in common that innovation starts with a broad and constant stream of potential ideas which have to be systematically structured and prioritized to increase the quality of the innovation inputs and hence the odds of success (Reid/de Brentani 2004). It is a reaction to the basic challenge of innovation activities as inherently uncertain endeavours characterized by bounded rationality as well as missing, unreliable or strictly qualitative information (Cooper 2006, Freel 2005). Hence, firms need to search for innovation opportunities both internally and externally as well as on the technological and market side. Ideas need to be prioritized based upon their technological and commercial feasibility which is why most best practice models stress the importance of early, in-depth customer involvement (Cooper/Edgett/Kleinschmidt 2002a). However, integrating customer inputs is challenging as their needs are largely unarticulated (Von Zedtwitz/Gassmann 2002) and assessments, requests and suggestions have been found to be frequently wrong, myopic or narrow (Frosch 1996). Von Hippel (1988) suggests the identification and activation of lead users in this context. This requires extensive background knowledge and local experience, both of which are more difficult for foreign subsidiaries to develop or acquire. Deficits in host country legitimacy and reputation may further reinforce this effect. This should result in smaller project portfolios and an increased likelihood to fewer projects. Thus, we propose:

> Hypothesis I: Foreign subsidiaries are more likely to neglect innovation projects than host country competitors.

Liability of foreignness at the selection and implementation stages

The ideas generated and structured at the initial stage need to be translated into projects with dedicated resources. This requires projects to be ranked and rated to assess which ones should receive resources and, if so, to what extent (Cooper/Edgett/Kleinschmidt 2002b). This evaluation process is challenging for a variety of reasons: dynamic opportunities, project interdependencies, multiple goals and strategy considerations, unreliable or changing information and multiple decision makers (Cooper/Edgett/Kleinschmidt 2001). Innovation management therefore typically tackles this issue by constructing a portfolio of projects. The intention behind this is similar to the idea behind a financial portfolio. The portfolio of innovation projects allows firms facing an uncertain environment to balance individual risks,

align innovation engagements with overall business strategy and maximize the returns on R&D spending (Cooper/Edgett/Kleinschmidt 2001).

The opposing forces of local embeddedness and MNC integration become especially relevant at this decision making stage. Harvey/Novicevic (2000) introduce the concept of global organizational ignorance to cross border interactions: an unawareness of relevant information and how to interpret it correctly. Managers are guided by past experiences given the contextual ambiguity abroad (Dow 2006). Decisions are based on knowledge from the home market even when it is not suitable for the host country context. This follows decision making theory. Home country knowledge and routines are more readily available, can be related back to a class of previous experiences and guarantee consistency with previous beliefs (Harvey/Novicevic 2000). These patterns should make foreign subsidiaries relatively more likely to choose the wrong projects or allocate insufficient resources to the ones that are chosen. Hence, we derive two hypotheses:

> Hypothesis II: Foreign subsidiaries are more likely to cancel innovation projects than host country firms.
>
> Hypothesis III: Foreign subsidiaries are more likely to delay innovation projects than host country competitors.

Reinforcing and mitigating factors

International R&D units fulfill differentiated roles within the MNC network. They are reflected in their charter or mandate, i.e. the shared understanding between subsidiary and headquarters about the scope of the subsidiary's responsibilities (Birkinshaw/Hood 1998). These range from home-base exploiting mandates (e.g. adaptation of existing products to local demands or regulations) to home-based augmenting ones (Kuemmerle 1999). In the most extreme case, units at international subsidiaries can become centers of excellence which have superior sets of capabilities, acknowledged by the parent company, and the clear intention to derive value from these capabilities for the MNC as a whole (Frost/Birkinshaw/Ensign 2002). Shifts in subsidiary mandates are typically an evolutionary process based on headquarters' decisions but also capability building at the subsidiary level and the quality of its local environment (Nobel/Birkinshaw 1998).

In line with Cantwell/Mudambi (2005) we will use the terms competence-exploiting and competence-creating mandates. These authors provide an overview on different subsidiary mandate classifications and relate them back to the general distinction between exploitation and exploration in organizational learning. The former relies on existing knowledge, processes and customers, while the latter generates new ones (March 1991). Caves (1971) argues that liabilities of foreignness can be overcome if international firms already possess firm-specific advantages. We extend this idea to subsidiary mandates and argue that liability of foreignness is especially relevant for subsidiaries with competence-creating mandates while exploiting ones may benefit from existing assets inside the MNC. We propose:

> Hypothesis IV: Competence-exploiting subsidiary mandates help to mitigate the effects of liability of foreignness in all stages of the innovation process.

However, these mandates cannot be separated from a subsidiary's communication and knowledge sourcing patterns (Nobel/Birkinshaw 1998). Frost/Birkinshaw/Ensign (2002) suggest four sources for competence development: customers, suppliers, competitors and external research institutions such as universities. The latter is most closely related to the acquisition of new knowledge and hence competence-creating mandates (Nobel/Birkinshaw 1998). Subsidiaries with the capabilities to access university knowledge from both domestic and foreign locations may possess firm-specific advantages compared to local rivals that mitigate the effects from liability of foreignness. We argue:

> Hypothesis V: Foreign subsidiaries with the capabilities to acquire knowledge from both domestic and foreign universities are less likely to suffer from the effects of liability of foreignness across all stages of the innovation process.

Communication with host country customers, suppliers and competitors has been linked to competence-exploiting strategies (Nobel/Birkinshaw 1998). Intensive network relations developed over time generate mutual trust and interactive learning (Hakanson 1989) which may in turn provide responsiveness to the local market environment (Bartlett/Goshal 1987). As a result, the lack of local embeddedness as a source for liability of foreignness could be overcome. We hypothesize:

> Hypothesis VI: Foreign subsidiaries with knowledge sourcing from host country customers, suppliers and competitors are less likely to experience the negative effects from liability of foreignness across all stages of the innovation process.

Empirical study

Estimation strategy

Liability of foreignness is not a tangible concept. It cannot be easily observed and survey respondents cannot simply be asked to estimate its extent. Therefore, an indirect approach is required. We follow the comprehensive measurement framework suggested by Mezias (2002a). It demands a firm level analysis with controls for other liabilities, contextual aberrations (e.g. size, age, newness) and domestic companies (which can also be multinational) as the comparison group. Within this framework we will address our research hypothesis by testing observable symptoms, asking: Are foreign firms more likely to neglect, cancel or delay their innovation projects abroad? We will estimate the probability of each of these three decisions separately but simultaneously via a trivariate probit model to make optimal use of the available information (for more methodological details see the annex). We will apply this concept to a market with a well developed innovation infrastructure and established innovation activities from multinational corporations: Germany. According to the World Investment Report, 19.1% of multinational firms with extensive R&D expenditures place R&D activities in Germany, which makes it the 8th most attractive foreign R&D location in the World (UNCTAD 2005).

Data

For the empirical part of this analysis we use cross section data from a survey on the innovation activities of German enterprises called the "Mannheim Innovation Panel" (MIP). The survey is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry of Education and Research. The methodology and questionnaire used by the survey, which is targeted at enterprises with at least five employees, are the same as those used in the Community Innovation Survey (CIS), conducted every four years under the coordination of Eurostat. For our analysis we use the 2003 survey, in which data was collected on the innovation activities of enterprises during the three-year period 2000-2002. About 5,000 firms in manufacturing and services responded to the survey and provided information on their innovation activities.[4] We utilize this data to operationalize the concepts presented above. Non-innovating firms were excluded from our analysis, because most variables can only be constructed for firms with innovation activities. Additionally, we complemented this dataset with international trade data provided by the OECD (ITCS – International Trade by Commodity Statistics 2003 and TIS – Trade in Services 2004) and data on business R&D expenditures (ANBERD - R&D Expenditure in Industry 2003).

CIS surveys are self-reported and largely qualitative which raises quality issues with regards to administration, non-response and response accuracy (for a recent discussion see Criscuolo/Haskel/Slaughter 2005). First, our CIS survey was administered via mail which prevents certain shortcomings and biases of telephone interviews (for a discussion see Bertrand/Mullainathan 2001). The multinational application of CIS surveys adds extra layers of quality management and assurance. CIS surveys are subject to extensive pre-testing and piloting in various countries, industries and firms with regards to interpretability, reliability and validity (Laursen/Salter 2006). Second, a comprehensive non-response analysis of more than 4,000 firms showed no systematic distortions between responding and non-responding firms with respect to their innovation activities. Third, the questionnaire contains detailed definitions and examples to increase response accuracy. Longhand questions (e.g. "Please describe your most important product innovation briefly") allow robustness checks for multiple choice answers.

In conclusion, the major advantages of CIS surveys are that they provide direct, importance-weighted measures for a comprehensive set of issues (Criscuolo/Haskel/Slaughter 2005). On the downside, this information is self-reported. Heads of R&D departments or innovation management are asked directly if and how they are able to generate innovations. This immediate information on processes and outputs can complement traditional measures of innovation such as patents (Kaiser 2002, Laursen/Salter 2006).

Our dataset consists of 1,010 company observations for which all variables of our model are available. The actual influence of foreign stakeholders (e.g. foreign management, shareholders, employees) cannot be readily observed. Hence, we rely on a conservative measure for identifying a firm as foreign:[5] We treat a company located in Germany as foreign if it indicated that it is part of a multinational group with its headquarters abroad. Following this line of reasoning, 95 foreign firms in our sample conduct innovation activities in Germany. The remaining companies will be the control group in all further steps of the analysis. This provision follows the rationale that foreign-controlled firms should be

compared with a complete sample of host country companies, not only domestically controlled multinationals (Mezias 2002a).

Variables

Dependent variables

Our three dependent variables are binary in nature. We derive them from three direct questions as to whether firms experience barriers in their innovation activities that prevent them from starting at least a single new project[6] (neglect), cause them to abandon at least one (cancel) or seriously delay at least one (overrun). Our firm level perspective necessitates the definition of a common standard ("at least a single one"). One could certainly argue that project data would provide additional insights. However, project setups and boundaries vary significantly across firms, which makes it difficult to draw general conclusions. The limitation to firm-level data should nevertheless be kept in mind when interpreting the results. In the absence of more detailed data we are confident that our conceptualization provides adequate, conservative measurement.

Independent variables

The dummy variable indicating whether a company is foreign-controlled or not ("part of a multinational group with headquarters abroad") is the cornerstone of our analysis. Our hypotheses will be supported if the coefficients for this dummy variable are positive and significant in all three equations (neglect, cancel, overrun).

To ensure the reliability of this measurement of liability of foreignness we have to control for the effects from other liabilities (e.g. size, age/newness) and other influences (Mezias 2002a). Most importantly, Hakanson/Nobel (2001) find that firms that were acquired by foreign firms are already better embedded in the host country than greenfield investments. However, this effect evaporates over time. For all foreign controlled firms in our sample, we investigate whether the majority of their shares have been acquired by a foreign company.[7] This is the case for 31% of foreign controlled firms. All acquisitions took place between 1999 and 2003. We add an additional dummy control variable to control for this effect.

We compare foreign subsidiaries with local firms, in contrast to most other studies in the field that focus strictly on subsidiaries or home country reference points (see for example Cantwell/Mudambi 2005, Nobel/Birkinshaw 1998). Hence, mandates need to be defined for both foreign and domestic firms. We develop these measures based on a survey question on firm's innovation strategy. Firms rate the importance of several strategy options on a 4 point Likert scale (not relevant – high). We construct scales by adding up these responses and dividing it by the maximum, i.e. firms with the most pronounced mandate have a value of 1. For competence-creating mandates with use the items:

- Technological leadership
- Industry leader with new products
- Industry leader with new processes
- Introduction of brand new technologies

For competence-exploiting mandates we use:

- Reaction to competitor moves
- Cost leadership
- Customized solutions for individual customers

We capture patterns of knowledge sourcing through survey questions[8] on the origins of the firm's most important sources for innovation along four dimensions: customers, suppliers, competitors and universities. We construct a scale based on three dummy variables indicating German customers, suppliers and competitors that are used as sources for innovation by adding them up. Besides, we introduce two separate dummy variables on knowledge sourcing from domestic and foreign universities to test hypotheses V and VI.

We also control for regional effects (whether a company is located in Eastern Germany and hence the particular German effect of reunification), company age[9] and firm size (measured by the number of employees in logs). We introduce control variables for a firm's[10] productivity (turnover per employee), export intensity (share of turnover with exports), profitability[11] and R&D intensity (R&D expenditure as a share of turnover). The latter has often been used to measure not only a firm's knowledge intensity but also its absorptive capacities (Cohen/Levinthal 1989). Finally, firm culture has been identified as an important determinant of success in innovation activities (van der Panne/van der Beers/Kleinknecht 2003). We address it through a combined scale of the importance of innovation incentives and stimulation (e.g. monetary incentives). A detailed description of the scale and its construction can be found in the annex.

Looking beyond the firm level, business expenditures on R&D have been found to present important signals for foreign R&D engagements (Feinberg/Gupta 2004). We control for this effect by adding the share of Germany in OECD R&D expenditures for each industry[12] and the revealed comparative advantage (RCA) per industry in 2002 as a measure for competitive performance.[13] Besides, to control for basic differences in technology we introduce industry dummies.[14]

Descriptive statistics

In this section we highlight major patterns in the variables presented before. A complete list of means and standard errors can be found in Table 2 of the annex. Roughly ten percent of the firms in our sample are foreign-controlled. They are on average not more likely to neglect innovation projects (40%) than their German counterparts (41%). Then again, they are typically more likely to cancel (41% vs. 25%) or delay projects (71% vs. 50%). Hence, a prima facie comparison partly supports our hypothesis on the effects of liability of foreignness.

However, these trends could also be attributed to other differences in firm characteristics. Most importantly, foreign-controlled firms are on average larger in terms of employment than the German ones. They are also more productive and export-oriented, but have lower R&D intensities (4% compared to 5%). This might be due to the fact that they are more engaged in stimulating innovation activities. Interestingly, the foreign-controlled firms are typically

older, measured from the time of their foundation in Germany. In conclusion, a multivariate analysis is warranted.

Results

Table 1 presents our estimation results for core variables (estimation results including all control variables are available in Table 3 and Table 4 in the annex).[15] We estimate two separate empirical models. Model 1 tests the main effects reflecting hypotheses I, II and III. We include additional, multiplicative interaction effects between foreign controlled firms and firm's mandates (innovation strategies) as well as knowledge sourcing patterns to test hypotheses IV, V and VI. On the methodological side we find our approach of separate but simultaneous estimation supported. All correlations (rho) between the three error terms are positive and significant. Hence, estimating the three equations as a system is clearly superior to three separate estimations. We do not develop a priori hypotheses for the control variables. However, significant results will be highlighted briefly in the annex.

Starting the interpretation with Model 1, we receive differentiated support for the hypotheses of our analytical framework. We find that liability of foreignness is not a significant hurdle for foreign-controlled firms when they have to develop and mobilize ideas and skillsets to start new innovation projects (neglect). In the selection and implementation stages, though, they are more likely to make suboptimal project choices (which translate into subsequent cancellations) and overrun project budgets. Hence, hypotheses I has to be rejected, while hypotheses II and III are supported. Apparently, the pitfalls from liability of foreignness materialize as ideas have to be combined with resources to form projects. We suspect that resource planning and management in foreign-controlled firms follows templates which are deeply influenced by the experience and practice of the multinational company as a whole. These may not readily fit into the local context and the frictional losses from this liability of foreignness surface as more frequent errors and delays. There is no additional significant effect from whether the foreign control stems from an international acquisition.

Table 1: Estimation results of trivariate probit estimations for core variables: Parameter estimates (robust standard errors in parentheses)

	Model 1			**Model 2**		
Variable	***Neglect***	***Cancel***	***Overrun***	***Neglect***	***Cancel***	***Overrun***
Foreign control (dummy)	0.03	0.36**	0.36*	-0.05	-0.56	1.49***
	(0.18)	(0.17)	(0.19)	(0.5)	(0.52)	(0.54)
International acquisition (dummy)	0.09	-0.28	-0.31	0.03	-0.25	-0.39
	(0.29)	(0.29)	(0.32)	(0.3)	(0.29)	(0.33)
Interaction: Foreign & comp. creating innovation strategy				-0.33	0.01	-0.2
				(0.65)	(0.64)	(0.68)
Interaction: Foreign & comp. exploiting innovation strategy				0.63	1.16*	-1.71**
				(0.68)	(0.67)	(0.74)
Interaction: Foreign & breadth of German innovation inputs				-0.11	0.21	0.26
				(0.18)	(0.17)	(0.17)

	Model 1			Model 2		
Variable	***Neglect***	***Cancel***	***Overrun***	***Neglect***	***Cancel***	***Overrun***
Interaction: Foreign & German university input				0.17	-0.12	0.18
				(0.49)	(0.50)	(0.44)
Interaction: Foreign & foreign university innovation input				-1.15**	0.13	-1.42**
				(0.52)	(0.55)	(0.56)
Multinational firm (dummy)	0.02	0.19*	0.02	0.00	0.19*	0.01
	(0.11)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Competence-creating innovation strategy (index)	-0.59***	-0.2	-0.04	-0.57***	-0.17	-0.03
	(0.18)	(0.19)	(0.18)	(0.19)	(0.2)	(0.19)
Competence-exploiting innovation strategy (index)	-0.54***	-0.42**	0.38*	-0.64***	-0.54**	0.53**
	(0.20)	(0.22)	(0.20)	(0.21)	(0.22)	(0.21)
Breadth of German innovation inputs (index)	0.03	0.00	0.04	0.05	-0.02	0.01
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
German university innovation input (dummy)	0.31**	-0.06	0.16	0.29**	-0.05	0.14
	(0.13)	(0.14)	(0.14)	(0.13)	(0.15)	(0.15)
Foreign university innovation input (dummy)	0.09	-0.33	0.58**	0.29	-0.08	0.88***
	(0.19)	(0.20)	(0.23)	(0.21)	(0.24)	(0.28)
Control variables		yes			yes	
Constant	-0.21	-0.93***	-0.9***	-0.23	-0.9***	-0.97***
	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)
	(1/2)	(2/3)	(1/3)	(1/2)	(2/3)	(1/3)
rho	0.59***	0.48***	0.54***	0.69***	0.56***	0.62***
	(0.04)	(0.05)	(0.04)	0.06	0.07	0.06
Observations		1010			1010	
Wald $Chi^2(78)$		264.67			315.49	
Prob > Chi^2		0.00			0.00	
Log-likelihood		-1680.52			-1663.79	
Aldrich Nelson Pseudo R2		0.27			0.30	

* significant at 10%; ** significant at 5%; *** significant at 1%;
robust standard errors in parentheses; full estimation results available in Table 3 and Table 4 of the annex.

The interaction effects of Model 2 can be interpreted as a separation of effects, capturing the particular effect of a factor (innovation strategy and knowledge sourcing) on foreign subsidiaries with regards to the likelihood of neglecting or cancelling a project, or overrunning a budget. [16] We find no factor that would influence foreign subsidiaries across all stages of the innovation process. Hence, neither hypothesis IV, V nor VI is fully supported. However, two items make a significant difference. A competence-exploiting innovation strategy makes foreign subsidiaries more likely to cancel projects but less likely to overrun budgets. This indicates that the exploitation of firm specific advantages helps foreign subsidiaries to overcome their liability of foreignness when it comes to implementing projects but they still have significantly more difficulties selecting the right projects. However, a "sticky layer" remains, in the form of increased likelihood of overrunning budgets, as

evidenced by the remaining negative and significant effect from being a foreign subsidiary even after adding interaction effects. Competence-exploring innovation strategies show no significant effect for foreign firms.

Foreign subsidiaries can significantly reduce their likelihood of neglecting projects or overrunning budgets if they are able to access and exploit knowledge from foreign universities. This may reflect the unique capability of multinational firms as social communities to transfer knowledge efficiently across borders (Kogut/Zander 1993). If foreign subsidiaries possess the capabilities to access, transfer and exploit university knowledge from abroad, they leverage it and overcome their liability of foreignness. Knowledge sourcing from German customers, suppliers, competitors or universities makes no significant difference, though, for foreign subsidiaries.

Conclusions

In this paper we focus our attention on how multinational companies can optimize their foreign innovation activities. The latter have been identified as a major vehicle for subsidiary evolution and thus as a cornerstone of MNC competitiveness. We find that foreign innovation engagements do not stumble at the idea generation stage, but rather when projects have to be selected, planned and managed.

One might argue that the courage to cancel failing projects is not a negative organizational trait at all. Pulling the plug on failing projects frees up scarce resources and employees may still draw valuable lessons from it. Hence, the tendency to cancel foreign innovation activities more frequently may just be the result of consistent project accounting. The more frequent project delays, though, spoil this argumentation and make us turn to another explanation. We argue that multinational companies have no problems in spotting worthwhile innovation impulses abroad. The effects from a lack of local embeddedness kick in once these ideas have to be prioritized and aligned with resources. We suspect that project priorities and resource planning follow general guidelines of the multinational corporation. These shared procedures provide consistency within the MNC but limit the flexibility of foreign subsidiaries to bring their innovation initiatives fully in line with host country best practices. As a result they are more often forced to recalibrate projects or necessary resources.

However, a simple switch from competence-exploring to more robust exploiting mandates is not enough to overcome liability of foreignness. It helps foreign subsidiaries to stay within budgets but project selection is still challenging. Then again, we find evidence that multinational firms can overcome their liabilities of foreignness in the innovation process if they leverage their unique capability to transfer knowledge across borders. They are better prepared to acquire valuable knowledge from foreign universities which sets them apart from host country competitors. As a result, the effects from liability of foreignness are reduced.

Luo/Shenkar/Nyaw (2002) suggest more generally that liabilities of foreignness can be mitigated through offensive (local immersion) or passive strategies (reserve). We argue that only the former is a suitable option in innovation activities that rely heavily on inter-firm and interpersonal relationships. Hence, we can derive several recommendations for the innovation management of foreign subsidiaries. First, foreign subsidiaries can achieve their full potential if they leverage their expertise in identifying, transferring and exploiting international

scientific knowledge. With respect to tackling project delays we opt for external, host country expertise in resource planning and accounting to achieve more realistic and tailor-made budgeting/scheduling. The project selection issue is more challenging since it is less suitable for outsourcing. We argue that foreign subsidiaries should actively encourage host country feedback on their innovation projects. This can be achieved by outlining and discussing broader innovation roadmaps for the future or active engagement in local technological networks. Finally, we suggest that foreign subsidiaries may streamline their innovation activities by benchmarking their innovation processes with host country, not MNC, counterparts. The MNC does not need "one size fits all" subsidiaries across the world, but perfectly fitted beachheads that plug into local innovation systems and get the most out of them for the better of the whole MNC.

Our analysis faces certain limitations which may in turn provide valuable roads for further research. Our dependent variables are rather low thresholds to cross (e.g., overrunning at least one project). As mentioned before, a project-level analysis may provide more targeted results if the heterogeneity in project delimitation across company lines can be overcome. Besides, not all projects are equally costly and important. Studies moving in the direction of such distinctions may provide important new insights into decision making mechanisms inside foreign subsidiaries and the effects of liability of foreignness. Hence, this study should be considered a first step. What is more, offshoring R&D activities is mostly discussed with reference to the destinations China and India. By considering Germany we focused on an important hub in innovation activities with established foreign links. We expect the effects of liability of foreignness in developing countries to be even more pronounced. Hence, we consider that comparative analysis could be very promising.

Annex

Econometric model and method

The occurrences of neglected, cancelled or overrun innovation projects are not independent of one another. It is quite conceivable that firms experience all of them at the same time or none at all (we found some of these cases in the data). To model this link between the three events adequately, we use a trivariate probit model instead of estimating the equations separately for each decision.[17] Within our empirical framework, the trivariate probit is superior to multinomial logit models since it allows us to reflect simultaneous multiple-event occurrence. The trivariate probit model is directly derived from the standard probit model, but allows more than one equation with correlated disturbances. This technique is comparable to the seemingly unrelated regressions model. Estimating three equations simultaneously allows us to improve the estimated sampling precision and subsequently facilitates a more complete usage of the available information. In essence, each probit equation holds information on factors that influenced the decisions on all three options. Estimating these equations simultaneously utilises this information for the complete system. The specification for our three-equation model is:

$$neglect^* = \beta_1' x + \varepsilon_1,\ \ neglect = 1\ if\ neglect^* > 0, 0\ otherwise,$$
$$cancel^* = \beta_2' x + \varepsilon_2,\ \ cancel = 1\ if\ cancel^* > 0, 0\ otherwise,$$
$$overrun^* = \beta_3' x + \varepsilon_3,\ \ delay = 1\ if\ delay^* > 0, 0\ otherwise.$$
$$Cov(\varepsilon_1, \varepsilon_2) = \rho_1$$
$$Cov(\varepsilon_1, \varepsilon_3) = \rho_2$$
$$Cov(\varepsilon_2, \varepsilon_3) = \rho_3$$

where x is the vector of explanatory variables and ρ_k is the correlation between the error terms ε_i of a pair of equations.

Estimating trivariate or more generally multivariate probit regression models using maximum likelihood methods involves some unique challenges. Normal probability distribution functions have to be calculated in the evaluation of probit-model likelihood functions. While algorithms for the bivariate case exist, higher dimensional normal distributions are still challenging. Hence, we turned to a simulation-based technique: the Geweke-Hajivassiliou-Keane (GHK) simulator.[18] This simulator relies on sequentially conditioned, univariate normal distribution functions, through which multivariate normal distribution functions can be expressed.

Discussion of control variable results

We develop no a priori hypotheses for the control variables presented in Table 3 (we focus this discussion on main effects presented in Model 1 of the results section). Hence, the discussion of their outcomes is explorative and extends the analytical scope of this paper. We identify two primary streams behind neglected, cancelled or overrun projects. Firstly, pressures from the environment force companies to narrow their project focus. Secondly, too many prospective project impulses propel prioritisation and concentration.

With respect to other liabilities we find an interesting regional effect in East Germany. Innovation processes there appear to run more smoothly across the board. Given that the bulk of innovation activity is still concentrated in the Western part of the country[19], the smaller number of innovation projects in East Germany appears to be more focused and better planned, which translates into fewer problems, albeit on a low overall level. Firm age makes companies more likely to neglect projects while firm size makes them more likely to overrun budgets. If companies are involved in M&A activities they become more prone to exceeding project schedules. We suspect that post-M&A integration efforts divert resources away from innovation projects.

The indices on innovation strategies (mandates) yield interesting results. Both competence-creating and exploiting strategies make firms less likely to neglect projects. However, exploiting strategies lead to firms canceling fewer projects. Still, the ones that are carried out are more likely to overrun their budgets. One may argue that existing competencies make it easier for firms to select projects but may also provide a false sense of certainty about what resources are necessary for implementation.

Focusing on export intensity, we suspect that firms that have to provide customer responsiveness across national and cultural borders face incalculable risks that impair exact

project planning, resulting in budget overruns and neglected projects. Multinational firms (German or foreign controlled) are also more likely to cancel projects. For profitability we find a predictable relationship between company success and future investments: Negative results propel cost reductions and hence project cancellations, while higher profits provide some slack for investment in projects that would otherwise have been shelved.

R&D intensity and external innovation impulses are strongly linked to absorptive capacity. If companies bring more ideas into their company they will probably also be more likely to set priorities and neglect certain initiatives with lower importance. This is supported by the innovation impulses from German universities and an increased likelihood to neglect projects. Inputs from foreign universities, though, increase the likelihood of budget overruns. Besides, higher levels of educated employees with the absorptive capacities to judge projects adequately leading to an increased likelihood of cancellations.

With an eye on industry variables we find that an environment in which knowledge and technology are more dynamic produces more project options. Firms have to set priorities and therefore neglect certain projects. What is more, the projects in these fields are less predictable in terms of outcomes and necessary resources. Increased rates of project cancellation and/or delays are the result.

Construction of the stimulation scale

The scale is created through principal factor analyses and varimax rotations. The results strongly indicate a single factor: One eigenvalue is above 1 (5.88), Cronbach's alpha Scale reliability coefficient 0.943, average interitem covariance 0.63.

The scale variables that entered the estimation model are the factor loadings rescaled between zero and one. The factor items are the survey responses on a four-point Likert scale of importance to the following components of stimulation techniques for innovation:

- Target setting
- Strengthening key personnel
- Talent recruiting/development
- Strengthening line managers
- Financial incentives
- Non-financial incentives
- Incentives for idea creation
- Groupwork
- Union involvement

Industry breakdown

Industry	NACE Code	Industry Group
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing

Industry	NACE Code	Industry Group
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.2	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

Descriptive statistics

Table 2: Means and standard errors of model variables

Variable	*Total*		*German*		*Foreign*	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
No. of observations	1010		915		95	
Company refrained from at least one innovation project (dummy)	0.4	0.5	0.4	0.5	0.4	0.5
Company cancelled at least one innovation project (dummy)	0.3	0.4	0.3	0.4	0.4	0.5
Company delayed at least one innovation project seriously (dummy)	0.5	0.5	0.5	0.5	0.7	0.5
Company is part of a multinational group with headquarters abroad (dummy)	0.1	0.3	0.0	0.0	1.0	0.0
Company has been acquired by foreign firm (dummy)	0.0	0.2	0.0	0.0	0.3	0.5
Company is part of multinational group (dummy)	0.4	0.5	0.3	0.5	1.0	0.0
Competence-creating innovation strategy	0.5	0.3	0.5	0.3	0.6	0.2

Variable	*Total*		*German*		*Foreign*	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
(index)						
Competence-exploiting innovation strategy (index)	0.6	0.3	0.6	0.3	0.6	0.2
Breadth of German innovation inputs (index)	0.8	0.9	0.8	0.8	0.8	0.9
German university innovation input (dummy)	0.1	0.3	0.1	0.3	0.1	0.3
Foreign university innovation input (dummy)	0.0	0.2	0.0	0.2	0.1	0.3
Index of importance of methods of stimulating innovation activities (index)	0.4	0.2	0.4	0.2	0.5	0.2
Company is located in East Germany (dummy)	0.3	0.5	0.4	0.5	0.3	0.4
Company age since founding in Germany (years)	17.4	16.4	16.8	15.7	23.2	21.5
Company was engaged in significant M&A activity (dummy)	0.0	0.2	0.0	0.2	0.1	0.3
No. of employees	258.8	626.1	228.8	569.4	548.3	980.7
Sales per employee 2001 (ratio)	0.3	0.3	0.3	0.3	0.4	0.3
Export share of sales 2001 (ratio)	0.2	0.2	0.2	0.2	0.4	0.3
Negative profitability 2001 (dummy)	0.2	0.4	0.2	0.4	0.1	0.3
Return on sales above 4% (dummy)	0.5	0.5	0.5	0.5	0.5	0.5
R&D share of sales 2001 (ratio)	0.0	0.1	0.0	0.1	0.0	0.1
Share of employees with university education (ratio. divided by industry average)	1.1	0.9	1.1	0.9	1.1	0.9
Germany's revealed comparative advantage (in logs. by industry)	16.2	53.0	16.3	53.5	14.9	48.6
German share of global business R&D expenditures (%. by industry)	10.0	5.9	10.0	5.9	10.1	5.8

Estimation results

Table 3: Estimation results of trivariate probit estimations without interaction terms: Parameter estimates (robust standard errors in parentheses)

Variable	*Neglect*	*Cancel*	*Overrun*
Company is part of a multinational group with headquarters abroad (dummy)	0.03	0.36**	0.36*
	(0.18)	(0.17)	(0.19)
Company has been acquired by foreign firm (dummy)	0.09	-0.28	-0.31
	(0.29)	(0.29)	(0.32)
Company is part of multinational group (dummy)	0.02	0.19*	0.02
	(0.11)	(0.12)	(0.12)
Competence-creating innovation strategy (index)	-0.59***	-0.20	-0.04
	(0.18)	(0.19)	(0.18)
Competence-exploiting innovation strategy (index)	-0.54***	-0.42**	0.38*
	(0.20)	(0.22)	(0.20)
Breadth of German innovation inputs (index)	0.03	0.00	0.04
	(0.05)	(0.05)	(0.05)
German university innovation input (dummy)	0.31**	-0.06	0.16
	(0.13)	(0.14)	(0.14)
Foreign university innovation input (dummy)	0.09	-0.33	0.58**

Variable	*Neglect*	*Cancel*	*Overrun*
	(0.19)	(0.2)	(0.23)
Index of importance of methods of stimulating innovation activities (index)	0.25	0.07	0.31
	(0.27)	(0.26)	(0.26)
Company is located in East Germany (dummy)	-0.25***	-0.32***	-0.37***
	(0.1)	(0.1)	(0.09)
Company age since founding in Germany (years)	0.01*	-0.01	0.00
	(0.00)	(0.00)	(0.00)
Company was engaged in significant M&A activity (dummy)	0.24	0.06	0.47**
	(0.18)	(0.19)	(0.21)
No. of employees	0.01	0.05	0.08**
	(0.03)	(0.04)	(0.04)
Sales per employee 2001 (ratio)	0.12	0.15	0.07
	(0.2)	(0.18)	(0.19)
Export share of sales 2001 (ratio)	0.37*	0.23	0.51**
	(0.21)	(0.21)	(0.21)
Negative profitability 2001 (dummy)	0.18	0.32***	0.14
	(0.12)	(0.12)	(0.12)
Return on sales above 4% (dummy)	-0.24***	0.02	0.28
	(0.09)	(0.1)	(0.09)
R&D share of sales 2001 (ratio)	2.1***	0.41	0.21
	(0.52)	(0.53)	(0.54)
Share of employees with university education (ratio. divided by industry average)	-0.25	0.12**	0.05
	(0.05)	(0.05)	(0.05)
Germany's revealed comparative advantage (in logs. by industry)	0.00*	0.00	0.00
	(0.00)	(0.00)	(0.00)
German share of global business R&D expenditures (%. by industry)	0.00	0.01	-0.01
	(0.01)	(0.01)	(0.01)
Medium-high tech manufacturing (dummy)	0.15	0.01	0.09
	(0.13)	(0.14)	(0.13)
High-tech manufacturing (dummy)	0.14	-0.01	0.32**
	(0.15)	(0.15)	(0.15)
Distributive services (dummy)	0.14	-0.12	-0.06
	(0.18)	(0.19)	(0.18)
Knowledge intensive services (dummy)	0.44**	0.26	0.44***
	(0.17)	(0.18)	(0.17)***
Technological services (dummy)	0.31**	0.07	0.43
	(0.13)	(0.14)	(0.14)
Constant	-0.21	-0.93***	-0.9***
	(0.21)	(0.21)	(0.21)
	(1/2)	(2/3)	(1/3)
rho	0.59***	0.48***	0.54***
	(0.04)	(0.05)	(0.04)

Variable	*Neglect*	*Cancel*	*Overrun*
Observations		1010	
Wald Chi²(78)		264.67	
Prob > Chi²		0.00	
Loglikelihood		-1680.52	
Aldrich Nelson Pseudo R2		0.27	

* significant at 10%; ** significant at 5%; *** significant at 1%;
robust standard errors in parentheses

Table 4: Estimation results of trivariate probit estimations with interaction terms: Parameter estimates (robust standard errors in parentheses)

Variable	Neglect	Cancel	Overrun
Company is part of a multinational group with headquarters abroad (dummy)	-0.05	-0.56	1.49***
	(0.5)	(0.52)	(0.54)
Company has been acquired by foreign firm (dummy)	0.03	-0.25	-0.39
	(0.3)	(0.29)	(0.33)
Company is part of multinational group (dummy)	0.00	0.19*	0.01
	(0.12)	(0.12)	(0.12)
Competence-creating innovation strategy (index)	-0.57***	-0.17	-0.03
	(0.19)	(0.2)	(0.19)
Competence-exploiting innovation strategy (index)	-0.64***	-0.54**	0.53**
	(0.21)	(0.22)	(0.21)
Breadth of German innovation inputs (index)	0.05	-0.02	0.01
	(0.06)	(0.06)	(0.06)
German university innovation input (dummy)	0.29**	-0.05	0.14
	(0.13)	(0.15)	(0.15)
Foreign university innovation input (dummy)	0.29	-0.08	0.88***
	(0.21)	(0.24)	(0.28)
Index of importance of methods of stimulating innovation activities (index)	0.31	0.06	0.30
	(0.27)	(0.26)	(0.26)
Company is located in East Germany (dummy)	-0.24**	-0.29***	-0.38
	(0.10)	(0.10)	(0.09)
Company age since founding in Germany (years)	0.01*	0.00	0.00
	(0.00)	(0.00)	(0.00)
Company was engaged in significant M&A activity (dummy)	0.23	0.02	0.46**
	(0.19)	(0.19)	(/0.21)
No. of employees	0.02	0.07*	0.08**
	(0.04)	(0.04)	(0.04)
Sales per employee 2001 (ratio)	0.14	0.14	0.1
	(0.19)	(0.18)	(0.19)
Export share of sales 2001 (ratio)	0.38*	0.19	0.55**
	(0.22)	(0.21)	(0.22)
Negative profitability 2001 (dummy)	0.17	0.3**	0.13
	(0.12)	(0.12)	(0.12)
Return on sales above 4% (dummy)	-0.26***	0	0.02

Variable	Neglect	Cancel	Overrun
	(0.09)	(0.1)	(0.09)
R&D share of sales 2001 (ratio)	2.08***	0.49	0.15
	(0.52)	(0.54)	(0.54)
Share of employees with university education (ratio. divided by industry average)	-0.03	0.12**	0.07
	(0.05)	(0.05)	(0.05)
Germany's revealed comparative advantage (in logs. by industry)	0.00*	0.00	0.00
	(0.00)	(0.05)	(0.00)
German share of global business R&D expenditures (%. by industry)	0.01	0.01*	-0.01
	(0.01)	(0.01)	(0.01)
Medium-high tech manufacturing (dummy)	0.17	-0.02	0.12
	(0.13)	(0.14)	(0.13)
High-tech manufacturing (dummy)	0.13	0.01	0.25
	(0.16)	(0.16)	(0.15)
Distributive services (dummy)	0.14	-0.10	-0.07
	(0.18)	(0.19)	(0.18)
Knowledge intensive services (dummy)	0.44**	0.24	0.45***
	(0.17)	(0.18)	(0.17)
Technological services (dummy)	0.32**	0.06	0.44***
	(0.14)	(0.14)	(0.14)
Interaction: Foreign & comp. creating innovation strategy	-0.33	0.01	-0.2
	(0.65)	(0.64)	(0.68)
Interaction: Foreign & comp. exploiting innovation strategy	0.63	1.16*	-1.71**
	(0.68)	(0.67)	(0.74)
Interaction: Foreign & breadth of German innovation inputs	-0.11	0.21	0.26
	(0.18)	(0.17)	(0.17)
Interaction: Foreign & German university input	0.17	-0.12	0.18
	(0.49)	(0.5)	(0.44)
Interaction: Foreign & foreign university innovation input	-1.15**	0.13	-1.42**
	(0.52)	(0.55)	(0.56)
Constant	-0.23	-0.9***	-0.97***
	(0.21)	(0.21)	(0.21)
	(1/2)	(2/3)	(1/3)
rho	0.69***	0.56***	0.62***
	0.06	0.07	0.06
Observations		1010	
Wald $Chi^2(93)$		315.49	
Prob > Chi^2		0.00	
Loglikelihood		-1663.79	
Aldrich Nelson Pseudo R2		0.30	

* significant at 10%; ** significant at 5%; *** significant at 1%;
robust standard errors in parentheses

References

Aiken, L.S./West, S.G., *Multiple Regression: Testing and Interpreting Interactions*, Newbury Park: SAGE Publications 1993.

