Regulation and Decision Making: Three Essays

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1 General Introduction

The impact of regulation on economic activity, growth and development is subject of a growing body of academic literature. Regulation provides a powerful policy tool for market intervention and for forming the economic environment. Without regulation, market forces determine the allocation of resources, thereby shaping economic conditions. Yet, this may lead to market solutions which are socially not desirable, for example market power exploitation or the creation of negative externalities.

In recent years, the academic discussion about market regulation received a lot of public and political attention. Research by Djankov et al. (2002), for example, triggered an international wave of market entry deregulation (Arruñada 2007). The authors show that entry regulation is not related to an increase in the quality of goods and services, but positively correlated with corruption and the size of the inofficial economy. Complementary studies show that entrepreneurial activity, measured for example as the number of entrants, entry size or operating margin, is higher in less regulated markets (see Becht et al. (2008), Fisman & Sarria-Allende (2010), Klapper et al. (2006)). This provides further evidence in favor of market entry deregulation. On the contrary, in the wake of the financial crisis of 2008, many economists as well as politicians discussed the necessary refinements of financial market regulation in order to stabilize the financial and therefore the economic system (see for example Goodhart (2008) and CEPR (2009)).

According to Djankov (2009), the theoretical literature explaining the existence of regulation can be grouped along two strands.[1] The public choice theory argues that regulation is implemented by self-centered interest groups of incumbent firms or politicians and bureaucrats. It comes in two forms: According to the capture theory, industry incumbents are interested in regulation in order to increase entry barriers. Less competition is conducive to the realization of extra rents. The tollbooth theory argues that politicians and officials pursue regulation for individual rent seeking in form of bribes, votes and other benefits. In both forms of the public choice theory, regulation is not meant to improve social welfare, but exists only to the benefit of particular groups.

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[1]For more details see Djankov (2009) and the literature cited therein.

The public interest theory, on the other hand, explains regulation as an attempt of policy makers to prevent market failure and inefficient outcomes. Their aim is to achieve superior welfare levels and to protect the society from a misuse of market power. According to the public interest theory, adequate market regulation leads to better welfare outcomes that are closer to the social optimum.

Considering the contrary motives for regulation, it is important to understand how precisely regulation influences markets in order to evaluate the economic effect and welfare implications. In an increasingly complex economic environment, the understanding of regulatory (side) effects is crucial for a target-oriented application.

There is a wide spectrum of research questions concerning regulation and they can be grouped along different dimensions. The literature can be ordered by the regulated market type, such as labor market regulation, product market regulation, or financial market regulation, as well as combinations in order to investigate interaction effects.[2] Alternatively, one may classify the literature according to the group that is affected, such as startup firms (for example regulation of firm entry as in Klapper et al. (2006)), banks and other financial institutions (for example the effects of banking (de-)regulation as in Angelini & Cetorelli (2003)), or the effect on individuals (for example through access to financial markets for potential entrepreneurship as in Black & Strahan (2002)). The research questions could also be grouped along the "life-cycle" of a regulation, ranging from the explanation for its existence or necessity, over the understanding of the precise mechanism that influences market participants' behavior, to the economic evaluation of a currently active regulation, up to the effects of deregulation. These multiple dimensions show that regulations are very complex policy tools, which are not homogeneous with respect to their application and economic effect, and thus every setting requires scrutiny.

This dissertation consists of three studies which target different facets of regulation by investigating different stages in the life-cycle. In the following, we present an overview of each chapter: We briefly summarize each study's topic and objective, point out the different methodological approaches and present the main results. Individuals or small and medium enterprises are at the center of all chapters. We use this microeconomic perspective to explore the mechanisms of regulation and the determinants of individual decision making. Every chapter has its own research question which raises its own methodological challenges. Therefore, we employ diverse investigation methods: Depending on the specific research

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[2]Respective examples in the literature are Botero et al. (2004), Kerr & Nanda (2009), and Aghion et al. (2008).

question, every chapter displays the results of an analysis which is based on a different methodological approach and data base. All chapters are self-contained. Therefore, the reader is free to choose the order of reading the chapters according to her interests.

Portfolio Selection and Framing: Experimental Evidence[3]

First, we consider a potential case for the implementation of legal guidelines for private investor protection. Prior research has shown that individuals do not behave according to the assumptions of standard economic models and suffer from cognitive biases and imperfect information processing (DellaVigna 2009). According to the public interest theory, regulation is imposed in order to solve market failures and to enhance social welfare. This includes the protection of market participants from the exploitation of their biases.

In Chapter 2, we analyze how the presentation of portfolio risk and return information, either in terms of percentage changes or final asset values, influences private investors' portfolio selections. For this investigation of information framing on private investor decision making, we design an online experiment in survey form. In contrast to the observation of real world portfolio selections, the experimental setup allows to design a controlled decision environment such that we can isolate the effect of information framing. In order to recruit experiment participants, an article was launched in the print and online issue of the investor magazine Börse Online (2008). This recruiting channel reflects two important aspects of our experiment: First, we recruit subjects who have investment experience and a pronounced interest in financial matters. A test on financial literacy and a survey about the demographic background reveal that our sample does not represent the average German population, but rather the group of experienced private investors. Second, this recruiting channel reaches a large number of subjects. Over 4,000 participants start the online experiment and we include 2,908 finalized observations in our study. This large number of participants makes this study outstanding in the field of online experiments and enables us to derive statistically robust results.

Using 2,908 experimental survey observations, we find that information framing significantly affects rational decision-making: From a set of dominating and dominated portfolios, dominated portfolios are selected more frequently if subjects are provided with final asset values as opposed to percentage changes information. Furthermore, the framing of information as percentage changes consistently induces less risk-taking in single invest-

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[3]Earlier drafts of the analysis presented in Chapter 2 were presented at: Summer School on Economic Behavior, Law and Organizations in Arco, Italy (July 2009); HypoVereinsbank-UniCredit (HVB) Doctoral Seminar in Oldenburg, Germany (February 2010); Foundations and Applications of Utility, Risk and Decision Theory (FUR) in Newcastle, United Kingdom (June 2010); World Meeting of the Economic Science Association (ESA) in Copenhagen, Denmark (July 2010).

ment decisions as well as in a series of portfolio choices. These results are startling because both frameworks are common in investment advice and our subject pool largely consists of active private investors with investment experience. Since framing influences even these financially more literate and interested subjects, we assume that our results provide a lower bound to the framing effect in the average population. Thus, private investors might be vulnerable to manipulation by financial advisors, banks, and other sophisticated market participants. Regulatory guidelines could lead to a standardization of information, which may support private investors to have an unbiased perception of risk and return, and to make rational investment decisions which suit their individual interests. After considering a potential reason for policy interventions, we analyze the impact of an existing regulation in Chapter 3.

Incorporation Law and Entry[4]

Once a regulation is in place, it should be scrutinized with respect to its desired – as well as undesired – effects on market participants and economic outcomes.[5] Hence, in Chapter 3, we empirically investigate the economic impact of German corporate law regulation on entrepreneurial activity, that is on the number of entrants and the entry size of startups. Entrepreneurs who strive for limited liability have to incorporate their firm according to the legal guidelines, otherwise they are personally liable for their business.

In order to evaluate the effect of corporate law regulation on entry activity and size, we employ a stratified random firm sample from panels of the Centre of European Economic Research (ZEW), Mannheim. It covers all German regions and major industries, and contains extensive firm and owner information (Prantl 2003). The dataset analyzed in this study encompasses 11,518 startup firms. The data is particularly suitable for our analysis, because the detailed information combined with the unique setting of German unification allows the identification of the regulatory effect.

Before unification, Germany consisted of the East and West German territory which had distinct, historically grown economic environments. Due to unification, the East German economy opened up for private businesses and therefore entrepreneurship was flourishing. Furthermore, German unification lead to the application of West German corporate law

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[4]The work presented in Chapter 3 is joint work with Prof. Dr. Susanne Prantl (University of Cologne; Max Planck Institute for Research on Collective Goods, Bonn; Institute for Fiscal Studies, London). Earlier versions were presented in an informal Doctoral Seminar at the University of Hamburg, Germany (December 2008) and the 36th Annual Conference of the European Association for Research in Industrial Economics (EARIE) in Ljubljana, Slovenia (September 2009).

[5]We investigate corporate law regulation as an entry regulation. Djankov (2009) surveys the literature with respect to market entry regulation across countries, providing evidence on latest deregulations and empirical results on the effects of entry regulation.

in the East German territory, such that both parts of the country became subject to the same regulation. In the Western part, the economic and legal situation with respect to entrepreneurial activity remained stable. Using this setting, we can set up a difference-in-difference estimation approach: We observe corporate and non-corporate startups, and compare the respective differences in entry and entry size between the high-entry East German territory and the stable-entry West German territory. This approach isolates the differential effect of corporate law regulation on entrepreneurial activity across the two territories, and controls for base effects of firm location and limited liability.

Our results suggest that regulatory requirements reduce the entry of limited liability firms compared to full liability firms more strongly in East Germany than in West Germany. Furthermore, we find that the difference in entry size between limited liability firms and full liability firms is significantly higher in East Germany than the respective West German difference. These results indicate a strong impact of corporate law regulation on entry dynamics and suggest that corporate law regulation hampers firm incorporation more in a transitory, expanding economy. Therefore, special scrutiny is necessary when transferring existing regulations to new territories.

Experimental Investigation of Entry Regulation and Overconfident Entry[6]

After investigating a potential reason for legal protection of private investors in Chapter 2, and the analysis of the economic impact of entry regulation in Chapter 3, we finally want to find an answer to the following question: How precisely does regulation influence the behavior and decision making of market participants? In Chapter 4, we continue to investigate market entry regulation and shed light on the role of entry regulation on the process of entrepreneurial self-selection. Entrepreneurial self-selection is still a black box in the academic literature: An empirical study can only evaluate the regulatory impact on measurable outcomes of the decision making process, but it is limited with respect to conclusions about the process itself. Entry regulation was shown to decrease the rate of business creation, but little is known about its impact on entrepreneurial self-selection. Entrepreneurial self-selection is hard to identify in the field, especially if it involves characteristics such as overconfidence in own skills which cannot be observed or quantified directly. Overconfidence is a recognized, though not necessarily desirable trait of entrepreneurs, because it can cause excess entry as well as high failure rates among startups. Skilled entrepreneurs, on the other hand, should be encouraged to enter because they are more likely to found startups that contribute to economic prosper.

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[6]The investigation and results of Chapter 4 were presented in the Adam Smith Research Seminar at the University of Hamburg, Germany (November 2010).

The central problem in the investigation of entry regulation is the lack of information about potential entrepreneurs who would have founded a firm in the absence of entry regulation. To overcome this problem, we use a laboratory experiment which constitutes a well-controlled decision environment. The participating 80 student subjects have an economic background and can be assumed to resemble a group of potential future entrepreneurs. We design a market entry game with regulatory entry costs, which builds on the experiment by Camerer & Lovallo (1999) to capture overconfident entry. Using the results of three skill tasks, we derive a skill ranking of subjects relative to each other which serves as a proxy for the general skill level. The sessions and market settings are structured such that they are suitable to identify the effect of entry regulation on overconfident and skilled entry, while controlling for the base effects of regulation and overconfidence on market entry.

In our experimental markets, we find that total entry decreases in regulated markets, whereas overconfident entry increases. Furthermore, skilled subjects are less likely to enter regulated markets. Our results suggest that entry regulation not only causes less entry, but more importantly, it leads to an impairment of the quality of the entrant pool with respect to skills and overconfidence. The study provides a first piece of evidence in the missing link between theoretical contributions about entrepreneurial overconfidence and empirical studies addressing the effect of entry regulation.

The results presented in Chapter 3 and 4 provide insights about the effect and mechanism of entry regulation. We can show that regulation influences the number and size of start-ups, as well as the self-selection process with respect to entrepreneurial overconfidence and skills. Combining the results, they may be used as arguments in favor of market entry deregulation. On the other hand, we found in Chapter 2 that cognitive limits and behavioral biases can lead to suboptimal decisions. This may provide a good reason for the implementation of regulation. Therefore, the present dissertation highlights the complexity of regulation and its economic consequences.

2 Portfolio Selection and Framing: Experimental Evidence

2.1 Introduction

Private investor participation in financial markets is becoming increasingly important, e.g. for retirement savings, and has been growing over the last decades due to easier market access and better information provision. Adequate risk-taking and optimal portfolio selection are important levers for financial well-being. Nevertheless, surprisingly little is known about the drivers of individual financial decisions and therefore we follow the call of Campbell (2006) for further research on this subject.

Private investors face a vast variety of financial products. The corresponding information is available through manifold sources such as the internet and newspapers, product brochures, financial advisors, or friends and family. These sources do not only differ with respect to information quality, but also employ distinct frameworks for information presentation. Newspapers, for example, are more inclined to state return information in terms of percentage changes to cater to all readers independent from their wealth, whereas a financial advisor considers the statement of the investment's final asset value as an individual service to the client. To our knowledge, this is the first study to explicitly investigate the seemingly minor difference in stating portfolios' risk-return information either in terms of percentage changes or in final asset values.

Framing is the logically equivalent rewording of choice descriptions. According to the invariance assumption of standard economic decision models, the framing of portfolio return information should not influence portfolio selection. Yet, it can change the perspective on the decision problem and we show that information framing not only influences rational portfolio selection, but also financial risk-taking. Considering the every-day nature of the two frameworks, our research provides a relevant starting point for advisory guidelines and regulations concerning financial information presentation.

We conduct a between-subject online experiment with 2,908 participants who select their

preferred portfolios from different sets of investment alternatives. For each portfolio we present simple, lottery-like information about expected returns and losses either in terms of percentage changes or final asset values. Within the portfolio choice sets, some risk-return combinations dominate others in the Markowitz sense.[1] This allows the identification of rational decisions and conclusions about risk-taking behavior depending on the framing of the provided information. In addition, a close investigation of risk aversion and financial literacy is conducted.

Overall, 17.6% of the participants do not detect patterns of dominance among the offered investment alternatives leading to irrational selections of inferior portfolios. A closer look reveals that information framing significantly influences rational decision making: Subjects with return information in terms of percentage changes select less frequently dominated portfolios than participants receiving final asset values (14.7% vs. 20.7% respectively). Furthermore, the risk-return level of the first selected portfolio is higher in case of final asset value information. In subsequent decisions, the majority of subjects in both treatment groups keeps the return level constant and does not change it upon the inclusion of additional investment opportunities.[2] Nevertheless, *if* subjects change their initial return level, participants in the percentage changes framework are more likely to choose lower returns, whereas subjects with final asset value information tend to increase them. Thus, framing information in terms of final asset values does not only lead to higher risk-return levels in the initial but also in subsequent portfolio decisions.

A complementary analysis focusses on financial literacy and risk aversion since these are known to be related to portfolio selection.[3] We find that financial risk aversion is intra-domain specific and hinges on the elicitation context. The analysis of self-perceived and actual financial literacy detects differences between these two measures. The level of self-perceived financial literacy is related to the decision for risk-return levels, but the actual financial literacy measured in a quiz correlates with rational portfolio selection. Our results indicate that even financially literate private investors lack basic knowledge of financial engineering. The regression results for the framing effect are robust to the inclusion of control variables for financial literacy and risk aversion which are recognized determinants of portfolio selection. According to investor protection laws, financial advisors are required to ask clients about their investment experience and risk behavior in order to provide

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[1] Dominance of a portfolio occurs if it has the same risk at a higher return or a lower risk at the same return, compared to another portfolio. Markowitz (1952) refers to the return's standard deviation as risk measure. We apply the same concept of dominance, but state risk in a different way.

[2] Risk and return are positively correlated, i.e. a higher return implies a higher risk level.

[3] Frederick (2005) for example shows that cognitive reflection matters for risky decisions by increasing task objectivity, leading to lower behavioral bias. In general, financial literacy appeals to the accurate evaluation of portfolio risk and aligning it with the individual level of risk aversion.

adequate consultancy and product choices. Our results suggest that this is not sufficient. The remainder of the chapter is organized as follows. The following section derives the hypotheses in the literature context. Section 2.3 presents the experimental setup and accomplishment, followed by a data and sample description. The empirical analysis in Section 2.5 starts with the effect of framing on rational decision making, before turning to the investigation of risk-return level choices. It includes an overview of our findings with respect to financial literacy and risk aversion as well as robustness checks, and provides a brief discussion of the results. Finally, we conclude.

2.2 Literature Review and Derivation of Hypotheses

The effect of framing has been considered in financial and non-financial contexts (e.g. Tversky & Kahneman (1981), Levin et al. (1998)) and investigated for marketing purposes of financial products (Jordan & Kaas 2002).[4] The particular case of framing portfolio return information in percentage changes or final asset values has received little attention despite – or maybe because of – being such common information representations. Nevertheless, some studies have considered similar settings or frames. Glaser et al. (2007) show that the forecast of stock prices hinges on the elicitation frame: Mean reversion prevails in price level forecasts, and trend persuasion dominates in forecasts in terms of price changes. Whereas Glaser et al. (2007) investigate the subjects' active forecast results depending on the elicitation frame, our study analyzes the investment decision as a reaction to given information in these two frames. Andreassen (1988) experimentally analyzes individual trading behavior and finds that subjects track stock prices better if they are provided with information about prices rather than price changes.[5] The author concludes that the type of information matters for stock trading but that "much research is needed to establish the severity of the flaws in the judgement and choice processes of real investors" [p. 386]. In the consumer credit market, Bertrand et al. (2005) apply different frames for interest rate conditions and competitor comparisons in a field experiment. It results that the gain/loss frame in the competitor comparison only has an impact on the credit take-up rate if the comparison is presented as monthly Rand savings, which is the most familiar information frame for the debtors.[6] In the context of money illusion, Shafir et al. (1997) find similar

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[4]Bertrand et al. (2006) consider the influence of marketing and framing for helping less wealthy people to make good decisions and to increase welfare. Marketing can also "exploit" patterns in human behavior by framing because the information receiver tends to interpret the information frame chosen by the sender as additional information (McKenzie & Nelson 2003).

[5]Andreassen provides price changes in absolute terms and not percentage changes. We concentrate on the investigation of information provision in terms of percentage changes because it is more common in the financial context due to its independence of the underlying investment sum.

[6]The published version of the paper no longer includes this information (Bertrand et al. 2010).

buying and selling decisions if information on inflation gains and losses is presented in either percent or total value changes. The results indicate that in their context framing does not matter such that they pool the observations. To summarize, the existing evidence is mixed and not conducive to draw conclusions about the effect of framing portfolio return information on private investors' portfolio selection. This study closes the gap and provides new insights about the decision process and its determinants.

Our research also relates to the literature of decision making under risk. We present information about expected returns either as positive and negative percentage changes relative to the investment sum over the investment period, or as information about the expected final asset values at the end of the investment horizon. These are the most common presentation modes for investment product information.[7] The content of information is equivalent and therefore allows to test whether framing influences portfolio selection. Specifically, we analyze 1) whether subjects recognize portfolio dominance and make rational decisions in a simple information setting, 2) whether subjects systematically pick portfolios with different risk-return characteristics, and 3) whether subsequent portfolio decisions and adjustments differ across the presentation frames.

Standard choice models, such as the expected utility theory or Markowitz's portfolio selection, build on conventional economic assumptions. According to the assumption of invariance, the framing of information does not matter – subjects have well-defined, stable preferences and base their decision on the content of the information provided, rather than on its representation. Based on the invariance assumption, we state three working hypotheses:

Hypothesis 1: The framing of information does not influence rational decision making in terms of identifying and choosing dominant portfolios.

Hypothesis 2: The decision for the risk-return level of the selected portfolio is independent from information framing.

Hypothesis 3: If subjects change their preferred risk-return profile in subsequent portfolio choices, the decision for more or less risk and return of the new selection is independent from framing.

A drawback of standard decision theory is that it hinges on a set of assumptions that were proven to be violated in many real-world and experimental decision situations.[8] Several

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[7]One can think of other but less common information frames, e.g. asset value changes in absolute terms or final asset values in percentage terms. This study concentrates on the most prevalent two frames and leaves the investigation of alternative frames for future research.

[8]An overview over the expected utility model assumptions, applications and limitations can be found in

studies point out that cognitive limitations and psychological factors have an effect on investors' behavior and therefore affect market outcome.[9] For example, it was shown that the number of choices influences individuals' decisions in everyday consumption (Iyengar & Lepper 2000) as well as in financial contexts (Iyengar & Kamenica 2010, Iyengar et al. 2004, Agnew & Szykman 2005, Barber & Odean 2008). Although our choice set is limited to a maximum of eight options, participants might be overstrained by comparing these alternatives. This effect may be different across information frames, depending on the familiarity of the subjects with the respective representation (Bertrand et al. 2005). Information presented in terms of percentage changes occurs frequently in general contexts such as financial product brochures whereas final asset values are provided in individual advisory situations or example calculations. Although both are common frames, the majority of subjects might be more familiar with percentage change information and find it easier to compare portfolios with the help of this type of standardized information. The evaluation of information for investment decisions is difficult and becomes more erroneous the larger the choice set. This effect might be enforced if the information is presented in terms of final assets because it provides the same information as percentage changes, but in a less familiar way. The negative effect from information overload due to the number of portfolio comparisons may be strengthened, leading to a relative increase in the rate of irrational choices. This contradicts Hypothesis 1 and leads to the alternative hypothesis:

Hypothesis 1a: The framing of information influences rational decision making in terms of identifying dominant portfolios. Subjects are more likely to make irrational choices by selecting dominated portfolios if the information is presented in terms of final asset values rather than in percentage changes.

Hypotheses 2 and 3 are concerned with the risk-return level of portfolio decisions. Kahneman & Tversky (1979) criticize the expected utility model's qualification as a descriptive theory for decisions under risk and develop prospect theory, which is later amended by the reference-dependent model (Tversky & Kahneman 1991). Prospect theory provides a model to describe actual behavior more closely and accommodates violations of the expected utility model axioms, such as invariance and dominance (Tversky & Kahneman 1986). In prospect theory, individuals evaluate their choices in terms of gains and losses relative to a reference point. Decisions depend on the location of the reference point, which

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Schoemaker (1982) and Tversky & Kahneman (1986).

[9]A survey about individual investor behavior is provided by De Bondt (1998) who reviews the literature and derives stylized facts about the most prevalent investment mistakes. Hirshleifer (2001) investigates how investor psychology matters for expected returns and asset prices and provides a broad literature review.

can be shifted by framing (Tversky & Kahneman 1986).[10] If framing changes the decision, it is at odds with the assumption of invariance and the representation of information can have a significant impact on private investor decision making.

In our case, we hypothesize that framing leads to different portfolio selections due to different lottery interpretations of the provided portfolio information. Returns in terms of percentage changes are expressed as positive and negative deviations from the initial investment sum. Portfolios are described by explicit gain and loss information; the portfolio decision appears like selecting from a choice of mixed lotteries. The value of final assets, on the other hand, is not negative for our portfolios, even in the case of losses. This characterizes the portfolio selection as a selection between positive lotteries.

Two implications with respect to our working hypotheses result: Firstly, mixed lotteries make losses obvious by stating them explicitly. In this case, subjects are more likely to focus on investment risk compared to subjects who receive final asset value information which always provides positive figures. If mixed lotteries are perceived as riskier than positive lotteries, framing can induce more cautious investment behavior. We expect that subjects who base decisions on percentage changes information select portfolios with lower risk-return combinations than subjects who get the same information in final asset values.[11] This contradicts Hypothesis 2 and leads to an alternative hypothesis:

Hypothesis 2a: The framing of information influences the risk level of investment decisions. Subjects choose less risky portfolios if the information is presented in terms of percentage changes rather than in terms of final asset values.

Secondly, it can be expected that framing influences risk-taking along the same channels in subsequent decisions. Accordingly, we expect that framing also influences the direction of risk-taking relative to the prior choice. This is at odds with Hypothesis 3. A further aspect concerning Hypothesis 3 is the "stickiness" of decisions, also known as status-quo bias. There are rational reasons for retaining prior choices, e.g. if other options are inferior or if additional information is not relevant. In a choice situation where one option resembles the status quo, Samuelson & Zeckhauser (1988) show that this option has an increased

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[10]A reference point can also be influenced by the composition of the choice set. Kamenica (2008) points out that the context of choices, e.g. the product range, contains valuable information that is used by rational consumers. Huber et al. (1982) show that the introduction of a choice, which is dominated by another option in the choice set, biases consumer decisions in favor of the dominating alternative, violating the regularity condition and the similarity hypothesis of decision theory. We construct our choice sets such that they are neutral to these effects.

[11]Shafir et al. (1997) provide a similar argumentation for an example of wealth changes. Additionally, they state that reliance on a certain frame is usually guided by convenience and less by strategic calculations. Subjects confronted with either frame are likely to think within that frame rather than transferring it into a standard canonical representation that would lead to consistent decisions among participants (Tversky & Kahneman 1986).

relative probability to be chosen compared to a neutral framing without a status quo indication. In the literature concerning retirement savings and default options, it is well-documented that investment decisions – once made – remain unchanged for a longer period of time (Mitchell et al. 2006). The sum of these considerations leads us to the following alternative hypothesis which comes in two parts:[12]

Hypothesis 3a: I) In subsequent portfolio choices, subjects are likely to stick to their status-quo risk-return preference. *II)* If they change their risk-return level, they are more likely to decrease risk if information is presented in terms of percentage changes and to increase it if provided with final asset value information.