Almeida, P./Kogut, B., Localization of Knowledge and the Mobility of Engineers in Regional Networks, *Management Science*, 45, 7, 1999, pp. 905-917.

Almeida, P./Phene, A., Subsidiaries and Knowledge Creation: The Influence of the Mnc and Host Country on Innovation, *Strategic Management Journal*, 25, 8/9, 2004, pp. 847-864.

Aschoff, B./Doherr, T./Ebersberger, B./Peters, B./Rammer, C./Schmidt, T., *Innovation in Germany - Results of the German Innovation Survey 2005*, Mannheim: Centre for European Economic Research 2006.

Bartlett, C.A./Goshal, S., Managing across Borders: New Organizational Responses, *Sloan Management Review*, 29, 1, 1987, pp. 43-54.

Bertrand, M./Mullainathan, S., Do People Mean What They Say? Implications for Subjective Survey Data, *American Economic Review*, 91, 2, 2001, pp. 67-72.

Bessant, J./Tidd, J., *Innovation and Entrepreneurship*, Chichester: John Wiley & Sons Ltd 2007.

Bilkey, W.J./Nes, E., Country-of-Origins Effects on Product Evaluation, *Journal of International Business Studies*, 13, 1, 1982, pp. 89-99.

Birkinshaw, J./Hood, N., Multinational Subsidiary Evolution: Capability and Charter Change in Foreign-Owned Subsidiary Companies, *Academy of Management Review*, 23, 4, 1998, pp. 773-795.

Boeddrich, H.-J., Ideas in the Workplace: A New Approach Towards Organizing the Fuzzy Front End of the Innovation Process, *Creativity & Innovation Management*, 13, 4, 2004, pp. 274-285.

Boschma, R., Proximity and Innovation: A Critical Assessment, *Regional Studies*, 39, 1, 2005, pp. 61-74.

Cantwell, J./Mudambi, R., Mne Competence-Creating Subsidiary Mandates, *Strategic Management Journal*, 26, 12, 2005, pp. 1109-1128.

Caves, R.E., International Corporations: The Industrial Economics of Foreign Investment, *Economica*, 38, 149, 1971, pp. 1-27.

Cohen, W.M./Levinthal, D.A., Innovation and Learning: The Two Faces of R&D, *The Economic Journal*, 99, 1989, pp. 569-596.

Cooper, R./Edgett, S./Kleinschmidt, E., Portfolio Management for New Product Development: Results of an Industry Practices Study, *R&D Management*, 31, 4, 2001, pp. 361-379.

Cooper, R.G., Managing Technology Development Projects, *Research Technology Management*, 49, 6, 2006, pp. 23-31.

Cooper, R.G./Edgett, S.J./Kleinschmidt, E.J., Optimizing the Stage-Gate Process: What Best-Practice Companies Do--I, *Research Technology Management*, 45, 5, 2002a, pp. 21-27.

Cooper, R.G./Edgett, S.J./Kleinschmidt, E.J., Optimizing the Stage-Gate Process: What Best-Practice Companies Do--II, *Research Technology Management*, 45, 6, 2002b, pp. 43-49.

Criscuolo, C./Haskel, J.E./Slaughter, M.J., *Global Engagement and the Innovation Activities of Firms*, NBER Working Paper No. 11479, Cambridge, MA, 2005.

DeYoung, R./Nolle, D.E., Foreign-Owned Banks in the United States: Earning Market Share or Buying It?, *Journal of Money, Credit, and Banking*, 28, 1996, pp. 622-636.

Diamantopoulos, A./Schlegelmilch, B.B./Du Preez, J.P., Lessons for Pan-European Marketing? The Role of Consumer Preferences in Fine-Tuning the Product-Market Fit, *International Marketing Review*, 12, 2, 1995, pp. 38-52.
Dow, D., Adaptation and Performance in Foreign Markets: Evidence of Systematic under-Adaptation, *Journal of International Business Studies*, 37, 2, 2006, pp. 212-226.
Eden, L./Miller, S.R., Distance Matters: Liability of Foreignness, Institutional Distance and Ownership Strategy, in Hitt, M. A./Cheng, J. L. C. (eds.), *Advances in International Management*: New York 2004, pp. 187-221.
Feinberg, S.E./Gupta, A.K., Knowledge Spillovers and the Assignment of R&D Responsibilities to Foreign Subsidiaries, *Strategic Management Journal*, 25, 8/9, 2004, pp. 823-845.
Freel, M., Perceived Environmental Uncertainty and Innovation in Small Firms, *Small Business Economics*, 25, 4, 2005, pp. 49-64.
Frosch, R.A., The Customer for R&D Is Always Wrong!, *Research Technology Management*, 39, 6, 1996, pp. 22-25.
Frost, T.S./Birkinshaw, J.M./Ensign, P.C., Centers of Excellence in Multinational Corporations, *Strategic Management Journal*, 23, 11, 2002, pp. 997-1018.
Ghemawat, P., Distance Still Matters: The Hard Reality of Global Expansion, *Harvard Business Review*, 79, 8, 2001, pp. 137-146.
Ghemawat, P., The Forgotton Strategy, *Harvard Business Review*, 81, 11, 2003, pp. 76-84.
Greene, W.H., *Econometric Analysis*, New York: Macmillan Publishing Company 1993.
Gulati, R./Nohria, N./Zaheer, A., Strategic Networks, *Strategic Management Journal*, 21, 3, 2000, pp. 203-215.
Hajivassiliou, V.A./McFadden, D.L./Ruud, P., Simulation of Multivariate Normal Rectangle Probabilities and Their Derivatives: Theoretical and Computational Results, *Journal of Econometrics*, 72, 1-2, 1996, pp. 85-134.
Hakanson, L., *Corporate Technologcial Behaviour: Co-Operation and Networks*, London: Routledge 1989.
Hakanson, L./Nobel, R., Organizational Characteristics and Reverse Technology Transfer, *Management International Review (MIR)*, 41, 4, 2001, pp. 395-420.
Harvey, M./Novicevic, M.M., Staffing Global Marketing Positions: What We Don't Know Can Make a Difference, *Journal of World Business*, 35, 1, 2000, pp. 80-94.
Hasan, I./Hunter, W.C., Efficiency of Japanese Multinational Banks in the United States, in Chen, A. H. (ed.) *Research in Finance*: Greenwich and London 1996, pp. 157-173.
Hsieh, M.-H., An Investigation of Country-of-Origin Effect Using Correspondence Analysis: A Cross-National Context., *International Journal of Market Research*, 46, 3, 2004, pp. 267-295.
Hymer, S.H., *The International Operations of National Firms: A Study of Direct Investment*, Cambridge: MIT Press 1976.
Jarillo, J.C./Martinez, J.I., Different Roles for Subsidiaries: The Case of Multinational Corporations in Spain, *Strategic Management Journal*, 11, 7, 1990, pp. 501-512.
Jensen, R./Szulanski, G., Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers, *Journal of International Business Studies*, 35, 6, 2004, pp. 508-523.
Kaiser, U., An Emprical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector, *International Journal of Industrial Organization*, 20, 6, 2002, pp. 747-774.
Kogut, B./Zander, U., Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation, *Journal of International Business Studies*, 24, 4, 1993, pp. 625-645.

Kuemmerle, W., The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation., *Journal of International Business Studies*, 30, 1, 1999, pp. 1-25.
Laursen, K./Salter, A., Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms, *Strategic Management Journal*, 27, 2, 2006, pp. 131-150.
Lord, M.D./Ranft, A.L., Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge, *Journal of International Business Studies*, 31, 4, 2000, pp. 573-589.
Luo, Y./Shenkar, O./Nyaw, M.-K., Mitigating Liabilities of Foreignness: Defensive Versus Offensive Approaches, *Journal of International Management*, 8, 3, 2002, pp. 283-301.
March, J.G., Exploration and Exploitation in Organizational Learning, *Organization Science*, 2, 1, 1991, pp. 71-87.
Mezias, J.M., How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations., *Journal of International Management*, 8, 3, 2002a, pp. 265-283.
Mezias, J.M., Identifying Liabilities of Foreignness and Strategies to Minimize Their Effects: The Case of Labor Lawsuit Judgement in the United States, *Strategic Management Journal*, 23, 2002b, pp. 229-244.
Miller, S.R./Richards, M., Liability of Foreignness and Membership in a Regional Economic Group: Analysis of the European Union, *Journal of International Management*, 8, 3, 2002, pp. 323-337.
Nobel, R./Birkinshaw, J., Innovation in Multinational Corporations: Control and Communication Patterns in International R&D Operations, *Strategic Management Journal*, 19, 5, 1998, pp. 479-496.
OECD, *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, Paris: Organisation for Economic Co-operation and Development 2005.
Petersen, B./Pedersen, T., Coping with Liability of Foreignness: Different Learning Engagements of Entrant Firms, *Journal of International Management*, 8, 3, 2002, pp. 339-350.
Reid, S.E./de Brentani, U., The Fuzzy Front End of New Product Development for Discontinuous Innovations: A Theoretical Model, *Journal of Product Innovation Management*, 21, 3, 2004, pp. 170-184.
Rosenzweig, P.M./Singh, J.V., Organizational Environments and the Multinational Enterprise, *Academy of Management Review*, 16, 1991, pp. 340-361.
Rugman, A.M./Verbeke, A., A Perspective on Regional and Global Strategies of Multinational Enterprises, *Journal of International Business Studies*, 35, 1, 2004, pp. 3-18.
Spielkamp, A./Rammer, C., Balanceakt Innovation - Erfolgsfaktoren Im Innovationsmanagement Kleiner Und Mittlerer Unternehmen, 2006.
UNCTAD, *World Investment Report 2005*, Geneva: United Nations 2005.
van der Panne, G./van der Beers, C./Kleinknecht, A., Success and Failure of Innovation: A Literature Review, *International Journal of Innovation Management*, 7, 3, 2003, pp. 309-338.
Vernon, R., International Investment and International Trade in the Product Cycle, *Quarterly Journal of Economics*, 80, May, 1966, pp. 190-207.
Von Hippel, E., *Sources of Innovation*, New York: Oxford University Press 1988.
Von Zedtwitz, M./Gassmann, O., Managing Customer Oriented Research, *International Journal of Technology Management*, 24, 2/3, 2002, pp. 165-193.

Vora, D./Kostova, T./Roth, K., Roles of Subsidiary Managers in Multinational Corporations: The Effect of Dual Organizational Identification, *Management International Review (MIR)*, 47, 4, 2007, pp. 595-620.
West, J./Graham, J.L., A Linguistic-Based Measure of Cultural Distance and Its Relationship to Managerial Values, *Management International Review*, 44, 2, 2004, pp. 239-260.
Wolter, F., *Factor Proportions, Technology and West-German Industry's International Trade Patterns*, Weltwirtschaftliches Archiv No. 113, Tübingen, 1977.
Zaheer, S., Overcoming the Liability of Foreignness., *Academy of Management Journal*, 38, 2, 1995, pp. 341-364.
Zaheer, S., The Liability of Foreignness, Redux: A Commentary, *Journal of International Management*, 8, 3, 2002, pp. 351-358.
Zaheer, S./Mosakowski, E., The Dynamics of the Liability of Foreignness: A Global Study of Survival in Financial Services, *Strategic Management Journal*, 18, 6, 1997, pp. 439-464.
Zaheer, S./Zaheer, A., Country Effects on Information Seeking in Global Electronic Networks, *Journal of International Business Studies*, 28, 1, 1997, pp. 77-100.

[1] See for example Almeida/Kogut (1999), Almeida/Phene (2004), Jarillo/Martinez (1990).
[2] This aspect is probably best captured through the stream of marketing literature on country of origin effects. Several studies in this field find that customers use the information about a product's country of origin as a cue for the expected product quality (see for example Diamantopoulos/Schlegelmilch/Du Preez 1995, Hsieh 2004), e.g. elegant Italian design or precise German engineering. For a review see Bilkey/Nes (1982).
[3] Eden/Miller (2004) suggest that the economic dimensions of the costs of doing business abroad should be investigated separately. Our study is not designed to disentangle the economic and sociological roots and effects.
[4] The sample was drawn using the stratified random sample technique. For a more detailed description of the dataset and the survey see Spielkamp and Rammer (2006).
[5] Zaheer/Mosakowski (1997) discuss several concepts: nationality of the majority of workers, share of foreign shareholders, nationality of the largest single shareholder, perception of a company in a particular country, location of international headquarters.
[6] The survey does not explicitly define project boundaries. Instead, it follows the widely accepted Oslo manual standards for innovation surveys (OECD 2005) which characterize innovation activities as a link between inputs (monetary assets and skills) and outputs (e.g. patents, new products and processes).
[7] We track changes in shareholder structure based on a unique dataset provided the largest German credit rating agency CREDITREFORM. The database is comprehensive, covering roughly 2.6 million firms which are registered in the German trade register and their shareholding structure for more than 10 years.
[8] The question is part of a section that initially defines external sources for innovation as impulses that were indispensable for the firm's new products, services or processes. The exact question is: "Have you introduced significantly improved products or processes between 2000 and 2002 because specific customers asked for them or demanded them directly? If yes, from which country did they come predominantly? … also from? …". The supplier question is identical with the ending " … were only made possible through new innovations by suppliers." (competitor question is identical). In case of academic sources: "… were only made possible through new research results by universities or public research institutions." We consider an important German knowledge flow as established when the respondent wrote "Germany" into the "predominantly" country field of the customer, supplier, competitor or academia question.
[9] Conceptually this control component should cover the effects from liabilities of age/newness. We have no explicit information in our dataset on when the German company became foreign-controlled and if it was originally founded by the foreign parent company or acquired. We address this issue through two separate concepts. We include the company's age since foundation assuming that older companies have better reputations and are more deeply rooted in local networks. Additionally, we add a dummy variable indicating whether the company has been involved in substantial (more than 10% change in turnover) M&A activities since 2000. The latter should help us to control for dynamics introduced through firm acquisitions.
[10] We use lagged values for 2001 which can be considered predetermined. This allows us to achieve more clarity in differentiating between causes and effects (endogeneity).

[11] The specific design of the profitability question in our survey (ordinal scale) requires the introduction of two dummy variables. One dummy variable indicates whether a firm had a negative return on investment, a separate one captures whether a firm had a return on investment above 4%.

[12] 1999 is the most recent year that features a high level of data availability in the OECD ANBERD database.

[13] We formulate it in logarithmic terms yielding continuous, unbound and symmetric results (Wolter 1977).

[14] These industry groups are more broadly defined as “other”, “medium high-tech” and “high-tech” manufacturing, and “distributive”, “knowledge-intensive” and “technological” services. The base group in all cases is “other” manufacturing.

[15] There are no indications of troubling degrees of multicollinearity in our dataset. The mean of variance inflation factors is 1.4, condition number 19.2.

[16] Interaction terms follow a straightforward rationale (Aiken/West 1993): a regression equation of the form $Y=b_1X+b_2Z+b_0$ allows testing for linear, additive effects of X on Y and Z on Y respectively. An additional interaction term producing $Y=b_1X+b_2Z+b_3XZ+b_0$ allows additional insights. Firstly, if b_3 is significant then Y depends jointly upon X and Z. Secondly, if b_1 and/or b_2 are significant there is a separate effect of X on Y (or Z on Y) apart from the mitigating factor XZ.

[17] On this topic see Greene (1993).

[18] The GHK simulator is part of the triprobit procedure in the STATA statistical software package. The GHK simulation method has been found to be one of the best simulators for empirical problems based on multivariate normal distributions (Hajivassiliou/McFadden/Ruud 1996)

[19] Innovation expenditures in East German manufacturing were 5.2 bn € in 2004, out of 75.3 bn € German manufacturing total (Aschoff/Doherr/Ebersberger/Peters/Rammer/Schmidt 2006).

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Liability of Foreignness as a Barrier to Knowledge Spillovers: Lost in Translation?

AUTOREN: ***Tobias Schmidt***

[Deutsche Bundesbank, ZEW Mannheim]

Wolfgang Sofka

[Universität Hamburg, ZEW Mannheim]

JAHR: 2006

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper No. 06-001, Mannheim

Zweite Einreichungsrunde bei Journal of International Management, Status: Revision eingereicht.

AUSGEWÄHLTE PRÄSENTATIONEN: European Association for Research in Industrial Economics (EARIE) Amsterdam, 2006

Danish Research Unit for Industrial Dynamics (DRUID) Kopenhagen, 2006

Liability of Foreignness as a Barrier to Knowledge Spillovers: Lost in Translation?

Tobias Schmidt

Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43
D-68034 Mannheim
Germany
Schmidt@zew.de
Phone: +49/621/1235-235
Fax: +49/621/1235-170

Wolfgang Sofka

Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43
D-68034 Mannheim
Germany
Sofka@zew.de
Phone: +49/621/1235-181
Fax: +49/621/1235-170

Corresponding author:

Wolfgang Sofka
Sofka@zew.de
Phone: +49/621/1235-181, Fax: +49/621/1235-4181
Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43
D-68034 Mannheim
Germany

Abstract

We investigate the innovation activities of foreign subsidiaries which have been found to be an important mechanism for accessing localized expertise worldwide. Access to host country knowledge flows is an important ingredient for its success. Foreign firms find it difficult to overcome cultural and social barriers which make their foreign engagements more strenuous and error prone (liability of foreignness). In our analysis we break down the complex mechanisms behind knowledge spillovers and identify conceptual links with liability of foreignness. We hypothesize that liability of foreignness acts as a filter for foreign subsidiaries, restricting their access to host country knowledge. We use a broad sample of almost 1 000 firms in Germany to empirically test the existence of liabilities of foreignness in leveraging knowledge spillovers. Our particular setting allows us to distinguish between upstream (suppliers, academia) and downstream (customers) liabilities of foreignness. We find that multinational firms can compete on an equal footing with host country rivals when it comes to generating impulses for innovations from suppliers and academia. They are significantly challenged by liabilities of foreignness, though, where customers are involved. We suggest that the frictional losses from a lack of social and cultural embeddedness (liability of foreignness) in the host country are especially relevant when promising lead customers have to be identified and their tacit and often unarticulated impulses have to be transferred, understood and prioritized.

Keywords: Liability of foreignness, knowledge spillover, globalization, trivariate probit

JEL-Classification: F23, O31, O32, D83

1 Introduction

The subsidiaries of multinational corporations (MNC) and their innovation activities have received much attention in recent academic discussion. International economics research has focused on their potential to transfer knowledge to the host country (see for example Aitken and Harrison, 1999; Haskel et al., 2002; Keller, 2002). International business literature, though, has chosen a different perspective by emphasizing the role of subsidiaries for accessing knowledge from host countries (see for example Almeida, 1996; Frost, 2001). This follows the basic rationale that firms need to harvest creativity worldwide in a globalized world. They need "pipelines" to valuable technological expertise and market intelligence around the world (Malmberg and Maskell, 2005). This implies a shift in the locus of knowledge production. Global headquarters are no longer the sole origin of new technologies which are subsequently passed through and adapted by a network of subsidiaries. Instead, host country subsidiaries play a far more active role. Intra-MNC knowledge transfers are still crucial but the central role of foreign subsidiaries stems from their ability to tap into localized pools of expertise in the host country and access technological and market-related information (Almeida and Phene, 2004). Foreign subsidiaries with the ability to turn these external impulses into successful innovation generate competitive potential for the MNC as a whole (Birkinshaw and Hood, 1998). A crucial ingredient for these innovation activities are knowledge spillovers from the host country. We investigate the innovation activities of foreign subsidiaries and their access to host country knowledge spillovers.

Almeida and Phene (2004) find that apart from the technological richness of the MNC, knowledge linkages with the host country and its technological diversity positively influence innovation. We extend their work by investigating the sources of these knowledge exchanges. More precisely, we focus on impulses for innovation and distinguish between various sources of host country knowledge (customers, suppliers, academic institutions). The latter is especially challenging as knowledge transfers across cultural and social barriers have been found to be more frequently prone to errors and delays (Lord and Ranft, 2000). These frictional losses of multinational firms operating outside of their home market are typically summarized as liability of foreignness (Zaheer, 1995). We incorporate this stream of research into the more general concept of knowledge spillovers. Our theoretical reasoning suggests that liability of foreignness prevents them from achieving seamless integration. Furthermore, we explore the origins of these disadvantages (customers, suppliers, universities) so that targeted countervailing strategies can be derived.

Besides, we hope to contribute to the existing literature through the empirical testing of our hypotheses. Previous research has largely focused on high-tech industries (e.g. semiconductors) and traced only successful knowledge flows through patent citations (see for example Almeida and Kogut, 1999; Almeida and Phene, 2004). We are able to utilize survey data of almost 1,000 companies in Germany from various industries and their innovation activities.

The paper is organized as follows. The next section presents our conceptual framework followed by the analytical part and hypothesis development in section 3. Section 4 outlines the empirical study. The results of these quantitative tests are interpreted in section 5. A discussion of these results and management recommendations are provided in section 6. The article concludes with concluding remarks and limitations of the research in section 7.

2 Conceptual framework

A brief review of liability of foreignness

Zaheer (1995) introduces the concept of "liability of foreignness" based on Hymer (1976): multinational companies face inevitable disadvantages abroad that companies operating in their home environment do not. This is due to two factors. On the one hand host country stakeholders (customers, investors, politicians) have an increased level of uncertainty because of the missing knowledge about the foreign company and the quality of its products and services. This aspect of "lack of legitimacy" in foreign markets has been a focal point of the marketing literature on country-of-origin effects. Put simply, it refers to buyer conceptions that treat the information of the country of origin as a clue as to product quality (Bilkey and Nes (1982) present an overview). On the other hand, foreign firms project their competitive practices and capabilities from their home countries on the host market in ways that are not compatible with the local context (Hymer, 1976).

Host country competitors can translate this "home field" advantage into superior effectiveness and efficiency (Mezias, 2002b). Even if multinational firms rely heavily on host country management teams, they will always have to carry the extra burden of securing intra-firm consistency in communication and coordination across national and cultural borders (Mezias, 2002a, b). This generates frictional losses which firms do not face in their home markets. These relative disadvantages are hard to eliminate since they represent the sum of numerous small delays, bad decisions or unnecessary risks (Lord and Ranft, 2000). They include additional or disproportionately high costs for foreign firms, as well as foregone revenues and profits (Mezias, 2002a). Individual firms can overcome these liabilities of foreignness if they possess superior firm specific competitive advantages (Caves, 1971).

The concept of liability of foreignness has been investigated and supported in numerous studies. They identify these disadvantages in various sectors (most prominently banking and currency trading) and at several performance levels, e.g., relative lack of efficiency or profitability, market exits, increased likelihood to be subject to labour lawsuits (DeYoung and Nolle, 1996; Hasan and Hunter, 1996; Hennart et al., 2002; Mezias, 2002b; Miller and Parkhe, 2002; Miller and Richards, 2002; Zaheer, 1995; Zaheer and Zaheer, 1997). We extend this line of research to potential disadvantages in the innovation activities of foreign subsidiaries.

Internationalization of innovation activities

The development of new technologies is concentrated in relatively few countries worldwide. The seven most industrialized countries accounted for 84% of global R&D expenditures in 1995 (Keller, 2004) with some countries such as South Korea catching up in recent years (Furman and Hayes, 2004; Mahmood and Singh, 2003). Hence, the diffusion of knowledge across borders becomes a necessity for global growth (Romer, 1990). However, knowledge flows have been found to be geographically localized and largely an intra-national phenomenon (Branstetter, 2001). Geographic distance and language barriers (Keller, 2002) and not only national as well as state borders restrain knowledge diffusion (Jaffe et al., 1993) even when controlling for regional clusters of production (Audretsch and Feldman, 1996). These border effects are typically explained by the tacit nature of important parts of the knowledge to be transferred, i.e. it cannot be articulated and is acquired through action (Polanyi, 1967) or understood in practical experience under changing contexts as the closely related concept of skills (Nelson and Winter, 1982). This makes it difficult to transfer. MNCs and their network of international subsidiaries have been seen as channels for facilitating knowledge flows though border-spanning intra-firm mechanisms based on interpersonal networks and social context (Kogut and Zander, 1993). This function of multinational firms has been investigated with mixed results for knowledge flows towards host countries (for a review see Keller, 2004) and those out of host countries (see for example Almeida, 1996; Frost, 2001). We investigate the latter and more precisely the knowledge spillovers from the host country to foreign subsidiaries. Foreign subsidiaries evolve through their innovation engagements from home-base exploiting towards increasingly home-base augmenting mandates (Birkinshaw and Hood, 1998; Kuemmerle, 1999). If they can tap local pools of expertise and make them accessible for the multinational company (MNC), these innovation engagements of foreign subsidiaries can generate competitive advantage for the MNC as a whole. This leads to our research question: do foreign subsidiaries achieve similar access to host country knowledge spillovers in their innovation activities as their local competitors?

The importance of knowledge spillovers

In recent years industries and technologies have undergone major changes that have led to an increase in the uncertainty and complexity of innovation processes. Combined with rising costs for the development of new products and processes, as well as shorter innovation and product life cycles, these factors have contributed to a surge in the demand for external knowledge. This is evident in the rising number of collaborative innovation agreements formed during the 1980s and 1990s (see Hagedoorn, 2002).[1] The speed of technological changes requires firms to source knowledge externally because they cannot generate new ideas and inventions solely by using the knowledge they have in-house (Matusik and Heeley, 2005) or as Tsang (2000; p.225) put it: “tapping external sources of know-how becomes a must”. This is because firms do not have enough expertise in all technological areas needed to develop innovative products and processes. However, it is not only the changes in environments that provide an incentive for firms to use external knowledge. The literature has

[1] Note: one of the main reasons to collaborate on innovation projects is to get access to external knowledge (Hagedoorn, 1993; Powell, 1987; Cassiman and Veugelers, 2002).

identified a number of positive effects of so-called "knowledge spillovers"[2] on firms performance. Nadiri (1993) for example finds that firms using knowledge that has spilled over from the firm's environment have a higher rate of return of R&D than firms not using it. Landry and Amara (2002) find that the novelty of innovations increases with the use of a larger variety of external sources of information. Love and Roper (2004) show that sourcing knowledge from external partners affects firms' innovation success positively. Their finding is supported by Gemünden et al. (1992), who find that the capability to generate innovations is lower for firms that do not use external knowledge. We focus on knowledge spillovers that are external to the firm, i.e. not the result of research collaborations or joint ventures.

3 Analytical framework

Liability of foreignness and the mechanisms behind knowledge spillovers

External knowledge can be tacit or formal (e.g., Polanyi, 1967; Cowan et al., 2000; Bartholomaei, 2005), specific or generic (see e.g., Breschi et al., 2000), embodied or disembodied (Romer, 1990) or in the form of information and know-how (Kogut and Zander, 1992), to name a few widely-used distinctions of knowledge types. These attributes of knowledge are important for its degree of transferability. Unique experience and organizational learning are important sources of knowledge. Therefore, only parts of knowledge can be codified. It is also embedded routines, tasks, practices, norms and values of organizations (Bhagat et al., 2002). Complexity makes the transfer of knowledge less efficient as larger amounts of information have to be transferred for a complete and accurate transmission of its meaning (Bhagat et al., 2002). The transfer of tacit knowledge is less effective. It cannot be readily articulated or codified and is discovered only through action and experience (Polanyi, 1967). Absorbing this kind of knowledge entails causal ambiguities (Szulanski, 1996). Hence, conveying knowledge correctly and comprehensively is in itself challenging. We argue that liability of foreignness adds additional barriers to this process.

Knowledge cannot be separated from the commitments and belief patterns of its holders (Nonaka, 1994). Long-lasting exposure, experience and interaction produce a tailor-made entity to function effectively and efficiently in the home market. This knowledge is largely acquired automatically at minimal extra costs. Substantial parts of these social and cultural laws are causally ambiguous and not codified (Jensen and Szulanski, 2004). Firms lose these certainties of their home market once they engage in markets abroad. They encounter cognitive uncertainty, i.e. in predicting and explaining the behavior of others (Harvey and Novicevic, 2000). These frictional losses from cultural and social barriers represent the roots of liability of foreignness (Zaheer, 1995). The forces behind liability of foreignness are sociological in nature and have structural, relational and legitimacy dimensions (Zaheer, 2002). Differences in language and hence communication and understanding are a major

[2] The term "knowledge spillovers" can be attributed to Griliches (1979), who distinguished between rent spillovers, which occur because firms pay less for inputs than the quality of these inputs is worth, and knowledge spillovers, which happen because information and ideas flow form one industry to another industry without payment.

factor, yet not the only one (West and Graham, 2004). The visible symptoms of these challenges are more frequent errors, unnecessary risks and delays (Lord and Ranft, 2000). These are as lasting as the liabilities of size and newness (Zaheer and Mosakowski, 1997). Foreign direct investments primarily reduce the spatial distance between a foreign firm and the host country knowledge pools. They do not automatically remove other important barriers to knowledge flows such as social, cultural, cognitive, administrative, institutional and organisational differences (Boschma, 2005; Ghemawat, 2001, 2003). These obstacles are particularly pronounced when foreign firms search for valuable sources of innovation abroad (Al-Laham and Amburgey, 2005).

Moreover, liability of foreignness does not solely originate from a lack of legitimacy but also from a lack of responsiveness. It is a "stranger in a strange land" phenomenon. Foreign subsidiaries operate in a dual context because they need to provide consistency with both the MNC and the host country (Almeida and Phene, 2004). They follow shared practices and procedures within the MNC that may not be compatible with the host country environment. In order to be able to source and use external knowledge in their innovation processes, firms need to have so-called "absorptive capacities", i.e. the ability to "identify, assimilate and exploit knowledge from the environment" (Cohen and Levinthal, 1989; p.569). Harvey and Novicevic (2000) introduce the concept of global organizational ignorance to cross border interactions: an unawareness of relevant information and how to interpret it correctly. Managers rely on past experiences given the contextual ambiguity abroad (Dow, 2006). The underlying logic is derived from general decision making theory. Deciders tend to rely on knowledge from their home market even when it is not suitable for the host country context. This is due to the fact that it is more readily available, can be related back to a class of previous experiences and provides consistency with previous convictions (Harvey and Novicevic, 2000). Hence we derive our first hypothesis:

> Hypothesis 1: Foreign subsidiaries are less likely to benefit from host country knowledge spillovers in their innovation activities than domestic firms.

The impact of liability of foreignness on different knowledge sources

How can firms deal with these disadvantages? Luo et al. (2002) suggest more generally that liabilities of foreignness can be mitigated through offensive (local immersion) or passive strategies (reserve). The former appears more promising for successful innovation activities. Almeida and Phene (2004) find that knowledge linkages with host country firms have a positive effect on innovation of foreign subsidiaries in the US semiconductor industry. These may be established through collaborations or engagements in local networks (Dyer and Singh, 1998; Gulati et al., 2000). A recent stream of literature hints more generally that establishing social capital in the host country promotes knowledge flows, i.e. a "goodwill" of sympathy, trust and forgiveness that propels knowledge transfer (Adler and Kwon, 2002). This may stem from personnel mobility, its shaping effect on interpersonal networks and even co-ethnicity (Agrawal et al., 2006; Almeida and Kogut, 1999; Kalnins and Chung, 2006; Singh, 2005). In essence, individual networks of employees compensate for deficits in organizational linkages.

Then again, liability of foreignness has also been identified in the job market (Newburry et al., 2006): foreign-based firms are less attractive for prospective employees.

We propose a different perspective. Knowledge can not only be distinguished by the form it takes but also by the source it stems from and the channels it is transmitted through (Harabi, 1997). A widely-used distinction for knowledge sources is between academic sources and industrial sources (Adams, 2004). The industrial sources can further be split up into upstream sources and downstream sources. As Von Hippel (1988) has shown, the sources of innovation can be users, producers or suppliers. From a management perspective it may be less relevant to ask "should we create local linkages?" but "with whom?" Most studies on the topic trace knowledge flows by using patent statistics (e.g. Almeida and Phene, 2004; Singh, 2005). While these provide a much needed paper trail through patent citations they have certain limitations. Not all patents are innovations and not all innovations are patented (Griliches, 1990). Furthermore, patent activity is rather concentrated. Bloom and Van Reenen (2002) report for example that among their sample of almost 60,000 patents by UK firms, 72% were filed by just 12 companies. More importantly, the patent system forces the disclosure and codification of knowledge in exchange for protection (Gallini, 2002). Therefore, cultural barriers may be less relevant. Finally and most importantly for our case, patent citations do not reveal whether and how the respective exchange partners were previously linked with each other, with the exception of prior job experience of inventors. The latter has been investigated in the studies mentioned above.

We suggest that the benefits of existing linkages for transferring knowledge to foreign subsidiaries are not limited to prior work experience but that their effectiveness differs with the respective source. As suggested by Schmidt (2005), Lane and Lubatkin (1998), Dussauge et al. (2000), Becker and Peters (2000) different types of knowledge require specific types of methods and capabilities to be absorbed. Dyer and Singh (1998) introduce the idea of building absorptive capacity through collaboration and interaction between firms. Sustained relationships facilitate the identification of promising knowledge sources, as patterns of interaction and shared understanding are already established (Laursen and Salter, 2006). We argue that foreign subsidiaries lack this embeddedness which forces them to rely overly on explicit signals by promising sources. These are not limited to patents. The most obvious signal for a promising source are the outcome of successful knowledge development processes themselves, i.e. innovative products and services (Ndofor and Levitas, 2004). They are especially relevant in what Pavitt (1984) calls supplier-dominated firms because their innovation stems directly from new machines and equipment provided by suppliers. Publications in scientific journals provide strong signals for scientific knowledge. They are an immediate and codified output of academic research activities which enters the public domain. Therefore, scientific knowledge has been considered a public good (Arrow, 1962; Jaffe, 1986). Promising market sources, though, mostly lack these signaling opportunities. Customer needs are largely unarticulated (Von Zedtwitz and Gassmann, 2002) and their impulses have been found to be frequently wrong, myopic or narrow (Frosch, 1996). Hence, identifying and activating reliable lead users (Von Hippel, 1988) requires extensive background knowledge and local experience, both of which are difficult for foreign firms to

acquire. The lack of legitimacy and reputation in the host country may further amplify this effect. Thus, we propose:

> Hypothesis 2: Foreign subsidiaries are less likely to benefit from host country customer knowledge flows than domestic firms.

4 Empirical study

4.1 Data

For the empirical part of this analysis we use cross section data from a survey on the innovation behavior of German enterprises called the "Mannheim Innovation Panel" (MIP) The survey is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry of Education and Research. The methodology and questionnaire used by the survey, which is targeted at enterprises with at least five employees, are the same as those used in the Community Innovation Survey (CIS), conducted every four years by Eurostat. For our analysis we use the 2003 survey, in which data was collected on the innovation activities of enterprises during the three-year period 2000-2002. About 4 500 firms in manufacturing and services responded to the survey and provided information on their innovation activities.[3] We utilize this data to operationalize the concepts presented above. Additionally, we complement this dataset with international trade data provided by the OECD (ITCS – International Trade by Commodity Statistics 2003 and TIS – Trade in Services 2004) and data on business R&D expenditures (ANBERD - R&D Expenditure in Industry 2003). Non-innovating firms were excluded from our analysis, because most variables can only be constructed for firms with innovation activities.

Most of the literature presented before has relied on quantitative patent statistics. CIS surveys are self-reported and largely qualitative which raises quality issues with regards to administration, non-response and response accuracy (for a recent discussion see Criscuolo et al., 2005). First, our CIS survey was administered via mail which prevents certain shortcomings and biases of telephone interviews (for a discussion see Bertrand and Mullainathan, 2001). The multinational application of CIS surveys adds extra layers of quality management and assurance. CIS surveys are subject to extensive pre-testing and piloting in various countries, industries and firms with regards to interpretability, reliability and validity (Laursen and Salter, 2006). Secondly, a comprehensive non-response analysis of more than 4 000 firms showed no systematic distortions between responding and non-responding firms with respect to their innovation activities. Third, the questionnaire contains detailed definitions and examples to increase response accuracy. Longhand questions (e.g. "Please describe your most important product innovation briefly") allow robustness checks for multiple choice answers.

[3] The sample was drawn using the stratified random sample technique. For a more detailed description of the dataset and the survey see Rammer et al. (2005).

In conclusion, the major advantages of CIS surveys are that they provide direct, importance-weighted measures for a comprehensive set of sources (Criscuolo et al., 2005). On the downside, this information is self-reported. Heads of R&D departments or innovation management are asked directly if and how they are able to generate innovations. This immediate information on processes and outputs can complement traditional measures for innovation such as patents (Kaiser, 2002; Laursen and Salter, 2006).