2.3 Experiment Setup and Accomplishment

In reality, private investors are free to invest in thousands of financial products about which they can receive a large variety of information. A precise effect identification from field data is infeasible due to the lack of a defined decision environment. Therefore we choose an experimental setup which provides a well-designed decision space with a controlled set of information and framing stimuli.[13]

We construct portfolios with different risk-return profiles including safe investments with positive guaranteed returns. For each portfolio, we provide return information over the investment horizon of two years. We choose the short, two-year investment horizon to avoid confounding influences from unobservable future expectations, problems with compound interest rate calculation, or tax concerns.[14] The experimental information set is restricted to two dimensions: expected returns and losses. In the percentage frame, we indicate the 'expected return' and the 'guaranteed minimum return' or 'maximum loss'; in the final asset value frame we show the 'expected portfolio value', the 'guaranteed minimum portfolio value' or the 'minimum portfolio value'.[15] The lottery-style of information simplifies the comparison of portfolios relative to more complex real world decisions and provides a well-defined setting to identify the framing effect. The portfolios are created and grouped such that each portfolio in one group dominates or is dominated by another portfolio in another

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[12]As regards content, Hypothesis 3a has two parts which are kept together because both relate to Hypothesis 3.

[13]Appendix Section A.1 provides a more detailed presentation of the experimental setup including a translation of the central portfolio choice questions and an explanation of the different design elements.

[14]Returns from capital gains were tax-free for German private investors after a holding period of one year. To ensure that subjects understand that taxes do not matter for the decision, we pick the time horizon strictly greater than one year.

[15]Veld & Veld-Merkoulova (2008) show that private investors use a variety of risk measures, but to reduce information complexity, losses are presented such that participants are not required to understand more sophisticated risk measures, such as standard deviation, semi-variance, asset beta, or value at risk.

group. For simplification, we apply dominance in one dimension only,[16] that is, less risk at the same expected return (risky portfolios) or the same guaranteed return with a higher expected return (guarantee portfolios). Table 2.1 provides an overview over the portfolio sets and the respective information in both information frameworks.

Table 2.1: Portfolio Choices in the Experiment

Name	Total Asset Frame			Percentage Frame		
	Expected	Guaranteed	Minimum	Expected	Guaranteed	Minimum
Portfolio Set AB						
AB1	€11,300		€8,700	13.0%		-13.0%
AB2	€10,670	€10,300		6.7%	3.0%	
AB3	€12,200		€6,150	22.0%		-38.5%
Portfolio Set ABC						
ABC1	€10,790	€10,300		7.9%	3.0%	
ABC2	€12,200		€8,460	22.0%		-15.4%
ABC3	€11,300		€9,280	13.0%		-7.2%
ABC4	€13,000		€7,390	30.0%		-26.1%
Portfolio Set AC						
AC1	€11,300		€9,870	13.0%		-1.3%
AC2	€10,910	€10,300		9.1%	3.0%	
AC3	€13,000		€7,980	30.0%		-20.2%
AC4	€12,200		€8,870	22.0%		-11.3%

Note: The table displays the portfolio choice sets in the two information frame treatments. In the experiment, the columns were labeled "Expected investment portfolio value", "Guaranteed minimum investment portfolio value", "Minimum investment portfolio value" in the value treatment and "Expected return", "Guaranteed minimum return", "Maximum loss" in the percentage change treatment. Risky portfolios of group ABC dominate portfolios of group AB and are dominated by portfolios of group AC by varying degrees of risk at the same return level. For the guarantee portfolios, dominance is imposed by variation of the expected return given the same guaranteed return. The portfolio names indicate the underlying securities: safe investment (A), mutual stock fund (B) and a call option (C). Participants receive either information in the total asset frame or the percentage frame (between-subject design).

Based on a computerized algorithm, participants are randomly allocated to either the percentage changes or the final asset value treatment group upon entering the experiment. The analysis of this "framing treatment" is at the center of our study: We investigate whether and how the information frame matters for private investor decision making.

The general setup of the decision environment is introduced by a question to which we refer as "security choice" (SC). Subjects indicate in which type of securities or security mix they would invest their savings of €10,000 for a period of two years. They can choose between a safe investment (A), a stock investment fund (B), a call option on stocks (C), any combination of the three (AB, AC, BC, ABC), and the option 'Do not know' (DK). For each individual security class A, B, and C they receive information about the security type, the respective historical annual returns and a verbal risk categorization. The question tests

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[16]Lurie (2004) shows that the information structure itself (rather than the pure amount of information) can lead to information overload and lower decision quality. We want to minimize confounding effects from information overload that are unrelated to the framing effect under study.

whether subjects have preconceptions with respect to the investment in a certain security type and supplements information about risk aversion and financial literacy.

We also use these answers to assign participants endogenously to a second treatment that varies the order of portfolio sets to be presented in the following investment decisions ("order treatment"). External incentives for honest participation are low and therefore we stimulate the intrinsic motivation of participants using the endogenous treatment assignment. It signals that subjects' decisions matter for the course of the experiment which should encourage truthful and complete preference revelation. Three portfolio set orders are applied: AB/AB-ABC (choice block 1: CB1), ABC/ABC-AC (CB2), and AC/AC-ABC (CB3). From the reverse order of portfolio set presentation in CB2 and CB3 we infer whether it matters to receive first the dominated or the dominating set of portfolios (order effect).

The SC question does not vary between the framing treatment groups. The question provides a common introduction to the following three investment decisions which are at the core of this study.

We call the first question "portfolio choice 1" (PC1). Participants receive information about one of the portfolio sets AB, ABC, or AC described in Table 2.1. They are asked to indicate in which portfolio they would invest their €10,000 savings for a period of two years. PC1 aims at identifying the initial risk-return combination that a subject feels most attracted to.

For the second portfolio choice (PC2), a fictive investment advisor offers a second set of portfolios in addition to the one provided in PC1. This introduces dominance patterns between portfolios of the two sets. Participants choose again one portfolio to invest their €10,000 over a period of 2 years. A rational choice can be defined as the selection of a dominant portfolio. This question aims at capturing the degree of rational decision making depending on information framing, and provides information about changes in the risk-return level.

Finally, subjects are told that their prior choice from PC2 is not available. They have to indicate their next preference within the remaining investment opportunities of the two portfolio sets. This leads to a re-evaluation of the portfolio sets and the investment task. Using the third portfolio choice (PC3) we want to draw conclusions about the effect of compelled choice set reconsideration and shifts in risk-return patterns. A graphical overview of the experiment's structure and treatment assignment is presented in Figure 2.1.

Besides these investment questions, an additional survey retrieves information about the
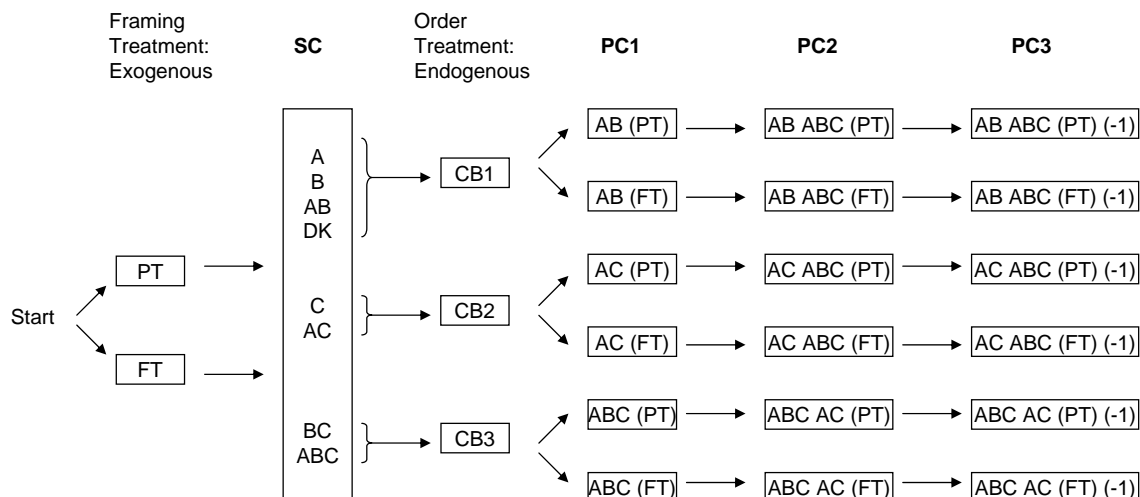
Figure 2.1: Structure of the Experiment and Treatment Assignment

Note: The information framing treatment is assigned randomly upon starting the questionnaire and denoted by "PT" for the percentage changes treatment and "FT" for the final asset value treatment in this graphic. Based on the decision SC subjects are endogenously allocated to the order treatment. The order treatment determines which portfolio sets are presented and in which order. The portfolio sets are displayed in Table 2.1 for both framing treatments. Each order treatment group, that we call choice blocks (CB), provides a combination of two portfolio sets. In the last decision PC3, the choice of portfolios is the same as in PC2, but the portfolio that was selected in PC2 is excluded (-1).

demographic background and private investor experience. Participants evaluate their self-perceived financial literacy and risk aversion in different investment situations and complete a quiz to assess their actual financial knowledge. This provides a large set of control variables. Especially financial literacy and risk aversion are known to be determinants of private investor's portfolio choice, and are considered in detail in Section 2.5.3. Table A.1 in the Appendix Section A.2 provides an overview over the main variables used in this study.

The online experiment was announced in the editorial of a weekly investor magazine.[17] An article was dedicated to the topic of financial decision making, featuring a link to the experiment (Börse Online 2008). Furthermore, the experiment link was posted on the homepage of Börse Online, the online version of the magazine article, and on the homepage of the university department. It was online from January 17, 2008 until January 31, 2008.[18] Subjects were told that it would take roughly 15 minutes to complete the questionnaire and that upon completion they could choose to enter a lottery for non-pecuniary prizes.[19]

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[17]Börse Online is a German print and online magazine for private investors. The weekly print version has a paid circulation > 100,000. For the online version see: www.boerse-online.de.

[18]The experimental period was before the culmination of the global financial crisis in 2008. Therefore, the results are not influenced by private investors' insecurity due to the recent financial market disturbances.

[19]We do not provide pecuniary incentives to the participants based on their investment decisions and follow Veld & Veld-Merkoulova (2008) [p. 232/233] who argue that financial motivation could introduce an endowment effect, would be too costly for the amounts investigated, and a lottery of the choice is only applicable if the expected-utility hypothesis is maintained (yet this theory is tested in this study). Furthermore, our interest rests in the difference between the two treatments what should alleviate the concerns.

2.4 Data and Descriptive Results

The experiment was accessed 4,437 times during its online period. We impose several restrictions to the initial dataset: We drop 1,299 unfinished surveys and exclude 204 observations due to multiple experiment participation.[20] Furthermore, subjects who report to be below the full age of 18 or over the age of 100 are withdrawn from the sample. The lower bound is set because the full age in Germany is 18 years and the upper bound is imposed because it is unlikely to have online participation of subjects over the age of 100 years. The final sample comprises 2,908 observations.

The average participant is 44 years old, male (85%) and married (53%). About 51% of the subjects hold an academic degree and a further 34% completed an apprenticeship or secondary level education (German Abitur). The high education level is reflected in the occupational pattern, with only 3% being unemployed or homemakers. 22% are freelancer, 54% work in a company or for the state. Students and retirees account for about 18% of the subjects. Roughly 13% of our participants work in the financial sector. The annual household income does not exceed €50,000 for 37% of the participants, and 11% of them receive more than €100,000. Subjects report to have substantial financial experience. Besides holding low-risk investments such as a savings accounts (40%) and fixed income securities (30%), they also have investments in stocks (66%), stock mutual funds (68%) and derivatives (21%). 42% have their main bank account with a direct bank and therefore it is not surprising that, on average, the internet is the most frequently consulted source of investor information (weekly), followed by newspapers (several times a month), friends and family (monthly) and financial advisors (quarterly).

These characteristics suggest that our sample does not represent the average German population, but rather the average experienced and finance-interested German private investor. We have a well-defined sample selection which is suited for the analysis of framing effects in the private investor's decision making process. If these participants react systematically to framing, we argue that our results provide a lower bound to the impact on the average population. The median completion time for the experiment is 16:54 minutes, i.e. participants devoted a substantial amount of their time. This hints at a high intrinsic motivation. Despite similar total answering times, subjects in the final asset value framework need significantly more decision making time for the framing-relevant questions PC1 to PC3 (mean difference: 23.36 sec, $t(2906)=5.586$).

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[20]Once the experiment started, a cookie was installed on the subject's computer and the IP-address of the computer was logged to identify repeated participation. Participants were informed that they have to fill out the survey in one step and that re-entry after leaving or reloading the site is not possible.

2.5 Results

We first analyze rational decision making, before turning to the investigation of risk-taking behavior. Thereafter, we summarize our findings with respect to financial literacy and risk aversion. Finally, we provide robustness tests and discuss our results. The results are going to be commented in the return dimension, because across all portfolio sets the return levels are always positively related to the (among portfolios in different sets varying) risk levels. Therefore, more return implies more risk.

2.5.1 Identification of Dominant Portfolios

Hypothesis 1 and 1a concern the relationship between rational decision making and information framing. The empirical investigation is based on Portfolio Choices 2 and 3 (PC2 and PC3). We derive the binary variables D_{inf2} and D_{inf3} which are 1 in case of an inferior portfolio selection in PC2 and PC3, respectively. In PC2, subjects choose from two portfolio sets with a dominance relation described in Section 2.3. On average, 17.6% of all subjects choose an inferior portfolio and thus make an irrational decision. This is an alarmingly high share. Since our research interest rests on the information framing effect for rational decision making, we analyze inferior choices in PC2 by framing treatment groups (Table 2.2).

Subjects who receive information in final asset values are significantly more likely to make inferior choices than those who get information in percentage changes (20.7% vs. 14.7%, respectively). The framing effect is of similar magnitude for all four return levels available in the second portfolio choice.

Additionally, we consider whether changes in the return level between the first and the second portfolio choice (PC1 and PC2) are relevant for the strength of the treatment effect. Keeping the *same portfolio* in PC2 as in PC1 automatically leads to an inferior decision in the order treatments CB1 and CB3 and a dominant selection in CB2 (see Figure 2.1 and Table 2.1). Subjects in CB2 and CB3 choose among the same portfolio sets but the sets are introduced in reverse order. Therefore, a comparison of CB2 and CB3 allows to control for order effects. Table 2.3 shows that the share of subjects choosing inferior portfolios is not statistically different between CB2 and CB3, neither for the whole sample nor if the two framing treatment groups are considered separately. Since we cannot find order effects for rational decision making, we pool the data across order treatments and report the results for the pooled data in the following.[21]

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[21]In the regression analysis we include flexible control variable sets for the order treatments to take potential systematic unobserved characteristics into account. We discuss the pooling of the order

Table 2.2: Inferior Portfolio Selection: Descriptive Statistics

| | Second Portfolio Choice (PC2) | | | | | | Third Portfolio Choice (PC3) | | | | | |
	FT	PT	diff	FT	PT	diff	FT	PT	diff	FT	PT	diff
	Full Sample			**Return Level PC2: 3%**			**Full Sample**			**Return Level PC3: 3%**		
	0.207	0.147	0.060***	0.209	0.139	0.071***	0.146	0.097	0.049***	0.180	0.066	0.114***
	(0.011)	(0.009)	(0.014)	(0.021)	(0.014)	(0.025)	(0.009)	(0.008)	(0.012)	(0.018)	(0.010)	(0.019)
	[1409]	[1499]		[363]	[599]		[1409]	[1499]		[434]	[653]	
	Same Return Level as in PC1			**Return Level PC2: 13%**			**Same Return Level as in PC2**			**Return Level PC3: 13%**		
	0.233	0.173	0.060***	0.220	0.163	0.056**	No inferior choices			0.158	0.154	0.004
	(0.014)	(0.012)	(0.018)	(0.017)	(0.016)	(0.024)				(0.017)	(0.017)	(0.024)
	[930]	[986]		[615]	[520]					[449]	[473]	
	Return Level Increasing			**Return Level PC2: 22%**			**Return Level Increasing**			**Return Level PC3: 22%**		
	0.120	0.071	0.049**	0.199	0.139	0.060**	0.139	0.104	0.036	0.107	0.085	0.022
	(0.017)	(0.014)	(0.022)	(0.022)	(0.020)	(0.030)	(0.016)	(0.015)	(0.022)	(0.015)	(0.016)	(0.023)
	[382]	[337]		[326]	[294]		[466]	[414]		[403]	[295]	
	Return Level Decreasing			**Return Level PC2: 30%**			**Return Level Decreasing**			**Return Level PC3: 30%**		
	0.299	0.142	0.157***	0.242	0.169	0.073	0.329	0.216	0.113***	0.114	0.064	0.050
	(0.047)	(0.026)	(0.050)	(0.053)	(0.047)	(0.071)	(0.023)	(0.019)	(0.029)	(0.029)	(0.028)	(0.042)
	[97]	[176]		[66]	[65]		[428]	[476]		[123]	[78]	

Notes: The table reports the means for the binary variables D_{inf2} and D_{inf3} for the two framing treatment groups ("FT" final asset value treatment and "PT" percentage changes treatment). The standard deviation is reported in parentheses and the number of observations in brackets. We perform a mean comparison test to compare the share of inferior decisions across the framing treatment groups. We consider the total sample as well as specific subsamples. Return level increases and decreases are derived comparing the return level choices from PC1/PC2 and PC2/PC3. Inferior decisions in PC2 at the return level of 30% were only possible in CB2 and CB3 because CB1 only has one portfolio at this level such that no dominance structure exists. Inferior decisions in PC3 at the same return as in PC2 were not possible. ***, **, and * indicate significant differences at the 1%, 5%, and 10% confidence level, respectively.

Table 2.3: Test of Order Effect on Inferior Portfolio Choice

	All Observations			FT			PT		
	CB2	CB3	diff 3-2	CB2	CB3	diff	CB2	CB3	diff
D_{inf2}	0.201	0.214	0.013	0.218	0.268	0.050	0.184	0.171	-0.013
	(0.030)	(0.016)	(0.035)	(0.045)	(0.026)	(0.053)	(0.042)	(0.020)	(0.045)
	[174]	[654]		[87]	[291]		[87]	[363]	
D_{inf3}	0.172	0.156	-0.016	0.195	0.172	-0.024	0.149	0.143	-0.006
	(0.029)	(0.014)	(0.031)	(0.043)	(0.022)	(0.047)	(0.038)	(0.018)	(0.042)
	[174]	[654]		[87]	[291]		[87]	[363]	

Notes: The table reports the means for inferior decisions in PC2 and PC3, the respective standard errors in parentheses and the number of observations in brackets for the whole sample and by framing treatment group ('FT' final asset value treatment and "PT" percentage changes treatment). A mean comparison test is performed to compare CB2 and CB3. Participants in CB2 choose from the choice sets AC ABC and participants in CB3 receive the same portfolios but in reverse order (ABC AC). Portfolios of the choice set AC dominate ABC portfolios. By comparing the subjects of CB2 and CB3 we test whether the order of portfolio set presentation matters for rational decision making. ***, **, and * indicate significant differences at the 1%, 5%, and 10% confidence level, respectively.

In table 2.2 we find that roughly a quarter of the participants increases the return level of their portfolio (719/2,908=24.7%). This group exhibits the lowest framing effect in rational portfolio selection but it is still statistically significant at the 5% confidence level. The effect is strongest if subjects decide to decrease the return level: in this case, 30% of the participants in the final asset value treatment make inferior choices, with only 14% in the percentage changes treatment. Thus, the framing effect does not vary with return levels but rather with return (and risk) level changes.

In the decision PC3, the prior selected portfolio from PC2 is no longer available and subjects have to indicate their preference within the reduced choice set. The probability to pick an inferior portfolio by random choice is lower in PC3, given that one dominance relation is resolved due to the unavailability of one portfolio.[22]

Table 2.2 reveals that overall, the share of inferior choices decreases more than can be expected by the lower random choice probability. Reconsideration leads to more rational choices, but the difference between the framing groups is still 4.9 percentage points and highly significant (t(2906)=4.042). Across return levels, the strongest framing effect occurs for the safe 3% investment opportunity. At higher returns, the share of inferior choices is consistently higher in the final asset value treatment group but the differences are not statistically significant. Compared to PC2, more people change the return level. Subjects who decrease the return between PC2 and PC3 are more likely to make inferior choices and exhibit a stronger framing effect than those who increase it. This finding is qualitatively similar to what we find in PC2. To summarize, a compelled reconsideration of the choice set leads to less inferior choices but it does not eliminate the overall framing effect.

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treatment groups in Section 2.5.4.

[22]To be precise, for the whole sample the expected share of inferior picks by random selection in PC2 is 44.89% and in PC3 36.16%.

The descriptive findings are complemented with regression analysis displayed in Table 2.4. Although the dependent variables are binary, we run OLS instead of binary dependent regression models because we include interacted control variables in some regression specifications.[23]

Table 2.4: Inferior Portfolio Selection (PC2 and PC3): OLS Regressions

	PC2			PC3		
	(1)	(2)	(3)	(4)	(5)	(6)
D_{final}	0.066***	0.067***	0.057***	0.059***	0.047***	0.039***
	(0.014)	(0.014)	(0.016)	(0.012)	(0.011)	(0.013)
D_{inf2}					0.171***	0.171***
					(0.019)	(0.019)
spec. risk	0.011***	0.004	0.004	0.002	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
fin.lit. quiz	-0.030***	-0.031***	-0.031***	-0.020***	-0.015***	-0.015***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
fin.lit. self	-0.008	-0.007	-0.007	-0.006	-0.005	-0.004
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
13% return		0.050***	0.051***	-0.010	-0.007	-0.007
		(0.019)	(0.019)	(0.016)	(0.016)	(0.016)
22% return		0.078***	0.078***	-0.083***	-0.080***	-0.080***
		(0.027)	(0.027)	(0.021)	(0.021)	(0.021)
30% return		0.033	0.033	-0.085***	-0.079***	-0.081***
		(0.035)	(0.034)	(0.027)	(0.026)	(0.026)
Return Increase		-0.133***	-0.132***	0.168***	0.167***	0.168***
		(0.020)	(0.020)	(0.017)	(0.016)	(0.016)
Return Decrease		-0.002	0.001	0.270***	0.275***	0.276***
		(0.027)	(0.027)	(0.015)	(0.015)	(0.015)
CB2*D_{final}			0.008			0.037
			(0.063)			(0.054)
CB3*D_{final}			0.040			0.025
			(0.036)			(0.029)

Control Variables (df): Wald-Statistic χ^2

Ind. Charac.	21.10(4)***	21.12(4)***	21.28(4)***	9.57(4)***	5.47(4)***	5.56(4)***
HH income	4.34(4)***	4.00(4)***	4.05(4)***	1.25(4)	0.91(4)	0.91(4)
Inv. Exp.	2.75(3)**	3.83(3)***	3.78(3)**	2.16(3)*	1.29(3)	1.26(3)
Education				3.12(3)**	3.27(3)**	3.31(3)**
CB2/CB3		2.25(2)	0.48(2)		5.05(2)***	1.77(2)

Regression Statistics

N	2908	2908	2908	2908	2908	2908
(Pseudo) R^2	0.062	0.083	0.084	0.162	0.199	0.200

Notes: The dependent indicator variables D_{inf2} and D_{inf3} are 1 in case of the selection of an inferior (dominated) portfolio in PC2 or PC3, respectively. For columns (1)-(3) return level controls are based on PC2 and return changes between PC1 and PC2, columns (4)-(6) take PC3 return levels and changes between PC2 and PC3. Individual control variables include age, sex, married and time_PC2/3. Income, Education, and Investment Experience controls are included according to their listing in Table A.1. A constant is included. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

The effect of framing enters the base model regression in column (1) statistically significant: Subjects who receive information as final asset values are about 6.6% more likely

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[23]The standard errors and interpretation of interaction variables in non-linear models is not as straightforward as in linear regression models (Ai & Norton 2003). Although statistical adjustment methods for the marginal effects and standard errors exist (Norton et al. 2004, Mallick 2009), we prefer to use standard linear regression. For robustness, we perform probit regressions for the models in column (1), (2), (4), and (5). The results are virtually identical.

to make an inferior decision than those who receive information in percentage changes. A higher willingness to bear specific investment risk increases the probability of making inferior decisions whereas financial literacy reduces the propensity.[24] The coefficient for self-perceived financial literacy does not significantly influence rational decision making, and this is robust to the exclusion of the quiz score. Thus, rational choice is based on actual financial knowledge rather than self-perception. The coefficient for the framing treatment essentially remains constant and highly significant if we include control variables for the return level, return level changes and order treatment groups in column (2). In line with the descriptive results, we find that a return level increase reduces the likelihood of inferior choice. In column (3), we include interaction variables between the framing and the order treatment dummies. This provides a flexible control for potential differences of the framing treatment effect across order treatment groups. The main coefficient decreases slightly but remains highly significant, indicating a 5.7% higher propensity for inferior choice in case of final asset value information. The interaction coefficients are insignificant, meaning that the influence of the framing treatment does not vary statistically between order treatment groups. This strengthens our pooling argument.