Measuring knowledge spillovers (Dependent Variables)

The amount of knowledge generated and available in an industry is hard to measure (Jaffe, 1986). This is, of course, also a problem for the measurement of knowledge spillovers. What is more, knowledge spillovers leave hardly any paper trail. The exception are patent applications, which allow researchers to analyze the citing behavior of the applicant and trace some of the ideas in the application back to its origins (Jaffe and Trajtenberg, 1999). A fundamental issue with patent analysis is that "not all inventions are patentable, not all inventions are patented" (Griliches, 1990; p.1669). This fact limits the ability to trace knowledge spillovers through patents. In particular, knowledge generated by customers is seldom reflected in patent citations and can thus not be analyzed with patent data. With the advent of innovation surveys, some authors have used questionnaires on the importance of external sources of information for the innovation activities of firms, as a proxy for knowledge flows and spillovers (e.g., Cassiman and Veugelers, 2002; Belderbos et al., 2004; Bönte and Keilbach, 2005). The questions on external sources can also be interpreted as a paper trail left by spillovers. They are a more direct measure than patent data and cover a wider range of knowledge (sources and types) than patent applications.

In line with our hypothesis, we use three dependent variables to measure knowledge spillovers: one for knowledge from customers, one for knowledge from suppliers and one for knowledge from academic institutions. We utilize three separate survey questions that ask firms whether their innovations during the three year period 2000-2002 were essentially based on impulses from customers (scustomer), suppliers (ssupplier) or academic institutions (sscientific) in Germany.[4] Hence, our three dependent variables are binary. These variables provide a qualitative, importance-weighted assessment of knowledge spillovers in the sense that we are not able to assess the channels through which the knowledge has reached the firm (e.g. joint R&D activities or publications) and the number of impulses received. We think nonetheless that our variables are adequate to asses the impact of liability of foreignness on knowledge spillovers, since the question allows us to capture important knowledge spillovers and not just general ones.

[4] The question is part of a section that initially defines external sources for innovation as impulses that were indispensable for the firm's new products, services or processes. The exact question is: "Have you introduced significantly improved products or processes between 2000 and 2002 because specific customers asked for them or demanded them directly? If yes, from which country did they come predominantly? … also from? …". The supplier question is identical with the ending " … were only made possible through new innovations by suppliers." In case of academic sources: "… were only made possible through new research results by universities or public research institutions." We consider an important German knowledge flow as established when the respondent wrote "Germany" into the "predominantly" country field of the customer, supplier or academia question.

Measuring liability of foreignness and additional independent variables

Firms' degrees of liability of foreignness cannot be readily observed and managers can hardly be surveyed to give reasonable estimates of it. Hence, we follow Mezias (2002a) who suggests an adequate empirical framework to capture the effects of liability of foreignness. It includes a broad definition of liabilities (costs that only foreign firms have to bear or bear disproportionately, including forfeiting benefits), controls for other liabilities (e.g., age, newness, size), controls for contextual aberrations (e.g. regional differences), a comparison group of domestic firms (which can be multinational themselves) and an analysis at the firm-level (preferably through a dummy variable).

Of central importance to our analysis is the definition of foreignness. Zaheer and Mosakowski (1997) discuss a number of concepts that indicate whether a company can be considered foreign: nationality of the majority of workers (Reich, 1990), share of foreign shareholders, nationality of the largest single shareholder, perception of a company in a particular country or the location of international headquarters. We will resort to the latter. Hence, we treat a company located in Germany as foreign if it indicated that it is part of a multinational group with its headquarters abroad. The coefficient for this dummy variable will tell us whether we can identify liability of foreignness. Hypothesis 1 would be supported if the coefficients are negative and significant for customer, supplier and academia equations. The effect for customers should be significantly larger than for suppliers and academic institutions to support Hypothesis 2.

To achieve an unbiased estimate of the degree of liability of foreignness we have to control for other important influencing factors of knowledge spillovers (Mezias, 2002a). We suggest three components which have to be considered: different levels of absorptive capacity, varying needs and opportunities and other liabilities. All three will be described below.

Companies differ with respect to absorptive capacities, which are usually proxied by R&D related variables in empirical studies[5] (see Schmidt, 2005). In our model we use the R&D intensity, measured as the share of R&D expenditure over total turnover, and a dummy variable for continuous R&D activities as one of the proxies for absorptive capacity. However, R&D is not the only building block of absorptive capacity. It also depends on the employees' skills (Cohen and Levinthal, 1990; Rothwell and Dodgson, 1991), which are represented by the share of employees with higher education in our empirical model. The management literature has stressed that the ability to access and exploit external knowledge is not a given, but has to be actively managed and stimulated (e.g., Lenox and King, 2004; Lord and Ranft, 2000; Mahnke et al., 2005). To capture this aspect of absorptive capacity, an index

[5] Absorptive capacity is a multilevel concept, which could also be measured by output indicators ("realized AC") see Zahra and George (2002). The data at hand does not contain these indicators. This is not a major drawback, however, since the link between the input measures we use and absorptive capacity is well established in the empirical literature.

for the stimulation of knowledge-sharing and innovation activities is calculated and included in the model.[6]

Furthermore, companies vary in their needs and opportunities for utilizing knowledge spillovers. Most importantly, they may have different mandates and goals for their German innovation activities. This has been found to be an important factor for the innovation activities of foreign subsidiaries (Birkinshaw and Hood, 1998; Nobel and Birkinshaw, 1998). Foreign subsidiaries may just adapt products to local tastes/regulations (Mansfield et al., 1980) or act as listening posts (Almeida, 1996). We control for these potential biases by introducing an index variable indicating the breadth and depth of a firm's innovation strategy.[7] Also at the firm level, we control for different levels of productivity (turnover per employee) and profitability (return on turnover).[8]

We introduce additional industry-level[9] measures: On the one hand, one might argue that foreign companies draw their innovation impulses from abroad because German sources are less attractive. To control for this effect of Germany's lead status, we introduce Germany's revealed comparative advantage (RCA)[10] among OECD countries in 2002 at the industry level as a measure for competitive performance. We further use the German share of global business R&D expenditures (BERD)[11] by industry in 1999 as a measure for competitive potential.

---

6 The index was derived as follows: Companies indicated on a four-point Likert scale what importance their company assigned to nine different measures of stimulating innovation, ranging from targeted recruiting to immaterial incentives and monetary bonuses. A principal component factor analysis was performed on these nine categories, yielding a single factor with an eigenvalue larger than one (5.94; Cronbach's alpha scale reliability coefficient 0.84; Kaiser-Meyer-Olkin measure of sampling adequacy 0.87). The index represents these factor loadings after Varimax rotation rescaled between 0 and 1.

7 The index was derived as follows: Companies indicated on a four-point Likert scale what importance their company assigned to five innovation strategies: technological leadership, cost leadership, first in industry with new products, first in industry with new processes, development of cutting edge technologies. A principal component factor analysis was performed on these five categories, yielding a single factor with an eigenvalue larger than one (1.88; Cronbach's alpha scale reliability coefficient 0.75; Kaiser-Meyer-Olkin measure of sampling adequacy 0.73). The index represents these factor loadings after Varimax rotation rescaled between 0 and 1.

8 We use the lagged values for 2001 in this case to achieve clarity in interpretation (endogeneity). Hence, productivity and profitability are considered predetermined.

9 Note, these measures are calculated at the two digit NACE level to avoid collinearity problems with the industry dummies described below.

10 The strength of the RCA analysis stems from the opportunity to assess how successful a country has been on foreign markets (exports) in comparison to the foothold foreign competitors were able to gain in that country's domestic market (imports). Additionally, this ratio is compared to the overall export/import ratio of a particular country to the world as a whole.

11 The OECD ANBERD database covers the business R&D expenditures of Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, Spain, Sweden, the United Kingdom and the United States. Hence, it is considered a

To control for other liabilities suggested by Mezias (2002a) we introduce company size (number of employees), age/newness (years since founding of the company in Germany), regional deficiencies (East Germany) and internationalization experience (export status). Birkinshaw and Hood (1998) find that the mandates of foreign subsidiaries evolve over time. Therefore, the time since the firm has been foreign controlled may be more important than its founding date in Germany (although the latter may be more important for reducing legitimacy effects). We have no information on the former. Although, we add an additional dummy variable indicating whether the firm has been part of significant merger or acquisition activities that may have led to the foreign control since the year 2000. This variable should at least capture short-term disruptions. Furthermore, border effects have been found to be less pronounced in certain industries, such as semiconductors (Irwin and Klenow, 1994). Hence, six additional, instrumental industry group[12] variables have been introduced to capture industry-specific aspects that would distort the explanatory power of our other exogenous variables.

4.2 Descriptive statistics

Our final dataset of observations without any missing values consists of 997 companies located in Germany. 97 of these indicated being part of a multinational group with headquarters abroad (foreign controlled firms). Table 2 of the annex provides an overview of the descriptive statistics. Major issues will be outlined briefly.

The prima facie comparison shows some differences in the sourcing behavior of German and foreign controlled firms. Both groups rely heavily (roughly 50%) on customers as sources of innovation, followed by suppliers and academic institutions. Interestingly, 23% of foreign controlled firms use domestic suppliers as an important source of innovation while only 16% of their German counterparts do so. Foreign and German controlled firms treat R&D activities largely as a permanent engagement. Likewise, Germany's competitive performance on international markets and the R&D investments in these industries show no major difference between the groups.

Interestingly enough, foreign controlled firms employ a lower share of highly educated employees and spent a smaller share of their turnover on R&D in 2001. However, they are more active in stimulating innovation and have on average more aggressive innovation strategies. They are also more productive. These findings might, to some degree, be related to the fact that foreign controlled firms are larger and more mature and have an overwhelming tendency (87%) to sell their products on markets outside of Germany. 9% of them have been

---

suitable proxy for global R&D business expenditures. 1999 is the most recent year featuring a high level of data availability.

[12] These industry groups are more broadly defined as "other", "medium high-tech" and "high-tech" manufacturing, and "distributive", "knowledge-intensive" and "technological" services. Industry classification follows the product or service that generates the most turnover. Multiple industry assignments are not possible. The base group in all cases is "other" manufacturing, which contains firms from NACE 10-22, 25-28, 36-37, 40-41, 45. For details on the industry classification, see Table 8.1 in the appendix.

part of significant merger and acquisition activities since the year 2000. Given these facts, a multivariate analysis should provide additional valuable insights.

4.3 Model

The decisions to use customers, suppliers or academic institutions as sources for innovation are not independent of one another. It is quite conceivable that firms choose multiple sources at the same time. To model this link between the three decisions adequately, we used a trivariate probit model instead of estimating the equations for each source separately.[13] Within our empirical framework, the trivariate probit is superior to multinomial logit models since it allows us to reflect simultaneous multiple-source usage. The trivariate probit model is directly derived from the standard probit model, but allows more than one equation with correlated disturbances. This technique is comparable to the seemingly unrelated regressions model. Estimating three equations simultaneously allows us to improve the estimated sampling precision and subsequently facilitates a more complete usage of the available information. In essence, each probit equation holds information on factors that influenced the decisions on all three possible foreign sources. Estimating these equations simultaneously utilizes this information for the complete system. The specification for our three-equation model is:

$$scustomer^* = \beta_1' x + \varepsilon_1, \quad scustomer = 1 \text{ if } scustomer^* > 0, 0 \text{ otherwise},$$
$$ssupplier^* = \beta_2' x + \varepsilon_2, \quad ssupplier = 1 \text{ if } ssupplier^* > 0, 0 \text{ otherwise},$$
$$sresearch^* = \beta_3' x + \varepsilon_3, \quad sresearch = 1 \text{ if } sresearch^* > 0, 0 \text{ otherwise}.$$
$$Cov(\varepsilon_1, \varepsilon_2) = \rho_1$$
$$Cov(\varepsilon_1, \varepsilon_3) = \rho_2$$
$$Cov(\varepsilon_2, \varepsilon_3) = \rho_3$$

where x is the vector of the explanatory variables presented above and ρ_k is the correlation between the error terms ε_i of a pair of equations.

Estimating trivariate or more generally multivariate probit regression models using maximum likelihood methods involves some unique challenges. Normal probability distribution functions have to be calculated in the evaluation of probit-model likelihood functions. While algorithms for the bivariate case exist, more highly dimensional normal distributions are still challenging. Hence, we turned to a simulation-based technique: the Geweke-Hajivassiliou-Keane (GHK) simulator.[14] This simulator relies on sequentially conditioned, univariate normal distribution functions, through which multivariate normal distribution functions can be expressed. The following chapter provides the results.

---

[13] On this topic see Greene (1993).

[14] The GHK simulator is part of the triprobit procedure developed by Antoine Terracol in the STATA statistical software package. The GHK simulation method has been found to be one of the best simulators for empirical problems based on multivariate normal distributions (Hajivassiliou et al., 1996)

5 Results

Table 1 summarizes the results of our estimation. An extended version can be found in Table 3 in the annex. The choice of a trivariate probit setup instead of three separate probit estimations is justified. Correlation among all individual error terms is both positive and highly significant. Additionally, we conduct pairwise likelihood ratio tests on constrained model specifications assuming equality of coefficients between all three source decisions. All of these tests are rejected on at least a 95% significance level. In conclusion, the driving forces behind our three types of German source for innovation are related (significant, positive correlation of error terms) but not homogeneous (rejected likelihood ratio tests). When interpreting the results, one should bear in mind that we have restricted the sample firms that have been successful in their innovation activities. Hence, we cannot measure what makes them innovative but what makes them different among each other.

Table 1: Coefficients of trivariate probit estimation

Variable	*Source German Customer*	*Source German Supplier*	*Source German Science*
Company is part of foreign group with headquarters abroad (dummy)	-0.33**	0.14	-0.08
	(0.14)	(0.16)	(0.17)
Share of employees with higher education (%)	0.00	-0.00	0.01***
	(0.00)	(0.00)	(0.00)
Continuous R&D activities (dummy)	0.34***	0.10	0.53***
	(0.11)	(0.13)	(0.16)
R&D intensity in 2001 (%)	0.00	-0.02**	0.01
	(0.00)	(0.01)	(0.00)
Index of importance of methods of stimulating innovation activities (Index)	0.40*	0.17	-0.15
	(0.22)	(0.26)	(0.27)
Index of importance of innovation strategies (Index)	0.43**	0.42**	0.48**
	(0.17)	(0.21)	(0.21)
Germany's revealed comparative advantage by industry (logarithm)	-0.00**	-0.00	-0.00**
	(0.00)	(0.00)	(0.00)
German share of global business R&D expenditures by industry (%)	-0.00	-0.02*	0.02
	(0.01)	(0.01)	(0.01)
Profitability in 2001 (index)	0.03	0.02	0.00
	(0.02)	(0.03)	(0.03)
Turnover per employee in 2001 (%)	-0.05	0.12	0.05
	(0.08)	(0.09)	(0.11)
No of employees (logarithm)	0.00	0.01	0.07*
	(0.03)	(0.03)	(0.04)
Age since founding in Germany (in years)	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)
East Germany (dummy)	0.11	0.09	-0.02

Variable	*Source German Customer*	*Source German Supplier*	*Source German Science*
	(0.09)	(0.11)	(0.12)
Export status (dummy)	0.02	-0.25**	0.04
	(0.11)	(0.12)	(0.14)
Company has been part of M&A activities with an impact on turnover of more than 10% during the last two years (dummy)	0.15	-0.18	0.17
	(0.19)	(0.22)	(0.21)
Industry dummies	YES	YES	YES
Constant	-0.76***	-1.25***	-2.63***
	(0.20)	(0.24)	(0.30)
rho	(1/2) 0.26 ***	(2/3) 0.20 ***	(1/3) 0.42 ***
	(0.06)	(0.06)	(0.07)
Observations		997	
Wald chi2(60)		167.83	
Aldrich Nelson R2		0.21	
Loglikelihood		-1 431.48	

* significant at 10%; ** significant at 5%; *** significant at 1% ; Robust SEs in parentheses

We start by focusing on the core of our study, whether foreign control of an enterprise in Germany makes a significant difference in their domestic knowledge source success. Hypothesis 1 has to be rejected. Foreign controlled firms are not generally disadvantaged because we find no significant effect with regards to German supplier and science inputs. Hypothesis 2 can be accepted because there is a significant negative effect when foreign subsidiaries in Germany try to access from German customers.

We add a number of control variables that would explain sourcing ideas for innovation in general without developing explicit a priori hypotheses. Hence, the discussion of their estimation results is explorative in nature. We find the most consistent, positive effect from the boldness of a firms' innovation strategy (or mandate). The mechanisms regarding absorptive capacities vary with the source they try to access. German customer and university sources benefit from continuous R&D engagements which is in line with the central finding by Cohen and Levinthal (1989, 1990) that absorptive capacities are a by-product of performing R&D. In that sense R&D expenditures in a particular year are not as important as accumulating knowledge consistently over time. Continuous R&D engagements have often been equated with having a dedicated R&D department that serves as a nexus for these learning processes. R&D intensity shows even a negative, significant effect on sourcing knowledge from German suppliers, also at an industry level as the German share of industry R&D. This supports the suggestion by Pavitt (1984) that the innovative potentials in certain supplier-dominated firms may be limited and depend heavily on innovative capital goods provided by suppliers. Interestingly, firms that are active on foreign markets (export status) are significantly less likely to rely on domestic supplier impulses and this suspected mechanism.

Furthermore, we find that more ambitious motivational schemes for stimulating innovation resonate in an increased likelihood for listening to domestic customers for innovative ideas. Employing more employees with university education increases the likelihood of accessing knowledge from academic sources. This fits nicely into the concept of social capital with education and career as a channel and facilitator for knowledge flows (Adler and Kwon, 2002). Besides, it supports the findings of Lane and Lubatkin (1998) that a congruence between "teacher" and "student" institutions facilitates learning engagements. German customers and academic institutions are less attractive knowledge sources in industries where German export successes are especially strong (a positive RCA indicates that German industry exports do not only supersede imports but also overall export/import ratio). This may reflect a need for providing responsiveness for foreign demand (Bartlett and Goshal, 1987).

We find no liabilities of age or newness. Mergers and acquisitions since the year 2000 make also no significant difference. Liability of size (smallness) is only an issue when it comes to accessing German academic knowledge. Industry effects (these are reported in annex Table 3) are fairly in line with what one would expect. German customer impulses are important to all industry sectors. Important supplier impulses are significantly more pronounced in medium high-tech sectors (such as automotives) and distributive services (e.g. wholesale). As product technologies become especially sophisticated in high-tech manufacturing (e.g. medical instruments) and technological services (e.g. ICT), scientific knowledge becomes more valuable.

6 Discussion and recommendations

We designed this study to combine the existing literature on knowledge spillovers with the research stream on liability of foreignness and test the relationship empirically. Considering the large attention given to the topic of internationalizing R&D activities (see for example UNCTAD, 2005) and generating "metanational" competitive advantages from tapping the scarce, globally dispersed pockets of market and technological intelligence (Doz et al., 2001), we add to the discussion by investigating how these merits can be realized abroad. This process depends upon successful innovation activities by foreign subsidiaries which in turn rely upon host country inputs (Birkinshaw and Hood, 1998). Our results show that foreign firms can effectively compete with host country rivals when it comes to generating ideas for innovations from suppliers and academia. We generally support the results by Almeida and Phene (2004) and extend their empirical findings beyond the semiconductor industry and knowledge flows based on patents.

Yet, foreign subsidiaries are severely challenged by liabilities of foreignness where customers are involved. We suggest that the frictional losses from a lack of social and cultural embeddedness (liability of foreignness) in the host country are especially tangible when relevant lead customers have to be identified and their tacit and often unarticulated impulses have to be transferred, understood and prioritized. We argue that a significant portion of this information is "lost in translation." This is an important result, since achieving responsiveness for local tastes and needs has been identified as a major driver of business internationalization

(Bartlett and Goshal, 1987; Doz and Prahalad, 1984; Prahalad and Doz, 1987). It is apparently easier for multinational corporations to fish for valuable innovation inputs abroad in the upstream segments of their value chains, while liabilities of foreignness confine downstream flows from customers. Therefore, our results may contribute to explaining the differences between the dynamics of upstream and downstream globalization of multinational firms identified by Rugman and Verbeke (2004). They argue that globalization is not a symmetric process. Instead, multinational firms find it easier to leverage their firm-specific advantages in internationalizing, sourcing and production (upstream), while distribution and sales (downstream) remain challenging.

An alternative but related interpretation may be based on the finding of individual personal networks that facilitate knowledge flows (Agrawal et al., 2006; Singh, 2005). In essence, individual employees from the host country compensate the lack of embeddedness of the foreign subsidiaries through their personal network. They turn the private good of social capital into a public one for the company (Inkpen and Tsang, 2005). As these personal networks stem from previous educational and professional experience, they may be a very effective tool for accessing knowledge from suppliers or universities. Customer knowledge may be a different issue. Lead users are difficult to identify (Von Hippel, 1988). Hence, an important mechanism for overcoming liability of foreignness with regards to host country suppliers and academic institutions may be missing when it comes to customers.

What managerial recommendations can be drawn from our research? First, MNCs that worry about the integration of their subsidiaries in host country knowledge flows are, at least on average, fine when it comes to sourcing knowledge from host country suppliers and academic institutions. We suspect that this is due to the personal networks of local employees. Secondly, and more importantly, the link to host country customers is the problem. We suggest two countervailing strategies. If foreign subsidiaries face markets with large numbers of dispersed, heterogeneous customers a defensive strategy may be appropriate. That is, outsourcing early stage market research and innovation marketing to local firms with established networks and procedures. If it is easier to identify, observe and evaluate local customers, foreign subsidiaries should move towards active strategies. This could imply recruiting key personnel from customers (following the personal network rational), collaborations or joint development with key customers. The latter should be focused on establishing broad interfaces and personal networks between subsidiary employees and local customers to generate extensive channels for future knowledge flows. Third, our research shows that domestic firms cannot count on preferential access to local supplier and academic knowledge. Their home field advantage in innovation activities depends largely on their embeddedness with local customers. Deepening and cultivating this link may be an important source for future competitive advantage.

7 Concluding remarks and limitations

In conclusion, we face certain limitations in our analysis that should be acknowledged and may lead to promising research projects in the future. We did benefit from a large, high

quality dataset that enabled insights that could not have been drawn from traditional patent analyses. However, it was not specifically designed for this analysis and limits our empirical study. Most importantly, we can observe knowledge flows but have relatively little information (apart from the source) on how it was achieved. This limits our potential for recommendations. What is more, our measure of knowledge flows is direct and importance-weighted, although it is qualitative and self-reported. We have no means to assess whether the number of patents or citations would produce superior insights or whether our findings on customer inputs could be reproduced. Besides, we have to rely on several proxy variables for presenting the concepts developed in the theoretical section. More detailed information especially on the history of the foreign controlled firms may be helpful. Finally, our study is not confined to a particular industry but to a particular country. While the German perspective may contribute to other studies that have mostly dealt with the US, its economic, historical and cultural environment cannot be readily generalized. Comparative studies would certainly provide further interesting insights.

8 Annex

8.1 Industry breakdown

Industry	NACE Code	Industry Group
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.2	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

8.2 Descriptive statistics

Table 2: Descriptive statistics: means, standard errors in parentheses

Variables	*Total*	*German controlled companies*	*Foreign controlled companies*
Observations	997	900	97
German customer as source for innovation (dummy)	0.54	0.55	0.46
	(0.50)	(0.50)	(0.50)
German supplier as source for innovation (dummy)	0.17	0.16	0.23
	(0.37)	(0.37)	(0.42)
German academia as source for innovation (dummy)	0.15	0.14	0.15
	(0.35)	(0.35)	(0.36)

Variables	*Total*	*German controlled companies*	*Foreign controlled companies*
Company is part of foreign group with headquarters abroad (dummy)	0.10	0.00	1.00
	(0.30)	(0.00)	(0.00)
Share of employees with higher education (%)	29.12	29.58	24.89
	(28.36)	(28.88)	(22.72)
Continuous R&D activities (dummy)	0.75	0.75	0.79
	(0.43)	(0.44)	(0.41)
R&D intensity in 2001 (%)	5.50	5.69	3.75
	(10.61)	(11.00)	(5.60)
Index of importance of methods of stimulating innovation activities (Index)	0.44	0.43	0.55
	(0.22)	(0.22)	(0.20)
Index of importance of innovation strategies (Index)	0.54	0.53	0.64
	(0.27)	(0.28)	(0.21)
Germany's revealed comparative advantage by industry (logarithm)	17.85	18.07	15.80
	(53.17)	(53.25)	(52.65)
German share of global business R&D expenditures by industry (%)	9.82	9.81	9.90
	(5.83)	(5.84)	(5.80)
Profitability in 2001 (index)	3.45	3.42	3.76
	(1.81)	(1.80)	(1.85)
Turnover per employee in 2001 (%)	0.33	0.31	0.57
	(0.52)	(0.46)	(0.88)
No of employees	602.13	463.44	1,888.93
	(4,345.37)	(2,907.57)	(10,718.32)
Age since founding in Germany (in years)	18.62	18.21	22.45
	(21.30)	(21.34)	(20.60)
East Germany (dummy)	0.34	0.35	0.25
	(0.47)	(0.48)	(0.43)
Export status (dummy)	0.65	0.63	0.87
	(0.48)	(0.48)	(0.34)
Company has been part of M&A activities with an impact on turnover of more than 10% during the last two years (dummy)	0.05	0.05	0.09
	(0.23)	(0.22)	(0.29)
Other manufacturing (dummy)	0.31	0.31	0.31
	(0.46)	(0.46)	(0.46)
Medium-high-tech manufacturing (dummy)	0.22	0.21	0.35
	(0.42)	(0.41)	(0.48)
High-tech manufacturing (dummy)	0.13	0.12	0.18
	(0.33)	(0.33)	(0.38)
Distributive Services (dummy)	0.06	0.06	0.05
	(0.24)	(0.25)	(0.22)
Knowledge-intensive Services (dummy)	0.09	0.09	0.06
	(0.29)	(0.29)	(0.24)
Technological Services (dummy)	0.19	0.20	0.05
	(0.39)	(0.40)	(0.22)

8.3 Estimation results

Table 3: Coefficients of trivariate probit estimation

Variable	*Source German Customer*	*Source German Supplier*	*Source German Science*
Company is part of foreign group with headquarters abroad (dummy)	-0.33**	0.14	-0.08
	(0.14)	(0.16)	(0.17)
Share of employees with higher education (%)	0.00	-0.00	0.01***
	(0.00)	(0.00)	(0.00)
Continuous R&D activities (dummy)	0.34***	0.10	0.53***
	(0.11)	(0.13)	(0.16)
R&D intensity in 2001 (%)	0.00	-0.02**	0.01
	(0.00)	(0.01)	(0.00)
Index of importance of methods of stimulating innovation activities (Index)	0.40*	0.17	-0.15
	(0.22)	(0.26)	(0.27)
Index of importance of innovation strategies (Index)	0.43**	0.42**	0.48**
	(0.17)	(0.21)	(0.21)
Germany's revealed comparative advantage by industry (logarithm)	-0.00**	-0.00	-0.00**
	(0.00)	(0.00)	(0.00)
German share of global business R&D expenditures by industry (%)	-0.00	-0.02*	0.02
	(0.01)	(0.01)	(0.01)
Profitability in 2001 (index)	0.03	0.02	0.00
	(0.02)	(0.03)	(0.03)
Turnover per employee in 2001 (%)	-0.05	0.12	0.05
	(0.08)	(0.09)	(0.11)
No of employees (logarithm)	0.00	0.01	0.07*
	(0.03)	(0.03)	(0.04)
Age since founding in Germany (in years)	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)
East Germany (dummy)	0.11	0.09	-0.02
	(0.09)	(0.11)	(0.12)
Export status (dummy)	0.02	-0.25**	0.04
	(0.11)	(0.12)	(0.14)
Company has been part of M&A activities with an impact on turnover of more than 10% during the last two years (dummy)	0.15	-0.18	0.17
	(0.19)	(0.22)	(0.21)
Medium-high-tech manufacturing (dummy)	0.01	0.29*	0.26
	(0.13)	(0.15)	(0.17)
High-tech manufacturing (dummy)	0.02	0.01	0.36**
	(0.15)	(0.17)	(0.18)
Distributive Services (dummy)	0.10	0.39*	-0.19
	(0.18)	(0.21)	(0.32)
Knowledge-intensive Services (dummy)	0.20	0.17	0.18

Variable	*Source German Customer*	*Source German Supplier*	*Source German Science*
	(0.18)	(0.22)	(0.25)
Technological Services (dummy)	0.06	0.03	0.45**
	(0.16)	(0.19)	(0.21)
Constant	-0.76***	-1.25***	-2.63***
	(0.20)	(0.24)	(0.30)
rho	(1/2) 0.26 ***	(2/3) 0.20 ***	(1/3) 0.42 ***
	(0.06)	(0.06)	(0.07)
Observations		997	
Wald chi2(60)		167.83	
Aldrich Nelson R2		0.21	
Loglikelihood		-1 431.48	

* significant at 10%; ** significant at 5%; *** significant at 1% ; Robust SEs in parentheses

9 References

Adams, J.D., 2004. Learning, Internal Research, and Spillovers: Evidence from a Sample of Industrial R&D Laboratories. Rensselaer Working Papers in Economics No. 0409, Troy, NY.

Adler, P.S., Kwon, S.-W., 2002. Social Capital: Prospects for a New Concept. Academy of Management Review 27 (1), 17-40.

Agrawal, A., Cockburn, L., McHale, J., 2006. Gone but Not Forgotten: Knowledge Flows, Labor Mobility, and Enduring Social Relationships. Journal of Economic Geography 6 (5), 571-591.

Aitken, B.J., Harrison, A.E., 1999. Do Domestic Firms Benefit from Direct Foreign Investment? American Economic Review 89 (3), 605-618.

Al-Laham, A., Amburgey, T.L., 2005. Knowledge Sourcing in Foreign Direct Investments: An Empirical Examination of Target Profiles. Management International Review 45 (3), 247-275.

Almeida, P., 1996. Knowledge Sourcing by Foreign Multinationals: Patent Citation Analysis in the U.S. Semiconductor Industry. Strategic Management Journal 17, 155-165.

Almeida, P., Kogut, B., 1999. Localization of Knowledge and the Mobility of Engineers in Regional Networks. Management Science 45 (7), 905-917.

Almeida, P., Phene, A., 2004. Subsidiaries and Knowledge Creation: The Influence of the Mnc and Host Country on Innovation. Strategic Management Journal 25 (8/9), 847-864.

Arrow, K.J., 1962. The Economic Implications of Learning by Doing. The Review of Economic Studies 29 (3), 155-173.

Audretsch, D.B., Feldman, M.P., 1996. R&D Spillovers and the Geography of Innovation and Production. American Economic Review 86 (3), 630-640.

Bartholomaei, M., 2005. To Know Is to Be: Three Perspectives on the Codification of Knowledge. SPRU Electronic Working Paper Series No. 131, Brighton.

Bartlett, C.A., Goshal, S., 1987. Managing across Borders: New Organizational Responses. Sloan Management Review 29 (1), 43-54.

Becker, W., Peters, J., 2000. Technological Opportunities, Absorptive Capacities, and Innovation. Volkswirtschaftliche Diskussionsreihe No. 255, Augsburg.

Belderbos, R., Carree, M., Lokshin, B., 2004. Cooperative R&D and Firm Performance. Research Policy 33 (10), 1477-1492.

Bertrand, M., Mullainathan, S., 2001. Do People Mean What They Say? Implications for Subjective Survey Data. American Economic Review 91 (2), 67-72.

Bhagat, R.S., Kedia, B.L., Harveston, P.D., Triandis, H.C., 2002. Cultural Variations in the Cross-Border Transfer of Organizational Knowledge: An Integrative Framework. Academy of Management Review 27 (2), 204-221.

Bilkey, W.J., Nes, E., 1982. Country-of-Origins Effects on Product Evaluation. Journal of International Business Studies 13 (1), 89-99.

Birkinshaw, J., Hood, N., 1998. Multinational Subsidiary Evolution: Capability and Charter Change in Foreign-Owned Subsidiary Companies. Academy of Management Review 23 (4), 773-795.

Bloom, N., Van Reenen, J., 2002. Patents, Real Options and Firm Performance. Economic Journal 112 (478), C97-C116.

Bönte, W., Keilbach, M., 2005. Concubinage or Marriage? Informal and Formal Cooperations for Innovation. International Journal of Industrial Organization 23 (3-4), 279-302.

Boschma, R., 2005. Proximity and Innovation: A Critical Assessment. Regional Studies 39 (1), 61-74.

Branstetter, L.G., 2001. Are Knowledge Spillovers International or Intranational in Scope? Journal of International Economics 53 (1), 53-80.

Breschi, S., Malerba, F., Orsenigo, L., 2000. Technological Regimes and Schumpeterian Patterns of Innovation. Economic Journal 110 (463), 388-410.

Cassiman, B., Veugelers, R., 2002. R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium. American Economic Review 44 (3), 1169-1184.

Caves, R.E., 1971. International Corporations: The Industrial Economics of Foreign Investment. Economica 38 (149), 1-27.

Cohen, W.M., Levinthal, D.A., 1989. Innovation and Learning: The Two Faces of R&D. The Economic Journal 99, 569-596.

Cohen, W.M., Levinthal, D.A., 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly 35 (1), 128-153.

Cowan, R., David, P.A., Foray, D., 2000. The Explicit Economics of Knowledge Codification and Tacitness. Industrial and Corporate Change 9 (2), 211-254.

Criscuolo, C., Haskel, J.E., Slaughter, M.J., 2005. Global Engagement and the Innovation Activities of Firms. NBER Working Paper No. 11479, Cambridge, MA.

DeYoung, R., Nolle, D., 1996. Foreign-Owned Banks in the United States: Earning Market Share or Buying It? Journal of Money, Credit, and Banking 28, 622-636.

Dow, D., 2006. Adaptation and Performance in Foreign Markets: Evidence of Systematic under-Adaptation. Journal of International Business Studies 37 (2), 212-226.

Doz, Y.L., Prahalad, C.K., 1984. Patterns of Strategic Control within Multinational Corporations. Journal of International Business Studies 15 (2), 55-72.

Doz, Y.L., Santos, J., Williamson, P., 2001. From Global to Metanational: How Companies Win in the Knowledge Economy, Harvard Business School Press, Boston.

Dussauge, P., Garrette, B., Mitchell, W., 2000. Learing from Competing Partners: Outcomes and Duration of Scale and Link Alliances in Europe, North America and Asia. Strategic Management Journal 21 (2), 99-126.

Dyer, J.H., Singh, H., 1998. The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. Academy of Management Review 23 (4), 660-679.

Frosch, R.A., 1996. The Customer for R&D Is Always Wrong! Research Technology Management 39 (6), 22-25.

Frost, T.S., 2001. The Geographic Sources of Foreign Subsidiaries' Innovations. Strategic Management Journal 22 (2), 101-123.

Furman, J.L., Hayes, R., 2004. Catching up or Standing Still? National Innovative Productivity among `Follower´ Countries, 1978-1999. Research Policy 33 (9), 1329-1354.

Gallini, N.T., 2002. The Economics of Patents: Lessons from Recent U.S. Patent Reform. Journal of Economic Perspectives 16 (2), 131-154.

Gemünden, H., Heydebreck, M., Wijnberg, R., 1992. Technological Interweavement: A Means of Achieving Innovation Success. R&D Management 22 (4), 359-376.

Ghemawat, P., 2001. Distance Still Matters: The Hard Reality of Global Expansion. Harvard Business Review 79 (8), 137-146.

Ghemawat, P., 2003. The Forgotton Strategy. Harvard Business Review 81 (11), 76-84.

Greene, W.H., 1993. Econometric Analysis, Macmillan Publishing Company, New York.

Griliches, Z., 1979. Issues in Assessing the Contribution of Research and Development to Productivity Growth. Bell Journal of Economics 10 (1), 92.

Griliches, Z., 1990. Patent Statistics as Economic Indicators: A Survey. Journal of Economic Literature 28, 1661-1707.

Gulati, R., Nohria, N., Zaheer, A., 2000. Strategic Networks. Strategic Management Journal 21 (3), 203-215.

Hagedoorn, J., 1993. Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences. Strategic Management Journal 14 (5), 371-385.

Hagedoorn, J., 2002. Inter-Firm R&D Partnership: An Overview of Major Trends and Patterns since 1960. Research Policy 31, 477-492.

Hajivassiliou, V.A., McFadden, D.L., Ruud, P., 1996. Simulation of Multivariate Normal Rectangle Probabilities and Their Derivatives: Theoretical and Computational Results. Journal of Econometrics 72 (1-2), 85-134.

Harabi, N., 1997. Channels of R&D Spillovers: An Empirical Investigation of Swiss Firms. Technovation 17 (11/12), 627.

Harvey, M., Novicevic, M.M., 2000. Staffing Global Marketing Positions: What We Don't Know Can Make a Difference. Journal of World Business 35 (1), 80-94.

Hasan, I., Hunter, W., 1996. Efficiency of Japanese Multinational Banks in the United States. in: Chen, A. H. (Ed.) Research in Finance, Greenwich and London,pp 157-173.

Haskel, J.E., Pereira, S.C., Slaughter, M.J., 2002. Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms? NBER Working Paper No. 8724, Boston.

Hennart, J.-F., Roehl, T., Zeng, M., 2002. Do Exits Proxy a Liability of Foreignness? The Case of Japanese Exits from the Us. Journal of International Management 8 (4), 241-264.

Hymer, S.H., 1976. The International Operations of National Firms: A Study of Direct Investment, MIT Press, Cambridge.

Inkpen, A.C., Tsang, E.W.K., 2005. Social Capital, Networks, and Knowledge Transfer. Academy of Management Review 30 (1), 146-165.

Irwin, D.A., Klenow, P.J., 1994. Learning-by-Doing Spillovers in the Semiconductor Industry. Journal of Political Economy 102 (6), 1200-1227.

Jaffe, A.B., 1986. Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Values. American Economic Review 76 (5), 984-1001.

Jaffe, A.B., Trajtenberg, M., 1999. International Knowledge Flows: Evidence from Patent Citations. Economics of Innovation & New Technology 8 (1/2), 105-137.

Jaffe, A.B., Trajtenberg, M., Henderson, R., 1993. Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. The Quarterly Journal of Economics 108 (3), 577-599.

Jensen, R., Szulanski, G., 2004. Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers. Journal of International Business Studies 35 (6), 508-523.

Kaiser, U., 2002. An Emprical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector. International Journal of Industrial Organization 20 (6), 747-774.

Kalnins, A., Chung, W., 2006. Social Capital, Geography, and Survival: Gujarati Immigrant Entrepreneurs in the U.S. Lodging Industry. Management Science 52 (2), 233-247.

Keller, W., 2002. Georgaphical Localization of International Technology Diffusion. American Economic Review 92 (1), 120-140.

Keller, W., 2004. International Technology Diffusion. Journal of Economic Literature XLII (September 2004), 752-782.

Kogut, B., Zander, U., 1993. Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. Journal of International Business Studies 24 (4), 625-645.

Kogut, R., Zander, U., 1992. Knowledge of the Firm, Combinative Capabilities and the Replication of Technology. Organization Science 33 (3), 383-397.

Landry, R., Amara, N., 2002. Effects of Sources of Information on Novelty of Innovation in Canadian Manufacturing Firms: Evidence from the 1999 Statistics Canada Innovatin Survey. Study prepared for Industry Canada No., Quebec.

Lane, P.J., Lubatkin, M., 1998. Relative Absorptive Capacity and Interorganizational Learning. Strategic Management Journal 19, 461-477.

Laursen, K., Salter, A., 2006. Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms. Strategic Management Journal 27 (2), 131-150.

Lenox, M., King, A., 2004. Prospects for Developing Absorptive Capacity through Internal Information Provision. Strategic Management Journal 25 (4), 331-345.

Lord, M.D., Ranft, A.L., 2000. Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge. Journal of International Business Studies 31 (4), 573-589.

Love, J.H., Roper, S., 2004. Knowledge Sourcing, Innovation and Performance: A Preliminary Analysis Off Irish Innovation Panel Data. Aston Business School Working Paper No., Birmingham.

Mahmood, I.P., Singh, J., 2003. Technological Dynamism in Asia. Research Policy 32 (6), 1031-1054.

Mahnke, V., Pedersen, T., Venzin, M., 2005. The Impact of Knowledge Management on Mnc Subsidiary Performance: The Role of Absorptive Capacity. Management International Review 45 (Special Issue 2), 101-119.

Malmberg, A., Maskell, P., 2005. Localized Learning Revisited. DRUID Working Paper No. 05-19.

Mansfield, E., Teece, D., Romeo, A., 1980. Overseas Research and Development by Us-Based Firms. International Executive 22 (1), 10-12.

Matusik, S.F., Heeley, M.B., 2005. Absorptive Capacity in the Software Industry: Identifying Dimensions That Affect Knowledge and Knowledge Creation Activities. Journal of Management 31 (4), 549-572.

Mezias, J.M., 2002a. How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations. Journal of International Management 8 (3), 265-283.

Mezias, J.M., 2002b. Identifying Liabilities of Foreignness and Strategies to Minimize Their Effects: The Case of Labor Lawsuit Judgement in the United States. Strategic Management Journal 23, 229-244.

Miller, S.R., Parkhe, A., 2002. Is There a Liability of Foreignness in Global Banking? An Empirical Test of Banks' X-Efficiency. Strategic Management Journal 31 (1), 323-337.

Miller, S.R., Richards, M., 2002. Liability of Foreignness and Membership in a Regional Economic Group: Analysis of the European Union. Journal of International Management 8 (3), 323-337.

Nadiri, I.M., 1993. Innovations and Technological Spillovers. NBER Working Paper No. 4423, Cambridge, MA.

Ndofor, H.A., Levitas, E., 2004. Signaling the Strategic Value of Knowledge. Journal of Management 30 (5), 685-702.

Nelson, R.R., Winter, S.G., 1982. An Evolutionary Theory of Economic Change, Belknap Press of Harvard University Press, Cambridge, MA.

Newburry, W., Gardberg, N.A., Belkin, L.Y., 2006. Organizational Attractiveness Is in the Eye of the Beholder: The Interaction of Demographic Characteristics with Foreignness. Journal of International Business Studies 37 (5), 666-686.

Nobel, R., Birkinshaw, J., 1998. Innovation in Multinational Corporations: Control and Communication Patterns in International R&D Operations. Strategic Management Journal 19 (5), 479-496.

Nonaka, I., 1994. A Dynamic Theory of Organizational Knowledge Creation. Organization Science 5 (1), 14-37.

Pavitt, K., 1984. Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory. Research Policy 13 (6), 343-373.

Polanyi, M., 1967. The Tacit Dimension., Doubleday & Co., Garden City, NY.

Powell, W.W., 1987. Hybrid Organizational Arrangements. New Forms or Transitional Developement? California Management Review 30 (1), 67-87.

Prahalad, C.K., Doz, Y.L., 1987. The Mulinational Mission: Balancing Local Demands and Global Vision 1, The Free Press, New York.

Rammer, C., Peters, B., Schmidt, T., Aschhoff, B., Doherr, T., Niggemann, H., 2005. Innovationen in Deutschland - Ergebnisse Der Innovationserhebung 2003 in Der Deutschen Wirtschaft. Zew Wirtschaftsanalysen 78, Nomos, Baden-Baden.

Reich, R., 1990. Who Is Us? Harvard Business Review 68 (1), 53-64.

Romer, P.M., 1990. Endogenous Technological Change. Journal of Political Economy 98 (5), 71-102.

Rothwell, R., Dodgson, M., 1991. External Linkages and Innovation in Small and Medium-Sized Enterprises. R&D Management 21, 125-137.

Rugman, A.M., Verbeke, A., 2004. A Perspective on Regional and Global Strategies of Multinational Enterprises. Journal of International Business Studies 35 (1), 3-18.

Schmidt, T., 2005. Absorptive Capacity - One Size Fits All? A Firm-Level Analysis of Aborpstive Capacity for Different Kinds of Knowledge. ZEW Discussion Paper No. 05-72, Mannheim.

Singh, J., 2005. Collaborative Networks as Determinants of Knowledge Diffusion Patterns. Management Science 51 (5), 756-770.

Szulanski, G., 1996. Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within the Firm. Strategic Management Journal 17 (Special issue), 27-43.

Tsang, E.W.K., 2000. Transaction Cost and Resource-Based Explanations of Joint Ventures: A Comparison and Synthesis. Organizational Studies 21 (1), 215-242.

UNCTAD, 2005. World Investment Report 2005, United Nations, Geneva.

Von Hippel, E., 1988. Sources of Innovation, Oxford University Press, New York.

Von Zedtwitz, M., Gassmann, O., 2002. Managing Customer Oriented Research. International Journal of Technology Management 24 (2/3), 165-193.

West, J., Graham, J.L., 2004. A Linguistic-Based Measure of Cultural Distance and Its Relationship to Managerial Values. Management International Review 44 (2), 239-260.

Zaheer, S., 1995. Overcoming the Liability of Foreignness. Academy of Management Journal 38 (2), 341-364.

Zaheer, S., 2002. The Liability of Foreignness, Redux: A Commentary. Journal of International Management 8 (3), 351-358.

Zaheer, S., Mosakowski, E., 1997. The Dynamics of the Liability of Foreignness: A Global Study of Survival in Financial Services. Strategic Management Journal 18 (6), 439-464.

Zaheer, S., Zaheer, A., 1997. Country Effects on Information Seeking in Global Electronic Networks. Journal of International Business Studies 28 (1), 77-100.

Zahra, S.A., George, G., 2002. Absorptive Capacity: A Review and Reconceptualization, and Extension. Academy of Management Review 27 (2), 185-203.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

The Pulse of Liability of Foreignness: Dynamic Legitimacy and Experience Effects in the German Car Market

AUTOREN: ***Ulrich Kaiser***

[University of Southern Denmark, Odense und weitere]

Wolfgang Sofka

[Universität Hamburg, ZEW Mannheim]

JAHR: 2006

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper
No. 06-070, Mannheim
Zweite Einreichungsrunde bei
Journal of World Business
Status: Revise and resubmit.

AUSGEWÄHLTE PRÄSENTATIONEN: European International Business Academy (EIBA)
Catania, 2007

Academy of International Business
Indianapolis, 2007

The Pulse of Liability of Foreignness

Dynamic Legitimacy and Experience Effects in the German Car Market

Ulrich Kaiser[1,2] and Wolfgang Sofka[2,3]

[1] University of Southern Denmark at Odense; Centre for European Economic Research; Centre for Economic and Business Research at Copenhagen Business School and Centre for Industrial Economics at the University of Copenhagen

[2] Centre for European Economic Research, Mannheim

[3] University of Hamburg, Germany

Abstract

Globalization has provided many companies with new opportunities for growth and efficiency. This requires them to operate successfully across cultural and social borders. These can be stumbling blocks to internationalization and have been found to cause frequent errors and delays for multinational companies. Such liabilities of foreignness are persistent in nature. We investigate the causes behind these detrimental effects. We identify two major factors conceptually: a lack of legitimacy in the host country on the demand side and a lack of responsiveness on the side of the multinational corporation. We test these hypotheses empirically using a comprehensive sample of the German car market, which is especially suitable due to its established domestic producers and international competitors. Our results suggest that the two factors interact. For less experienced customer groups, we find that legitimacy is the dominant factor behind the effects of liability of foreignness. As customer experience increases, liability of foreignness caused by a lack of responsiveness becomes more of an issue.

Keywords: Liability of foreignness, internationalization strategy, globalization

JEL-Classification: F23, L62, M10

Corresponding author:
Wolfgang Sofka
Sofka@zew.de
Phone: +49/621/1235-181, Fax: +49/621/1235-170
Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43, D-68034 Mannheim, Germany

The authors thank Christian Rammer, Thorsten Teichert and Jörg Zimmermann for invaluable comments and discussions.

1 Introduction

Internationalizing business activities is a key strategy for most modern companies to achieve growth in revenues and profits. While internationalization potentials have mostly materialized in procurement and production, internationalizing sales remains a more difficult task (Rugman and Verbeke, 2004). Even though legal obstacles have diminished (e.g through, free trade, common currencies or information technology), the adverse effects from social and cultural borders remain. Foreign subsidiaries often lack roots and reputation in the host country, compared to domestic competitors. These deficits generate frictional losses when interaction with local stakeholders (e.g. customers, regulators) is crucial. They become visible in the form of more frequent mistakes, delays and risks in the foreign engagements of multinational corporations (MNC) (Lord and Ranft, 2000). These stumbling blocks were initially perceived as temporary effects associated with market entry. However, it turns out that overcoming this "liability of foreignness", as termed by Zaheer (1995)[1], is more of a marathon than a sprint and that the associated performance effects are as lasting as the liabilities of size and newness as discussed by Zaheer and Mosakowski (1997).

The objective of this study is to provide more insights into the tenacious factors behind the liability of foreignness. Its results are directed at multinational management scholars and practitioners. We advance the academic discussion by developing a theoretical argument of the dynamic antecedents of liability of foreignness. Along these lines we introduce a distinction between host country costumer-induced elements (lack of legitimacy) and MNC-specific factors (lack of responsiveness and adaptation). We explore the driving forces behind both streams of liability of foreignness and challenge the assumption that they will eventually converge and evaporate. Conversely, we argue that sticky layers of liability of foreignness remain which materialize as persistent stumbling blocks for foreign operations. We test this analytical framework empirically using data on more than 1,200 models on the German new car market. This setting is particularly appropriate because the automotive industry is at the forefront of globalization and Germany is a large market with well-established domestic and foreign competitors. Based on our results, practitioners can develop targeted countervailing strategies that focus either on the host customer (marketing) side or on organizational adaptation.

Our study is organized as follows. Section 2 presents the conceptual framework and briefly summarizes existing research. Section 3 maps our discussion onto analytical arguments and derives empirically testable hypotheses. Section 4 presents our empirical study and is followed by a discussion of our results in Section 5. In the final part, Section 6, we derive conclusions and recommendations.

[1] This relates to the concept of "cost of doing business abroad" (Hymer, 1976).

2 Conceptual framework

The rationale behind liability of foreignness follows the basic assumption that firms operating in their home market environment benefit from a "home turf advantage". They know their business environment and the environment knows them. Foreign competitors find it relatively harder to fit in. They suffer from more frequent mistakes, delays and unnecessary risks (Lord and Ranft, 2000; Sofka, 2006). These stumbling blocks in internationalization make up the subject matter for an important part of the literature on multinational corporations (MNC). They are collectively described as the "liability of foreignness" (Hymer, 1976; Zaheer, 1995). The term refers to unavoidable disadvantages for firms operating outside of their home environment. By its nature, liability of foreignness is a relative concept, i.e. foreign firms face barriers that host country competitors do not. These can materialize as extra or disproportionably high costs as well as forfeited benefits (Mezias, 2002a). They are the result of a lack of local roots (e.g. higher learning costs), a perceived lack of host country legitimacy, spatial distance (e.g.. transportation, communication across large distances and different time zones) and/or legal restrictions imposed by the home country (e.g. high-tech exports) as described by Zaheer, (1995).

The studies by DeYoung and Nolle (1996), Hasan and Hunter (1996), Mezias (2002b), Miller and Parkhe (2002), Schmidt and Sofka (2006), Sofka and Zimmermann (2005), Zaheer (1995), Zaheer and Mosakowski (1997), Zaheer and Zaheer (1997) identify the effects of liability of foreignness. They support the concept at various performance layers like profitability, growth, efficiency, exposure to lawsuits, absorptive capacities.

Our study attempts to take the literature a step further by trying to identify the *causes* of liability of foreignness and by providing strategies to mitigate the detrimental effects of being a foreign firm.

3 Analytical framework

The roots of liability of foreignness

Liability of foreignness is a sociological concept[2] with structural, relational and legitimacy dimensions (Zaheer, 2002). Differences in languages and the ways people communicate are important, but not exclusive, factors (West and Graham, 2004). Environmental pressure and opportunities in the domestic market shape skills, structures, practices and routines of companies and their staff over time. A firm's constant exposure to its environment and the interaction between the two leads to an organizational entity that functions effectively and efficiently within the specific domestic social, cultural, economic and legal environment. This process is typically an "automatic" by-product of company evolution. Foreign competitors find it difficult to acquire, substitute or imitate this knowledge because it is largely tacit and causally ambiguous (Barkema and Bell, 1996; Jensen and Szulanski, 2004). They lack local embeddedness and suffer from frictional losses in their host country engagements that materialize as lower levels of efficiency and effectiveness (Granovetter, 1985; Mezias, 2002a).

Overcoming liability of foreignness is therefore closely related to time and experience. Host country rivals necessarily have a head-start and foreign firms need to achieve time compression in their learning engagements to gain an equal footing (Barkema and Bell, 1996; Dierickx and Cool, 1989). The few longitudinal studies on the dynamic effects of liability of foreignness hint that this is typically a long journey and not a short trip, e.g. 16 years in the currency trading industry (Petersen and Pedersen, 2002; Zaheer and Mosakowski, 1997).

There is a need for a clearer understanding of the persistent elements behind liability of foreignness. Barkema and Bell (1996) suggest that all learning is incremental and therefore related to time. Our study is designed to support MNC managers who want to go beyond a "wait and see" approach and achieve time compression in overcoming liability of foreignness. Targeted strategies require more insight into learning engagements and the relevant actors. We distinguish between two interrelated perspectives which are typically illustrated as "stranger in a strange land" (Zaheer and Mosakowski, 1997): the inflexibility of host country customers that hinders them from accepting foreign companies as equals (customer learning) and/or the inability of foreign firms to learn and adapt (organizational learning). The former refers to deficits in legitimacy while the latter describes shortcomings in responsiveness. Most studies in the field assume, at least implicitly, a convergence between these two forces over time.[3] We extend the existing literature by questioning this assumption. We argue that the underlying factors behind achieving legitimacy and responsiveness differ. The former requires learning engagements from the customers, the latter from the MNC. Time and experience are

[2] Eden and Miller (2004) argue that the economic aspects, i.e. costs of doing business abroad, should be separated from the sociological factors. Our study is not designed to disentangle the economic and sociological roots and effects.

[3] See for example Petersen and Pedersen, 2002; Zaheer and Mosakowski, 1997.

factors behind both elements (Barkema and Bell, 1996) but this does not readily translate into eventual convergence of the two streams.

Deficits in host country legitimacy

Purchasing decisions and hence product preferences are integral to the definition of self and the expression and performance of roles (e.g. Belk, 1988). People enact roles that define their self-concept (Mehta and Belk, 1991). These roles are typically stable over time, leading to reliable product preferences (Mathur et al., 2003). It is difficult for foreign competitors to enter these established structures. Host country customers find it more difficult to judge foreign firms and the quality of their product. The marketing literature covers this lack of legitimacy of foreign products under the heading of "country of origin effects" (for a review see Bilkey and Nes, 1982). Several studies in this field find that customers use information about a product's country of origin as a proxy for the expected product quality (see for example Diamantopoulos et al., 1995; Hsieh, 2004).[4] Hence, host country customer preferences have been identified as permanent aspects of liability of foreignness (Petersen and Pedersen, 2002). Customers abstain from buying or demand a price/quality premium. Both would translate into relative disadvantages for foreign competitors and hence liability of foreignness.

Deficits in organizational responsiveness

From the MNC perspective achieving responsiveness to local requirements (e.g. from markets or regulations) is a major driver of internationalization (Rugman and Verbeke, 2003). This implies learning from the environment and adapting products and processes. Still, these localization efforts have to be balanced with the benefits from global integration (Doz and Prahalad, 1984; Prahalad and Doz, 1987). Put simply, an MNC subsidiary cannot simply morph into an independent host country firm. It has to apply to certain MNC practices and procedures to generate internalization advantages within the MNC (Dunning, 1981; Petersen and Pedersen, 2002). The foreign subsidiary always has to put additional resources into balancing host country integration with intra-MNC consistency when communicating, coordinating and monitoring across national and cultural borders (Mezias, 2002a, 2002b). Dow (2006) shows that transaction costs and increased uncertainty on foreign markets lead to an increased reliance on home country practices on the part of managers abroad. He concludes that organizational inertia reinforces these effects and leads to systematic under-adaptation of strategies used in the host country. Lasting effects of liability of foreignness are the result if they cannot be compensated by firm-specific advantages (Caves, 1971).

Hypotheses

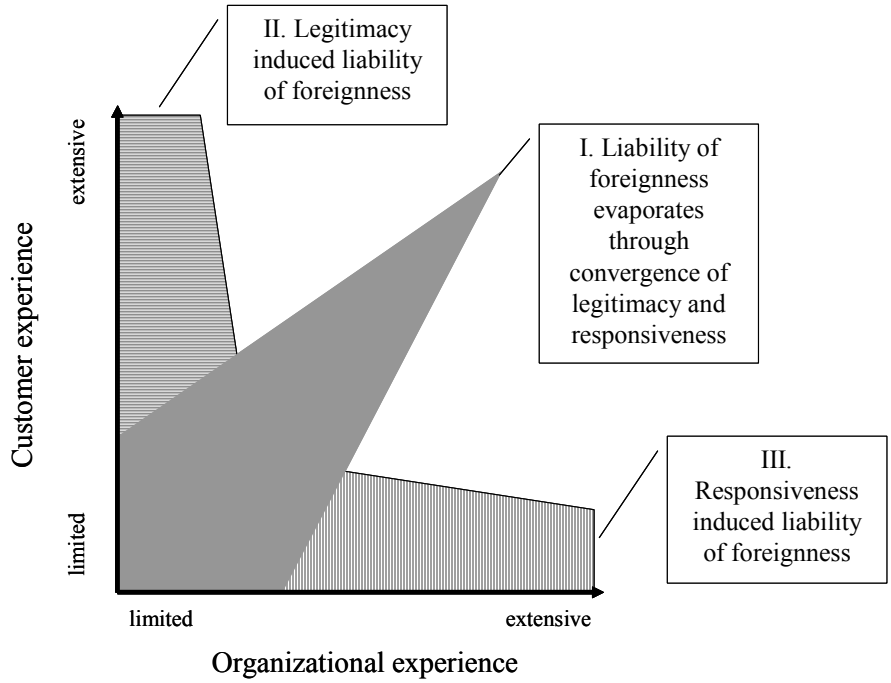
Based on the previous discussion we argue that liability of foreignness does not automatically evaporate over time. The legitimacy and responsiveness issues are driven by different factors which do not necessarily converge. Figure 1 illustrates our line of reasoning. It is typically assumed that situation I occurs: host country customers get used to the foreign

[4] These are not necessarily negative associations, e.g. elegant Italian design or precise German engineering.

company (legitimacy) and the MNC subsidiary simultaneously streamlines its organizational approach to fit into the host country context (responsiveness). We hypothesize that two other outcomes are possible. Host country customer preferences may be so rigid in favouring domestic companies that a sticky layer of legitimacy-induced liability of foreignness remains (Situation II). Alternatively, the advantages of intra-MNC standardization may limit the subsidiary's efforts to localize, resulting in a persistent responsiveness-induced layer of liability of foreignness (Situation III). Hence, we derive the following hypotheses:

> Hypothesis I: Deficits in perceived host country legitimacy as part of customer product preferences do not evaporate over time. Sticky effects remain that constitute the persistent barriers associated with liability of foreignness.
>
> Hypothesis II: Chronic disadvantages from liability of foreignness are the result of intra-MNC needs for consistency. Common products and practices across cultural and social borders prevent foreign subsidiaries from fully blending into the host country environment.

Figure 1: Dynamics of liability of foreignness



4 Empirical study

4.1 Evaluation scheme

Study setting

We test our analytical framework empirically on data from the German new passenger car market. We use the population of new car sales in 2003 and hence do not run into sample selection problems that usually emerge when samples are used instead of populations. Our data is at the model variant level and is hence much more detailed than other studies that use data on the model level (Verboven, 2002). While existing studies typically consider models, e.g. a BMW 525, our data further distinguishes between a BMW 525i (with fuel injection), a BMW 525d (diesel engine) or a BWM 525i touring (a station wagon with fuel injection). Table 1 clarifies the terminology followed in this analysis.

Table 1: Automotive terminology

Category	***Example***
Group	DaimlerChrysler Corp.
Brand	Mercedes
Line	S class
Model	SLK
Model variant	SLK 320 Kompressor 160 kw

This evaluation platform has two major advantages for our research setting. Firstly, cars are highly differentiated products with traceable product (model) generations. Developing a new car model requires extensive time and resources (over 1 bn €) which makes economies of scale effects from foreign market sales a necessity. Secondly, the automotive industry is at the forefront of globalization (Nunnenkamp, 2000). Germany is a large, highly competitive market for automobiles with long-standing domestic producers (which are typically multinationals themselves) and established competition from almost all automotive companies in the world (Licht et al., 2005).[5] What is more, we focus on the primary item of competition in the automotive market: the car model variant. Firms do not compete on individual car sales but through relatively standardized product lines, so-called models and their variants.

Empirical implementation

Our research setting requires a differentiation between customer and organizational learning engagements. We capture the former through customer age and the latter through the duration of a producer's market presence. On the one hand, we argue that legitimacy issues are related to customer age. That is, older customers are more likely to be aware of the amount of time that elapsed before foreign competitors entered the German market while younger customers take the current situation as a given. On the other hand, the time elapsed since an automotive

[5] For example, Ford has operated in Germany since 1925.

manufacturer entered the German market should be a good predictor for the duration of the company's organizational learning engagement and thus the need to achieve responsiveness.

4.2 Estimation strategy

We translate this evaluation scheme into an empirical test setting by adopting a matrix structure. To capture the legitimacy dimension of our research question we estimate a system of car demand equations for young customers (below 30 years of age) and senior customers (60 years and older).[6] Positive and significant coefficients for foreign producer dummy variables are interpreted as signs of legitimacy-induced liability of foreignness. We introduce our second dimension of liability of foreignness, lack of responsiveness, by incorporating a brand's market presence in years. Our theoretical argumentation suggests that these organizational learning engagements differ between domestic (German) and foreign manufacturers. Hence, we introduce a multiplicative interaction term between the foreign producer dummy and the duration of market presence in both equations (i.e. for junior and senior customers). This interaction term approach has two major advantages. Firstly, it separates the legitimacy deficit effects of foreign producers from the modulating/amplifying effects of organizational experience. Secondly, the latter effect represents the specific organizational learning trajectories of foreign manufacturers by separating them from domestic ones.[7] If the coefficients of these interaction terms are positive and significant in both equations we have identified responsiveness-induced liability of foreignness.

4.3 Data

We generate a cross sectional dataset for the year 2003 based on the "New passenger car registrations by regional and contextual criteria"[8] statistics provided by the Kraftfahrt-Bundesamt (KBA, Federal Bureau of Motor Vehicles and Drivers). The KBA approves all vehicle types in Germany. We derive new registrations by car model variants as defined by official German statistics and age groups from this data source[9]. We add historical data from

---

[6] The ideal formulation of this empirical setting would include the age of each individual car buyer. Unfortunately, this information is not available to us. For a workable solution we rely on the youngest (below 30) and oldest age group (60+) which also corresponds nicely with the earliest (1950) and the most recent entrance (1994) of a foreign brand in the German market (see annex Table 4).

[7] Interaction terms follow a straightforward rationale (Aiken and West, 1993): a regression equation of the form $Y=b_1X+b_2Z+b_0$ allows testing for linear, additive effects of X on Y and Z on Y respectively. An additional interaction term producing $Y=b_1X+b_2Z+b_3XZ+b_0$ allows additional insights. Firstly, if b_3 is significant then Y depends jointly upon X and Z. Secondly, if b_1 and/or b_2 are significant there is a separate effect of X on Y (or Z on Y) apart from the mitigating factor XZ.

[8] „Neuzulassungen von Kraftfahrzeugen und Kraftfahrzeuganhängern nach Regional- und Sachmerkmalen."

[9] It should be noted that we observe the age group of the person who registers the car, not the intended driver or persons that influenced the purchasing decision decisively. One could certainly argue that parents may buy and register their children's car for financing or insurance reasons. We acknowledge this limitation. Still, in the absence of more detailed data we are confident that our registration statistics can serve as a reliable proxy.

KBA's "Directory of passenger car manufacturers and types."[10] Price and more specific quality features are provided by a German car evaluation company, EurotaxSchwacke. The pricing information for new cars reflects list prices which do not incorporate any discounts, trade-ins[11] or throw-ins[12]. These arrangements are quite common in car purchasing. Albeit in the absence of more detailed price information, we are confident that these list prices are the most reliable proxy variable available. Besides, we extend our dataset with information published by automotive intelligence provider B&D Forecast GmbH, Germany's leading automobile assistance association ADAC, the EU industrial R&D investment scoreboard report (European Commission, 2004) and the International Organization of Motor Vehicle Manufacturers (OICA).

We obtain a comprehensive snapshot of the German automotive market with a total of 1,233 different car model variants (excluding some observations due to missing values). 809 of these variants are foreign brands, 424 are German. Details of brand assignment can be found in Table 4 of the annex. Descriptive statistics as well as a brief discussion can be found in annex 7.2.

4.4 Variables

Dependent variables

We choose unit sales as our indicator of success on the German automotive market.[13] We estimate a system of two equations, one with the number of sales to customers below 30 years of age (junior) and the other with sales to their counterparts aged 60 years and older (senior) as the dependent variable. Using sales numbers necessarily requires incorporating control variables for prices. High unit sales could be the result of discount pricing or vice versa. Hence, the causal direction is unclear (endogeniety). We will address this issue methodologically (see section 4.5).

Liability of foreignness variables

For the legitimacy-induced effects of liability of foreignness we add a dummy variable indicating whether a car model belongs to a German brand or not. With regards to the foreign status, Zaheer and Mosakowski (1997) discuss a number of suitable concepts: location of a firm's international headquarters, nationality of the majority of workers, share of foreign shareholders, nationality of the largest single shareholder or the perception of a company in a particular country. We find the latter most adequate for our specific research question. What

10 „Verzeichnis der Hersteller und Typen von Personenkraftwagen."

11 The customer receives a more generous offer for her used car from the dealership if she decides to buy a new one there.

12 The dealership keeps the price for a particular car offer unchanged but enhances its equipment, e.g., by adding mats or service vouchers.

13 Obviously, profits per car model variant would be preferable but are generally not available.

is more, dealing with legitimacy issues and customer perceptions requires a brand perspective. All German brands will consequently serve as the comparison group (Mezias, 2002a).

We add interaction terms (i.e. the product) of the foreign status and company experience in Germany to the empirical model to capture the effects of organizational learning engagements on responsiveness that are specific to foreign firms. At the same time, the interaction terms "purge" the previously introduced legitimacy dummies from the organizational effects.

Control variables

Measuring liability of foreignness requires controlling for other liabilities (e.g. size, newness) and contextual aberrations (Mezias, 2002a). We address the former by incorporating size, advertising expenditure, the duration of market presence (company and model variant) as well as average R&D expenditures per vehicle. The latter refers primarily to differences in quality characteristics of the car. Automobiles are complex bundles of features which makes an extensive set of control variables inevitable. It is a challenge to avoid comparing apples and oranges. Naturally, some quality features that made a difference in previous studies are now considered standard equipment in a modern car (e.g. air conditioning), or even mandatory by law (e.g. catalytic converter). We focus on five major quality themes:[14] basic outfit, performance, economic/ecological efficiency, safety, convenience/amenity. We derive a comprehensive list of control variables which is summarized in Table 2.

Table 2: Control variables

Other liabilities	***Quality characteristics***				
	Basic outfit	*Performance*	*Economic/ecological efficiency*	*Safety*	*Convenience/amenity*
Global production volume (log)	Price (thsd. €; log)	Engine power (kilowatts; log)	Value loss 2002 (%)[15]	Airbags (no.)	Onboard computer (dummy)
Media expenditure (log)[16]	Medium segment (dummy)[17]	Diesel engine (dummy)	EcoTest ranking (points)[18]	Breakdown frequency 2002 (no.)[19]	Luxury interior (dummy)
Average R&D exp.	Upper segment			Antiskid system	Power windows (no.)

[14] We base this categorization on studies in marketing (see for example Brownstone et al., 2000; Bunch et al., 1993) or hedonics (see for example Goldberg and Verboven, 2001, 2004; Verboven, 1998, 2002).

[15] After four years and 60.000 km as defined by ADAC.

[16] We add an additional squared variable of this term to control for a curvelinear relationship.

[17] Model segmentation follows official KBA and ADAC statistics.

[18] The EcoTest ranking is constructed by ADAC as a composite point score of emissions and fuel efficiency. A car model can achieve 100 points at best. Toyota achieved the highest score of 89 with its hybrid powered Prius model.

[19] Breakdowns per 1,000 vehicles as collected by ADAC.

Other liabilities	*Quality characteristics*				
	Basic outfit	*Performance*	*Economic/ecological efficiency*	*Safety*	*Convenience/amenity*
per vehicle (€)	(dummy)			(dummy)	
Model exposure to German market (months)	Station wagon (dummy)			Immobilizer (dummy)	Power steering (dummy)
Company exposure to German market (years)[20]					

4.5 Model and method

We apply so-called "Seemingly Unrelated Regression" (SUR) models to estimate the effect of foreignness and other model quality characteristics. The only difference between the SUR model and the more popular OLS model is that we simultaneously estimate car demand for young and old consumers and allow unobserved (by us) quality components (the error terms) to be correlated between young and old consumers. If our specification contained different variables for old and young consumers, joint estimation would also lead to efficiency gains, e.g. we would obtain smaller standard errors. Since this is not the case in our model, the only advantage of applying SUR is that we obtain a joint variance-covariance matrix for both demand equations which allows us to directly test for statistically significant differences between car demand by young and old consumers.

A second technical aspect is that we need to instrument price since it is endogenous to demand: both consumers and producers know the unobserved (to the econometrician) quality components and producers take its value into account in its pricing decision which, in turn, induces a positively correlation between car prices and unobserved model quality. This leads to a downward bias in the estimate for the parameter corresponding to price, i.e. it is estimated "too small" in absolute value.

We therefore need to instrument product price. For an instrument to be valid in this case, it must have two properties: (i) it must be highly correlated with the endogenous variable, car price, and (ii) it must be uncorrelated with unobserved car quality. Candidates for such instruments are cost-side variables that at the same time are unrelated to car demand. We use three cost-side variables as instruments, namely (i) the natural logarithm of car height, since higher cars are likely to be more expensive than smaller cars, (ii) the sum of the squared

[20] Companies have to apply for a general production permit at the KBA if they want to sell their product on the German market. We consider the date of this production permit a reliable proxy variable for market entry. Official post World War II statistics start at 1949. Hence, the maximum time of market exposure is 54 years. See Table 4 of the appendix for an overview.

model-level shares in total brand sales (the Herfindahl-Hirschman index of model production) since a high index indicates that a brand focuses production on a small range of products and (iii) the natural logarithm of the number of employees at the brand level which is a direct cost measure.

Since any model's price is a function of the characteristics of other cars, these characteristics are valid instruments for car price as discussed in detail by Berry et al. (1995). We follow their suggestion and use the sum of the following characteristics of other models as instruments: number of power windows, power steering, immobilizer system, automatic transmission, tinted glass windows, rotational engine speed sensor, ski bag and halogen front lights.

As shown in annex 7.3, which displays "first stage" regression results, our instruments are indeed highly correlated with the endogenous variable, product price. Most instruments are separately significant and our instruments are also highly significant. There is no evidence for correlation between the unobserved quality characteristics and the instruments, since "*J*-tests" for over-identifying restrictions cannot reject the validity of our instruments at any conventional significance level. The formal model specification is

$$\ln q_{ijunior} = \beta_{0\,junior} + \sum_{j=1}^{l} \beta_{jjunior} \times X_{ij} + \beta_{junior} \times D_i + \varepsilon_{ijunior}$$

$$\ln q_{isenior} = \beta_{0\,senior} + \sum_{j=1}^{l} \beta_{jsenior} \times X_{ij} + \beta_{senior} \times D_i + \varepsilon_{isenior}$$

$$i = 1,..,N$$

$$cov(\varepsilon_{ijunior}, \varepsilon_{isenior}) = \rho$$

where

$q_{ijunior}$: *Quantity sold of model i to customers below 30 years*

$q_{isenior}$: *Quantity sold of model i to customers 60 years and older*

X_{ij} : *Quality characteristic j of model i*

D_i : *Foreign producer dummy of model i*

ρ : *Correlation between the error terms* $\varepsilon_{ijunior}$ *and* $\varepsilon_{isenior}$ *(to be estimated)*

β : *parameters to be estimated*

5 Results

Our empirical analysis yields some interesting insights. Table 3 shows the results of the relevant variables for our analytical setting. We did not develop any a priori hypotheses for the control variables. Therefore, estimation results for them are explorative in nature. We find many similarities between junior and senior buyer groups and a few, but quite substantial, differences. A detailed discussion would divert the attention from the core issue of this paper, liability of foreignness. Still, the full set of coefficients as well as a brief discussion can be found in annex 7.4. This section focuses on the results that relate to liability of foreignness.

Table 3: Regression results for liability of foreignness variables

Variable	*Model I*		*Model II*	
	Junior	***Senior***	***Junior***	***Senior***
LIABILITY OF FOREIGNNESS VARIABLES				
Brand from outside Germany (dummy)	-0.87 ***	-0.93 ***	-1.45 **	0.68
	(0.17)	(0.17)	(0.73)	(0.75)
Interaction term: company exposure and foreign status			0.02	-0.03 *
			(0.01)	(0.01)
Company exposure to German market (years)			0.02	0.04 ***
			(0.01)	(0.01)
CONTROL VARIABLES	YES		YES	
Observations	1,233	1,233	1,233	1,233
RMSE	1.58	1.56	1.55	1.58
R2	0.22	0.25	0.26	0.23
P>0	0.00	0.00	0.00	0.00

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors in parentheses
Full set of coefficients available in annex 7.4.

We estimate a baseline case excluding the variables that relate to learning engagements (Model I, Table 3). We find significant negative coefficients for the foreign brand dummy in both age groups, indicating that foreign engagements in Germany are generally subject to liability of foreignness. We subsequently add firms' learning engagement in Germany and its interaction term for foreign brands to the model (Model II, Table 3). This yields the core result of our study.

For young customers, the significant negative effect of the foreign brand dummy remains in Model II. The control variables for foreign firms' learning engagements are statistically both separately and jointly insignificant. This means that the foreign brands' market experience does not have a significant effect on sales to young German customers. This result implies that the disadvantages faced by foreign brands in selling to young customers mainly stem from the demand side. Foreign producers can apparently not achieve the same levels of legitimacy among young German customers that domestic brands can. The opposite is true for senior car buyers: for this age group we do not find significantly negative demand-side effects. The foreign brand dummy is statistically insignificant. Hence, legitimacy-induced liability is not an issue for this age group. Instead, the more experience and more

responsiveness a foreign brand develops in the German market, the more attractive its models become to German senior customers. The interaction term (company exposure times foreign brand dummy) is negative and statistically significant which means that the learning effect for foreign brands is smaller than for German brands. We hence identify a MNC-induced element of liability of foreignness, namely the relative shortcoming of foreign producers when it comes to adapting their products to domestic taste.