For analyzing the third portfolio choice decision (PC3), we start with the model specification that controls for return levels and changes and find a significant positive framing effect of similar magnitude as in PC2. The propensity to make an inferior choice is larger for decreasing returns than for increasing returns.[25] To control for repetitive irrational choices, we include the dummy variable for inferior decision making in PC2 in column (5). As can be expected, the coefficient is positive and highly significant. Subjects who made an irrational decision before are more likely to select an inferior portfolio again.[26] In the last column, we include the interacted order treatment control variables. The framing effect remains positive, highly significant and does not vary statistically across order treatment groups. The coefficient indicates that subjects who receive final asset value information are 3.9% more likely to make inferior choices.

To summarize, many participants do not detect and select dominant portfolios, even within a restricted and simplified decision setting. This cannot be solely attributed to inattentive experiment participation, because we consistently find differences between the framing

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[24]Subjects self-assess their willingness to take financial risk on a scale from 0 to 9 for general financial situations, and the specific situation of investing €10,000 for two years. The latter, specific measure of risk aversion is used in all regressions concerning portfolio choices because it refers to the underlying decisions.

[25]Both coefficients are positive and significant because the reference is to keep the return level constant, which in PC3 always leads to a rational choice.

[26]We also used a regression specification including an additional interaction variable $D_{inf2} * D_{final}$ to test whether the framing effect is of different strength between the two decisions. The coefficient turns out to be low and insignificant.

treatment groups. Subjects who receive information in percentage changes are about 6 percentage points less likely to make inferior choices than participants who get information as total value changes (t(2906)=4.29, p<0.0001). Compelled repetitive selection reduces the number of inferior decisions, but the effect of framing on rational decision making remains. This contradicts Hypothesis 1 which is based on the invariance assumption and provides evidence in favor of Hypothesis 1a. The result is robust to the inclusion of a large set of control variables and the order of portfolio set presentation in the regression analysis.

2.5.2 The Choice of Risk-Return Levels

Hypothesis 2 states that preferences for portfolio returns and therefore risk levels are independent from information framing. We test this hypothesis by investigating the return level of the first portfolio choice (PC1). Table 2.5 shows the descriptive results including mean performance tests for the framing treatment.[27] A significantly higher share of subjects in the percentage changes treatment chooses the lowest (and safe) return level of 3%. Participants receiving final asset value information tend to select portfolios with higher returns and therefore more risk.

Table 2.5: First Portfolio Choice (PC1): Descriptive Statistics

Return	FT	PT	diff
3%	0.328	0.416	-0.088***
	(0.013)	(0.013)	(0.018)
13%	0.495	0.417	0.078***
	(0.013)	(0.013)	(0.018)
22%	0.136	0.130	0.006
	(0.009)	(0.009)	(0.013)
30%	0.041	0.037	0.004
	(0.005)	(0.005)	(0.007)
N	1409	1499	

Notes: The table reports the fraction of participants who choose a certain return level by framing treatment group. Subjects receive risk-return information either in final asset values (FT) or percentage changes (PT). A Mean Comparison Test is performed. ***, **, and * indicate significant differences at the 1%, 5%, and 10% confidence level, respectively.

We underpin the descriptive results with ordered probit regressions to investigate whether framing influences the probability to select a certain return level. The dependent variable is the return level of the first portfolio selection which is ordinal scaled with 3%, 13%, 22% and 30% as parameter values. The results are displayed in Table 2.6.

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[27]The total shares to each return level are not very informative because subjects in the order treatment group CB1 select between only three portfolios with return levels 3%, 13%, and 22%, whereas participants in CB2 and CB3 can additionally choose a portfolio with 30% return level. Since we are not interested in the total shares at each return level, but in the difference between the framing treatment groups, we can pool the data across choice blocks nonetheless.

Table 2.6: First Portfolio Choice (PC1): Ordered Probit

Marginal Effects by Return Level

	(1)				(2)			
	D_{final}	spec. risk	fin.lit. quiz	fin.lit. self	D_{final}	spec. risk	fin.lit. quiz	fin.lit. self
3%	-0.058***	-0.125***	0.006	0.027***	-0.084***	-0.097***	0.001	0.021**
	(0.016)	(0.005)	(0.008)	(0.010)	(0.016)	(0.005)	(0.007)	(0.010)
13%	0.026***	0.055***	-0.003	-0.012***	0.043***	0.050***	-0.001	-0.011**
	(0.007)	(0.004)	(0.003)	(0.004)	(0.008)	(0.004)	(0.004)	(0.005)
22%	0.026***	0.055***	-0.003	-0.012***	0.037***	0.042***	-0.000	-0.009**
	(0.007)	(0.003)	(0.003)	(0.004)	(0.007)	(0.003)	(0.003)	(0.004)
30%	0.007***	0.014***	-0.001	-0.003***	0.005***	0.005***	-0.000	-0.001**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)

Control Variables (df): Wald-Statistic χ^2

	(1)	(2)
Ind. Char.	19.47(6)***	9.82(6)
Education	6.62(3)*	2.54(3)
Inv. Exp.	15.54(3)***	0.86(3)
CB2 / CB3		447.89(2)***

Regression Statistics

	(1)	(2)
N	2908	2908
Pseudo R^2	0.137	0.213

Notes: The dependent return level of PC1 is ordinal scaled with parameter values 3%, 13%, 22%, and 30%. The table reports marginal effects and the respective robust standard errors in parentheses. A constant is included as well as control variables for individual characteristics (age, sex, finance, time_PC1, married, single), education, investment experience and order treatment. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

The marginal effect for the framing treatment is highly significant in both regression specifications. If we control for the order treatment (column (2)), the probability to choose the safe 3% return is about 8.4% lower for subjects who receive final asset values. The marginal probabilities to choose higher returns are positive and significant. The results suggest that return information presented in final asset values induces more risk-taking behavior. This is at odds with Hypothesis 2 but supportive of Hypothesis 2a.

As can be expected, the return level increases in the specific willingness to take risk (WTR). Lower risk aversion leads to the selection of higher risk-return combinations. The framing treatment has about the same impact as a one unit increase in the WTR, which highlights its importance. Higher self-perceived levels of financial knowledge lead to more investment prudence but actual financial literacy does not enter the regression significantly. This demonstrates the importance of taking both measures into account. The higher a subject's self-perceived financial knowledge, the higher the likelihood that they will opt for the 3% return level and the lower the likelihood that they will choose a risky portfolio. Actual financial literacy measured in the financial literacy quiz score does not influence the return level and therefore the risk preferences. The order treatment controls are highly significant which is intuitive, given that the choice sets in CB2 and CB3 have four investment portfolios and CB1 only three.

In the next step, we investigate the effect of information framing on the sequence of return decisions comparing the return levels between Portfolio Choices 1 and 2 (PC1/PC2) and 2 and 3 (PC2/PC3).[28] Relative to their prior choice, subjects can decide to keep the return level constant or to change it. Return level changes between decisions are rational if another risk-return combination is more attractive, given the present choice set and individual preferences. Individual preferences are randomly distributed across the two framing treatment groups due to random treatment assignment. If globally preferred risk-return combinations exist and framing does not matter, they should be chosen equally likely in both treatment groups. According to Hypothesis 3, subjects' preferences for a constant or a changing return profile are independent from information presentation.

The descriptive results for *constant return* decisions with respect to the framing effect are displayed in Panel A of Table 2.7.[29] Between PC1 and PC2, about 67% of the subjects

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[28]Subjects of the order treatment group CB1 who choose the 30% return level are excluded from the analysis in this part, because this return level cannot be maintained constant in all portfolio choices.

[29]Subjects can keep the return constant by selecting exactly the same portfolio as in the prior choice (which is only possible between PC1/PC2 and not between PC2/PC3 due to the experimental design) or by deciding for the alternative portfolio with the same return but a different risk level. The first figure in Panel A of Table 2.7 summarizes both ways, whereas the second one only considers the share of subjects who select exactly the same portfolio again.

keep the return constant and the difference between the framing treatment groups is not statistically significant. The general preference for constant returns between PC1 and PC2 is independent from information framing.

Table 2.7: Descriptive Statistics For Keeping or Changing Risk-Return Level

	PC1/PC2			PC2/PC3			PC2/PC3 conditional		
	FT	PT	diff	FT	PT	diff	FT	PT	diff
Panel A: Constant Return Level									
Constant return	0.679	0.667	0.012	0.376	0.412	-0.036**	0.487	0.561	-0.074***
	(0.013)	(0.012)	(0.018)	(0.013)	(0.013)	(0.018)	(0.019)	(0.017)	(0.026)
	[1370]	[1478]	[2848]	[1370]	[1478]	[2848]	[713]	[815]	[1528]
Constant portfolio	0.191	0.149	0.042***						
	(0.011)	(0.009)	(0.014)						
	[1370]	[1478]	[2848]						
Panel B: Changing Return Level									
Decrease	0.071	0.119	-0.048***	0.284	0.308	-0.024	0.125	0.183	-0.058***
	(0.007)	(0.008)	(0.011)	(0.012)	(0.012)	(0.017)	(0.012)	(0.014)	(0.019)
	[1370]	[1478]	[2848]	[1370]	[1478]	[2848]	[713]	[815]	[1528]
Increase	0.250	0.214	0.037**	0.340	0.280	0.060***	0.388	0.256	0.132***
	(0.012)	(0.011)	(0.016)	(0.013)	(0.012)	(0.017)	(0.018)	(0.015)	(0.024)
	[1370]	[1478]	[2848]	[1370]	[1478]	[2848]	[713]	[815]	[1528]

Notes: The table displays the mean (standard errors in parentheses and included number of observations in brackets) for keeping or changing the return by framing treatment groups FT and PT and the respective difference is tested using a Mean Comparison Test. ***, **, and * indicate that the difference is significantly different from zero at the 1%, 5%, and 10% confidence level, respectively. We compare the return levels between PC1 and PC2, PC2 and PC3, as well as PC2 and PC3 under the condition that the return level remained constant between PC1 and PC2 and that PC2 was a rational choice. For constant returns we also look at the shares of subjects who keep exactly the same portfolio between PC1 and PC2. Subjects who choose the 30% return level in CB1 are excluded from the sample.

Nevertheless, 17% of the subjects choose the very same portfolio as in PC1. Considering the framing groups separately, we find that portfolio persistence is higher in the total asset value treatment. The share of subjects who select exactly the same portfolio as in PC1 is 4.2 percentage points higher in the final asset value treatment. This difference is statistically significant at the 1% confidence level. Thus, framing does not change the general preference for a constant return level but information in terms of final asset values leads to more persistent portfolio choices. Keeping the same portfolio is only rational if the prior chosen portfolio is still dominating other portfolios given the choice set and individual preferences. Otherwise a switch to the new, dominant portfolio is necessary for rational decision making. Thus, framing either enhances inertia or it impacts adequate information processing, both being potential channels how framing could influence rational decision making.

The total share of constant return choices decreases between PC2 and PC3 to an average of 39%. Subjects who receive information as percentage changes are significantly more likely to keep the return level constant which shows that those with final asset value information are not generally more inert as one might have suspected from the PC1/PC2 comparison.

In the last comparison, we consider only subjects who choose a dominant portfolio in PC2 at the same return level as in PC1. This is an interesting subgroup because in PC3, these subjects can either decide to stick to their return level, but with a worse risk-position than before (choosing the formerly dominated portfolio) or they change to a different return level. Sticking to the same return comes at the "mental cost" of accepting an impairment compared to PC2. Nevertheless, 51% of this subgroup hold the return constant between PC2 and PC3, with a significantly lower share of the subjects being in the final asset value treatment. Therefore, we do not find evidence that final asset value information enhances inertia.

Next, we test whether *return level changes* are influenced by framing. Panel B of Table 2.7 shows that subjects who receive final asset value information are less likely to decrease the return level but, conversely, more likely to increase it. This pattern holds true for the comparison of PC1/PC2 as well as PC2/PC3. Framing seems to impact the choice of return levels in case of return level changes: Subjects with final asset value information strive for higher risk-return combinations than subjects in the comparison group who instead prefer to shift to lower risk-return levels. The difference between the two treatment groups is even stronger for subjects who kept the return level constant and made rational decisions in the two prior portfolio selections.

In the subsequent regression analysis we control for return levels and a variety of individual characteristics. Table 2.8 presents only the coefficients and marginal effects for the framing variable in regression models where the dependent variables are binary and indicate 1 for retaining the return constant (Panel A) or for increasing/decreasing the return level (Panel B).[30]

For keeping the same return level, the framing coefficient is positive insignificant between PC1/PC2 and only weakly significant between PC2/PC3. The preference, i.e. the probability for choosing a constant return level, is not strongly influenced by framing. The results in Panel B strengthen the descriptive findings with respect to return level changes. Controlling for the return levels and other individual characteristics, the probability of decreasing the return level is significantly lower if subjects are provided with information about final asset values rather than percentage changes. Subjects in the final asset value treatment are significantly more likely to choose higher returns and thus more risk.

To summarize, private investors react (unconsciously) to information presentation by ex-

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[30]We present OLS and probit results because in the probit regressions, numerous observations are excluded due to perfect prediction. We show that this does not influence the general framing result.