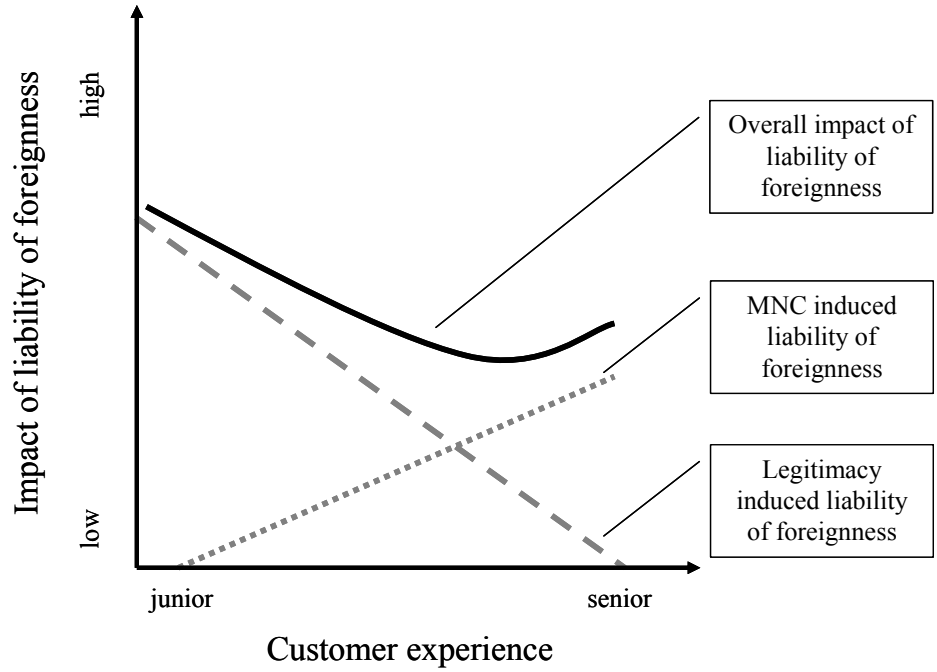
Our empirical results neither fully confirm nor reject our hypotheses. Instead, we obtain a rather differentiated picture of the dynamic effects of learning and responsiveness on the German car market. First, we find that foreign brands face an "uphill battle" among young customers. This is surprising since these buyers most likely cannot remember a market situation without foreign competition. Then again, young customers are typically first car buyers, i.e. they have no or very little direct prior experience of owning and operating a car. We suspect that their product perception is largely imprinted by second hand private and public experience, most importantly that of their on own parents. Since different car offers are already difficult to compare, brand popularity reassures buyers (Chung Koo and Jay Young, 1997) and we suggest that this effect is elevated among inexperienced, young customers. Our results for older customers indicate that this effect is waning as buyers get older. The lack of legitimacy effect diminishes as their direct experience of domestic and/or foreign car ownership increases. Eventually, prejudice against foreign products evaporates. Interestingly, Newburry et al. (2006) identify a similar experience/age effect for employment attractiveness.[21] Older automotive consumers enter a stage of loyalty to dealers, models and brands (Lambert-Pandraud et al., 2005). Strikingly, we find that in such a situation without customer-induced liability of foreignness, the effects from MNC-induced disadvantages become visible. Domestic brands are slightly faster in adapting to market trends in this segment. We suspect that domestic and foreign producers receive equal feedback from senior customers, but foreign manufacturers have to channel these impulses through extra layers of cross-border management which makes them slower to respond.

[21] They find that liability of foreignness in organizational attractiveness for prospective employees diminishes with age.

6 Conclusions

Our empirical results allow no simple conclusions about the antecedents of the negative effects of liability of foreignness. They cannot be simply attributed either to the demand or to the MNC side. This is probably part of the explanation why practitioners find dealing with this particular challenge so difficult (Mezias, 2002a). We suspect that there is an interrelation between legitimacy-induced and MNC-induced liability of foreignness as depicted in Figure 2. We argue that customer acceptance (legitimacy) is a major stumbling block at the beginning but evaporates as host country customers gain more experience with both foreign and domestic brands. Once this balance with domestic competitors is achieved the frictional losses from cross-border coordination and communication (MNC induced) become more binding. It is difficult for foreign subsidiaries to pick promising lead customers (Schmidt and Sofka, 2006) and select and implement innovation projects (Sofka, 2006). Therefore, the forces behind liability of foreignness shift but a persistent layer of relative disadvantage remains.

Figure 2: Dynamic effects of legitimacy and MNC induced liability of foreignness



Building upon this central finding we derive management recommendations. First of all we advocate loyalty programs for host country customers. Our findings suggest that the cost of new customer acquisition may be relatively higher for foreign competitors since they already have issues with perceived legitimacy. Secondly, Luo et al. (2002) suggest defensive (shielding the MNC from the host market) and offensive strategies (engaging in the host market). We argue that the latter is warranted. More precisely, MNC localization engagements are most promising when they provide responsiveness for experienced customers. Third, customer recognition of "foreignness" depends to a large degree on guesses based on brand language (Samiee et al., 2005). Hence, foreign market entrants that target

young customers may opt for brands that disguise their foreign origin to mitigate legitimacy-induced effects of liability of foreignness. One could argue that Toyota's brand "Scion" that targets young American customers follows such a rationale.

Finally, our study faced some important limitations which may provide room for further research. First of all, longitudinal analyses would provide additional insights. Secondly, we conducted an industry study for empirical testing. While the automotive industry is certainly one of the most promising subjects in internationalization, the results can obviously not be readily generalized. The country affiliation of automotive brands is typically very visible and easy to assess for customers (Samiee et al., 2005). This is not true for the majority of day-to-day purchases which may for example be evaluated with lower levels of motivation (Gurhan-Canli and Maheswaran, 2000). What is more, we focus on a German perspective. Comparable results for one or more other markets would certainly enhance our understanding.

7 Annex

7.1 Brands

The involvement of General Motors and Ford in Germany runs deep and dates back to the pre World War II era. General Motors has controlled Opel, the company that was founded 1862 by the German engineer Adam Opel, since 1929. The German branch of Ford was established in 1925. Both companies have extensive production facilities in Germany. Hence, one could certainly argue that these companies should be considered German (i.e. domestic) instead of foreign. Still, we fear that by doing so, we would severely neglect the internalization activities and subsequently the liabilities of foreignness of two of the largest car producers in the world.

Table 4: Brand origins; year of first production permit in parentheses

German brands	***Foreign brands***			
(comparison group)	*Rest of Europe*	*Japanese brands*	*Korean brands*	*US brands*
Audi (1950)	Citroen (1954)	Honda (1968)	Daewoo (1994)	Chrysler (1970)
Mercedes (1949)	Fiat (1950)	Mazda (1973)	Hyundai (1991)	Ford (1949)
BMW (1949)	MG Rover (1966)	Nissan (1974)	Kia (1993)	Opel (GM) (1949)
Smart (1997)	Peugeot (1963)	Suzuki (1981)		
Volkswagen (1949)	Renault (1952)	Toyota (1972)		
	Saab (1974)			
	Seat (1970)			
	Skoda (1958)			
	Volvo (1967)			

7.2 Descriptive statistics

We conduct a prima facie comparison of German and domestic brands to outline major trends in the data. A detailed list of descriptive statistics can be found in Table 5. First of all we find that German models outsell their foreign competitors among both junior and senior buyers. The gap is, however, larger among senior customers.

With respect to quality features, foreign brands appear to be more concentrated at the entry level of the market. This becomes especially apparent in the midsize segment. Almost half of the German model variants target this sub-market compared to only roughly 30 percent of foreign model variants. Obviously this segmentation has repercussions in other car features. Foreign variants have less power than German ones (120 vs. 89 kilowatts average engine power) and come with fewer safety features (e.g. 70 % of German models have antiskid systems, compared to 41% among foreign brands), but are fairly equal in terms of efficiency and convenience (with the exception of luxury interior). These quality differences feed back to prices: foreign models are on average cheaper than German ones.

Given this data structure, a prima facie comparison cannot convincingly answer our research question. A multivariate analysis is warranted.

Table 5: Means of model variables (standard errors in parentheses)

Variable	*Domestic brands*	*Foreign brands*
No of observations	424	809
DEPENDENT VARIABLES		
Unit sales to customers under 30 years old	117.95	80.11
	(326.57)	(176.95)
Unit sales to customers 60 years old and above	433.38	243.80
	(1,005.65)	(504.53)
CONTROL VARIABLES		
Other Liabilities		
Company exposure to German market (years)	51.98	40.35
	(9.12)	(12.71)
Model exposure to German market (months)	22.66	22.55
	(11.24)	(11.24)
Global production volume	3,280,995.00	3,337,865.00
	(1,664,049.00)	(1,433,655.00)
Media expenditure (mn €)	39.98	32.15
	(16.29)	(19.82)
Avg. R&D expenditure per vehicle	16.57	58.94
	(20.45)	(135.70)
Quality Characteristics		
Basic Outfit		
Price (tsd. €)	33.83	22.74
	(16.51)	(9.01)
Medium segment (dummy)	0.49	0.29
	(0.50)	(0.46)
Upper segment (dummy)	0.19	0.21
	(0.40)	(0.41)
Station wagon (dummy)	0.21	0.14
	(0.41)	(0.34)
Height (cm)	1,486.22	1,528.10
	(119.40)	(138.89)
Performance		
Engine power (kilowatts)	119.31	88.64
	(52.26)	(30.16)
Diesel engine (dummy)	0.35	0.30
	(0.48)	(0.46)
Economic/ecological efficiency		
Value loss 2002 (%)	45.69	53.09
	(1.00)	(3.04)
EcoTest ranking (points)	63.82	61.01
	(2.90)	(7.88)
Safety		
Airbags (no.)	5.17	4.76
	(1.48)	(1.65)
Alarm system (dummy)	0.22	0.13

Variable	*Domestic brands*	*Foreign brands*
	(0.41)	(0.34)
Antiskid system (dummy)	0.70	0.41
	(0.46)	(0.49)
Immobilizer (dummy)	0.99	0.94
	(0.11)	(0.23)
Breakdown frequency 2002 (no.)	18.46	27.37
	(2.42)	(13.02)
Convenience/amenity		
Onboard computer (dummy)	0.56	0.61
	(0.50)	(0.49)
Luxury interior (dummy)	0.62	0.38
	(0.49)	(0.48)
Power windows (no.)	3.30	3.14
	(1.01)	(1.11)
Power steering (dummy)	0.95	0.98
	(0.22)	(0.14)

7.3 First stage regression results

Table 6: First stage OLS; baseline case: excluding learning engagements (dependent variable: price)

Variable	*Coef.*	*Std. err.*
INDEPENDENT VARIABLES		
Foreign status	-0.07***	0.02
Global production volume (log)	-0.09***	0.01
Media expenditure (mn €; log)	0.06	0.10
Media expenditure squared term (mn €; log)	0.00	0.01
Average R&D expenditure per vehicle (€)	0.00***	0.00
Medium segment (dummy)	0.10***	0.01
Upper segment (dummy)	0.21***	0.02
Station wagon (dummy)	0.02*	0.01
Height (cm; log)		
Engine power (kilowatts; log)	0.67***	0.02
Value loss 2002 (%)	0.00	0.00
Diesel engine (dummy)	0.13***	0.01
EcoTest ranking (points)	0.00	0.00
Airbags (no.)	0.01***	0.00
Antiskid system (dummy)	0.01	0.01
Immobilizer (dummy)	0.07	0.08
Breakdown frequency 2002 (no.)	0.00***	0.00
Onboard computer (dummy)	0.01	0.01
Luxury interior (dummy)	0.07***	0.01
Power windows (no.)	0.15***	0.02
Power steering (dummy)	-0.25***	0.05
INSTRUMENT VARIABLES		
Herfindahl-Hirschman index of model production (log)	-0.15***	0.04
Employees at brand level (no.; log)	0.07***	0.01
Height (sum of all other models)	0.04	0.07
Halogen front lights (sum of all other models)	0.01	0.01

Variable	*Coef.*	*Std. err.*
Ski bag (sum of all other models)	0.00	0.02
Rotational speed sensor (sum of all other models)	-0.04**	0.02
Immobilizer (sum of all other models)	0.04	0.09
Power windows (sum of all other models)	0.13***	0.02
Power steering (sum of all other models)	-0.11	0.08
Color glass windows (sum of all other models)	0.02	0.04
Automatic transmission (sum of all other models)	-0.17***	0.02
Constant	-0.51	0.69
Observations	1,404	
RMSE	0.14	
R2	0.89	
P>0	0.00	
Test for instrument variables equaling zero can be rejected (F(11/ 1371) = 18.77; Prob > F = 0.00)		

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors in parentheses

Table 7: First stage OLS: Including learning engagements (dependent variable: price)

Variable	*Coef.*	*Std. err.*
INDEPENDENT VARIABLES		
Foreign status	0.58***	(0.19)
Interaction term: company exposure and foreign status	-0.01***	(0.00)
Company exposure to German market (years)	0.01***	(0.00)
Model exposure to German market (months)	0.00*	(0.00)
Global production volume (log)	-0.12***	(0.02)
Media expenditure (mn €; log)	0.00	(0.11)
Media expenditure squared term (mn €; log)	0.00	(0.01)
Average R&D expenditure per vehicle (€)	0.00***	(0.00)
Medium segment (dummy)	0.10***	(0.01)
Upper segment (dummy)	0.21***	(0.02)
Station wagon (dummy)	0.02**	(0.01)
Engine power (kilowatts; log)	0.67***	(0.02)
Value loss 2002 (%)	0.00	(0.00)
Diesel engine (dummy)	0.13***	(0.01)
EcoTest ranking (points)	0.00**	(0.00)
Airbags (no.)	0.01***	(0.00)
Antiskid system (dummy)	0.02	(0.01)
Immobilizer (dummy)	-0.01	(0.09)
Breakdown frequency 2002 (no.)	0.00***	(0.00)
Onboard computer (dummy)	0.00	(0.01)
Luxury interior (dummy)	0.07***	(0.01)
Power windows (no.)	0.12***	(0.02)
Power steering (dummy)	-0.65***	(0.12)
INSTRUMENT VARIABLES		
Herfindahl-Hirschman index of model production (log)	-0.24***	(0.06)
Employees at brand level (no.; log)	0.09***	(0.02)
Height (sum of all other models)	0.05	(0.07)
Halogen front lights (sum of all other models)	0.01	(0.01)
Ski bag (sum of all other models)	0.00	(0.02)
Rotational speed sensor (sum of all other models)	-0.04**	(0.02)
Immobilizer (sum of all other models)	-0.03	(0.09)
Power windows (sum of all other models)	0.10***	(0.02)
Power steering (sum of all other models)	-0.50***	(0.14)
Color glass windows (sum of all other models)	0.02	(0.04)
Automatic transmission (sum of all other models)	-0.17***	(0.02)
Constant	0.02	(0.74)
Observations	1,404	
RMSE	0.14	
R2	0.89	
P>0	0.00	

Test for instrument variables equaling zero can be rejected (F(11/ 1369) = 18.47; Prob > F = 0.00)

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors in parentheses

7.4 Regression results

This section focuses on the estimation results for the control variables. We have no a priori hypothesis on their outcomes so all discussions are explorative in nature. An analysis of the variables related to the core topic of this paper, liability of foreignness, can be found in section 5.

Table 8 shows the complete results (Table 9 outlines a baseline case without learning engagement variables). With regards to other liabilities junior and senior customers appear similar. Both prefer newer car models over older ones, indicating that the former may fit better with their needs. Large global production volumes have a negative impact. Apparently, a trade-off exists between large global volumes and responsiveness to local demand (Prahalad and Doz, 1987). Advertising increases sales up to a certain point, after which extra money spent on marketing no longer produces results (an inverse u-shaped relationship). Finally, expenditure on R&D should indicate technologically advanced car models which translates into higher sales.

With regards to the basic outfit of the car, we identify negative price elasticities of demand in both age groups, as expected. Young customers are substantially more price elastic than senior customers. Customers in both age groups prefer upper segment cars. Senior customers are also more attracted to the medium segment while they dislike station wagon models. We suspect that their usage patterns no longer require as much space as, for example, those of young families. Young customers opt for engine power and diesel engines while these are not attractive for senior customers given that we already control for model segments (i.e. middle, upper class). Again, this is largely in line with the expected more conservative driving patterns of senior customers. Value stability is only an important quality feature for young customers while senior customers opt for safer cars with more airbags. Both age groups prefer reliable cars with low breakdown frequencies. Additionally, an immobilizer system makes a car model more attractive for junior customers. With regards to convenience features, there are no differences between young and old customers. Both consider cars more attractive if they have onboard computer systems and power windows.

The term "ρ" measures the correlation between the unobserved car quality characteristics. It is estimated at 0.78 which indicates that those unobserved components are valued similarly by both young and senior customers.

Table 8: Estimation results: Including learning engagements

Variable	*Junior*		*Senior*	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*
LIABILITY OF FOREIGNNESS VARIABLES				
Brand from outside Germany (dummy)	-1.45**	(0.73)	0.68	(0.75)
Interaction term: company exposure and foreign status	0.02	(0.01)	-0.03*	(0.01)
CONTROL VARIABLES				
Other Liabilities				
Company exposure to German market (years)	0.02	(0.01)	0.04***	(0.01)
Model exposure to German market (months)	-0.03***	(0.00)	-0.04***	(0.00)
Global production volume (log)	-0.18*	(0.10)	-0.31***	(0.11)

Variable	*Junior*		*Senior*	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*
Media expenditure (mn €; log)	2.81**	(1.37)	3.71***	(1.40)
Media expenditure squared term (mn €; log)	-0.15**	(0.07)	-0.18**	(0.07)
Average R&D expenditure per vehicle (€)	0.00*	(0.00)	0.00**	(0.00)
Quality Characteristics				
Basic Outfit				
Price (instrumented variable)	-4.57***	(0.81)	-1.61*	(0.82)
Medium segment (dummy)	-0.13	(0.16)	0.69***	(0.16)
Upper segment (dummy)	0.77***	(0.24)	0.82***	(0.24)
Station wagon (dummy)	0.16	(0.13)	-0.26**	(0.13)
Performance				
Engine power (kilowatts; log)	1.74***	(0.61)	-1.32**	(0.62)
Diesel engine (dummy)	0.67***	(0.14)	-0.76***	(0.15)
Economic/ecological efficiency				
Value loss 2002 (%)	-0.07**	(0.03)	0.02	(0.03)
EcoTest ranking (points)	0.00	(0.01)	0.01	(0.01)
Safety				
Airbags (no.)	0.04	(0.04)	0.10***	(0.04)
Breakdown frequency 2002 (no.)	-0.02**	(0.01)	-0.02***	(0.01)
Antiskid system (dummy)	0.05	(0.11)	0.12	(0.11)
Immobilizer (dummy)	0.80***	(0.25)	0.30	(0.25)
Convenience/amenity				
Onboard computer (dummy)	0.30***	(0.11)	0.23**	(0.11)
Luxury interior (dummy)	-0.09	(0.12)	0.06	(0.13)
Power windows (no.)	0.10*	(0.06)	0.22***	(0.06)
Power steering (dummy)	0.15	(0.45)	0.13	(0.46)
Constant	1.81	(7.61)	-2.67	(7.76)
P	0.78 ***			
Observations	1,233		1,233	
RMSE	1.55		1.58	
R2	0.26		0.23	
P>0	0.00		0.00	

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors in parentheses

Table 9: Estimation results baseline case: Excluding learning engagements

Variable	*Junior*		*Senior*	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*
LIABILITY OF FOREIGNNESS VARIABLES				
Brand from outside Germany	-0.87***	(0.17)	-0.93***	(0.17)
CONTROL VARIABLES				
Other Liabilities				
Model exposure to German market (months)	-0.04***	(0.00)	-0.03***	(0.00)
Global production volume (log)	-0.29***	(0.11)	-0.17*	(0.10)
Media expenditure (mn €; log)	4.65***	(1.36)	4.50***	(1.34)
Media expenditure squared term (mn €; log)	-0.22***	(0.07)	-0.22***	(0.07)

Variable	*Junior*		*Senior*	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*
Average R&D expenditure per vehicle (€)	0.00***	(0.00)	0.00	(0.00)
Quality Characteristics				
Basic Outfit				
Price (instrumented variable)	-1.77**	(0.83)	-4.22***	(0.82)
Medium segment (dummy)	0.71***	(0.16)	-0.23	(0.16)
Upper segment (dummy)	0.79***	(0.23)	0.52**	(0.23)
Station wagon (dummy)	-0.25*	(0.13)	0.12	(0.13)
Performance				
Engine power (kilowatts; log)	-1.09*	(0.63)	1.49**	(0.62)
Diesel engine (dummy)	-0.70***	(0.15)	0.64***	(0.15)
Economic/ecological efficiency				
Value loss 2002 (%)	0.03	(0.03)	-0.06**	(0.03)
EcoTest ranking (points)	0.01	(0.01)	0.01	(0.01)
Safety				
Airbags (no.)	0.11***	(0.04)	0.05	(0.04)
Breakdown frequency 2002 (no.)	-0.01**	(0.01)	0.00	(0.01)
Antiskid system (dummy)	0.10	(0.11)	0.10	(0.11)
Immobilizer (dummy)	0.31	(0.26)	0.80***	(0.25)
Convenience/amenity				
Onboard computer (dummy)	0.20*	(0.11)	0.24**	(0.11)
Luxury interior (dummy)	0.10	(0.13)	-0.08	(0.13)
Power windows (no.)	0.20***	(0.06)	0.07	(0.06)
Power steering (dummy)	0.81**	(0.36)	0.12	(0.35)
Constant	-8.56	(7.44)	-8.65	(7.31)
P	0.78 ***			
Observations	1,233		1,233	
RMSE	1.58		1.56	
R2	0.22		0.25	
P>0	0.00		0.00	

*** significant at 99%, ** significant at 95%, * significant at 90%
Robust standard errors in parentheses

8 References

Aiken, L.S. and S.G. West (1993), *Multiple Regression: Testing and Interpreting Interactions*, Newbury Park.

Barkema, H.G. and J.H.J. Bell (1996), Foreign Entry, Cultural Barriers, and Learning, *Strategic Management Journal* 17 (2), 151-166.

Belk, R. (1988), Possessions and the Extended Self, *Journal of Consumer Research* 15 (2), 139-168.

Berry, S., J. Levinsohn and A. Pakes (1995), Automobile Prices in Market Equilibrium, *Econometrica* 63 (4), 841-890.

Bilkey, W.J. and E. Nes (1982), Country-of-Origins Effects on Product Evaluation, *Journal of International Business Studies* 13 (1), 89-99.

Brownstone, D., D.S. Bunch and K. Train (2000), Joint Mixed Logit Models of Stated and Revealed Preferences for Alternative Fuel Vehicles, *Transport Research Part B: Methodological* 34 (5), 315-338.

Bunch, D.S., M. Bradley, T.F. Golob and R. Kitmura (1993), Demand for Clean-Fuel Vehicles in California – a Discrete Choice Stated Preference Pilot Project, *Transportation Research Part A: Policy and Practice* 27 (3), 237-253.

Caves, R.E. (1971), International Corporations: The Industrial Economics of Foreign Investment, *Economica* 38 (149), 1-27.

Chung Koo, K. and C. Jay Young (1997), Brand Popularity, Country Image and Market Share: An Empirical Study, *Journal of International Business Studies* 28 (2), 361-386.

DeYoung, R. and D. Nolle (1996), Foreign-Owned Banks in the United States: Earning Market Share or Buying It?, *Journal of Money, Credit, and Banking* 28, 622-636.

Diamantopoulos, A., B.B. Schlegelmilch and J.P. Du Preez (1995), Lessons for Pan-European Marketing? The Role of Consumer Preferences in Fine-Tuning the Product-Market Fit, *International Marketing Review* 12 (2), 38-52.

Dierickx, I. and K. Cool (1989), Assett Stock Accumulation and Sustainability of Competitive Advantage, *Management Science* 35 (12), 1504-1511.

Dow, D. (2006), Adaptation and Performance in Foreign Markets: Evidence of Systematic under-Adaptation, *Journal of International Business Studies* 37 (2), 212-226.

Doz, Y.L. and C.K. Prahalad (1984), Patterns of Strategic Control within Multinational Corporations, *Journal of International Business Studies* 15 (2), 55-72.

Dunning, J.H. (1981), *International Production and the Multinational Enterprise*, London.

Eden, L. and S.R. Miller (2004), Distance Matters: Liability of Foreignness, Institutional Distance and Ownership Strategy, in: Hitt, M. A. and J. L. C. Cheng (eds.), *Advances in International Management*, New York, 187-221.

European Commission (2004), *Eu Industrial R&D Investment Scoreboard*, Brussels.

Goldberg, P.K. and F. Verboven (2001), The Evolution of Price Dispersion in the European Car Market., *Review of Economic Studies* 68 (4), 811-849.

Goldberg, P.K. and F. Verboven (2004), Cross-Country Price Dispersion in the Euro Era: A Case Study of the European Car Market., *Economic Policy* 19 (40), 484-522.

Granovetter, M. (1985), Economic Action and Social Structure: The Problem of Embeddedness, *American Journal of Sociology* 91 (3), 481-510.

Gurhan-Canli, Z. and D. Maheswaran (2000), Determinants of Country-of-Origin Evaluations, *Journal of Consumer Research* 27 (1), 96-108.

Hasan, I. and W. Hunter (1996), Efficiency of Japanese Multinational Banks in the United States, in: Chen, A. H. (ed.) *Research in Finance*, Greenwich and London, 157-173.

Hsieh, M.-H. (2004), An Investigation of Country-of-Origin Effect Using Correspondence Analysis: A Cross-National Context., *International Journal of Market Research* 46 (3), 267-295.

Hymer, S.H. (1976), *The International Operations of National Firms: A Study of Direct Investment*, Cambridge.

Jensen, R. and G. Szulanski (2004), Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers, *Journal of International Business Studies* 35 (6), 508-523.

Lambert-Pandraud, R., G. Laurent and E. Lapersonne (2005), Repeat Purchasing of New Automobiles by Older Consumers: Empirical Evidence and Interpretations, *Journal of Marketing* 69 (April), 97-113.

Licht, G., W. Sofka and W. Urban (2005), Competitiveness: A Market Perspective, in: Heneric, O., G. Licht and W. Sofka (eds.), *Europe's Automotive Industry on the Move: Competitiveness in a Changing World*, Heidelberg, 45-102.

Lord, M.D. and A.L. Ranft (2000), Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge, *Journal of International Business Studies* 31 (4), 573-589.

Luo, Y., O. Shenkar and M.-K. Nyaw (2002), Mitigating Liabilities of Foreignness: Defensive Versus Offensive Approaches, *Journal of International Management* 8 (3), 283-301.

Mathur, A., G. Moschis and E. Lee (2003), Life Events and Brand Preference Changes, *Journal of Consumer Behaviour* 3 (2), 129-141.

Mehta, R. and R. Belk (1991), Artifacts, Identity, and Transitions: Favourite Possessions of Indians and Indian Immigrants to the Us, *Journal of Consumer Research* 17 (4), 398-411.

Mezias, J.M. (2002a), How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations., *Journal of International Management* 8 (3), 265-283.

Mezias, J.M. (2002b), Identifying Liabilities of Foreignness and Strategies to Minimize Their Effects: The Case of Labor Lawsuit Judgement in the United States, *Strategic Management Journal* 23, 229-244.

Miller, S.R. and A. Parkhe (2002), Is There a Liability of Foreignness in Global Banking? An Empirical Test of Banks' X-Efficiency, *Strategic Management Journal* 31 (1), 323-337.

Newburry, W., N.A. Gardberg and L.Y. Belkin (2006), Organizational Attractiveness Is in the Eye of the Beholder: The Interaction of Demographic Characteristics with Foreignness, *Journal of International Business Studies* 37 (5), 666-686.

Nunnenkamp, P. (2000), Globalisierung Der Automobilindustrie: Neue Standorte Auf Dem Vormarsch, Traditionelle Anbieter Unter Druck?, *Kieler Arbeitspapier* 1002.

Petersen, B. and T. Pedersen (2002), Coping with Liability of Foreignness: Different Learning Engagements of Entrant Firms, *Journal of International Management* 8 (3), 339-350.

Prahalad, C.K. and Y.L. Doz (1987), *The Multinational Mission: Balancing Local Demands and Global Vision* 1, New York.

Rugman, A.M. and A. Verbeke (2003), Extending the Theory of the Multinational Enterprise: Internalization and Strategic Management Perspectives, *Journal of International Business Studies* 34 (2), 125-137.

Rugman, A.M. and A. Verbeke (2004), A Perspective on Regional and Global Strategies of Multinational Enterprises, *Journal of International Business Studies* 35 (1), 3-18.

Samiee, S., T.A. Shimp and S. Sharma (2005), Brand Origin Recognition Accuracy: Its Antecedents and Consumers' Cognitive Limitations, *Journal of International Business Studies* 36 (4), 379-397.

Schmidt, T. and W. Sofka (2006), *Lost in Translation - Empirical Evidence for Liability of Foreignness as Barriers to Knowledge Spillovers,* ZEW Discussion Paper No. 06-001, Mannheim.

Sofka, W. (2006), *Innovation Activities Abroad and the Effects of Liability of Foreignness: Where It Hurts,* ZEW Discussion Paper No. 06-029, Mannheim.

Sofka, W. and J. Zimmermann (2005), *There's No Place Like Home a Strategic Framework to Overcome Liability of Foreignness in the German Car Market*, ZEW Discussion Paper No. 05-84, Mannheim.

Verboven, F. (1998), Testing for 'Monopoly' Market Power When Products Are Differentiated in Quality. , *Manchester School* 70 (1), 115-134.

Verboven, F. (2002), Quality-Based Price Discrimination and Tax Incidence: Evidence from Gasoline and Diesel Cars., *RAND Journal of Economics* 33 (2), 275-298.

West, J. and J.L. Graham (2004), A Linguistic-Based Measure of Cultural Distance and Its Relationship to Managerial Values, *Management International Review* 44 (2), 239-260.

Zaheer, S. (1995), Overcoming the Liability of Foreignness., *Academy of Management Journal* 38 (2), 341-364.

Zaheer, S. (2002), The Liability of Foreignness, Redux: A Commentary, *Journal of International Management* 8 (3), 351-358.

Zaheer, S. and E. Mosakowski (1997), The Dynamics of the Liability of Foreignness: A Global Study of Survival in Financial Services, *Strategic Management Journal* 18 (6), 439-464.

Zaheer, S. and A. Zaheer (1997), Country Effects on Information Seeking in Global Electronic Networks, *Journal of International Business Studies* 28 (1), 77-100.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Internationalizing R&D Co-opetition: Dress for the Dance with the Devil

AUTOREN: ***Anja Schmiele***

[ZEW Mannheim]

Wolfgang Sofka

[Universität Hamburg, ZEW Mannheim]

JAHR: 2007

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper
No. 07-045, Mannheim
Eingereicht bei
Journal of World Business

AUSGEWÄHLTE PRÄSENTATIONEN: European Network on Industrial Policy
Florenz, 2007

Internationalizing R&D Co-opetition: Dress for the Dance with the Devil

Anja Schmiele and Wolfgang Sofka

Centre for European Economic Research (ZEW), Mannheim, Germany

Abstract

Competitors can be valuable sources and partners for innovation activities. Against the background of international expansion of firms and increased international competition, the R&D collaborations with international competitors (international co-opetition) is becoming an increasingly interesting way to gain access to well guarded knowledge from abroad. However, to be able to benefit from these paradox alliances, a certain level of international co-opetition readiness is required. On the one hand, this readiness is important to protect the companies' intellectual property that should not be leaked to competitors. On the other hand, the firm has to be able to absorb and utilize the knowledge and capabilities of the collaborating competitor. Hence, we envision co-opetition as a balancing act between appropriability practices and absorptive capacities in a cross-border context. We test these dual hypotheses for a broad sample of roughly 1,000 innovative firms in the German manufacturing sector. We find that co-opetition with international competitors requires a shift in appropriability practices from informal methods (secrecy, lead time) towards formal ones (like patents and copyrights). Besides, we discover that the readiness for international co-opetition can be achieved by developing international collaboration experience through collaborations with international customers or suppliers.

Keywords: Co-opetition, R&D collaboration, internationalization, innovation management

JEL-Classification: F23, O31, O32, D83

Anja Schmiele
Schmiele@zew.de
Phone: +49/621/1235-188, Fax: +49/621/1235-170
Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43, D-68034 Mannheim, Germany

The authors thank Ulrich Kaiser, Thomas Ronde and Christian Rammer for invaluable comments and discussions.

1 Introduction

Looking beyond company boundaries in innovation projects to share risks, costs and expertise is a major trend in innovation management discussions among both scholars and practitioners (see for example Chesbrough, 2003; Huston and Sakkab, 2006). Some companies even go as far as to cooperate with competitors (typically referred to as co-opetiton) in innovation initiatives. This situation is as paradoxical as war and peace at the same time (Nalebuff and Brandenburger, 1996). Why would anyone voluntarily share with a competitor the very knowledge that could be the basis for future competitive advantage? Several studies have dealt with these co-opetitive cooperations, alliances or joint ventures (see for example Hamel, 1991). Our goal is to complement this literature by investigating a more focussed research question: What does it take to make a firm ready to move from domestic to foreign co-opetition?

The latter is especially relevant as globalization has resulted in firms finding themselves increasingly confronted with international competitors, on both domestic and foreign markets (Kleinschmidt and Cooper, 1988). We embed our argumentation in the resource and capability-based view of the firm and argue that organizational processes suitable for domestic co-opetition need to be refocused as firms move to the international stage. More precisely, we suggest that firms need to rethink the way in which they absorb and protect knowledge in international co-opetition. The latter is especially demanding as cultural and social barriers add additional levels of complexity and uncertainty. We develop hypotheses based on this core concept and test them empirically for a sample of about 1,000 manufacturing firms in Germany.

As our research question indicates, this study is designed to provide practitioners with guidance on how to “get international co-opetition ready.” However, we also try to advance the academic discussion by investigating the organizational processes that facilitate the refocusing of existing capabilities to achieve a renewed fit within an internationalized environment.

The analysis is structured as follows: Following this introduction, section 2 provides the conceptual framework on co-opetition, which we develop further in the analytical section 3 to form hypotheses. Section 4 outlines the empirical study. The results of the estimation procedures are presented section 5, while section 6 provides a discussion of the results, conclusions and management recommendations.

2 Establishing and Transferring Capabilities

Our analysis focuses on the influence of the national and cultural environments on establishing capabilities and whether they can be successfully transferred across borders. Hence, we ground our theoretical investigation in the resource-based theory of the firm. This theory is built around the basic rationale that firms achieve sustainable competitive advantage through heterogeneously distributed resources that are valuable, rare and difficult for competitors to imitate or substitute (Barney, 1991; Conner, 1991; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984). Often possessing these resources is not enough - firms need to know how to use them (Collis and Montgomery, 1995; Penrose, 1959). This implies evaluating, manipulating and deploying them appropriately into unique combinations that enable specific actions for generating superior customer value and subsequent firm performance (Sirmon et al., 2007). This "bundling" of resources through organizational processes is typically referred to as a firm capability. Capabilities are cultivated in practice over time which makes them causally ambiguous as well as socially complex and hence difficult to copy or acquire on markets (Amit and Schoemaker, 1993; Dierickx and Cool, 1989).

We focus on the factors that shape these capabilities. The resource and capability-based view of the firm has been criticized for being overly concerned with resources internal to the firm and neglecting "when, where and how" they turn into competitive advantage (Priem and Butler, 2001). Sirmon et al. (2007) suggest a contingency logic to explain how resources are acquired and leveraged. They argue that environmental munificence and uncertainty shape capabilities. The goal is to achieve a fit with the environment. Munificent environments can support the growth of internal resources because access to external resources provides support (Baum and Wally, 2003). We extend this argumentation by relating it back to institution theory. As firms grow and develop within their home market, both the organization and its employees develop and refine certain skills, structures, practices and routines that reflect their social, cultural, economic and legal environment. Put simply, long-lasting exposure, experience and interaction produce a tailor-made entity that functions effectively and efficiently in the home market. This knowledge is largely acquired automatically at minimal extra costs. Substantial parts of these social and cultural laws are causally ambiguous and not codified (Jensen and Szulanski, 2004). Firms lose these certainties of their home market once they engage in international markets. They encounter cognitive uncertainty, i.e. uncertainty predicting and explaining the behaviour of others (Harvey and Novicevic, 2000). These frictional losses from cultural and social barriers have been summarized as liabilities of foreignness (Zaheer, 1995).[1] The forces behind liability of foreignness are sociological in nature and have structural, relational and legitimacy dimensions (Zaheer, 2002). Differences in languages and hence understanding are a major but not exclusive factor (West and Graham, 2004). They translate into relative deficits in efficiency and effectiveness (Mezias, 2002). The visible symptoms of these challenges are more frequent errors, unnecessary risks and delays

[1] It relates back to an earlier concept suggested by Hymer, 1976.

(Lord and Ranft, 2000). These performance effects are as lasting as the liabilities of size and newness (Zaheer and Mosakowski, 1997). We explore whether capabilities developed in the home market can be transferred across national and cultural borders or if - and how - they need to be refocused. We investigate this research question in the very specific context of firms cooperating in innovation projects with competitors that have their headquarters abroad.

3 Co-opetition

3.1 A brief review of co-opetition research

Cooperating with a competitor is a by its very nature a rather paradoxical act. The literature refers to this fusion of the two dichotomous conditions, cooperation and competition, as co-opetition (Nalebuff and Brandenburger, 1996). More precisely, this means that two or more competitors cooperate at the same time as they compete (Luo, 2004). The idea of co-opetition builds on a changed view of competitors, moving from the traditional position that considers rivals purely as companies that endanger a company's market share with similar products and services towards a more open-minded position that also embraces complementary elements of competitors (Nalebuff and Brandenburger, 1996). Since firms do not compete across the whole range of their activities (Tether, 2002) competitors can be seen as valuable partners for building strategic alliances and realizing potential synergies (Luo, 2004). Co-opetition forms a window to the competitors' capabilities (Hamel et al., 1989) and does not only enable access to the skills of the collaborating competitor but also their assimilation (Hamel, 1991). The readiness of firms to engage in co-opetition depends on the firms' global experience, corporate culture, competitive goals, strategic orientation, competence complementarity, firm size and market power (Luo, 2004).

Then again, unique knowledge can be considered a firm's most valuable asset for generating competitive advantage (Liebeskind, 1996). It provides firms with the necessary platform to decide which resources or capabilities to deploy, develop or discard as their environment changes (Ndofor and Levitas, 2004). This perspective is typically summarized as the knowledge based view of the firm (Grant, 1996). An important stream of literature has dealt with the nature of knowledge as a "public good" that has to be kept proprietary as an incentive for firms to invest in its development (Jaffe, 1986; Porter Liebeskind, 1997). If this is the case, why should firms willingly let knowledge spill over to their competitors? Co-opetition in innovation activities and hence knowledge production can indeed be a mutually beneficial arrangement under certain circumstances.

Competing firms usually operate in a similar context and therefore develop a similar logic (Dussauge et al., 2000) which is a prerequisite for inter-partner learning (Hamel, 1991). The underlying motives for co-opetition in the field of R&D can be seen in the rapid changes in technologies that force innovative companies to recover their investments in shorter periods of time (Narula and Hagedorn, 1999). Hence, the most commonly named motives for collaborative R&D activities with competitors are the consolidation of resources, cost and risk sharing during the innovation process as well as the establishment of a common standard in the industry (Tether, 2002). Several studies have dealt with structural forms of co-opetition, international strategic alliances and R&D cooperations (see for example (Nalebuff and Brandenburger, 1996; Luo, 2004, Fritsch and Lukas, 2001).

We attempt to extend this literature by focussing on a capability development perspective inside the co-opetiting firm. More precisely, we envision the capability to successfully engage in innovation cooperations with competitors as a balancing act: firms try to benefit as much as possible from incoming spillovers while limiting the outgoing ones. These competing learning incentives alter the relative bargaining power among partners (Hamel, 1991). What makes this arrangement especially fragile is that the co-opetiting partner has exactly the same incentives. The question of whether this very capability can be preserved as firms engage in co-opetition with foreign competitors is the core of this analysis.

3.2 Internationalization of co-opetition

Globalization is not a one-way street. As more new international markets emerge for domestic firms so do international competitors at home, or as Kleinschmidt and Cooper (1988), put it: “Our domestic market is someone else’s foreign market.” Globalization leads to increased global competition in many branches and therefore to a new dimension of co-opetition: international co-opetition, cooperation between international competitors (Luo, 2007). While advances in information and telecommunications technology reduce the costs of coordinating and communicating across spatial distance, cultural and social barriers remain (Ghemawat, 2001; 2003). The latter are difficult to overcome as underlying norms and values on both sides of the border are typically unwritten and causally ambiguous (Jensen and Szulanski, 2004). These attributes make the transfer of co-opetition capabilities across borders difficult. Harvey and Novicevic (2000) introduce the concept of global organizational ignorance during cross border interactions, which covers such factors as the unawareness of relevant information and how to interpret it correctly. Managers rely on past experiences given the contextual ambiguity abroad (Dow, 2006). The underlying logic is derived from general decision making theory. Deciders rely on knowledge from the home market even when it is not fitting since it is more readily available, can be related back to a class of previous experiences and provides consistency with previous convictions (Harvey and Novicevic, 2000).

Hence, dealing with international partners not only exposes companies to culturally complex knowledge but also increases uncertainty. These attributes make knowledge difficult to transfer (Garud and Nayyar, 1994; Szulanski, 1996). Uncertainty makes the process less effective while the additional knowledge needed to understand complex items makes it less efficient. We argue that firms need to address both issues as they refocus their co-opetition capabilities from domestic towards international co-opetition.

Complexity in international co-opetition

Getting the most out of co-opetition engagements requires firms to sharpen their competencies and processes for spotting valuable knowledge and processing it. An important stream of research has conceptualized these processes as a firm’s absorptive capacity (Cohen and Walsh, 2000). This consists of the identification of valuable knowledge in the environment, its assimilation with existing knowledge stocks and finally its exploitation for

successful innovation. Absorptive capacities are the "eyes and ears" of a company to reinforce, complement or refocus their knowledge base (Lane et al., 2001). Cohen and Walsh (2000) stress the technological aspect of absorptive capacities and argue that the competencies to evaluate and exploit external knowledge are developed while performing R&D activities internally. We adopt their argument and suggest spotting technological opportunities is even more challenging as the complexities induced by international co-opetition increase. We argue:

> Hypothesis I: Firms have to invest in technological absorptive capacities to engage in international co-opetition.

We extend this literature by arguing that absorptive capacities may not only stem from technological experience but also from international exposure. Firms may benefit from complementary resources and capabilities developed in related internationalization activities. Dyer and Singh (1998) introduces the idea of building absorptive capacity through collaboration and interaction between firms. Established relationships facilitate the detection of promising knowledge, as interaction precedents and shared understanding are already established (Laursen and Salter, 2006). An increase in the richness of transmission channels propels knowledge flows (Gupta and Govindarajan, 2000). Therefore, a firm's international exposure with regard to sales should provide complementary assets for succeeding in international co-opetition. Keller (2004) provides an excellent review on "learning by exporting." He concludes that studies in favor of this premise tend to be based on case studies while econometric analyses find no effect. We test whether this assessment holds for the specific circumstances of co-opetition and hypothesize:

> Hypothesis IIa: Firms with high degrees of internationalization in sales are more likely to engage in international co-opetition.

Additionally, we suggest that the more specific experience of cooperating with international partners (apart from competitors) for innovation projects provides firms with processes and competencies that can be leveraged in international co-opetition. We propose:

> Hypothesis IIb: Companies with other international innovation cooperations are more likely to engage in international co-opetition.

Uncertainty in international co-opetition

Beside the potential for inter-partner learning in innovation-orientated R&D, both partners have a lot to lose from a co-opetition alliance. The natural uncertainty of the co-opetition alliance is grounded mainly in the fear that the competitor could access information that would endanger the market position of the firm. Such undesired behavior can result in a loss of expensive or unique firm knowledge that previously gave the firm a comparative advantage. In addition, it becomes more challenging to observe and explain the behavior of foreign partners in co-opetition (cognitive uncertainty; Harvey and Novicevic, 2000). The uncertainty in international firm alliances also stems from trust asymmetry between partners from different cultural environments. (Zaheer and Zaheer, 2006). Especially if trust is less embedded in a certain national context then in others, additional mechanisms have to

compensate for the lack of trust (Zaheer and Zaheer, 2006). Having mentioned the risks of co-opetition it becomes obvious that the control of knowledge flows during joint R&D activities is a very important feature in successful innovation cooperations between competitors. The potential for appropriability in an alliance is therefore even higher when the partners are direct competitors (Seung Ho and Russo, 1996). The appropriability methods are grouped into formal appropriability methods and strategic appropriability methods (Rammer, 2002). Formal appropriability methods comprise legal ways of protection such as patents, copyrights and trade marks. They aim to prevent others from using the firm's patents and the knowledge associated with them but allow the competing firm to access the patent knowledge and to learn from it (Schmidt, 2006). Beside the formal methods, informal or strategic methods of knowledge non-disclosure exist which include secrecy, complex design, and lead time. Levin et al., 1987 showed in their study that secrecy and lead time were judged more effective in protecting new products and processes than patents. However, they also found that competitors incur higher costs and need more time to duplicate a firm's new products when the products and processes are patented. Veugelers (1998) investigated the knowledge protection behaviour of firms which have R&D collaborations. Again, the study revealed that firms rate the effectiveness of informal mechanisms higher than patents or design registrations. In contrast to the formal legal protection, namely patents, informal appropriability methods are not defendable in court, which is a severe disadvantage. Both appropriability methods decrease knowledge spillovers to other firms (Schmidt, 2006). However, since partnering with an international competitor induces additional uncertainty, which is caused by additional cultural and social barriers, the joint R&D activities take place under much more unpredictable and uncertain conditions. This additional uncertainty requires extended knowledge protection, in particular because certain knowledge which is embodied in machines and products can not be protected by secrecy (Schmidt, 2006). In areas where public knowledge access is strong, informal methods are less effective (Cohen and Walsh, 2000). Therefore we argue:

> Hypothesis III: Firms move towards formal forms of appropriablity as they engage in international co-opetition.

4 Method

4.1 Data

For the empirical part of this analysis we use cross section data from a survey on the innovation activities of German enterprises called the "Mannheim Innovation Panel" (MIP). The survey is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry of Education and Research. The methodology and questionnaire used by the survey, which is targeted at enterprises with at least five employees, are the same as those used in the European Union's Community Innovation Survey (CIS). For our analysis we use the 2005 survey, in which data was collected on the innovation activities of enterprises during the three-year period 2002-2004. About 5,200 firms in manufacturing and services responded to the survey and provided information on their innovation activities.[2] We utilize this data to operationalize the concepts presented above. Using CIS data has two major advantages. Firstly, heads of R&D departments or innovation management are asked directly if and how they were able to generate innovations. Hence, they produce direct measures for processes and outputs which can complement traditional measures for innovation such as patents (Kaiser, 2002; Laursen and Salter, 2006). Secondly, the multinational application of CIS surveys adds extra layers of quality management and assurance. CIS surveys are subject to extensive pre-testing and piloting in various countries, industries and firms, to verify their interpretability, reliability and validity (Laursen and Salter, 2006).

4.2 Variables

Dependent Variables

Firms may cooperate with other firms for various reasons, e.g. joint production. Innovation activities may simply be a by-product of these engagements. In addition, a firm's perception of what other company within its industry should even be considered a direct competitor may vary. The latter would only be true for companies with similar resource endowments serving the same market needs (Bergen and Peteraf, 2002). Otherwise, they are just potential or indirect competitors. Our dataset does not force us to make any assumptions on these issues. The survey asks directly whether a firm engaged in innovation cooperations with competitors and where those were located. We generate our dependent variables based on these responses. Firms that cooperated with German competitors are designated as engaging in domestic co-

[2] The sample was drawn using the stratified random sample technique. A comprehensive non-response analysis showed no systematic distortions between responding and non-responding firms with respect to their innovation activities. For a more detailed description of the dataset and the survey see Rammer, 2002.

opetition, those with foreign competitors as engaging in international co-opetition. Both variables are binary in nature.

Absorptive Capacity Variables

Absorptive capacities are not a tangible concept but rather a combination of different competencies and capabilities. Hence, companies cannot be easily surveyed to estimate the degree to which they possess these absorptive capacities. Cohen and Walsh (2000) emphasize the rationale that absorptive capacities are developed by performing R&D activities. We follow their suggestion and introduce R&D intensity (R&D expenditure as a share of sales) to our model. Cohen and Walsh (2000) also emphasize the importance of prior experience. Hence, R&D expenditures in any given year may not be as important as continuously accumulating stocks of knowledge. We incorporate this aspect by introducing a dummy variable indicating whether firms performed continuous R&D activities. We also incorporate the employees' level of education and academic achievement (Rothwell and Dodgson, 1991), through the share of employees with academic education. Hypothesis I would be supported if the significant effects of all absorptive capacity variables are larger for international co-opetition than domestic ones.

Internationalization Variables

We test Hypothesis IIa by introducing the share of exports in sales as well as two dummy variables indicating whether the firm is part of a multinational group with headquarters in Germany or abroad respectively. The significant effects of these variables should be larger for international than for domestic co-opetition to support the hypothesis. Furthermore, we capture the effect of international cooperation experience as a positive prerequisite for international co-opetition suggested in Hypothesis IIb. We add two dummy variables for existing cooperations of firms with international suppliers and international customers respectively to test the hypothesis. The significant effects for international co-opetition should exceed domestic ones.

Appropriability Variables

Several studies rely only on the importance of formal methods of appropriability (especially patents) because they are more easily traceable. Our survey also allows us to track the availability of informal mechanisms for appropriating knowledge in a firm and their importance. These may be based on organizational practices (secrecy, lead time) or inherent in the product (complex design). Hence, we add variables for all three forms of appropriability where firms ranked the importance of the various forms as high. Hence, we add dummy variables for all three forms of appropriability. Hypothesis III would be supported if significant effects of formal appropriability methods outweigh informal ones in international co-opetition.

Control Variables

We control for several other factors that may influence the estimation results of our core variables. We have no a-posteriori assumptions on their outcomes. We include control variables for firm size (no. of employees) and regional differences within Germany (firm location in East Germany). More importantly, we control whether a firm has received public funding for its innovation activities during our observation period from the European Union or the German federal or state governments, following the rationale that cross border innovation alliances may be (co-)funded by the German state. Public funding programs in Germany have moved towards a network approach since the 1980s, favoring project consortia over individual recipients to promote knowledge spillovers (for a review see Fier and Harhoff, 2002). Hence, the decision to cooperate with a competitor for innovation activities may be influenced by the prospect of public funding and not follow our theoretical argumentation as outlined above. The dummy variable is introduced to control for this effect.

Besides, firms may choose different approaches for their cooperation engagements based on firm specific goals and perceived shortages. Aschhoff and Schmidt (2006) identify two broad motives: cost/risk sharing and knowledge seeking. We add two dummy variables indicating whether a firm perceived high cost/risks as a dominant obstacle to its innovation activities and whether it did so based on a lack of technological and/or market information.

Finally, we add two industry dummy variables (medium high-tech manufacturing, high-tech manufacturing) to capture remaining industry specific differences.

4.3 Descriptive statistics

Out of the 5,200 firms in manufacturing and services sector that responded to the survey, we derive a final sample of 956 firms in the manufacturing sector of Germany which have innovation activities and show no missing values for any model variables. Out of this range of firms we found 47 companies that cooperated with foreign competitors and 74 had cooperations with domestic competitors. A detailed list of the descriptive statistics can be found in Table 1. Several firms engage both in domestic and in foreign co-opetition. Firms engaged in international co-opetition are larger than firms that choose domestic co-opetition and invest a higher share of their sales in R&D. However, they conduct continuous R&D activities less frequently. Firms that undertake international co-opetition are also more extensively involved in cooperation with international suppliers (34%) and international customers (53%). Among firms that engage in domestic co-opetition, only 19% cooperate with international suppliers, and 26% with international customers.

Table 1: Descriptive Statistics

	Domestic Co-opetition		International Co-opetition	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
Domestic Co-opetition	1.00	(0.00)	0.40	(0.50)
International Co-opetition	0.26	(0.44)	1.00	(0.00)
Number of Employees	667.08	(1,122.85)	1,886.09	(6,503.48)
Share of Employees with higher education (%)	0.23	(0.20)	0.24	(1.17)
R&D Expenditure as a share of Sales (%)	0.07	(0.10)	0.05	(0.07)
Continous R&D activities (dummy)	0.80	(0.40)	0.85	(0.36)
Appropriability: Patents, Copyrights (dummy)	0.53	(0.50)	0.79	(0.41)
Appropriability: Secrecy, Lead time (dummy)	0.73	(0.45)	0.72	(0.45)
Appropriability: Complex design (dummy)	0.12	(0.33)	0.17	(0.38)
MNE with Headquarters abroad (dummy)	0.12	(0.33)	0.21	(0.41)
MN Group with domestic Headquarters (dummy)	0.24	(0.43)	0.30	(0.46)
Exports as a share of Sales (%)	31.68	(26.34)	41.39	(26.02)
Obstacle: Cost/Risk (dummy)	0.36	(0.48)	0.40	(0.50)
Obstacle: Lack of technological / market knowledge (dummy)	0.05	(0.23)	0.09	(0.28)
Public funding for innovation (dummy)	0.65	(0.48)	0.64	(0.49)
Company located in East Germany (dummy)	0.39	(0.49)	0.19	(0.40)
Medium High Tech Manufacturing Industry (dummy)	0.32	(0.47)	0.45	(0.50)
High Tech Manufacturing Industry (dummy)	0.24	(0.43)	0.19	(0.40)
Cooperation with international Supplier (dummy)	0.19	(0.39)	0.34	(0.48)
Cooperation with international Customer (dummy)	0.25	(0.44)	0.53	(0.50)
Observations	74		47	

4.4 Method

The decisions to cooperate with domestic or foreign competitors in innovation activities are not independent of one another. Firms may simultaneously engage in both, selectively in one or none at all. Because of this we model each decision (domestic and international co-opetition) separately. We tested a bivariate probit approach that would assume that both decisions are related and that information captured in one equation could be used to improve the efficiency of the other, and vice versa (methodologically we allow the error terms of both equations to be correlated, for more details see Greene, 2002). The correlation of both error terms is positive but not significant, which implies that we are dealing with largely

independent decisions. Accordingly, we return to standard probit models and estimate one separately for each decision. Correlation between the variables on cooperation with foreign suppliers and customers prevents us from estimating them jointly. Hence, they are introduced to the models separately.

In addition, we calculate and report marginal effects. They reflect the effect of an infinitesimal change in each independent variable (from 0 to 1 in case of a dummy variable) on the probability of a positive decision to engage in domestic or international co-opetition. This allows us to compare effects and therefore to test our conceptual hypotheses.

5 Results

In Hypothesis I we suggest that firms need to invest in superior absorptive capacities for international co-opetition. This Hypothesis has to be rejected. The empirical results presented in Table 2 show that the share of employees who have completed higher education has significant effects for both domestic and international co-opetition. This indicates that individual skillsets are the dominant component of absorptive capacities in co-opetition. However, the effects for domestic co-opetition are stronger. This result is especially surprising as one would assume that educated employees possess superior language skills. Besides, we find that continuous R&D activities are more valuable in firms that undertake domestic co-opetition. This may indicate that accumulated stocks of knowledge are not as important in international co-opetition as they are in national co-opetition.

Hypothesis IIa has to be rejected, too. There is no significant "learning-by-exporting" effect in international co-opetiton, which supports the more general results of Keller, 2004 on international knowledge diffusion. Multinational group variables also produce no significant effects. However, Hypothesis IIb can be accepted. International cooperation experience with suppliers and customers enhance the likelihood of cooperating with competitors, both locally and internationally. Our results demonstrate that international cooperation experience has a far greater effect on international co-opetition than on domestic co-opetition. Hence, international cooperation experience propels both forms of co-opetition but the experience is much more valuable to international engagements.

Hypothesis III can be accepted. Our proposition that international co-opetition requires more formal appropriability methods is supported. While secrecy and lead time are well established appropriability methods in domestic co-opetition we find that these forms of informal knowledge protection are not significant for international co-opetition. Firms dealing with international co-opetition partners rely on formal methods like patents. There is an isolated negative, significant effect from complex product design on domestic co-opetition indicating that additional layers of complexity make domestic co-opetition less attractive.

With an eye on control variables, we identify a positive firm size effect on the probability of engaging in domestic co-opetition. This relationship is linear as the squared term of the number of employees is not significant. Besides, public funding for innovation projects has the outlined positive and significant effect on firm's decisions to engage in co-opetition. It increases the likelihood of domestic co-opetition by 11% and of international by 3%. Given the magnitude of this effect it proves to be an important control variable.

Table 2: Results from probit estimation: Marginal effects

	Model 1				Model 2			
	Domestic Co-opetition		***International Co-opetition***		***Domestic Co-opetition***		***International Co-opetition***	
Variables	***Marginal Effect***	***Std. Err.***	***Marginal Effect***	***Std. Err.***	***Marginal Effect***	***Std. Err.***	***Marginal Effect***	***Std. Err.***
Hypothesis I								
Share of Employees with higher education (%)	0.06**	(0.03)	0.02**	(0.01)	0.05**	(0.03)	0.02**	(0.01)
R&D Expenditure as a share of Sales (%)	0.00	(0.01)	-0.02	(0.02)	0.00	(0.01)	-0.05	(0.03)
Continous R&D activities (dummy)	0.04***	(0.02)	0.00	(0.01)	0.05***	(0.02)	0.01	(0.01)
Hypothesis IIa								
Exports as a share of Sales (%)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
MNE with Headquarter abroad (dummy)	-0.01	(0.01)	0.00	(0.00)	-0.01	(0.01)	0.00	(0.00)
MN Group with domestic Headquarter (dummy)	0.01	(0.02)	0.00	(0.00)	0.00	(0.02)	0.00	(0.00)
Hypothesis IIb								
Cooperation with international Supplier (dummy)	0.22**	(0.10)	0.34***	(0.12)				
Cooperation with international Customer (dummy)					0.20**	(0.09)	0.32***	(0.11)
Hypothesis III								
Appropriability: Patents, Copyrights (dummy)	0.00	(0.01)	0.02**	(0.01)	-0.01	(0.01)	0.02**	(0.01)
Appropriability: Secrecy, Lead time (dummy)	0.02*	(0.01)	0.00	(0.00)	0.02*	(0.01)	0.00	(0.00)
Appropriability: Complex design (dummy)	-0.02**	(0.01)	0.00	(0.00)	-0.02	(0.01)	0.00	(0.00)
Company located in East Germany (dummy)	0.02	(0.01)	0.00	(0.00)	0.02	(0.01)	0.00	(0.00)
No. of employees (in logs)	0.03*	(0.02)	0.00	(0.01)	0.03*	(0.02)	0.00	(0.01)
Squared No. of employees (in logs)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Medium High Tech Manufacturing Industry (dummy)	0.01	(0.01)	0.01	(0.01)	0.00	(0.01)	0.01	(0.01)
High Tech Manufacturing Industry (dummy)	0.01	(0.02)	0.00	(0.01)	0.01	(0.02)	0.00	(0.01)
Obstacle: Cost/Risk (dummy)	0.01	(0.01)	0.01	(0.01)	0.01	(0.01)	0.01	(0.01)
Obstacle: Lack of technological / market knowledge (dummy)	-0.01	(0.02)	0.00	(0.01)	-0.01	(0.02)	0.01	(0.01)
Public funding for innovation (dummy)	0.11***	(0.03)	0.03**	(0.01)	0.11***	(0.03)	0.03**	(0.01)
Adj Count R2	0.095		0.277		0.041		0.319	

*significant at 10%; ** significant at 5%; *** significant at 1%; constant term included;
for dummy variables: marginal effect for discrete change from 0 to 1

6 Discussion

We position co-opetition theoretically as a firm capability that can be transferred across national and cultural borders. Still, we hypothesize that firms need to refocus their underlying processes developed in a national environment to be ready for international co-opetition.

International cooperation experience with other firms (customers, suppliers) enables firms to develop certain processes and competences that enable international co-opetition activities. We suggest that international cooperation allows firms to develop a unique understanding and the necessary confidence for dealing with international competitors. They provide the firm with insights into more complex and uncertain partnerships incorporating cross cultural backgrounds. The attitudes of "cooperating" and "sharing" are also helpful for engaging in domestic co-opetition but much more fruitful in an international context. Interestingly, international cooperation experience is specific and cannot be replicated by simply exporting goods and services. We suspect that the sensitivity for foreign markets deriving from exports is largely developed in marketing and sales departments but does not reach R&D units.

It does not come as a surprise that skilled employees support international co-opetition but this effect is weaker compared to domestic co-opetition. We suspect that this is the result of a lack of personal networks across borders. These networks have been identified as important channels for knowledge flows. These may stem from personnel mobility, that shapes interpersonal networks and even co-ethnicity (Agrawal et al., 2006; Kalnins and Chung, 2006; Singh, 2005). This social capital (Adler and Kwon, 2002) may only be more readily available within national and cultural borders. This may be especially relevant as we empirically investigate Germany.

Furthermore, we find an important shift in the way companies control their existing knowledge when moving from domestic to international co-opetition. While informal appropriability mechanisms may be sufficient in the home environment they move towards formal ones (patents) in an international context. Apparently, this provides them with the means to make the relevant knowledge visible, traceable and defendable.

Returning to our initial research question: How do firms get "international co-opetition ready?" We cannot recommend a general strengthening of absorptive capacities. We suggest that firms need to develop processes, structures and skillsets which provide cultural sensitivity. These are most promisingly found where firms have already cooperated with international customers and suppliers. Lessons can and should be drawn from these experiences. What is more, there is a need to switch from informal modes of appropriability to formal ones. We cannot infer from our analysis whether this is just the legal expertise to apply for and litigate patents. Some studies have suggested that patents are also an important channel for the controlled release of knowledge (embodied in the patent) into the public domain. The latter may imply a more thorough reconfiguration of processes and attitudes from secrecy/lead time to controlled patenting.

7 Limitations and further research

Our study faced certain limitations that have to be acknowledged and may provide fruitful avenues for future research. First, we benefit from a high quality, extensive dataset. Still, it was not specifically designed for the particular purpose of this study. Hence, some measures, especially those which look at the degree of internationalization, are rather crude. Second, we focus empirically on Germany with its unique economic and cultural roots and circumstances. Comparative international studies would provide valuable additional insights. Third, we rely on a cross sectional dataset. Several of our claims can only be fully substantiated by a longitudinal analysis. Fourth, we investigate “actual” not “best” practices of co-opetition. Whether these are profitable may be a different issue.

8 Appendix

Appendix A: Industry breakdown

Industry	NACE Code	Industry Group
Mining and quarrying	10 – 14	Other manufacturing
Manufacture of food and tobacco	15 – 16	Other manufacturing
Manufacture of textiles and leather	17 – 19	Other manufacturing
Manufacture of wood / paper / publishing	20 – 22	Other manufacturing
Manufacture of chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Manufacture of plastic / rubber	25	Other manufacturing
Manufacture of glass / ceramics	26	Other manufacturing
Manufacture of metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing

9 References

Adler, P.S. and S.-W. Kwon (2002), Social Capital: Prospects for a New Concept, *Academy of Management Review* 27 (1), 17-40.

Agrawal, A., L. Cockburn and J. McHale (2006), Gone but Not Forgotten: Knowledge Flows, Labor Mobility, and Enduring Social Relationships, *Journal of Economic Geography* 6 (5), 571-591.

Amit, R. and P.J.H. Schoemaker (1993), Strategic Assets and Organizational Rent, *Strategic Management Journal* 14 (1), 33-46.

Aschhoff, B. and T. Schmidt (2006), *Empirical Evidence on the Success of R&D Co-Operation - Happy Together?,* ZEW Discussion Paper No. 06-059, Mannheim.

Barney, J.B. (1991), Firm Resources and Sustained Competitive Advantage, *Journal of Management* 17 (1), 99-120.

Baum, J.R. and S. Wally (2003), Strategic Decision Speed and Firm Performance, *Strategic Management Journal* 24 (11), 1107-1129.

Bergen, M. and M.A. Peteraf (2002), Competitor Identification and Competitor Analysis: A Broad-Based Managerial Approach, *Managerial & Decision Economics* 23 (4/5), 157-169.

Chesbrough, H.W. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Boston.

Cohen, W.M. and J.P. Walsh (2000), *R&D Spillovers, Appropriability and R&D Intensity: A Survey Based Approach.*

Collis, D.J. and C.A. Montgomery (1995), Competing on Resources: Strategy in the 1990s, *Harvard Business Review* 73 (4), 118-128.

Conner, K.R. (1991), A Historical Comparison of Resource-Based Theory and Five Schools of Thought within Industrial Organization Economics: Do We Have a New Theory of the Firm?, *Journal of Management* 17 (1), 121-154.

Dierickx, I. and K. Cool (1989), Assett Stock Accumulation and Sustainability of Competitive Advantage, *Management Science* 35 (12), 1504-1511.

Dow, D. (2006), Adaptation and Performance in Foreign Markets: Evidence of Systematic under-Adaptation, *Journal of International Business Studies* 37 (2), 212-226.

Dussauge, P., B. Garrette and W. Mitchell (2000), Learning from Competing Partners: Outcomes and Durations of Scale and Link Alliances in Europe, *Strategic Management Journal* 21 (2), 99.

Dyer, J.H. and H. Singh (1998), The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage, *Academy of Management Review* 23 (4), 660-679.

Fier, A. and D. Harhoff (2002), Die Evolution Der Bundesdeutschen Forschungs- Und Technologiepolitik: Rückblick Und Bestandsaufnahme, *Perspektiven der Wirtschaftspolitik* 3 (3), 279-301.

Fritsch, M. and R. Lukas (2001), Who Cooperates on R & D?, *Research Policy* 30 (2), 297.

Garud, R. and P.R. Nayyar (1994), Transformative Capacity: Continual Structuring by Intertemporal Technology Transfer, *Strategic Management Journal* 15 (5), 365-385.

Ghemawat, P. (2001), Distance Still Matters: The Hard Reality of Global Expansion, *Harvard Business Review* 79 (8), 137-146.

Ghemawat, P. (2003), The Forgotton Strategy, *Harvard Business Review* 81 (11), 76-84.

Grant, R.M. (1996), Toward a Knowledge-Based Theory of the Firm, *Strategic Management Journal* 17, 109-122.

Greene, W.H. (2002), *Econometric Analysis*, New York.

Gupta, A.K. and V. Govindarajan (2000), Knowledge Flows within Multinational Corporations, *Strategic Management Journal* 21 (4), 473-496.

Hamel, G. (1991), Competition for Competence and Inter-Partner Learning within International Strategic Alliances, *Strategic Management Journal* 12 (4), 83-103.

Hamel, G., Y.L. Doz and C.K. Prahalad (1989), Collaborate with Your Competitors -- and Win, *Harvard Business Review* 67 (1), 133-139.

Harvey, M. and M.M. Novicevic (2000), Staffing Global Marketing Positions: What We Don't Know Can Make a Difference, *Journal of World Business* 35 (1), 80.

Huston, L. and N. Sakkab (2006), Connect and Develop, *Harvard Business Review* 84 (3), 58-66.

Hymer, S.H. (1976), *The International Operations of National Firms: A Study of Direct Investment*, Cambridge.

Jaffe, A.B. (1986), Technological Opportunity and Spillovers of R&D: Evidence from Firm's Patent, Profits, and Market Value., *American Economic Review* 76 (5), 984-1001.

Jensen, R. and G. Szulanski (2004), Stickiness and the Adaption of Organizational Practices in Cross-Border Knowledge Transfers, *Journal of International Business Studies* 35 (6), 508-523.

Kaiser, U. (2002), An Emprical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector, *International Journal of Industrial Organization* 20 (6), 747-774.

Kalnins, A. and W. Chung (2006), Social Capital, Geography, and Survival: Gujarati Immigrant Entrepreneurs in the U.S. Lodging Industry, *Management Science* 52 (2), 233-247.

Keller, W. (2004), International Technology Diffusion, *Journal of Economic Literature* XLII (September 2004), 752-782.

Kleinschmidt, E.J. and R.G. Cooper (1988), The Performance Impact of an International Orientation of Product Innovation., *European Journal of Marketing* 22 (10), 56-72.

Lane, P.J., J.E. Salk and M.A. Lyles (2001), Absorptive Capacity, Learning, and Performance in International Joint Ventures, *Strategic Management Journal* 22 (12), 1139.

Laursen, K. and A. Salter (2006), Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms, *Strategic Management Journal* 27 (2), 131-150.

Levin, R.C., A.K. Klevorick, R.R. Nelson and S.G. Winter (1987), Appropriating the Returns from Industrial Research and Development, *Brookings Papers on Economic Activity* (3), 783.

Liebeskind, J.P. (1996), Knowledge, Strategy, and the Theory of the Firm, *Strategic Management Journal* 17, 93-107.

Lord, M.D. and A.L. Ranft (2000), Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge, *Journal of International Business Studies* 31 (4), 573-589.

Luo, Y. (2004), *Coopetition in International Business*, Copenhagen.

Luo, Y. (2007), A Coopetition Perspective of Global Competition, *Journal of World Business* 42 (2007), 129-144.

Mezias, J.M. (2002), How to Identify Liabilities of Foreignness and Assess Their Effects on Multinational Corporations., *Journal of International Management* 8 (3), 265-283.

Nalebuff, B. and A. Brandenburger (1996), *Coopetition - Kooperativ Konkurrieren*, Frankfurt/Main.

Narula, R. and J. Hagedorn (1999), Innovation through Strategic Alliances: Moving Towards International Partnerships and Contractual Agreements, *Technovation* (19), 283-294.

Ndofor, H.A. and E. Levitas (2004), Signaling the Strategic Value of Knowledge, *Journal of Management* 30 (5), 685-702.

Penrose, E.T. (1959), *The Theory of the Growth of the Firm*, New York.

Peteraf, M.A. (1993), The Cornerstones of Competitive Advantage: A Resource Based View, *Strategic Management Journal* 14 (3), 179-191.

Porter Liebeskind, J. (1997), Keeping Organizational Secrets: Protective Institutional Mechanisms and Their Costs, *Industrial & Corporate Change* 6 (3), 623-663.

Priem, R.L. and J.E. Butler (2001), Is the Resource-Based 'View' a Useful Perspective for Strategic Management Research?, *Academy of Management Review* 26 (1), 22-40.

Rammer, C. (2002), *Patente Und Marken Als Schutzmechanismen Für Innovationen, Studien Zum Deutschen Innovationssystem* 11-2003, Mannheim.

Rothwell, R. and M. Dodgson (1991), External Linkages and Innovation in Small and Medium-Sized Enterprises, *R&D Management* 21, 125-137.

Seung Ho, P. and M.V. Russo (1996), When Competition Eclipses Cooperation: An Event History Analysis of Joint Venture Failure, *Management Science* 42 (6), 875-890.

Singh, J. (2005), Collaborative Networks as Determinants of Knowledge Diffusion Patterns, *Management Science* 51 (5), 756-770.

Sirmon, D.G., M.A. Hitt and R.D. Ireland (2007), Managing Firm Resources in Dynamic Environments to Create Value: Looking inside the Black Box, *Academy of Management Review* 32 (1), 273-292.

Szulanski, G. (1996), Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within the Firm, *Strategic Management Journal* 17 (Special issue), 27-43.

Tether, B.S. (2002), Who Co-Operates for Innovation, and Why an Empirical Analysis, *Research Policy* 31 (6), 948.

Veugelers, R. (1998), Collaboration in R&D: An Assessment of Theoretical and Empirical Findings, *De Economist (0013-063X)* 146 (3), 419.

Wernerfelt, B. (1984), A Resource-Based View of the Firm, *Strategic Management Journal* 5 (2), 171-180.

West, J. and J.L. Graham (2004), A Linguistic-Based Measure of Cultural Distance and Its Relationship to Managerial Values, *Management International Review* 44 (2), 239-260.

Zaheer, S. (1995), Overcoming the Liability of Foreignness., *Academy of Management Journal* 38 (2), 341-364.

Zaheer, S. (2002), The Liability of Foreignness, Redux: A Commentary, *Journal of International Management* 8 (3), 351-358.

Zaheer, S. and E. Mosakowski (1997), The Dynamics of the Liability of Foreignness: A Global Study of Survival in Financial Services, *Strategic Management Journal* 18 (6), 439-464.

Zaheer, S. and A. Zaheer (2006), Trust across Borders, *Journal of International Business Studies* 37 (1), 21-29.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Rapid Response Capabilities: The Importance of Speed and Flexibility for Successful Innovation

AUTOREN: ***Christoph Grimpe***

[KU Leuven, ZEW Mannheim]

Wolfgang Sofka

[Universität Hamburg, ZEW Mannheim]

JAHR: 2007

BIBLIOGRAPHISCHER STATUS: ZEW Discussion Paper No. 07-062, Mannheim
Teilergebnisse erscheinen als Buchkapitel in:
Challenges in the Management of New Technologies
World Scientific Publishing Company
und
Contemporary Corporate Strategy: Global Perspectives
Routledge Studies in International Business and the World Economy.

AUSGEWÄHLTE PRÄSENTATIONEN: International Association for Management of Technology
Miami, 2007

Chapter XX

Rapid Response Capabilities: The Importance of Speed and Flexibility for Successful Innovation

Christoph Grimpe and Wolfgang Sofka***

** Centre for European Economic Research (ZEW), Mannheim, Germany*
K.U. Leuven, Belgium
*** Centre for European Economic Research (ZEW), Mannheim, Germany;*
Department for Marketing and Innovation, Institute for Marketing and Media,
University of Hamburg, Hamburg, Germany

Spanish fashion retailer ZARA has been the prototype for a new kind of competitive strategy by beating its rivals through superior flexibility and speed to market new products. We define this organizational ability to learn from the market and respond to it with superior speed as a "rapid response capability". We explore its origins conceptually by drawing arguments from the the capability based view of the firm. Based on a sample of 3,360 German companies our empirical results show that rapid response capabilities are either built around exploiting existing absorptive capacities or exploring options given strong environmental pressures from the technological or demand side, but not a combination of both.

Introduction

In the global fight for competitive advantage, many companies, especially in technology-driven industries, seem to have relied heavily on

a resource-based strategy (Barney, 1991; Conner, 1991; Peteraf, 1993; Wernerfelt, 1984). This strategy aims at accumulating valuable technological assets combined with an ambitious intellectual property policy. To create a sustained competitive advantage, however, this strategy alone is often not enough. In fact, gaining a head-start over competitors requires timely responsiveness as well as rapid and flexible product innovation. At the same time, competitive pressures from globalization have forced firms to streamline and rationalize their workflow. Many have shifted labor-intensive manufacturing to countries with significantly lower labor costs in order to decrease product prices (Teece *et al.*, 1997). Some however, have created their own approach of coping with this situation. Over the past few years, the Spanish textiles manufacturing company Inditex with its major fashion brand ZARA has successfully turned the predominant industry logic upside down. While traditional fashion companies rely on two collections a year designed and produced in factories all over the world almost nine months before entering stores, ZARA's customers can expect new items every week with an average lead time from design to store delivery of only three weeks. ZARA has been able to transform its dependence on rapidly changing fashion trends and vogues into a competitive advantage and even create own fashion trends. We conceptualize this particular capability as a *rapid response capability* and embed it in the literature on dynamic capabilities (Eisenhardt and Martin, 2000; Hoopes *et al.*, 2003). The development of rapid response capabilities is an important way to overcome competition based on price/cost advantages through speed and flexibility (Berger, 2006). More precisely, we explore its roots and antecedents to discover whether rapid response capabilities qualify as truly dynamic capability.

The goal of this analysis is twofold. On the academic side, we develop a theoretical argument on this particular type of capability and test it empirically. For management practitioners we provide recommendations on how to develop rapid response capabilities. Our study is designed as follows. Section 2 presents our conceptual considerations and the subsequent hypotheses. Section 3 highlights our empirical study to test the latter. The subsequent section 4 provides the results of this quantitative analysis. Based on these results, we discuss

these findings on rapid response capabilities in section 5. Section 6 closes with concluding remarks.

Theory and Hypotheses

Deliberate learning and dynamic capabilities

Capabilities are organizational processes that bundle strategic resources into unique combinations and constitute superior performance themselves. This follows the basic rationale that competitive advantage does not only arise from the possession of strategic resources but also from the way in which they are used (Penrose, 1959). Several studies argue that capabilities cannot be investigated without considering their relevant context (Atuahene-Gima and Haiyang, 2004; Brush and Artz, 1999): The "when, where and how" resources and capabilities translate into competitive advantage (Priem and Butler, 2001). We follow this stream of literature by discussing the roots of rapid response capabilities and their relevant context.