Table 2.8: Regression Results For Keeping or Changing Risk-Return Level

	PC1/PC2		PC2/PC3		PC2/PC3 conditional	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Constant Return Level						
Constant	0.021	0.023	0.035*	0.029*	0.008	0.006
	(0.018)	(0.018)	(0.020)	(0.017)	(0.029)	(0.024)
	[2848]	[2848]	[2848]	[2848]	[1528]	[1528]
Panel B: Changing Return Level						
Decreasing	-0.091***	-0.056***	-0.167***	-0.098***	-0.194***	-0.106***
	(0.017)	(0.011)	(0.024)	(0.015)	(0.032)	(0.017)
	[1767]	[2848]	[1886]	[2848]	[854]	[1528]
Increasing	0.036**	0.033**	0.076***	0.069***	0.108***	0.100***
	(0.017)	(0.016)	(0.019)	(0.017)	(0.025)	(0.024)
	[2735]	[2848]	[2717]	[2848]	[1468]	[1528]

Notes: The table displays the marginal effects/coefficients (standard errors in parentheses, included number of observations in brackets) of the framing treatment variable for keeping or changing the return level between PC1 and PC2, between PC2 and PC3, and between PC2 and PC3 conditional on PC2 being a rational choice with the same return level as PC1. Columns (1), (3), (5) are probit regressions, columns (2), (4), (6) are OLS regressions using the same model specification as the probit regressions. Every coefficient stands for a separate regression. Control variables included in all regressions are spec. risk, fin.lit. quiz, fin.lit. self, age, sex, married, time_PC1, time_PC2/3, return level controls (PC1/PC2: return level of the first decision, PC2/PC3: return level of the second decision), investor experience controls and order treatment dummies. A constant is included. Subjects who choose the 30% return level in CB1 are excluded from the sample. The difference in the number of observations between probit and OLS regressions stems from the exclusion of the lowest/highest return level group due to perfect prediction. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

pressing different risk and return preferences: Subjects receiving final asset values are not only more likely to select risky portfolios initially, but also have a higher probability to increase the return (and therefore the risk) level in subsequent decisions. Conversely, subjects in the percentage changes treatment prefer more conservative initial risk-return combinations and are more likely to adjust their return level downwards later on. The results about the initial risk-return level are in line with Hypothesis 2a. The probability for constant return level choices across the three decisions does not systematically vary by information framing. If subjects change their risk-return level, the framing of information becomes relevant. Therefore, both parts of Hypothesis 3a are supported by the results. Framing portfolio return information in terms of percentage changes seems to suggest the interpretation as a mixed lottery which stresses losses more than the total asset value representation where final portfolio values are always positive, resembling a positive lottery.

2.5.3 Financial Literacy, Risk Aversion, and Security Choice

This study focuses on the effect of framing on portfolio selection. Nevertheless, prior literature contributions point out that financial literacy and risk aversion are important determinants of investment decisions. We elicit different measures of risk aversion and

financial literacy in the experimental survey which are well suited to test the robustness of our results and to run a complementary analysis. Subjects state their risk preferences on a scale from 0 (no risk tolerance) to 9 (highly risk seeking) for an undefined general investment situation and the specific experimental situation of investing €10,000 for two years. Financial literacy is elicited by a self-evaluation of financial knowledge on a scale from 0 (no knowledge) to 5 (expert knowledge), and by an objective quiz score derived from the answers to 6 question about financial topics.[31] We use these measures to control in all regressions for financial literacy and risk aversion and find that the framing results are robust to the inclusion of these variables. A separate analysis of these two decision determinants yields further interesting insights.[32] The level of risk aversion is intra-domain specific (Nosić & Weber 2010, Van Rooij, Kool & Prast 2007). It varies between the general and specific investment situation and is significantly higher in the latter case. Risk aversion is related to subjects' actual financial literacy *and* what they believe to know. The strength of each effect depends on the specification of the elicitation domain. Higher financial literacy quiz scores are negatively related to the willingness to take risk in the *specific* investment situation, and a high self-perception of financial literacy is conducive to risk-taking, but more in the *general* than in the specific investment situation. We confirm the finding that men are more risk-seeking than women and that over- and underconfidence are related to risk aversion in the expected ways. Participants in our study exhibit a higher degree of financial literacy and investment experience than subjects of other studies (Van Rooij, Lusardi & Alessie 2007, Lusardi & Mitchell 2007*a,b*). Financial literacy is positively related to age, education, being male, having investor experience, and it depends on the source of financial information. Nevertheless, subjects seem to lack knowledge of basic financial engineering, which is revealed through the choice of portfolio securities (SC). They select combinations of securities according to the individual ranking of risk rather than taking potential diversification or hedging effects into account. This might prevent investment decisions that are in line with their actual individual risk aversion. Furthermore, we find that subjects select security combinations similar to the ones they report to hold in their own, real-world portfolios. This is a strong indicator for their active involvement in the experimental questionnaire.

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[31] Appendix Section A.3 contains the precise wording of the questions as well as a detailed analysis of the respective literature.

[32] Appendix Section A.4 provides the regressions and details of the investigation.

2.5.4 Robustness and Discussion of the Results

The empirical analysis builds on experimental survey data. We are aware of critical aspects involved in this method of collecting data and address three major concerns (Amromin & Sharpe 2006, Shafir et al. 1997). Firstly, one might be concerned about untruthful or frivolous responses, but this does not affect our results. We conduct a differential analysis such that unmotivated answers do not enter the coefficient for framing, but they are controlled for as fixed effects due to random treatment assignment. In fact, frivolous responses generate additional noise in the data, but we can still identify significant framing effects. This suggests that our results provide a lower bound to the true influence of framing. Secondly, 95% of the subject pool consists of readers of an investor magazine which counters the concern of participants' limited understanding of the topic. They report to have substantial real world investment experience. Subjects are familiar with the investment task from personal experience and magazine information, and the financial quiz reveals an above average understanding of financial matters. Thirdly, it is difficult to prove that the framing effect found in data from an experimental questionnaire reflects real-world decision processes. Nevertheless, subjects spend a significant amount of time to answer the questionnaire and choose security combinations in the SC-question which are remarkably similar to the reported setup of their real-world portfolios. This indicates that the majority of participants considers the experimental investment task seriously and in line with their actual investment behavior. This makes us confident about the applicability of our results. However, further research is welcome to support our analysis.

In addition to the central framing treatment, we employ a second treatment to control for order effects in the portfolio presentation and to encourage truthful answers by introducing path dependence in the experiment. The order treatment is assigned endogenously depending on the decision in SC, but it is independent from the randomly assigned framing treatment (see Figure 2.1). Therefore, it should not influence our findings for the framing treatment and we pool the data across the order treatment groups in the main analysis presented so far. Nevertheless, one might be concerned about two aspects related to the order treatment. First, the number of choices varies between the order treatment groups: CB1 has 7 portfolios in total vs. CB2 and CB3 with 8 portfolios. Second, since the order treatment is assigned endogenously, subjects in different choice blocks may have different unobserved characteristics that are related to their security choice, but not captured by the control variables we use in the framing treatment analysis. A combination of these two aspects could bias our pooled results because the sample distribution across the three

choice blocks is not equal: 71% of the participants are assigned to CB1, CB2 encompasses about 6% of all observations and CB3 23%. Thus, the larger groups might drive the results, either due to different portfolio set compositions or due to unobserved heterogeneity between the choice blocks.

We take these concerns into consideration by employing flexible sets of control variables in the regression analysis.[33] In addition to the choice block dummy variables, we include interaction variables between the choice block and the framing treatment variable. The coefficients of these interaction variables reveal whether the framing treatment effect varies between the reference group (CB1) and the other order treatment groups (CB2 and CB3). In a further step, we saturate the model by including a full set of interaction variables between the CB-dummies and all other control variables (Angrist & Pischke 2009). Although the strength of the framing treatment effect is not equal across order treatment blocks, we do not find contradicting results that are statistically significant. Finally, we exclude all subjects who choose the 30% return level in any of the three portfolio choices. Although this does not compensate for the reduced choice set in CB1, it makes the sample more homogeneous. We repeat the main analysis and come again to similar results.

2.6 Conclusion

To our knowledge, this is the first study to investigate the effect of two common risk-return information frames on portfolio selections. We show that the seemingly minor difference in stating risk-return information either in terms of percentage changes or final asset values significantly influences private investors' portfolio selections. Subjects with final asset value information are less likely to identify dominant portfolios and make more irrational choices than participants who receive the information in percentage changes. In addition, the initial risk-return level and the willingness to increase or decrease the expected return is influenced by information framing. Participants who select with final asset value information are not only more risk-taking in the initial investment choice, but are also more likely to increase their risk-return level in subsequent decisions. On the other hand, investors with information presented in terms of percentage changes start at lower risk-return levels and exhibit a higher propensity to decrease risk and return.

Our data is especially well-suited to investigate the framing effect of private investors. The sample comprises 2,908 individuals and the sample population is biased towards experienced German private investors with an interest in finance. If these participants exhibit

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[33]The Appendix Section A.5 shows the descriptive and regression results of saturated models and the analysis by Choice Blocks.

systematic framing effects, we argue that our results provide a lower bound to the impact on the average small investor. A large set of individual information allows to control for general and specific financial risk aversion, actual and self-perceived financial literacy, as well as demographic characteristics. Our framing results are robust to these considerations as well as the order of portfolio set introduction.

Our findings contribute to the field of private investor research and carry relevant policy implications because the investigated information frames are commonly used in financial brochures and advice situations. Private investors are susceptible to simple information framing. The conversion of information from percentage changes into final asset values and vice versa is an everyday activity, but the experimental evidence suggests that decisions are based on the information in the form that it is provided. According to our results, the individual advisory service of expressing the expected portfolio returns in final asset values can substantially influence the portfolio decision by unconsciously increasing the risk exposure as well as the probability to make low quality choices.

The development of advisory guidelines and regulations concerning investor protection should consider these results about information framing. Framing is an influential driver for portfolio selection, in addition to risk aversion and financial literacy. Our results suggest that these are independent though closely related determinants. However, further research is welcome to better understand the levers of successful information processing and sound investment decision making.

3 Incorporation Law and Entry[1]

3.1 Introduction

Entry costs for startups can vary substantially between the legal forms providing limited liability and the ones implementing full liability.[2] A firm's liability status influences the choice of project risk, limited liability companies being more inclined to pursue risky investments and output choices (Stiglitz & Weiss 1981, Brander & Lewis 1986, Gollier et al. 1997). This can yield negative effects not only to the firm's creditors and customers, but also to society if the liability limitation of entrepreneurs leads to an imprudent use of public goods such as the environment or administrative resources. The aim of higher entry requirements for limited liability companies is to prevent entry of fraudulent entrepreneurs with risky projects. Nevertheless, it may also hamper entry of innovative projects which are characterized by uncertain outcomes. Entrepreneurs with such projects are therefore prone to seek liability limitation to protect their private wealth in case of business failure. In our study we exploit a natural experiment setting by looking at East and West German firms entering shortly after German unification.[3] The conversion of the East German economy from a social planning system to a market based economy of the West German style following the sudden fall of the German wall provides intra-country variation of market dynamics that is unique worldwide.[4] At that time, East Germany exhibited the characteristics of a transitory economy with a massive foundation activity of privately owned firms. Due to the political change, the West German legal system was largely applied to the East German territory, including the entry regulation for limited liability

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[1]This chapter is joint work with Prof. Dr. Susanne Prantl (University of Cologne; Max Planck Institute for Research on Collective Goods, Bonn; Institute for Fiscal Studies, London).

[2]We use the terms corporate firm and limited liability firm interchangeably. An incorporated firm is considered as a legal person. "The liability of "the corporation" is limited by the fact that the corporation is not real." (Easterbrook & Fischel 1985, p. 89) In contrast, full liability (or non-corporate) firms are not legal persons and therefore the owners are vicariously liable with their private wealth.

[3]The same setting is used by Prantl & Spitz-Oener (2009) to identify the effect of educational requirements on firm entry and occupational mobility. Redding & Sturm (2008) use the German division after World War II and the unification in 1989 as natural experiment to test the role of market access for economic development of West German border cities.

[4]In the following, if we refer to West Germany, we mean the territory of the former German Federal Republic (Bundesrepublik Deutschland, BRD) and for East Germany the former German Democratic Republic (Deutsche Demokratische Republik, DDR), respectively.

companies. We exploit differences between the high-entry East German economy and the stable-entry West German market environment. The unification into one legislation and economic system allows us to identify the effects of entry regulation. If entry regulation of limited liability companies has an impact on firm foundation and company size, we would expect this effect to be more pronounced in the high-entry Eastern part compared to the stable West German territory. The comparison of full and limited liability companies across the two different entry regimes within one institutional environment constitutes the core of our identification strategy.