Management and economics literature has mostly dealt with timing in innovation activities in the context of first mover and follower advantages (see for example Jensen, 2003; Lieberman and Montgomery, 1988; Shankar et al., 1998). This follows a more static perspective: market novelties appear and firms find themselves either on the pioneering or catching-up side. As our concept of rapid response capabilities is dynamic in nature, it combines innovation and imitation. Rapid-response firms like ZARA do not innovate once and reap the benefits from temporary entry barriers for competitors afterwards (first mover). They keep offering new products and services while constantly adjusting to market pressures and opportunities. Their competitive advantage stems neither exclusively from innovation nor imitation but from a combination of both through short feedback and reaction cycles. More precisely, we define rapid response capabilities as organizational routines specifically directed at achieving time compression in a firm's response time to environmental change. It is a unique capability in the

sense that its merits originate not primarily from superior performance of individual tasks but instead from sharply reduced response times compared with major competitors. It translates into flexibility, which reduces a firm's exposure to two fundamental risks in innovation: strategic blind spots and technological lock-ins.

The mechanism behind the build-up of rapid response capabilities can be regarded as a continuous and deliberate learning process (Zollo and Winter, 2002). This process describes firms' systematic methods for modifying their operating routines. Such routines constitute stable patterns of organizational behavior and reaction on internal or external stimuli. Routines define predictable as well as interrelated organizational actions e.g. on the order processing for new fashion. However, a second type of routines exists which is typically referred to as search routines (Nelson and Winter, 1982). They deal with changes in the existing set of operating routines.

In a relatively stable environment, operating routines superior to those of competitors can be a source of sustainable competitive advantage. It may even be sufficient to rely on discrete and sporadic changes and improvements in the set of operating routines that may result from a tacit accumulation of experience. However, when the environment turns turbulent and involves rapid changes regarding customer demand, technology or competition, a stable set of routines might no longer be sufficient. Systematic efforts are needed to track the environment and dynamically adjust routines. An accumulation of experience resulting from a repeated execution of routines combined with a trial–and–error proceeding will therefore not be enough for a build-up of rapid response capabilities.

Learning evolves from discursive actions between individuals and groups in the execution of organizational tasks (Levitt and March, 1988; Levinthal and March, 1993). Expressing opinions and individual viewpoints, challenging them and mutually understanding causal linkages — especially in the presence of ambiguities — are a pre-requisite for making implicit or tacit knowledge explicit and hence for enabling collective learning efforts. Knowledge from relevant customers, suppliers, universities etc. has to be made available throughout the company in order to adjust operating routines accordingly and to spread

successful action-performance links within the whole organization. Sirmon et al. (2007) have suggested that the effectiveness of this step also depends on environmental munificence, i.e., the degree of availability and accessibility of external resources. The varying munificence of environments might critically affect the potential value of a firm's resources and capabilities. Moreover, munificent environments can support the growth of resources within firms by providing access to complementary, external resources (Baum and Wally, 2003). Those companies that are most efficient in their learning mechanism will reap the benefits in terms of competitive advantage in a given environmental context. In conclusion, a firms' ability to identify promising strategic resources in its environment and integrate them into the existing resource and capability portfolio for superior performance can be considered a capability in itself.

Antecedents of rapid response capabilities

The previous theoretical arguments suggest that rapid response capabilities are truly dynamic in nature. Put simply, they arise from a combination of internal capabilities and the munificence of the environment. We question whether both driving forces of rapid response capabilities necessarily converge. Hence, we develop an evaluation scheme that reflects this aspect by exploring each factor separately as well as their interaction.

Linking rapid response capabilities with absorptive capacities

Firms can differentiate themselves through their expertise in synthesizing this information, integrating and combining it with existing knowledge (Henderson and Cockburn, 1994; Kogut and Zander, 1992). An important stream of literature has summarized these capabilities as absorptive capacity (Cohen and Levinthal, 1989, 1990): a firm's ability to identify, assimilate and exploit knowledge from the environment. This differentiation corresponds with the three learning mechanisms in organizational capability development — experience accumulation, knowledge articulation and knowledge codification — but puts a

stronger emphasis on exploiting and capitalizing of acquired knowledge. Several studies have linked absorptive capacity to superior firm performance (Landry and Amara, 2002; Love and Roper, 2004; Nadiri, 1993). Absorptive capacities are typically accumulated as a by-product of firms' innovation activities and hence difficult to acquire, imitate or substitute (Amit and Schoemaker, 1993). We extend this view by focusing on the cycle time through all three stages, knowledge identification, assimilation and exploitation, and argue that higher turnover rates can constitute a capability in itself by increasing the efficiency of the whole process, i.e. rapid response capabilities.

Jansen et al. (2005) have recently argued along similar lines by differentiating between potential absorptive capacities (identification, assimilation) and realized absorptive capacity (exploitation). They find that a unique mix of organizational measures is required to balance a broad screening process for valuable ideas with a structured approach towards exploiting them. In conclusion, we derive the following hypothesis:

Hypothesis I: Investments into absorptive capacities enable firms to achieve time compression in their learning engagements and develop rapid response capabilities.

External pressures and opportunities

As mentioned before, rapid response capabilities imply change as they inevitably aim at improving operating routines (Collis, 1994; Winter, 2003). This change is necessary to the extent that competitive conditions change. Competitive conditions in turn are largely given by the industry structure with its well known five forces "threat of new entrants", "bargaining power of suppliers", "bargaining power of buyers", "threat of substitute products or services" and, finally, "rivalry among existing competitors" (Porter, 1980). These forces determine the attractiveness of the industry as they exert pressure on the companies but also reveal business opportunities. It is important to note that the industry structure is not completely external to the firm but also a result of a firm's actions

and interactions (Porter, 1991). Firms can use their position within an industry to influence the industry structure and take advantage from it.

The more rivals are able to imitate strategies the rougher the climate within an industry gets. Additionally, rivalry is determined by the remaining four forces. When the industry structure is characterized by stable rent appropriation with only minor changes of the competitive environment then the pressure on firms also stays on a rather low level. When the industry structure, however, is continuously altered by the entrance of new competitors, a strong threat by substitute products or a high bargaining power of suppliers and buyers or when existing competitors largely share resources and capabilities then firms typically perceive a high pressure affecting potential value creation (Sirmon et al., 2007). But this pressure also forces firms to learn and develop capabilities to deal with industry turbulence. The higher the rate of change the better capabilities to cope with it have to be developed. Firms unable to do so will ultimately disappear or pull out of the market. Hence, this pressure can also be a learning opportunity to develop rapid response capabilities. This will lead to sustainable competitive advantage to the extent that a firm disposes of rapid response capabilities that cannot be imitated by rivals. Our second hypothesis is thus given as follows:

Hypothesis II: Firms develop rapid response capabilities as they respond to pressure from their competitive environment.

Conceptualizing rapid response capabilities as dynamic capabilities

Given the previous discussion, a combination of internal capabilities and external pressures can be envisioned as reinforcing factors for developing rapid response capabilities. In fact, Jansen et al. (2005) find that potential absorptive capacities enhance performance as markets become more dynamic. Rapid response capabilities could therefore be considered as dynamic capabilities (Eisenhardt and Martin, 2000).

However, one may question the truly dynamic nature of the antecedents of rapid response capabilities. Rapid response capabilities may also either evolve based on absorptive capacity (resource driven) or

environmental pressure (market driven). We argue that there is a trade-off between them. Capability development is not per se performance enhancing (Sirmon et al., 2007). It is an investment-intensive process with uncertain outcomes (Sapienza et al., 2006). Absorptive capacities are based on experience and hence time. Dynamic shifts in the environment may quickly turn existing competencies obsolete. Hence, a differentiated view is required. Figure 1 summarizes our delineation of rapid response capabilities. Path III follows the dynamic capability logic. However, the environmental context plays a decisive role. Volatile environments increase the likelihood of strategic blind spots or "betting on the wrong horse" as companies invest in specific absorptive capacities. These uncertainties make the cost benefit ratio of such investments less attractive. As a result, rapid response capabilities would be simply a reaction to market pressures (Path II). Then again, stable environments reward investments in absorptive capacities. In this line of reasoning, reducing cycle times for rapid response capabilities stems from efficiency gains based on a reliable and established stock of absorptive capacities (Path I). We propose:

Hypothesis III: There exists an interaction between absorptive capacities and dynamic market environments as the building blocks for rapid response capabilities.

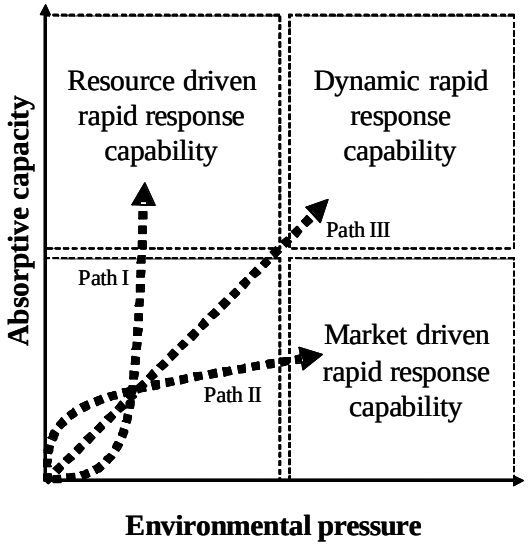


Figure 1: Classification of rapid response capabilities.

Methods

Data and estimation strategy

For the empirical part of this analysis we used cross-sectional data from an annual survey on the innovation activities of German enterprises called the "Mannheim Innovation Panel" (MIP) conducted by the Centre for European Economic Research (ZEW). The methodology and questionnaire used by the survey, which is targeted at enterprises with at least five employees, are the same as those used in the European Union's Community Innovation Survey (CIS). For our analysis we used the 2005 survey which covers the three-year period 2002–2004. About 5,200 firms in manufacturing and services responded to the survey and provided information on their innovation activities. The sample was drawn using the stratified random sample technique. A comprehensive non-response analysis showed no systematic distortions between responding and non-responding firms with respect to their innovation activities. For a more

detailed description of the dataset and the survey see Rammer et al. (2005). We utilize these data to measure the concepts presented above.

Our dataset without missing values contains data on 3,360 firms located in Germany. Very few companies collect data on the cycle time of their innovation activities. We therefore rely on the self assessment of heads of R&D departments and innovation management on whether they established rapid response capabilities. More precisely, the survey contains the question: 'Did your organizational innovation activities lead predominantly to a reduction in response time to customer or supplier requirements?' From the total sample, 779 firms did and we interpret this approach as the establishment of rapid response capabilities. This indicator is the dependent variable in all subsequent steps of the analysis; the remaining 2,581 serve as the comparison group.

We will subsequently estimate two probit models since our dependent variable is binary in nature (Baum, 2006). This allows us to identify factors which significantly increase a company's probability to pursue rapid response capabilities while controlling for other firm characteristics (e.g. industry effects). We will rely on interaction terms to separate additive effects from interactive ones. Interaction terms follow a straightforward rationale (Aiken and West, 1993). A regression equation of the form Y=b1X+b2Z+b0 allows testing for linear, additive effects of X on Y and Z on Y respectively. An interaction term producing Y=b1X+b2Z+b3XZ+b0 allows for additional insights. Firstly, if b3 is significant then Y depends jointly upon X and Z. Secondly, if b1 and/or b2 are significant there is a separate effect of X on Y (or Z on Y) apart from the mitigating factor XZ.

Exogenous Variables

Measuring absorptive capacity

Absorptive capacities are developed through the conduct of R&D activities. We capture their effect in line with the literature (Cohen and Levinthal, 1990; Rothwell and Dodgson, 1991) through variables on the two major inputs for innovation activities: R&D expenditures (as a share

of sales) and the expertise of employees (share of employees with college education divided by industry average). Given our analytical framework, we are especially interested in accumulation process of absorptive capacities. We add therefore an additional dummy variable for indicating whether R&D activities are performed on a continuous basis. Hypothesis I would be supported if the coefficients of the absorptive capacity variables are positive and significant.

Measuring environmental pressure

Environmental challenges and opportunities have been most prominently elaborated by Porter (1985). We rely on Porter's model with the following principles:

(1) Competitor behavior is difficult to predict.
(2) Threat from market entry of new competitor is high.
(3) Rapid changes in technology occur frequently.
(4) Market life cycles of products and services are short.
(5) Close substituting products exist.

Respondents were asked to rate the prevalence of each of these factors for their business on a four point Likert scale. In the next step, we generated a scale of environmental pressure through principal factor analysis and varimax rotations on these items. We retain one factor with an eigenvalue larger than one. The factor analysis produces a satisfactory Kaiser–Meyer–Olkin measure of sampling adequacy of 0.62.

Control variables

We control for several other factors: Regional differences between East and West Germany, company size (number of employees in logs and in squared terms to control for the effect of especially large firms), industry effects (grouped NACE2, see table A1 in the appendix for details) and technological stability (through the share of sales with unchanged products).

Descriptive details of the data are provided in table A3 in the appendix. Rapid responding firms are on average twice as large as the

control group and operate more frequently in medium-high tech manufacturing (e.g. automotives) and less frequently in distributive services (e.g. transportation). Interestingly, they are more likely to perform R&D continuously but invest lower shares of their turnover on it. Finally, they are exposed to higher levels of environmental pressures especially from technology changes and product obsolescence.

Results

The analysis is split up into two separate models shown in Table 1. While model 1, our baseline case, only estimates the main effects of absorptive capacity and environmental pressure on the development of rapid response capabilities, model 2 includes the interaction term that serves as a basis for describing rapid response capabilities as a dynamic capability.

Generally speaking, our results show a high stability across the different models. Starting with the main effects in model 1 we observe no significant impact of two of the variables that make up absorptive capacity: formal education of employees and R&D intensity. In contrast to that, continuous R&D engagement as third indicator of absorptive capacity is positive and significant. Obviously, there is a strong emphasis on the experience effect with its long-term accumulation of knowledge. This seems to shape absorptive capacities in a way that is relevant for building rapid response capabilities. We can hence confirm our first hypothesis. Regarding the impact of environmental pressure we can observe a positive and significant effect, too. Hypothesis II can therefore be supported as well.

Model 2 includes the effect of the interaction term that is made up of the significant variable continuous R&D engagement as our measure of absorptive capacities and environmental pressure. However, we do not find a significant effect. Evidently, there are additive effects of absorptive capacities and environmental pressure but no interaction of both. This also implies that rapid response capabilities do not necessarily stem from a combination of both which would have qualified them as a truly dynamic capability. Hypothesis III has thus to be rejected.

Furthermore, we included control variables in our analysis. Their effects vary across the four models only to a very limited extent. The results show that particularly large firms measured in terms of the number of employees are more likely to develop rapid response capabilities. An explanation might be that as firms grow larger they have to be more goal-oriented in improving their speed and flexibility while smaller firms are — at least to some degree — flexible anyway. Moreover, there is a negative significant effect of sales of existing products which serves as a measure for technological dynamics. Evidently, the lower this share of sales and consequently the higher the technological dynamics the more rapid response capabilities are propelled which is in line with our previous argumentation. Finally, we included industry effects into the analysis that are hardly significant with the exception of high-tech manufacturing companies that exhibit a negative effect on the build-up of rapid response capabilities. Results are shown in Table A1 of the Appendix.

Discussion

Our empirical results do not support the idea that rapid response capabilities are a dynamic capability. Rapid response capabilities are developed through persistent R&D engagements or highly dynamic environmental pressures, but not a combination of both. We discuss each capability separately and return to the reasons behind this branching in the final synthesis.

Resource-driven rapid response capability

The positive effect of absorptive capacity on rapid response capabilities stresses the importance of prolonged R&D commitments. Current investments in R&D projects and personnel have no significant impact. This supports the general accumulation aspect of absorptive capacity (Cohen and Levinthal, 1990). What is more, we find that firms that engage consistently in innovation activities develop routines and capabilities that cannot be readily acquired on factor markets (Amit and Schoemaker, 1993). This supports our view of capability building as a

continuous and deliberate learning mechanism. Firms with established competencies and routines find it easier to reduce cycle times for individual innovation projects. This is achieved by streamlining the knowledge accumulation, articulation and codification steps within the learning process. In other words, capabilities need to be "tightened" to ensure their efficiency (Sirmon et al., 2007). Hence, this facet of rapid response capabilities is born out of efficiency gains from experience effects.

Market-driven rapid response capability

With regards to environmental dynamics, we find that they propel the development of rapid response capabilities. Firms deal with these uncertainties in their environment by developing rapid response capabilities that allow flexible solutions and prevent strategic blind spots as well as technological lock-ins. When implemented effectively, this can produce a series of competitive advantages (Sirmon et al., 2007). Hence, rapid response capabilities of this type have primarily a kind of insurance function. While resource-driven strands of rapid response capabilities exploit existing internal assets, market-driven ones have more of an exploratory purpose of external assets (March, 1991), which is necessitated and potentially rewarded by dynamics in the environment depending on its munificence (Baum and Wally, 2003). However, it might also be possible that under extreme environmental uncertainty it might not be enough to rapidly respond but also to direct capabilities at the development of a new technology that might itself create environmental pressure for competitors (Sirmon et al., 2007).

Interaction of resource- and market-driven rapid response capabilities

While both resource- and market-driven rapid response capabilities make intuitively sense the most striking result of our analysis lies in the fact that they do not interact or converge. Then again, equating speed with flexibility may be questionable in the first place.

Helfat and Peteraf (2003) describe the process of capability branching when external factors are sufficiently strong to alter existing

development trajectories. We argue that the market-driven type of rapid response capabilities is in effect a branch of capabilities based on efficiency, i.e. long term R&D commitments and the resulting absorptive capacities. Building absorptive capacities requires continued resource commitments. It necessitates significant investments that have to be balanced with expected outcomes (Sapienza et al., 2006). If technological and demand uncertainties are high, lock-ins are dangerous because knowledge stocks may depreciate quickly. The overall cost/benefit ratio turns less favorable. As a result, firms return to an exploratory market-driven strategy that hedges their options until the fog clears. Part of this strategy is staying flexible and keeping investments in specialized absorptive capacities at a minimum level. If the technology and demand landscape becomes more predictable, though, investments in targeted absorptive capacities produce promising competitive assets which can be exploited in the future. Part of this exploitation is clearly superior speed in adapting products and processes (Baum and Wally, 2003). Put simply, overly exploration in stable environments is a waste of resources; exploitation in dynamic environments is risky. Based on this assessment, it is not surprising that we find two ways to rapid response capabilities: Speed in a sense of accelerating the exploitation of existing knowledge stocks (resource-driven) and speed in terms of the flexibility for securing future trajectories (market-driven). A combination of both is difficult to envision.

Practical implications

Environmental dynamics are not a factor under management discretion although firms can chose which market to enter. Hence, management recommendations have to center around the investments into building absorptive capacities. Our results indicate that rapid response capabilities are born out of long term engagements. Once technological routines have been established they can be tightened for more efficient execution. Then again, these investments have to be balanced with technological volatility and demand uncertainty. If the latter are high, lock-ins have to be avoided in favor of rapid response initiatives for flexible exploration. We suggest a generic three step process for dynamic environments.

Companies should enter such markets with a focus on flexibility with basic investments in absorptive capacities. As certain products or sub-markets mature decisively, long term commitments are advisable. Turning these engagements into efficient rapid response capabilities is only the final part of this process.

Table 1 Results of the probit models.

Variables	Model1	Model2
	Coeff.	Coeff.
Employees with graduate education divided by industry average (ratio)	0.01	0.01
	(0.02)	(0.02)
R&D expenditures as a share of sales (%)	0.00	0.00
	(0.00)	(0.00)
Continuous R&D engagement (dummy)	0.21***	0.22***
	(0.07)	(0.07)
Environmental pressure (scale)	0.17***	0.19***
	(0.03)	(0.04)
Interaction term Continuous R&D and Environmental pressure scale		-0.09
		(0.07)
Location East Germany (dummy)	-0.05	-0.04
	(0.05)	(0.05)
Employees (no. in logs)	0.12**	0.12**
	(0.05)	(0.05)
Employees (no. in logs, squared)	0.00	0.00
	(0.01)	(0.01)
Share of sales with existing products (%)	-0.01***	-0.01***
	(0.00)	(0.00)
Industry dummies	yes	yes

Variables	Model1 Coeff.	Model2 Coeff.
Constant	-0.63*** (0.17)	-0.64*** (0.17)
Observations	3,360	3,360
R^2	0.09	0.09
Wald chi2(14)	162.61	162.78
P>0	0.00	0.00

* significant at 10%; ** significant at 5%; *** significant at 1%.
Robust standard errors in parentheses. Industry dummy results reported in table A1.

Concluding Remarks

The goal of this study was to determine the antecedents of rapid response capabilities, embed them into the literature and test them empirically We acknowledge important limitations in this study, which may offer promising routes for future research projects. First, we can only report empirical results for Germany. Comparisons with other established (e.g. USA, Japan) as well as emerging economies could provide important additional insights. What is more, we work with a comprehensive dataset which is nevertheless only available as a cross section. As time has shown to be an important factor in this context, longitudinal studies could shed more light on the build-up process of capabilities over time. Regarding our conceptualization it has to be noted that we do not address performance effects of rapid response capabilities. Although we raised the importance of gaining competitive advantage from such capabilities we did not analyze the impact on firm performance. However, while creating value for customers, a firm must also generate profits to be distributed to the owners. Future research should hence focus on the performance effect of rapid response capabilities.

Appendix

A1: Probit results: Industry dummies

Variables	Model I	Model II
	Coef.	Coef.
High tech manufacturing (dummy)	-0.20*	-0.19*
	(0.10)	(0.10)
Medium-high tech manufacturing (dummy)	-0.02	-0.03
	(0.08)	(0.08)
Distributive services (dummy)	-0.10	-0.09
	(0.07)	(0.07)
Knowledge intensive services (dummy)	-0.03	-0.03
	(0.08)	(0.08)
Technological services (dummy)	-0.11	-0.11
	(0.09)	(0.09)

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses. For full regression results see Table 1.

A2: Industry breakdown

Industry	NACE Code	Industry group
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastics / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical equipment and electronics	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing

Industry	NACE Code	Industry group
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.2	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Motion picture/broadcasting	92.1 – 92.2	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

A3: Descriptive Statistics

Variables	Full sample		Rapid responders		Control group	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Employees (no.)	442.44	5,082.74	725.64	5,328.91	356.96	5,003.98
Share of sales with existing products (%)	86.77	22.71	80.67	25.84	88.61	21.35
Employees with graduate education (%)	19.80	24.29	20.01	23.08	19.74	24.64
Employees with graduate education divided by industry average (ratio)	0.97	1.10	1.01	1.02	0.96	1.12
R&D expenditures as a share of sales (%)	7.49	149.92	5.11	37.71	8.21	169.80
Continuous R&D engagement	0.26	0.44	0.37	0.48	0.22	0.42

Variables	Full sample		Rapid responders		Control group	
(dummy)						
Environmental pressure (scale)	-0.02	0.81	0.13	0.79	-0.07	0.81
Competitor moves are hardly predictable (dummy)	0.17	0.37	0.17	0.37	0.17	0.37
New competitors threaten market position (dummy)	0.15	0.35	0.16	0.36	0.14	0.35
Product technology changes rapidly (dummy)	0.09	0.29	0.14	0.35	0.07	0.26
Products become rapidly obsolete (dummy)	0.07	0.25	0.10	0.30	0.06	0.23
Easy substitution with competing products (dummy)	0.25	0.43	0.27	0.44	0.24	0.43
Demand forecasting is difficult (dummy)	0.21	0.41	0.23	0.42	0.20	0.40
Location East Germany (dummy)	0.34	0.47	0.31	0.46	0.34	0.48
Medium-high tech manufacturing (dummy)	0.13	0.34	0.17	0.37	0.12	0.32
High tech manufacturing (dummy)	0.07	0.26	0.08	0.27	0.07	0.25
Distributive services (dummy)	0.18	0.39	0.14	0.35	0.19	0.40
Knowledge intensive services (dummy)	0.12	0.32	0.11	0.31	0.12	0.32
Technological services (dummy)	0.13	0.33	0.12	0.33	0.13	0.33
Observations	3,360		779		2,581	

References

Aiken, L.S. and West, S.G. (1993). Multiple regression: Testing and interpreting interactions, Newbury Park.

Amit, R. and Schoemaker, P.J.H. (1993). Strategic assets and organizational rent, *Strategic Management Journal*, 14 (1), pp. 33–46.

Atuahene-Gima, K. and Haiyang, L. (2004). Strategic decision comprehensiveness and new product development outcomes in new technology ventures, *Academy of Management Journal*, 47 (4), pp. 583–597.

Barney, J.B. (1991). Firm resources and sustained competitive advantage, *Journal of Management*, 17 (1), pp. 99–120.

Baum, J.R. and Wally, S. (2003). Strategic decision speed and firm performance, *Strategic Management Journal*, 24, pp. 1107–1129.

Baum, C.F. (2006). An introduction to modern econometrics using stata, College Station (TX).

Berger, S. (2006). How we compete: What companies around the world are doing to make it in today's gobal economy, New York.

Brush, T.H. and Artz, K.W. (1999). Toward a contingent resource-based theory: the impact of information asymmetry on the value of capabilities in veterinary medicine, *Strategic Management Journal*, 20 (3), pp. 223–250.

Cohen, W.M. and Levinthal, D.A. (1989). Innovation and learning: The two faces of R&D, *The Economic Journal*, 99 (397), pp. 569–596.

Cohen, W.M. and Levinthal, D.A. (1990). Absorptive capacity: A new perspective on learning and innovation, *Administrative Science Quarterly*, 35 (1), pp. 128–152.

Collis, D.J. (1994). Research note: How valuable are organizational capabilities? *Strategic Management Journal*, 15 (8), pp. 143–152.

Conner, K.R. (1991). A historical comparison of resource-based theory and five schools of thought within industrial organization economics. Do we have a new theory of the firm? *Journal of Management*, 17 (1), pp. 121–154.

Eisenhardt, K.M. and Martin, J.A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, 21 (10/11), pp. 1105–1121.

Helfat, C.E. and Peteraf, M.A. (2003). The dynamic resource-based view: Capabilities life cycles, *Strategic Management Journal*, 24, pp. 997–1010.

Henderson, R. and Cockburn, I. (1994). Measuring competence? Exploring firm effects in pharmaceutical research, *Strategic Management Journal*, 15 (Special Issue Winter), pp. 63–84.

Hoopes, D.G., Madsen, T.L. and Walker, G. (2003). Guest editors' introduction to the special issue: Why is there a resource-based view? Toward a theory of competitive heterogeneity, *Strategic Management Journal*, 24, pp. 889–902.

Jansen, J.J.P., Van den Bosch, F.A.J. and Volberda, H.W. (2005). Managing potential and realized absorptive capacity: How do organizational antecedents matter? *Academy of Management Journal*, 48 (6), pp. 999–1015.

Jensen, R. (2003). Innovative leadership: First-Mover advantages in new product adoption, *Economic Theory*, 21 (1), pp. 97–116.

Kogut, B. and Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology, *Organization Science*, 3 (3), pp. 383–397.

Landry, R. and Amara, N. (2002). Effects of sources of information on the novelty of innovation in Canadian manufacturing Firms: Evidence from the 1999 Statistics Canada Innovation Survey.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development, *Strategic Management Journal*, 13 (5), pp. 111–125.

Levinthal, D.A. and March, J.G. (1993). The myopia of learning, *Strategic Management Journal*, 14, pp. 95–112.

Levitt, B. and March, J.G. (1988). Organizational learning, An*nual Review of Sociology*, 14, pp. 319–340.

Lieberman, M.B. and Montgomery, D.B. (1988). First-Mover advantages, *Strategic Management Journal*, 9, pp. 41–58.

Love, J.H. and Roper, S. (2004). Knowledge sourcing, innovation and performance: A preliminary analysis of Irish innovation panel data, *Aston Business School Working Paper*, Birmingham.

March, J.G. (1991). Exploration and exploitation in organizational learning, *Organization Science*, 2 (1), pp. 71–87.

Nadiri, I.M. (1993). Innovations and technological spillovers, *NBER Working Paper*, No. 4423, Cambridge, MA.

Nelson, R.R. and Winter, S.G. (1982). An evolutionary theory of economic change, Cambridge, MA.

Penrose, E.T. (1959). The theory of the growth of the firm, New York.

Peteraf, M.A. (1993). The cornerstones of competitive advantage: A resource-based view, *Strategic Management Journal*, 14 (3), pp. 179–191.

Porter, M.E. (1980). Competitive strategy. Techniques for analyzing industries and competitors, New York, London.

Porter, M.E. (1985). Competitive advantage: Creating and sustaining superior performance, New York.

Porter, M.E. (1991). Towards a dynamic theory of strategy, *Strategic Management Journal*, 12 (8), pp. 95–117.

Priem, R.L. and Butler, J.E. (2001). Is the resource-based 'view'a useful perspective for strategic management research? *Academy of Management Review*, 26 (1), pp. 22–40.

Rammer, C., Aschhoff, B., Doherr, T., Peters, B. and Schmidt, T. (2005). Innovationsverhalten der deutschen Wirtschaft - Indikatorenbericht zur Innovationserhebung 2004, ZEW / Infas, Mannheim.

Rothwell, R. and Dodgson, M. (1991). External linkages and innovation in small and medium-sized enterprises, *R&D Management*, 21, pp. 125–137.

Sapienza, H.J., Autio, E., George, G. and Zahra, S.A. (2006). A capabilities perspective on the effects of early internationalization on firm survival and growth, *Academy of Management Review*, 31 (4), pp. 914–933.

Shankar, V., Carpenter, G.S. and Krishnamurthi, L. (1998). Later mover advantage: How innovative late entrants outsell pioneers, *Journal of Marketing Research*, 35, pp. 54–70.

Sirmon, D.G., Hitt, M.A. and Ireland, R.D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box, A*cademy of Management Review*, 32 (1), pp. 273–292.

Teece, D.J., Pisano, G. and Shuen, A. (1997). Dynamic capabilities and strategic management, S*trategic Management Journal*, 18 (7), pp. 509–533.

Wernerfelt, B. (1984). A resource-based view of the firm, *Strategic Management Journal*, 5 (2), pp. 171–180.

Winter, S.G. (2003). Understanding dynamic capabilities, *Strategic Management Journal*, 24, pp. 991–995.

Zander, U. and Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test, *Organization Science*, 6 (1), pp. 76–92.

Zollo, M. and Winter, S.G. (2002). Deliberate learning and the evolution of dynamic capabilities, *Organization Science*, 13 (3), pp. 339–351.

Internationalisierungspotenziale von Open-Innovation-Strategien: Chancen und Herausforderungen für das Innovationsmanagement

Profiling Sustainable Innovators: Not Ready to Make Nice?

AUTOREN: ***Christoph Grimpe***

[KU Leuven, ZEW Mannheim]

Ihsen Ketata

[Georgia Institute of Technology Atlanta]

Wolfgang Sofka

[Universität Hamburg, ZEW Mannheim]

JAHR: 2007

BIBLIOGRAPHISCHER STATUS: Georgia Tech Center for International Business Education and Research Working Paper 030-07/08, Atlanta

Eingereicht bei Journal of Management

AUSGEWÄHLTE PRÄSENTATIONEN: International Product Development Management Conference Porto, 2007

European International Business Academy (EIBA) Catania, 2007

Profiling Sustainable Innovators: Not Ready to Make Nice?

Christoph Grimpe[1], Ihsen Ketata[2] and Wolfgang Sofka[1]

[1] Centre for European Economic Research, Mannheim

[2] Georgia Institute of Technology, Atlanta

Abstract

Over the past decade, sustainable or "green" innovation has occupied a top-ranking position on the agenda of many firms. Sustainable innovation can be broadly defined as an innovation that has to consider environmental and social issues and the needs of future generations. Although sustainable innovation provides considerable new opportunities for companies it goes along with an increased complexity and possible "traps". This in turn requires certain organizational routines and capabilities to deal with the upcoming challenges. We explore what the specific driving forces are that lead firms to innovate in a sustainable development domain and that lead towards a build-up of sustainable innovation capabilities. We test them empirically for more than 1,100 firms in Germany. We find that firms need to invest in internal absorptive capacities and draw both broadly and deeply from external impulses for innovation. In that sense, investments in employee training are more important than technological R&D expenditures.

Keywords: Sustainable innovation, absorptive capacity, environmental pressure, capability development

JEL-Classification:

Corresponding author:
Wolfgang Sofka
sofka@zew.de
Phone: +49/621/1235-181, Fax: +49/621/1235-170
Centre for European Economic Research (ZEW)
Department of Industrial Economics and International Management
P.O. Box 10 34 43, D-68034 Mannheim, Germany

The authors thank Klaus Rennings and Christian Rammer for invaluable comments and discussions.

1 Introduction

Over the past decade, sustainable or "green" innovation has occupied a top-ranking position on the agenda of many firms. This has partly been driven by prominent failures like Shell's Brent Spar experience or Nike and the Asian "sweatshops". Sustainable innovation in this notion goes beyond the more traditional understanding that is associated with a firm's long-term orientation and planning to ensure a continuous stream of new products and processes. In fact, increasing importance has been attached to environmental and social concerns in innovation processes (Verloop, 2006). Particularly environmental innovations have been defined as "… measures of relevant actors (firms, private households…), which: (i) develop new ideas, behavior, products and processes, apply or introduce them, and; (ii) contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" (Rennings, 2000: 322). Sustainable innovation adopts a broader focus in that it also incorporates social issues as well as the needs of future generations which most certainly have a number of overlaps with the environmental dimension. Therefore, sustainable innovation is generally perceived to be more challenging than other types of innovation activities in that it adds an additional layer of complexity (Hall & Vredenburg, 2003). In this respect, sustainable innovation turns out to have two facets. The first is pressure-driven: Companies are adopting responsible corporate behavior as a result of the increasing pressures that they are facing from their stakeholders, including governments or non-governmental organizations (NGOs) (Christmann & Taylor, 2002; Ottman, Stafford & Hartman, 2006). The second facet is demand-driven: Various stakeholders – and most importantly customers – are increasingly demanding products that have been produced in a sustainable way, i.e. in an eco-efficient process, consuming less resources and energy, reducing environmental stress and improving health and safety conditions for employees as well as for customers, the local community or society in general (Paramanathan, Farrukh, Phaal & Probert, 2004). In this context, customers can react with extreme aggressiveness, even resulting in boycotts of certain products or services. At the same time, customers seem to clearly appreciate the firms that are known for their sustainable development strategies or for their reputation for sustainable conduct (Ayuso, Rodriguez & Ricart, 2006). Many studies, such as Rindova et al. (2005), have shown that a firm's reputation can create competitive advantage since reputation constitutes a substantial part of the perceived utility of a product or service. Based on an event study of stock market returns, Gilley et al. (2000) confirm the positive effect of product-driven environmental initiatives. They argue that product-driven initiatives receive more attention than process-driven enhancements and therefore contribute more to a firm's reputation. Another indication might be the development of the Dow Jones Sustainability Index, which tracks the financial performance of the leading sustainability-driven companies worldwide. Since 2001, the index has constantly outperformed a global reference index.[1]

In order to comply with pressure from stakeholders on the one hand, and to satisfy new customer demands on the other hand, many firms are starting to consider an integration of

[1] See http://www.sustainability-indexes.com

sustainable development practices and a review of their established business models. Early attempts directed at an improvement of corporate reputation included the establishment of sustainability offices and the publication of sustainability reports (Hall & Vredenburg, 2003). Apart from public relations efforts, companies have also increasingly switched from conforming with regulations to becoming environmentally proactive and thus responsive (Berry & Rondinelli, 1998). Whereas during the 1960s and 1970s companies undertook major efforts to repair environmental damages, they had to try to keep up with ever-increasing environmental regulation during the 1980s. In the nineties, companies began to adopt more proactive environmental policies. Nowadays, sustainable innovation practices are considered an integral part of successful management (Lefebvre, Lefebvre & Talbot, 2003; Ketata & McIntyre, 2006). But this also implies that a simple public relations-driven approach to sustainable innovation might not be enough as it does not provide sufficient clues for differentiation in the marketplace.

Although sustainable innovation provides considerable new opportunities for companies it is accompanied by an increased complexity and possible "traps" (Hall & Vredenburg, 2003). This in turn requires certain organizational routines and capabilities to deal with the upcoming challenges. Rooted in the capability based view of the firm, we hypothesize that firms capable of realizing such innovation will have developed certain skills and competencies. These enable them to respond to stakeholders' pressures and demands and – as a consequence – to gain a head start over competitors (Eisenhardt & Martin, 2000; Hoopes, Madsen & Walker, 2003). It remains largely unclear, however, how these sustainable innovation capabilities are developed and what contribution a firm's innovation practices can actually make (Paramanathan et al., 2004). Although much work has been done to investigate the organizational outcomes of environmental initiatives, little is known about the antecedents of sustainable innovation activities (Gilley et al., 2000). Moreover, previous research has almost entirely focused on environmental innovation and environmental management systems (EMS) instead of on the broader concept of sustainability (e.g. (Foray & Grübler, 1996; Noci & Verganti, 1999; Lefebvre et al., 2003; Rennings, Ziegler, Ankele & Hoffmann, 2006). We investigate these processes and propose that sustainable innovation capabilities are the result of external demands and fitting internal absorptive capacities to leverage them.

The objective of this paper is twofold: We extend the existing literature by investigating this research question both theoretically and empirically. As Helfat and Peteraf (2003: 997) noted that "it is difficult to fully explain how firms use resources and capabilities to create a competitive advantage", we will provide recommendations on how to develop sustainable innovation capabilities. Important findings in the field have been derived from case studies or based on small samples (see for example Christmann, 2000; Hall & Vredenburg, 2003; Kreikebaum, 1999). We are able to provide empirical evidence for more than 1,100 German firms and their innovation activities. The remainder of this paper is designed as follows. Section 2 presents our conceptual considerations, focusing on the specifics of sustainable innovation and how sustainable innovation capabilities emerge. The subsequent section 3 develops a set of hypotheses that will be tested in our empirical study (section 4). Section 5 presents the results of this quantitative analysis followed by discussion and recommendations

in section 6. Section 7 closes, acknowledging some limitations of this research and providing an outlook on future research on this topic.

2 Deliberate learning and sustainable innovation capabilities

2.1 The specifics of sustainable innovation

Unique knowledge can be considered a firm's most valuable asset for generating competitive advantage (Liebeskind, 1996) as it provides firms with the necessary platform to decide which resources or capabilities to deploy, develop or discard as their environment changes (Ndofor & Levitas, 2004). This perspective is typically summarized as the knowledge based view of the firm (Grant, 1996). We suggest that the specific knowledge required for sustainable innovation entails additional layers of complexity and uncertainty.

Complex knowledge differs from simple knowledge in the amount of additional factual information that is required to transfer and understand it fully and accurately (Bhagat, Kedia, Harveston & Triandis, 2002). Sustainable innovation is related to environmental, social and economic domains (Hall & Vredenburg, 2003; Paramanathan et al., 2004). In that sense, sustainable innovation adds a broader, systematic perspective to the meaning of "sustainable" competitive advantage by incorporating the interests and needs of all parties involved; including not just shareholders but also employees, customers, local communities, regulators and advocacy groups (Gable & Shireman, 2004). The latter is an important aspect of sustainable innovation. The ability of non-governmental organizations (NGOs) to mobilize and publicize through modern communication technology has given them considerable clout on various issues ranging from food standards to child labor (Brugmann & Prahalad, 2007). These organizations have often resorted to public attacks on individual market-leading firms, with indirect repercussions for the industry as a whole. According to Hall and Vredenburg (2003), society's opinion of a technological innovation are extremely subjective, depend upon various stakeholder groups and change constantly. Some authors have captured this multidimensionality of sustainable innovation as a shift from the traditional one-dimensional profit target system towards a "triple bottom line" (Elkington, 1998). The latter adds social/ethical and environmental performance measures to traditional profit maximizing goals (Vanclay, 2004). In its simplest form this change in paradigm has the potential to save resources and hence costs, reduce a company's exposure to risks from publicized cases of malpractice (e.g. resulting in consumer boycotts) and build a favorable reputation that materializes as respect, trust and confidence (Dowling, 2004; Edelstein, 2004). However, this comprehensive target system is not very precise. Vanclay (2004), for example, presents 11 different descriptions of the triple bottom line ranging from "profit, people, planet" to "landscapes, lifestyles, livelihoods." Hence, the complexity of sustainable innovation stems from a multitude of external demands from various stakeholders with varying agendas. This makes it challenging to access and assess relevant stakeholder knowledge comprehensively because knowledge creation, organization and transfer depends heavily on the commitment and belief patterns of both holders and recipients (Nonaka, 1994).

These layers of complexity resonate inside the company. Sustainable innovation activities typically require a broader scope as they are related to different functional dimensions, i.e. spanning the human resource department, the R&D department, procurement, production and sales (Noci & Verganti, 1999). In fact, they can involve nearly all organizational functions as well as the whole supply chain. Management expertise is of particular importance as sustainable innovation projects and conventional innovation management strategies are not fully applicable (Hall & Vredenburg, 2003). This involves adequate communication with and training of employees as this domain needs to be integrated into their daily activities in order to avoid resistance and frustration. Ketata and McIntyre (2006), find that a lack of understanding for the benefits of innovating in the sustainable development domain among employees leads them to resist these projects.

Dealing with complex knowledge leads to causal uncertainty (Bhagat et al., 2002) which implies more frequent mistakes in sustainable innovation activities. Irrevocable investments into the wrong projects exhibit a considerable economic risk (Balachandra & Brockhoff, 1995). Besides, sustainability management is associated with a significant financial commitment (Walley & Whitehead, 1994). Sustainable innovation is likely to be more expensive than traditional innovation since the former involves almost the whole company structure, and implies investing in a whole set of different technologies that might considerably exceed the scope of a firm's competencies (Shrivastava, 1995). Moreover, the pay-offs from sustainable innovation may not immediately translate into monetary benefits but are often intangible and related to long-term objectives (e.g. reputation building). In contrast, the pressures to make the innovation process efficient and profitable are very direct, immediate and specific.

2.2 Learning processes and capability development

Looking at the length of time that it took companies to start developing capabilities for dealing with sustainable innovation concerns, it becomes clear that the creation of such capabilities necessarily involves a deliberate learning process. Firms obviously first need to understand the challenges of regulation and new demands in order to develop targeted capabilities that leverage competitive advantage. The knowledge (and capability[2]) based view of the firm complements traditional industry analysis in that internal and external factors have to be considered to understand the sources of such competitive advantage (Amit & Schoemaker, 1993; Sirmon, Hitt & Ireland, 2007). Several studies argue that capabilities cannot be investigated without considering their context (Atuahene-Gima & Haiyang, 2004; Brush & Artz, 1999): the "when, where and how" knowledge resources and capabilities translate into competitive advantage (Priem & Butler, 2001). We follow this stream of literature by discussing the roots of sustainable innovation capabilities and their relevant context.

[2] Capabilities are organizational processes which bundle strategic knowledge resources into unique combinations and constitute superior performance themselves. This follows the basic rationale that competitive advantage does not only arise from the possession of such resources but also from the way in which they are used (Penrose, E. T. 1959. *The theory of the growth of the firm*. Oxford.).

We argue that the mechanism behind the build-up of sustainable innovation capabilities can be regarded as a continuous and deliberate learning process (Zollo & Winter, 2002). This process describes the systematic methods a firm uses to modify its operating routines. Such routines constitute stable patterns of organizational behavior and reaction to internal or external stimuli. On the one hand, routines define predictable as well as interrelated organizational actions, e.g. the production process at globally dispersed production sites. On the other hand, a routine may also initiate the introduction of certain environmental or health standards in global production processes. Routines of this second type are typically referred to as search routines (Nelson & Winter, 1982). They deal with changes in the existing set of operating routines and can hence be seen as constitutive of sustainable innovation capabilities.

In a relatively stable environment, operating routines superior to those of competitors can be a source of competitive advantage. It may even be sufficient to rely on discrete and sporadic changes and improvements in the set of operating routines that may result from a tacit accumulation of experience. However, when the environment turns more demanding, in that new regulation is imposed from different regulatory bodies or stakeholders assert certain claims regarding the adoption of sustainable development practices, a stable set of routines might no longer be sufficient. Systematic efforts are needed to track the environment and dynamically adjust routines. This is where sustainable innovation capabilities become important. A failure to develop such capabilities, which leverage the value of a firm's resources in a more demanding environment, would turn once established core competencies into core rigidities (Leonard-Barton, 1992). A simple accumulation of experience and knowledge resulting from a repeated execution of routines combined with a process of trial-and-error will therefore not be enough for a build-up of sustainable innovation capabilities. The whole process must necessarily culminate in knowledge articulation and knowledge codification. The following section centers around these two aspects within the learning process to derive our hypotheses.

3 Hypothesis development

Knowledge articulation evolves from discursive actions between individuals and groups in the execution of organizational tasks (Levitt & March, 1988; Levinthal & March, 1993). Expressing opinions and individual viewpoints, challenging them and mutually understanding causal linkages – especially in the presence of ambiguities – are pre-requisites for making implicit or tacit knowledge explicit and hence for enabling collective learning efforts. Knowledge from relevant stakeholders has to be made available throughout the company in order to adjust operating routines accordingly and to spread successful action-performance links within the whole organization. Sirmon et al. (2007) have suggested that the effectiveness of this step also depends on environmental munificence. The varying munificence of environments might critically affect the potential value of a firm's resources and capabilities. Moreover, munificent environments can support the growth of resources within firms by providing access to complementary, external resources (Baum & Wally, 2003). We argue that sustainable innovation capabilities stem from investments in internal absorptive capacities that reflect the munificence of the environment.

3.1 Absorptive capacities for sustainable innovation

Learning processes are built around a firm's ability to extract relevant market knowledge and integrate it into new products and services as well as into the whole organization. While market impulses are generally available to all competitors, firms can differentiate themselves through their expertise in synthesizing this information, integrating and combining it with existing knowledge (Henderson & Cockburn, 1994; Kogut & Zander, 1992). An important stream of literature has summarized these capabilities as absorptive capacity (Cohen & Levinthal, 1989, , 1990): a firm's ability to identify, assimilate and exploit knowledge from the environment. This differentiation corresponds with the three learning mechanisms in organizational capability development – experience accumulation, knowledge articulation and knowledge codification – but puts a stronger emphasis on exploiting and capitalizing acquired knowledge. Several studies have linked absorptive capacity to superior firm performance (Landry, 2006; Love & Roper, 2004; Nadiri, 1993). Absorptive capacities are typically accumulated as a by-product of firms' innovation activities and hence difficult to acquire, imitate or substitute (Amit & Schoemaker, 1993).

Cohen and Levinthal (1989, 1990) follow the rationale that absorptive capacities are developed by performing R&D activities, which stresses the technological aspect of absorptive capacity. Technological advance is an obvious driver of innovation. However, absorptive capacities are especially relevant for sustainable innovation activities as they often appear outside of a firms' traditional field of technological expertise (Shrivastava, 1995). The technology for hybrid propulsion, for example, was first developed outside the automotive industry. Other studies have extended the absorptive capacity concept to include employees' level of education and academic achievement (Rothwell & Dodgson, 1991). In addition, motivational factors have been found to be important for activating these capacities (Lane & Lubatkin, 1998; Lord & Ranft, 2000). The discussion on the specifics of sustainable innovation has shown that it has both a technological and social facet. Hence we develop two hypotheses:

> Hypothesis Ia: Investments in technological absorptive capacities increase the likelihood of sustainable innovation.
>
> Hypothesis Ib: Investments in the education of employees and their individual absorptive capacities increase the likelihood of sustainable innovation.

3.2 Munificent environments for sustainable innovation

As outlined in the preceding text, sustainable innovation activities add new layers of complexity to a firms' innovation process (Noci & Verganti, 1999). As the pool of relevant stakeholders and therefore knowledge sources increases, firms need to broaden their spectrum for potential innovation impulses (Ayuso et al., 2006). Zahra and George (2002) introduce the distinction between potential and realized absorptive capacity. Put simply, they envision absorptive capacity as a funnel with a large opening for taking in a broad variety of diverse ideas with potential value. These have to be narrowed down, prioritized and codified to facilitate efficient assimilation and exploitation processes (Jansen, Van den Bosch &

Volberda, 2005). Complex knowledge requires the transfer and processing of additional knowledge that puts it into perspective. It may stem from technological, market or regulatory factors. This necessitates their integration in existing products and processes which depends heavily on available competencies. Early customer involvement has been found to be especially important for the market success of sustainable innovations (Hall & Kerr, 2003; Heiskanen, Kasanen & Timonen, 2005). However, important impulses for innovation can also be technologically or legally induced. Certain companies are more open to new ideas than others. Indeed, specific features related to the company help it to be more open to these ideas. In this context, the corporate culture and customs have an important influence. In fact, an open culture for innovation is a necessary condition for the firm to recognize the need to innovate (Ekvall & Ryhammar, 1998; Lester, 1998; van der Panne, van der Beers & Kleinknecht, 2003). Openness prevents firms from missing important dynamics in their environment (Chesbrough, 2003) and enables them to predict future trends more accurately (Cohen & Levinthal, 1994). We propose:

> Hypothesis IIa: As the diversity of external knowledge used inside the firm increases sustainable innovation becomes more likely.

However, Laursen and Salter (2006) contrast the concept of breadth in knowledge sourcing with the necessary depth. There is a need for focus as a company's information processing capacities are limited. A vast amount of ideas impedes selection and exploitation processes (Koput, 1997). Hence, we derive:

> Hypothesis IIb: As the depth of external knowledge used inside the firm increases sustainable innovation becomes more likely.

After all, it would be shortsighted to perceive sustainable innovation as a purely voluntary endeavor. Governmental and regulatory agencies play an important role in influencing sustainable innovation (Jaffe & Palmer, 1997; Lefebvre et al., 2003). Hall and Vredenburg (2003), stress this aspect when discussing the introduction of new laws that sanction those that are harmful to the environment and to the population. Following the munificence rationale, we argue that regulations can be supportive in nature, i.e. in the form of subsidies, or based on sanctioning mechanisms (Abdul-Gafaru, 2006). We therefore suggest:

> Hypothesis IIIa: As regulatory demands increase sustainable innovation becomes more likely.
>
> Hypothesis IIIb: As financial support from the government increases sustainable innovation becomes more likely.

4 Empirical study

4.1 Data

For the empirical part of this analysis we use cross section data from a survey on the innovation activities of German enterprises called the "Mannheim Innovation Panel" (MIP) The survey is conducted annually by the Centre for European Economic Research (ZEW) on

behalf of the German Federal Ministry of Education and Research. The methodology and questionnaire used by the survey, which is targeted at enterprises with at least five employees, are the same as those used in the Community Innovation Survey (CIS), conducted every four years under the coordination of Eurostat. For our analysis we use the 2005 survey, in which data was collected on the innovation activities of enterprises during the three-year period 2002-2004. About 5,000 firms in manufacturing and services responded to the survey and provided information on their innovation activities.[3] We utilize this data to operationalize the concepts presented above. Non-innovating firms were excluded from our analysis, because most variables can only be constructed for firms with innovation activities. In addition, we narrow our analysis to the manufacturing sector. As a result we retain a final sample of 1,124 innovative manufacturing firm observations.

CIS surveys are self-reported and largely qualitative which raises quality issues with regards to administration, non-response and response accuracy (for a recent discussion see (Criscuolo, Haskel & Slaughter, 2005). First, our CIS survey was administered via mail which prevents certain shortcomings and biases of telephone interviews (for a discussion see (Bertrand & Mullainathan, 2001). The multinational application of CIS surveys adds extra layers of quality management and assurance. CIS surveys are subject to extensive pre-testing and piloting in various countries, industries and firms with regards to interpretability, reliability and validity (Laursen & Salter, 2006). Second, a comprehensive non-response analysis of more than 4,200 firms showed no systematic distortions between responding and non-responding firms with respect to their innovation activities. Third, the questionnaire contains detailed definitions and examples to increase response accuracy. Longhand questions (e.g. “Please describe your most important product innovation briefly”) allow robustness checks for multiple choice answers.

In conclusion, the major advantages of CIS surveys are that they provide direct, importance-weighted measures for a comprehensive set of sources (Criscuolo et al., 2005). On the downside, this information is self-reported. Heads of R&D departments or innovation management are asked directly if and how they are able to generate innovations. This immediate information on processes and outputs can complement traditional measures for innovation such as patents (Kaiser, 2002; Laursen & Salter, 2006).

4.2 Variables and method

Measuring sustainable innovation

The previous theoretical discussion made it clear that our research question touches a multi-faceted construct. It cannot be readily observed. Hence we rely on qualitative, self-reported but importance-weighted answers to a question on the outcomes of a firm’s innovation activities. Respondents are asked to assess the importance of these outcomes on a 4 point Likert scale ranging from “not relevant” to “high”. In order to reflect the environmental and social dimensions of sustainable innovation we rely on three different outcomes: reduction in resource/energy consumption (per unit of output), reduction of economic stress and

[3] The sample was drawn using the stratified random sample technique. For a more detailed description of the dataset and the survey see Spielkamp and Rammer (2006).

improvement of health/safety. We construct a sustainability scale based on these ratings through principal factor analysis and retain a single factor with an eigenvalue larger than one (2.16; Cronbach's alpha scale reliability coefficient: 0.71; Kaiser-Meyer-Olkin measure of sampling adequacy: 0.71). A higher scale value indicates that firms assign higher importance to all three sustainable components of their innovation activities and vice versa. It will serve as the dependent variable in our empirical study.

Measuring absorptive capacity

Absorptive capacities are not a tangible concept but rather a combination of different competencies and capabilities. Hence, companies cannot be easily surveyed to estimate the degree to which they possess these absorptive capacities. Cohen and Levinthal (1989, 1990) follow the rationale that absorptive capacities are developed by performing R&D activities. We follow their suggestion and introduce R&D intensity (R&D expenditures as a share of sales) to our model. Besides, investment in employees' level of education and academic achievement have been recognized as an important indicator for a firms' absorptive capacity (Rothwell & Dodgson, 1991). We capture this item through the training expenditure per employee. Moreover, absorptive capacities are generally accumulated over time. Hence, consistent R&D engagements should produce superior results to sporadic ones. We therefore include a dummy variable indicating whether the firm performs continuous R&D activities.

Measuring environmental munificence

Laursen and Salter (2006) suggest a differentiation between breadth and depth of external innovation impulses by relying on the importance weighted information obtained through surveys. We are able to obtain information on a comprehensive list of potential sources for innovation and their importance. These nine options are suppliers, customers, competitors, consultancies, universities, public research institutions, conferences, scientific journals and trade associations. Following Laursen and Salter (2006), we measure a firm's breadth of external innovation inputs as the number of different sources used (from 0 to 9) and depth as the number of sources they assigned a high importance to.

With regards to governmental support/pressure, we add dummy variables indicating whether the firm received public funding for their innovation activities and whether it perceived regulatory pressure as an important obstacle to its (traditional) innovation activities.

Control variables

We control for several other factors that may influence the estimation results of our core variables. These control variables capture regional differences (whether the firm is located in East Germany) and a firm's size (number of employees in logs). We capture the effects from internationalization (share of exports of sales) and remaining industry effects through variables on whether a firm operates in medium high-tech manufacturing (e.g. automotives) or high-tech manufacturing (e.g. medical equipment). A detailed industry breakdown is provided in Appendix A. "Other manufacturing" (e.g. food and tobacco) will be the comparison group for all subsequent steps of the analysis.

Model and method

We choose a standard ordinary least squares regression model for estimation. One might argue that the investments in absorptive capacities are already reflected in the sources used (breadth and depth). We add absorptive capacity and munificence variables stepwise to the model and present both results. Effects should be consistent in both models.

Descriptive statistics

Appendix B provides a detailed overview on the characteristics of firms that conduct sustainable innovation activities divided by the median of the sustainable innovation scale. On average, these firms focus on resource and energy saving sustainable innovation activities followed by health and safety and environmental ones. They rely on a broad set of external sources for innovation (roughly 7) but high importance is assigned to just a single one. Firms with high sustainable innovation scale values invest more into the training of their employees and R&D. They feel more pressured by regulatory demands but are not more likely recipients of public R&D funding.

While this prima facie comparison is an early indication for the accuracy of our theoretically derived hypotheses these firms also differ in other important characteristics. They are on average larger, less frequently located in East Germany and less likely to be found in high-tech manufacturing industries. Hence, a multivariate analysis is required.

5 Results

Table 1 provides the results of the estimation. Our sample consists solely of firms with successful innovation activities. One should bear in mind that we measure differences between them with regards to sustainable aspects of innovation but not their general propensity to innovate. Focusing on the model specifications (Model I and its extension II), significant effects are consistent. Adding munificence variables increases the overall fit of the model considerably.

Table 1: Estimation results

	Model I			**Model II**		
Variable	*Coeff.*		*Std. Err.*	*Coeff.*		*Std. Err.*
R&D expenditures as a share of sales (ratio)	-0.64	*	0.38	-1.06	***	0.34
Training expenditures per employee (€)	0.40	***	0.01	0.32	***	0.01
Continuous R&D activities (dummy)	0.10		0.07	0.02		0.06
Breadth of innovation sources (index)				0.09	***	0.01

	Model I			Model II		
Variable	*Coeff.*		*Std. Err.*	*Coeff.*		*Std. Err.*
Depth of innovation sources (index)				0.05	**	0.02
High regulatory pressure on innovation activities (dummy)				0.37	***	0.08
Public funding for innovation projects (dummy)				-0.01		0.06
Location in East Germany (dummy)	-0.16		0.59	-0.03		0.05
No of employees (logs)	0.09	***	0.02	0.05	***	0.02
Share of exports of turnover (ratio)	-0.26		0.11	0.03		0.12
Medium high-tech manufacturing (dummy)	0.45		0.06	0.05		0.06
High-tech manufacturing (dummy)	-0.21	***	0.07	-0.23	***	0.05
Constant	-0.43	***	0.07	-0.92	***	0.08
Number of obs:	1,124			1,124		
Wald chi2 (12):	113.01			233.30		
Prob > chi2:	0.00			0.00		
R-squared:	0.06			0.13		
Adj R-squared:	0.05			0.12		
Root MSE:	0.82			0.79		

***, **, * indicate significance at the 1%, 5% and 10% level; bootstrapped standard errors

The estimation results reveal that investments into absorptive capacities for sustainable innovation are focused on investing in employees (positive effect of training expenditures) while investments in R&D (negative effect) are detrimental. This result holds both on the firm and the industry level (negative, significant effect on high-tech industry dummy). Therefore, Hypothesis Ia has to be rejected while Ib is supported. Continuous R&D activities, often associated with having a dedicated R&D department as a nexus of innovation engagements and learning, show no significant effect. This may be an indication for the multi-functional nature of sustainable innovation (Hall & Vredenburg, 2003).

With regard to the munificence of the environment both the breadth and depth of external innovation sources have a positive significant effect. Hypotheses IIa and IIb can be accepted. Interestingly, the effect of breadth is stronger. Direct regulatory pressure has a significant positive effect on sustainable innovation engagements while public funding produces no significant effect. Hypothesis IIIa is supported while IIIb has to be rejected. Control variables have no significant impact, except for firm size, which propels sustainable innovation, and the already mentioned negative effect in high-tech manufacturing.

6 Discussion and implications

Our analysis focused on the processes that allow firms to develop sustainable innovation capabilities. We suggest conceptually that the knowledge required for successful sustainable innovation is both more complex and more uncertain than for traditional innovation engagements. We argue that this needs to be reflected in a firm's investments in absorptive capacities and the breadth and depth of their learning engagements. Although prior studies have mostly dealt with the organizational outcomes of environmental activities little work has been devoted to develop a systematic understanding on how firms are brought in a position to actually implement such activities (Gilley et al., 2000). The current study addresses this gap in the literature by developing a conceptual framework rooted in the capability-based view of the firm. It turns out that the development of sustainable innovation activities can on the one hand be attributed to internally available absorptive capacities and on the other hand to the munificence of the environment. These results are discussed in more detail below, as are the limitations of the study and potential avenues for further research.

Our findings directly translate into management recommendations on how to strengthen or develop sustainable innovation capabilities. We find strong benefits of investing in the training of employees as opposed to technological R&D. We suggest that the merits of internal R&D may be limited as important technological impulses for sustainable innovation appear outside a firm's traditional fields of technological expertise (Shrivastava, 1995). Technological breakthroughs in energy storage and batteries for fuel efficient hybrid car production may be a fitting example. Motivated and well trained employees may give firms broader interfaces to deal with a multitude of potential stakeholders in the environment (Ayuso et al., 2006). This includes not only the ability to collect impulses but also to set priorities and choose the crucial ones. This function is ideally realized by technological "gatekeepers" (Hauschildt & Schewe, 1997) who are able to both identify promising external technological impulses and funnel them into the R&D organization.

This line of reasoning resonates immediately with our findings on the breadth and depth of innovation impulses. The former represents the potential of ideas for a company while the latter implies boiling them down to a few important ones to act on efficiently (Jansen et al., 2005). Both are important for sustainable innovation capabilities. Apparently, breadth is even more important than depth. We suggest that the dangers from blind spots or betting on the wrong horse are especially pronounced in sustainable innovation. Firms may hedge against long-lasting reputation effects from individual failures or cases of malpractice. Finally, we find that firms respond to the traditional mechanisms of regulatory intervention when it comes to sustainable innovation. In that sense, sustainable innovation may not just be a chosen capability but also a mandatory one.

7 Limitations and further research

Our analysis is constrained by certain limitations which may in turn provide opportunities for further research. First, our empirical analysis is limited to Germany. The country has a

large tradition of societal, political and regulatory awareness for environmental challenges. In fact, Germany has been frequently characterized as a lead market for sustainable innovation (Beise-Zee & Rennings, 2005). However, it may not be representative for other countries with different backgrounds and structures. Hence, we encourage comparative studies, for which harmonized European CIS data may be an excellent platform. Second, our findings on the link between openness to external ideas, internal absorptive capacities and successful sustainable innovation beg more in-depth analysis. Third, we capture only a single point in time. Sustainable innovation, however, follows long-term orientations that should be explored through longitudinal data.

8 Appendix

Appendix A: Industry classification

Industry	NACE Code	Industry Group
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Machinery and equipment	29	Medium high-tech manufacturing
Electronics	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Motor vehicles	34 – 35	Medium high-tech manufacturing
Furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing

Appendix B: Descriptive Statistics

Variables	Full sample		Above median sustainability scale		Below/equal median sustainability scale	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Innovation outcome: Resource/energy cost reduction (max. 3)	1.21	0.94	1.82	0.87	0.74	0.69
Innovation outcome: Reduction of environmental stress (max. 3)	0.96	0.92	1.71	0.80	0.38	0.51
Innovation outcome: Improvement of health/safety (max. 3)	1.00	0.95	1.76	0.80	0.41	0.55
Training expenditures per employee (€)	1.04	2.01	1.15	2.56	0.95	1.46
R&D expenditures as share of sales (ratio)	0.04	0.07	0.03	0.06	0.04	0.08
Continuous R&D activities (dummy)	0.47	0.50	0.52	0.50	0.43	0.50
Breadth of innovation sources (index)	6.69	2.02	7.18	1.85	6.31	2.07
Depth of innovation sources (index)	1.18	1.17	1.34	1.26	1.05	1.08
High regulatory pressure on innovation activities (dummy)	0.11	0.32	0.15	0.36	0.09	0.28
Public funding for innovation projects (dummy)	0.29	0.45	0.29	0.45	0.28	0.45
Location in East Germany (dummy)	0.30	0.46	0.27	0.45	0.32	0.47
No. of employees	276.01	637.06	370.71	771.99	202.50	496.54
Share of exports of turnover (ratio)	0.26	0.27	0.28	0.269	0.25	0.26
Other manufacturing (dummy)	0.58	0.49	0.59	0.49	0.57	0.49
Medium high-tech manufacturing (dummy)	0.27	0.44	0.30	0.46	0.25	0.43
High-tech manufacturing (dummy)	0.15	0.36	0.12	0.32	0.18	0.39
Observations	1,124		493		635	

9 References

Abdul-Gafaru, A. 2006. Are multinational compatible with sustainable development? The experience of developing countries. *International Research colloquium on Multinational Enterprises and Sustainable Development: strategic tool for Competitiveness*. Atlanta.

Amit, R., & Schoemaker, P. J. H. 1993. Strategic assets and organizational rent. *Strategic Management Journal, 14(1)*: 33-46.

Atuahene-Gima, K., & Haiyang, L. 2004. Strategic Decision Comprehensiveness and new Product Development Outcomes in new Technology Ventures. *Academy of Management Journal, 47(4)*: 583-597.

Ayuso, S., Rodriguez, M. A., & Ricart, J. E. 2006. Using stakeholder dialogue as a source for new ideas: A dynamic capability underlying sustainable innovation. *IESE Working Paper*. Barcelona.

Balachandra, R., & Brockhoff, K. 1995. Are R&D project termination factors universal? *Research Technology Management, 38(4)*: 31-36.

Baum, J. R., & Wally, S. 2003. Strategic decision speed and firm performance. *Strategic Management Journal, 24*: 1107-1129.

Beise-Zee, M., & Rennings, K. 2005. Lead Markets and Regulation: A Framework for Analyzing the International Diffusion of Environmental Innovation. *Ecological Economics, 52(1)*: 5-17.

Berry, M. A., & Rondinelli, D. A. 1998. Proactive corporate environmental management: A new industrial revolution. *Academy of Management Executive, 12(2)*: 38-50.

Bertrand, M., & Mullainathan, S. 2001. Do People Mean What They Say? Implications for Subjective Survey Data. *American Economic Review, 91(2)*: 67-72.

Bhagat, R. S., Kedia, B. L., Harveston, P. D., & Triandis, H. C. 2002. Cultural Variations in the Cross-Border Transfer of Organizational Knowledge: An Integrative Framework. *Academy of Management Review, 27(2)*: 204-221.

Brugmann, J., & Prahalad, C. K. 2007. Cocreating Business's New Social Compact. *Harvard Business Review, 85(2)*: 80-90.

Brush, T. H., & Artz, K. W. 1999. Toward a Contingent Resource-Based Theory: The Impact of Information Asymmetry on the Value of Capabilities in Veterinary Medicine. *Strategic Management Journal, 20(3)*: 223-250.

Chesbrough, H. W. 2003. *Open Innovation - The New Imperative for Creating and Profiting from Technology*. Boston, USA: Harvard Business School Press.

Christmann, P. 2000. Effects of "Best Practices" of Environmental Management on Cost Advantage: The Role of Complementary Assets. *Academy of Management Journal, 43(4)*: 663-680.

Christmann, P., & Taylor, G. 2002. Globalization and the environment: Strategies for international voluntary environmental initiatives. *Academy of Management Executive, 16(3)*: 121-135.

Cohen, W. M., & Levinthal, D. A. 1989. Innovation and learning: the two faces of R&D. *The Economic Journal, 99(397)*: 569-596.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive Capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35(1)*: 128-152.

Cohen, W. M., & Levinthal, D. A. 1994. Fortune Favors the Prepared Firm. *Management Science, 40(2)*: 227-251.

Criscuolo, C., Haskel, J. E., & Slaughter, M. J. 2005. Global Engagement and the Innovation Activities of Firms. *NBER Working Paper*. Cambridge, MA.

Dowling, G. R. 2004. Corporate Reputations: Should you Compete on Yours? *California Management Review, 46(3)*: 19-36.
Edelstein, M. R. 2004. Sustainable innovation and the siting dilemma: thoughts on the stigmatization of projects and proponents, good and bad. *Journal of Risk Research, 7(2)*: 233-250.
Eisenhardt, K. M., & Martin, J. A. 2000. Dynamic capabilities: What are they? *Strategic Management Journal, 21(10/11)*: 1105-1121.
Ekvall, G., & Ryhammar, L. 1998. Leadership Style, Social Climate And Organizational Outcomes: A study of a Swedish University College. *Creativity & Innovation Management, 7(3)*: 126-130.
Elkington, J. 1998. Partnerships from Cannibals with Forks: The Triple Bottom Line of 21st-Century Business. *Environmental Quality Management, 8(1)*: 37-51.
Foray, D., & Grübler, A. 1996. Technology and the environment: an overview. *Technological Change and Social Forecasting, 53(1)*: 3-13.
Gable, C., & Shireman, B. 2004. The Stakeholder Imperative. *Environmental Quality Management, 14(2)*: 1-8.
Gilley, K. M., Worrell, D. K., Davidson III, W. N., & El-Jelly, A. 2000. Corporate environmental initiatives and anticipated firm performance: The differential effects of process-driven versus product-driven greening initiatives. *Journal of Management, 26(6)*: 1199-1216.
Grant, R. M. 1996. Toward a Knowledge-Based Theory of the Firm. *Strategic Management Journal, 17*: 109-122.
Hall, J., & Kerr, R. 2003. Innovation dynamics and environmental technologies: the emergence of fuel cell technology. *Journal of Cleaner Production, 11(4)*: 459-471.
Hall, J., & Vredenburg, H. 2003. The Challenges of Innovating for Sustainable Development. *Mit Sloan Management Review, 45(1)*: 61-68.
Hauschildt, J., & Schewe, G. 1997. Gatekeeper und Promotoren. Schlüsselpersonen in Innovationsprozessen in statischer und dynamischer Perspektive. *Die Betriebswirtschaft, 57*: 506-616.
Heiskanen, E., Kasanen, P., & Timonen, P. i. 2005. Consumer participation in sustainable technology development. *International Journal of Consumer Studies, 29(2)*: 98-107.
Helfat, C. E., & Peteraf, M. A. 2003. The dynamic resource-based view: capabilities life cycles. *Strategic Management Journal, 24*: 997-1010.
Henderson, R., & Cockburn, I. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal, 15(8)*: 63-84.
Hoopes, D. G., Madsen, T. L., & Walker, G. 2003. Guest editors' introduction to the special issue: why is there a resource-based view? Toward a theory of competitive heterogeneity *Strategic Management Journal, 24*: 889-902.
Jaffe, A., & Palmer, K. 1997. Environmental Regulation and Innovation: A Panel Data Study. *Review of Economics and Statistics, 79(4)*: 610-619.
Jansen, J. J. P., Van den Bosch, F. A. J., & Volberda, H. W. 2005. Managing Potential and Realized Absorptive Capacity: How Do Organizational Antecendents Matter? *Academy of Management Journal, 48(6)*: 999-1015.
Kaiser, U. 2002. An emprical test of models explaining research expenditures and research cooperation: evidence for the German service sector. *International Journal of Industrial Organization, 20(6)*: 747-774.
Ketata, I., & McIntyre, J. 2006. Sustainable development Innovation and Multinational Firms: contrasting corporate approaches. *International Research Colloquium on multinational enterprises and sustainable development: strategic tool for competitiveness*. Atlanta.
Kogut, B., & Zander, U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3(3)*: 383-397.

Koput, K. W. 1997. A Chaotic Model of Innovative Search: Some Answers, Many Questions. *Organization Science, 8(5)*: 528-542.
Kreikebaum, H. 1999. Der Einfluss von Gutenbergs Organisationskonzeption auf moderne Ansätze der Organisation. In H. Albach, K. Brockhoff, E. Eymann, A. Luhmer and M. Steven (Eds.), *Die Theorie der Unternehmung in Forschung und Praxis*: 569-584. Berlin et al.
Landry, R. 2006. Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities. *Research Policy, 35*: 1599-1615.
Lane, P. J., & Lubatkin, M. 1998. Relative Absorptive Capacity and Interorganizational Learning. *Strategic Management Journal, 19*: 461-477.
Laursen, K., & Salter, A. 2006. Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal, 27(2)*: 131-150.
Lefebvre, É., Lefebvre, L. A., & Talbot, S. 2003. Determinants and impacts of environmental performance in SMEs. *R&D Management, 33(3)*: 263-283.
Leonard-Barton, D. 1992. Core capabilities and core rigidities: a paradox in managing new product development. *Strategic Management Journal, 13(5)*: 111-125.
Lester, D. H. 1998. Critical success factors for new product development. *Research Technology Management, 41(1)*: 36-43.
Levinthal, D. A., & March, J. G. 1993. The myopia of learning. *Strategic Management Journal, 14*: 95-112.
Levitt, B., & March, J. G. 1988. Organizational learning. *Annual Review of Sociology, 14*: 319-340.
Liebeskind, J. P. 1996. Knowledge, Strategy and the Theory of the Firm. *Strategic Management Journal, 17*: 93-107.
Lord, M. D., & Ranft, A. L. 2000. Organizational Learning About New International Markets: Exploring the Internal Transfer of Local Market Knowledge. *Journal of International Business Studies, 31(4)*: 573-589.
Love, J. H., & Roper, S. 2004. Knowledge Sourcing, Innovation and Performance: A Preliminary Analysis of Irish Innovation Panel Data. *Aston Business School Working Paper*. Birmingham.
Nadiri, I. M. 1993. Innovations and Technological Spillovers., *NBER Working Paper*. Cambridge, MA.
Ndofor, H. A., & Levitas, E. 2004. Signaling the Strategic Value of Knowledge. *Journal of Management, 30(5)*: 685-702.
Nelson, R. R., & Winter, S. G. 1982. *An evolutionary theory of economic change*. Cambridge, MA: Harvard University Press.
Noci, G., & Verganti, R. 1999. Managing 'green' product innovation in small firms. *R&D Management, 29(1)*: 3-15.
Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. *Organization Science, 5(1)*: 14-37.
Ottman, J. A., Stafford, E. R., & Hartman, C. L. 2006. Avoiding green marketing myopia. *Environmment, 48(5)*: 5-36.
Paramanathan, S., Farrukh, C., Phaal, R., & Probert, D. 2004. Implementing industrial sustainability: the research issues in technology management. *R&D Management, 34(5)*: 527-537.
Penrose, E. T. 1959. *The theory of the growth of the firm*. Oxford.
Priem, R. L., & Butler, J. E. 2001. Is the resource-based "view" a useful perspective for strategic management research? *Academy of Management Review, 26(1)*: 22-40.
Rennings, K. 2000. Redefining Innovation - Eco-Innovation Research and the Contribution from Ecological Economics. *Ecological Economics, 32*: 319-332.

Rennings, K., Ziegler, A., Ankele, K., & Hoffmann, E. 2006. The influence of different characteristics of the EU environmental management and auditing scheme on technical environmental innovations and economic performance. *Ecological Economics, 7(1)*: 45-59.
Rindova, V. P., Williamson, I. O., Petkova, A. P., & Sever, J. M. 2005. Being Good or Being Known: An Empirical Examinations of the Dimensions, Antecedents, and Consequences of Organizational Reputation. *Academy of Management Journal, 48(6)*: 1033-1049.
Rothwell, R., & Dodgson, M. 1991. External linkages and innovation in small and medium-sized enterprises. *R&D Management, 21*: 125-137.
Shrivastava, P. 1995. Environmental technologies and competitive advantage. *Strategic Management Journal, 16*: 183-200.
Sirmon, D. G., Hitt, M. A., & Ireland, R. D. 2007. Managing firm resources in dynamic environments to create value: looking inside the black box. *Academy of Management Review, 32(1)*: 273-292.
Spielkamp, A., & Rammer, C. 2006. Balanceakt Innovation - Erfolgsfaktoren im Innovationsmanagement kleiner und mittlerer Unternehmen.
van der Panne, G., van der Beers, C., & Kleinknecht, A. 2003. Success and Failure of Innovation: A Literature Review. *International Journal of Innovation Management, 7(3)*: 309-338.
Vanclay, F. 2004. The Tripple Bottom Line and Impact Assessment: How do TBL, EIA, SIA, SEA and EMS Relate to Each Other? *Journal of Environmental Assessment Policy & Management, 6(3)*: 265-288.
Verloop, J. 2006. The Shell way to innovate. *International Journal of Technology Management, 34(3/4)*: 243-259.
Walley, N., & Whitehead, B. 1994. It's not easy being green. *Harvard Business Review, 72*: 46-52.
Zahra, S. A., & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27(2)*: 185-203.
Zollo, M., & Winter, S. G. 2002. Deliberate Learning and the Evolution of Dynamic Capabilities. *Organization Science, 13(3)*: 339-351.