We use a representative, non-selective sample of German startups which enter between July 1990 and December 1993. Firms are classified as corporate or non-corporate companies depending on their reported legal form which determines limited or full liability of firm owners. Entrepreneurs seeking limited liability have to overcome more bureaucratic and financial hurdles in Germany than full liability firms due to corporate law regulations. This regulatory increase in entry costs can impede financially more constrained startups to enter with limited liability and therefore deny firm owners the protection of their private wealth. Using the German unification as a natural experiment to identify the regulatory impact, we find that the difference in entry of limited and full liability companies in East Germany is significantly lower compared to West Germany, and that the difference in entry size is higher, respectively. These findings provide evidence that regulation has a relatively stronger impact in the high-entry East German territory compared to West Germany, potentially hindering more innovative firms to enter under the protection of limited liability and therefore slowing-down the process of economic transition.

The impact of entry regulation on entrepreneurship is subject of a growing body of empirical literature.[5] The main challenge is to find a plausible identification strategy for the regulatory effect that withstands concerns about the direction of implied causality.
Several approaches can be found in the literature. Djankov et al. (2002) and Capelleras et al. (2007) run international comparisons to exploit variation of regulatory strength across countries for effect identification. They find that higher barriers to entry have a substantial impact on market outcomes.[6] Becht et al. (2008) analyze foreign incorporations in the UK following corporate law deregulation in the European Union. They find a large increase in cross-country incorporation mobility leading to regulatory competition amongst EU

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[5]A recent literature survey about entry regulation is provided by Djankov (2009). Audretsch (2003) gives an overview of the matter and the literature of entrepreneurship. The literature contribution by Geroski (1995) summarizes the results of empirical studies concerning firm entry and formulates stylized facts.

[6]Klapper et al. (2010) provide a more recent investigation of entrepreneurship across countries with respect to registration complexity and economic development, and thereby complement Djankov et al. (2002).

countries. A limitation of "pure" international comparisons is a potential bias of the results due to unobserved country characteristics. This questions the causality of regulation on the observed outcomes.

Klapper et al. (2006) and Fisman & Sarria-Allende (2010) extend the cross-country approach by using international industry data to perform a cross-country cross-industry analysis. They sort industries according to their natural entry barriers and compare industry differences within countries across countries with different regulation intensities.[7] They find that the effect of regulation is more pronounced in industries with naturally low barriers to entry. Due to the introduction of the industry dimension, these studies can isolate the regulatory impact more precisely than simple cross-country studies. A similar approach is applied by Griffith et al. (2007) who analyze internationally the role of product market regulations on unemployment, depending on different levels of workers' bargaining power. They conclude that a deregulation in the product market increases competition which leads to more employment. This effect is stronger in countries where workers have more bargaining power.

Other papers exploit temporal or spatial intra-country variation of regulatory levels to identify its effect. Although using intra-country data, most studies perform a comparison of different regions and time periods to control for underlying trends that are not related to regulation. Long et al. (2009) highlight this fact by comparing the results of a health reform in Massachusetts relative to other states instead of only running a pre-post-comparison within the state as it was done by a prior study. Holmes (1998) uses a borderline-identification approach between US states to show the positive effect of pro-business regulation on the establishment of manufacturing firms. Dammann & Schündeln (2010) investigate whether differences in substantive law matters can explain in which state of the US limited liability companies are founded. It turns out that especially larger firms are sensible to legal features and more likely to formalize in a different state than their primary place of business location. This result is related to the international comparison of Becht et al. (2008). Bertrand & Kramarz (2002) investigate regional differences of entry regulation decisions over time to identify the effect on labor market outcomes in France. For India, Aghion et al. (2008) demonstrate that pro-employer regulation in the labor market influences the effect of product market deregulation on industrial performance positively compared to states with labor regulations in favor of workers. Yet, they use variations in

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[7]The underlying assumption is that relative industry-specific entry dynamics are stable across countries. This assumption could be violated if countries have for example very different natural resources, strong other regulations not under study, or different levels of development. For a more detailed discussion see Ciccone & Papaioannou (2007).

labor market institutions to isolate the effect of deregulation, which is a similar approach to Griffith et al. (2007) on a national basis. Bertrand et al. (2007) and Kerr & Nanda (2009) analyze the role of banking sector deregulation on product market dynamics in France and the US respectively, and take advantage of regulatory variation over time and region.

This study contributes to the existing literature by identifying the impact of corporate law regulation (CLR) on market entry and entry size in a transitory, expanding market compared to a stable entry environment. We employ the unique setting of a natural experiment which bypasses several problems: First, the transfer of the West German legal system to the East German territory was only driven by the political integration process and independent from economic considerations. Therefore, CLR in East Germany is not an answer but a root for the distortions of corporate entry dynamics. This provides a direction of causality between the regulation and its economic effects.[8] Second, the different entry dynamics in East and West Germany are caused by the historically different economic developments. After reunification, the Eastern part enters a transitory phase from a state-directed economy towards a social market economy which is accompanied by high entry rates of privately owned companies. Other papers (Klapper et al. 2006, Capelleras et al. 2007, for example) need to define a benchmark in order to identify the impact of regulation relative to that benchmark. The exogenously imposed variation of entry dynamics makes our results invulnerable to benchmark misspecifications. Third, we compare firm foundations between two different entry environments, but within one country. All companies are subject to the same legal and economic system. We do not have country specific variations in contrast to other studies that run cross-country identification strategies. This makes our results less vulnerable to omitted variable biases that may occur if one can not properly control for all relevant country characteristics. Furthermore, this study is the first contribution that explicitly takes the role of alternative liability modes with different regulatory entry burden into consideration. We explicitly compare full and limited liability companies with respect to distortions in firm formation. Prior studies either do not analyze whether regulatory burden matter for the establishment of limited liability companies (Harhoff et al. 1998, for example) or investigate only limited liability firms across countries to learn about the effects of different entry regulation regimes (Djankov et al. 2002, Fisman & Sarria-Allende 2010, Klapper et al. 2006, 2010). Latter ones neglect that firms actually have entry alternatives within their countries that may be characterized by

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[8]The argumentation of causality often requires a series of empirical tests and verbal reasoning whereas in our case the direction of causality is less equivocal due to historic circumstances. A very profound example of reverse causality discussion about the effect of financial market development on economic growth is provided by Rajan & Zingales (1998).

a different set of entry costs and legal form benefits. If the foundation of a limited liability firm induces higher entry costs due to regulation, it does not necessarily mean that an entrepreneur decides to become part of the shadow economy or does not enter at all. Our study extends the previous literature thanks to the detailed data base encompassing full and limited liability companies: Across entry regimes, we compare the group of regulated firms not only with an other group of regulated firms but set it into relation to the group of firms choosing an alternative entry form. Thus, our study goes into more detail by considering the micro-level impact of regulation.

The remainder of this chapter is structured as follows: Section 3.2 introduces the case of corporate law regulation in the German context and presents the historic circumstances in Germany at the time of unification. The hypotheses are derived in Section 3.3 and we present the empirical identification approach in Section 3.4. An introduction to the data follows. The empirical results are documented in Section 3.6, including descriptive and regression results, as well as robustness checks and a discussion. Finally, we conclude in Section 3.7.

3.2 Corporate Law Regulation and the German Unification

The legal form of a firm determines the liability status of the owners.[9] Firm incorporation limits the personal liability of the entrepreneur to her equity share and allows a separation of ownership and management.[10] Easterbrook & Fischel (1985) summarize the rationales why corporate law allows for limited liability of firms and what it means for shareholders, for creditors, as well as for society. Horvath & Woywode (2005) provide a theoretical model and an empirical test to show that risk-aversion is one of the main drivers for entrepreneurs choosing limited liability. This is in line with theoretical contributions describing firms under limited liability as more risk-seeking than full liability firms due to the implied option character of firm value (Stiglitz & Weiss 1981, Gollier et al. 1997). Easterbrook & Fischel (1985) discuss the minimum equity requirement as a mean to prevent excessive risk-taking of limited liability firms, but they also address its effect as a barrier to entry, especially in the presence of financial constraints. Empirical evidence provided by Harhoff et al. (1998) concludes that limited liability companies grow faster but also file more often

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[9]Typical legal forms for German full liability enterprises are the sole proprietorship (Einzelunternehmer), civil-law association (BGB-Gesellschaften), limited and general commercial firm (Kommanditgesellschaft KG and Offene Handelsgesellschaft OHG). Alternatively, firms can enter with limited liability as limited liability company (Gesellschaft mit beschränkter Haftung GmbH) or limited commercial partnerships under limited liability (GmbH & Co KG). Since we observe only small startups, we neglect stock corporations (Aktiengesellschaft AG).

[10]Carr & Mathewson (1988) describe this fact as "increased cost of ownership rights of unlimited liability institutions" [p. 769].

for bankruptcy compared to full liability firms. This complements the theoretical models.[11]

The Foundation of Limited Liability Firms Is Regulated

In Germany, the foundation of a limited liability company is more complex and involves substantially higher legal fees than launching for example a sole proprietorship. In the following, we consider the laws that were in place at the time of data collection, that is between July 1990 and December 1993.[12] The Law for Limited Liability Companies (GmbHG)[13] requires a minimum equity of €25,000 to register as a limited liability corporation.[14] An exception to this rule was made for firms entering in East Germany between July 1, 1990 and July 1, 1992. They had to fulfill a reduced requirement of €10,000 (Gesetzblatt der Deutschen Demokratischen Republik 1990a). In addition to the equity requirement, substantial time and administrative costs are incurred in the process of limited liability firm formation, e.g. a notarially testified foundation contract is needed for the mandatory formal registration in the trade register and the fulfilment of publication guidelines. Holz & Icks (2008) analyze the administrative foundation costs for limited liability companies in Germany in 2008.[15] They find that 90% of the administrative entry costs result from legal requirements applying only to limited liability startups. Their study excludes information search costs but assumes fully informed entrepreneurs, implying a downward bias of the actual regulatory costs. In fact, the complexity of the decision frequently leads to the enrollment of a lawyer and/or tax adviser which increases foundation costs additionally. The major benefits of the burdensome registration procedure and the mandatory compliance with formal standards can be summarized as follows: limited liability of the owners, lower future transaction costs, reduced insolvency costs, and the existence of transparent information in case of litigation.[16] The minimum equity requirement is meant to provide a lower bound to firm value and to give a minimum security and protection to future claimants and consumers. Nevertheless, it may exclude entrepreneurs with financing restrictions from entry with limited liability. The adjustment in East Germany shows that

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[11]However, they do not analyze whether regulatory burden matter for the choice to enter as limited liability company.

[12]For a more detailed overview of the history of the German Corporate Law and its requirements for firm foundation see Appendix Section B.1.

[13]We will use GmbHG, incorporation law and corporate law interchangeably.

[14]Since 2001, the official currency in Germany is the Euro. The conversion rate for DM to Euro in 2001 was 1.95583:1. The minimum equity requirement was DM50,000 and converted at the rate 2:1.

[15]This is the first German study which reports reliable administrative entry costs and which allows to separate regulatory administrative costs. The total numbers for 2008 most likely underrepresent the costs in 1990-1993. The World Bank (2004, 2008) measures the time needed for German firm setup with limited liability to be 45 days in 2004 and 18 days in 2008. This indicates the high impact of technological change and optimization of the entry process.

[16]Storey (1994) investigates the choice of legal form in the UK and argues that banks consider the increase in publication standards during firm lifetime as a positive trait to signal serious business intention.

politicians were aware of the fact that the equity requirement had the character of an entry barrier. They wanted to stimulate entry in East Germany by taking lower private wealth levels into account.[17]

To summarize, entry costs for startups with limited liability are higher due to legal requirements codified in corporate law. This is what we refer to as corporate law regulation. Firms are generally free to choose their legal form, but the regulatory costs for firm incorporation may impede small startups to enter with having the benefits of corporate firms.

The German Unification Provides the Setting of a Natural Experiment

The sudden fall of the Berlin wall in 1989 and the subsequent German unification in 1990 with the fast change of the East German economic system and the extremely rapid transfer of West German laws to the new territory provides the setting of a natural experiment. It allows to identify the impact of CLR by comparing firm incorporations in a transitory, high-entry market environment and a market with stable entry. In the following, we briefly sketch the historical background facts which motivate the underlying identification approach.

After the German division in 1949, the economy of the German Democratic Republic was characterized by a socialist central-planning system whereas the German Federal Republic developed a social market-based economy. The success of these alternative economic models diverged over the years. West Germany developed a strong, export-oriented economy and was integrated in the international trading and political system. The DDR economy was embedded in the socialist system and mainly restricted to trade with Eastern Bloc countries. The economic situation worsened substantially by the end of the 1980s. The costs of the social system were economically not sustainable and people were discontent with their limited mobility and restrictions of personal freedom. This lead to public mass demonstrations starting September 1989 and finally culminated in the fall of the Berlin Wall on November 7, 1989.

Within months, several laws and treaties were passed which prepared the official unification. The Treaty for the Economic, Monetary and Social Union between East and West Germany (Bundesgesetzblatt 1990) is of special importance: It constitutes that major West German laws, amongst them the Civil Law, the Trade Law, and the Law for Limited Liability Companies, are extended to the East German territory and that the Deutsch

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[17]The development of a strong privately owned economy was one major aim of the DDR government after the breakdown of the Berlin wall (Gesetzblatt der Deutschen Demokratischen Republik 1990*b*). According to the German Central Bank, net assets of a West German household sum up to on average €140,050 and for an East German household €30,650 in 1990 (Deutsche Bundesbank 1999).

Mark replaces the Eastern currency Mark. These changes became effective July 1, 1990. Only 11 months after the fall of the Berlin Wall, on October 3, 1990, the two countries officially became one state of Germany by signing the Unification Treaty. The pace and the purely political motivation of legal changes establishes the causality of regulation on economic dynamics in East Germany.

In the aftermath of unification, large parts of the East German economy basically collapsed because the formerly state-owned and mostly inefficient working companies were exposed to national and international competition (Fritsch 2004). This lead to a dramatic drop in industrial production and GDP, as well as large-scale layoffs (Brezinski & Fritsch 1995, Sachverständigenrat 1993). The sector of the private economy was underdeveloped and existed only rudimentarily, mainly in the manufacturing industry with small family businesses. The breakdown of the old "state economy" and an increasing demand of the East German people for goods and services induced a massive need of private firms to enter the market, which lead to high entrepreneurial activity in the territory of the former DDR.[18] The West German economy was a stable social market economy at the time of unification. Despite the increase of inner-German demand, entry dynamics were little affected and can be considered as stable. Thus, after unification Germany consisted of two parts with varying entry dynamics but one legislature, constituting the setting of a natural experiment.

3.3 Hypotheses for Firm Entry and Entry Size

The setting of a natural experiment in Germany after reunification can be used to identify the regulatory effect on firm entry and initial firm size. The approach centers around the analysis of four firm groups that are characterized by legal status and location: Limited liability entrants have to obey the regulated entry procedure prescribed by corporate law, and full liability firms enter without these regulatory obligations. The differences between these two groups of firms are compared between the high entry environment of East Germany and the stable entry environment of West Germany.

We use a standard Cournot model with a linear demand function to derive our hypotheses.[19] Since East Germany is in a high-entry stage, we assume that there are lower barriers to entry than in West Germany. After the German unification, the existing East German state companies were forced to restructure or to close down. In general, firm efficiency was

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[18]Unfortunately, our data does not allow to differentiate between necessity and opportunity foundations. This distinction is made by Ardagna & Lusardi (2009) who investigate internationally the role of entry regulation on these two different types of entrepreneurs.

[19]In Appendix Section B.2 we show the different steps in more detail.

low due to outdated production facilities. The private sector economy was largely under-developed or not existing. This provides an economic environment with many profitable investment opportunities and leads to a high entry market compared to the mature West German market environment.

A firm's entry costs can be described as $C_i(q_i) = c_i q_i + R + K$ with $c_i q_i$ being the variable costs, $R \geq 0$ are the regulatory entry costs imposed by corporate law, and $K \geq 0$ stands for other 'barriers to entry', or the entry environment as described above. The competitive barriers to entry are higher in the Western territory than in the Eastern territory. In our context, the exact source of these entry barriers does not matter, it is only important that there exist some component that is territory specific.[20] The regulatory entry costs R are the same in East and West because they are caused by the same legislation and they only apply to limited liability firm foundations.[21]

Entrepreneurs are profit maximizer and enter as long as they make non-negative profits. We can show that the number of firms N which fulfills this condition is convex in R and K, i.e. $\frac{\partial N}{\partial R} = \frac{\partial N}{\partial K} < 0$ and $\frac{\partial^2 N}{\partial R \partial K} > 0$. Thus, the negative effect of entry regulation is mitigated in a high entry barrier (low entry) environment. Since the number of entrants is larger in East than in West Germany, a regulation that affects limited liability entry due to increased entry costs applies to more potential entrants in East Germany compared to the Western territory. Therefore, the decrease of limited liability entrants is higher in East Germany compared to West Germany. Considering the entry situation in East Germany and the regulatory restrictions for firm incorporation, we derive the following hypothesis:

Hypothesis 1: Due to corporate law regulation, the difference between limited and full liability entry in the transitory East German market is negative and larger in absolute terms than the respective difference in the mature West German market.

The total impact of regulatory entry costs in the presence of low entry rates is small because only few firms would enter at all and thus entry deterrence is low. In the case of a high entry environment, more firms would be willing to enter with limited liability but are restrained from doing so due to the high regulatory entry costs. Thus, regulation decreases limited liability entry more in a transitory than in a stable market environment.

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[20]Plausible reasons for this difference could be the lower wage level in East Germany, or the higher competition level in West Germany. In West Germany, the mature market environment offers less positive net present value opportunities and the price-cost-margin is lower.

[21]For motivating the hypotheses about regulation in general, we abstract from the lower minimum equity requirement in East Germany during the two-year legal adjustment period. For 2008, Holz & Icks (2008) cannot find significant regional differences for entry costs within Germany.

The second hypothesis is closely related to the entry hypothesis and concerns the differences in entry size between limited and full liability firms in East Germany compared to West Germany. The average firm size is the equilibrium output q^* per number of entrants N, that is $(\frac{q^*}{N}) \equiv x$, and we can show that it is convex in R and K: $\frac{\partial x}{\partial R} > 0$ and $\frac{\partial^2 x}{\partial R \partial K} < 0$. In other words, firms entering under regulation start larger, but this effect is mitigated in a high entry barrier (low entry) environment. For our investigation this means that we expect larger entry sizes of corporate entrants compared to non-corporate entrants, and that this difference is more pronounced in East Germany than in West Germany.

In a theoretical model, Brander & Lewis (1986) show that debt financing of a firm induces limited liability for the entrepreneur. As the debt level increases, so do the financing costs and therefore the cost of limited liability, leading entrepreneurs to choose higher output levels. In our case, limited liability is set in place by firm incorporation which raises the entry costs exogenously due to regulation. Entrepreneurs with an incorporated firm thus have an incentive to increase output above the respective level under full liability to recover entry costs. Under the assumption that output and firm size are positively correlated, we therefore expect that limited liability firms enter larger than full liability firms. Furthermore, the market conditions in East Germany were characterized by lower competitive pressure and thus higher price-cost-margins.[22] The economically more unstable conditions in East Germany increased the value of limited liability as a real option on firm value.[23] This argumentation leads to the second hypothesis:

Hypothesis 2: Corporate law regulation leads to a larger entry size of limited liability firms compared to full liability firms, and the difference is larger in the transitory East German market compared to the respective difference in the stable market environment of West Germany.

In the following, we are going to investigate these hypotheses empirically.

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[22]The specific mechanisms leading to prices higher than marginal costs are manifold and not relevant for this context. Possible sources in East Germany are different levels of firm efficiency or the economy's character of being in an early product market life cycle with process and product innovations (see for example Klepper (1996)). The Cournot oligopoly theory can explain any situation between monopoly and perfect competition and allows for markup prizing.

[23]In case of a bad market outcome the entrepreneurs' private liability is limited, and in case of success they fully participate in the profits that exceed entry and debt financing costs.

3.4 Identification Strategy and Econometric Methodology

Identification of the Causal Effect

The interest of this analysis centers on the impact of CLR on firm formation and entry size of limited liability firms. To identify the effect of CLR, one can define the average treatment effect on the treated (ATT) as follows:[24]

$$ATT = E[Y_t - Y_c|CLR = 1] \tag{3.1}$$

where Y denotes the outcome variables entry or entry size of firms that enter either with limited liability (treatment group t with outcome Y_t) or with full liability (control group c with outcome Y_c) in an environment where corporate law regulation exists ($CLR = 1$). At the heart of the evaluation of the average regulatory effect on corporate firms is a missing data problem: Every firm is either in the treatment or the control group, no firm's outcome can be observed simultaneously in both states and thus the counterfactual outcome remains unobserved. Estimating the ATT yields:

$$E[Y|CLR = 1] - E[Y|CLR = 0]$$
$$= \underbrace{E[Y_c|CLR = 1] - E[Y_c|CLR = 0]} + E[Y_t - Y_c|CLR = 1]$$
$$= \text{selection bias} + ATT \tag{3.2}$$

If the legal form was assigned randomly, CLR would not influence the average outcome of the control group and we could use $E[Y_c|CLR = 1] = E[Y_c|CLR = 0]$ to estimate the unbiased ATT according to equation (3.2). This is not the case. CLR is assumed to have an influence on the assignment of firms to the treatment and control group (non-random assignment) what leads to a self-selection bias which is not separable from the ATT in this setup.

To estimate the unbiased effect of CLR on the expected outcome of limited liability companies, the identification strategy needs to control for self-selection. To this aim, we employ the natural experiment of German unification as described in Section 3.2 in our identification strategy. Unification leads to a high entry environment in East Germany, compared to a stable entry environment in West Germany. If CLR has an impact on the outcome variables entry and entry size, then it is reasonable to expect it to be larger in an envi-

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[24]Section 3.4 is based on Angrist & Pischke (2009), Wooldridge (2002), Blundell & Dias (2009), as well as Blundell & MaCurdy (1999).

ronment where it matters for more firms, that is in East Germany. The causal effect of CLR is assumed to be additive but not necessarily constant across different entry regimes. This is what we exploit for identification. Considering the high-entry environment in East Germany as a treatment $EAST = 1$ on all Eastern firms in the presence of the same CLR that exists in West Germany, the new ATT effect of interest becomes:

$$ATT' = E[\quad E[Y_t - Y_c|CLR = 1]\quad |EAST = 1\quad] \tag{3.3}$$

which measures the average treatment effect of CLR on limited liability firms compared to full liability firms in East Germany, compared to the respective average treatment effect of CLR in West Germany.[25] After unification, the same corporate law applies in both parts of the country as described in Section 3.2[26] and thus CLR is constant and independent from firm location, $CLR \perp\!\!\!\perp EAST$. Furthermore, firm allocation to the Eastern and Western territory is assumed to be exogenous and random, that is entrepreneurs do not choose actively in which part of the country they set up their firm. Using this framework of a natural experiment, one can estimate ATT' as follows:[27]

$$E[E[Y|CLR = 1] - E[Y|CLR = 0]|EAST = 1]$$
$$-\quad E[E[Y|CLR = 1] - E[Y|CLR = 0]|EAST = 0]$$
$$=\quad (E[Y|CLR = 1, EAST = 1] - E[Y|CLR = 0, EAST = 1])$$
$$-\quad (E[Y|CLR = 1, EAST = 0] - E[Y|CLR = 0, EAST = 0])$$
$$=\quad (\underbrace{E[Y_c|CLR = 1, EAST = 1] - E[Y_c|CLR = 0, EAST = 1]} + E[Y_t - Y_c|CLR = 1, EAST = 1])$$
$$-\quad (\underbrace{E[Y_c|CLR = 1, EAST = 0] - E[Y_c|CLR = 0, EAST = 0]} + E[Y_t - Y_c|CLR = 1, EAST = 0])$$

$$\tag{3.4}$$

$$=\quad E[Y_t - Y_c|CLR = 1, EAST = 1] - E[Y_t - Y_c|CLR = 1, EAST = 0] \tag{3.5}$$

The under-braced terms in (3.4) capture the self-selection of entrepreneurs to the limited or full liability entry group depending on CLR, in East and West Germany respectively (compare with equation (3.2)). Since we assume that the process of entrepreneurial self-selection to either group follows the same non-random process in both parts of the country,

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[25] $ATT' = E[ATT|EAST = 1]$ where the ATT is defined in equation (3.1).

[26] For now we abstract from the lower minimum equity requirement in East Germany that was in place during a transition period between July 1990 and July 1992.

[27] Assume $Z = (Z_1, Z_2)$ are conditions on X. If X and Z_1 are together independent from Z_2, that is $(X, Z_1) \perp\!\!\!\perp Z_2$, then the following holds: $E[X|Z_1] = E[X|Z] = E[X|Z_1, Z_2]$. In our context $X = Y$, $Z_1 = CLR$, $Z_2 = EAST$ and as long as (Y, CLR) are non-randomly connected but independent from firm location $EAST$, we can use $E[Y|CLR] = E[Y|CLR, EAST]$ for the first transformation.

these two terms cancel each other out. Therefore, the comparison of firms in the two territories solves the problem of the selection bias based on CLR. A selection bias for East or West Germany does not occur due to the random assignment process of entrepreneurs to the two territories. The natural experiment allows to identify the differential effect of CLR on limited liability firms in East Germany compared to West Germany. Equation (3.5) can be estimated using the data at hand.

To identify the causal effect in the empirical part we maintain the stable unit treatment value assumption (SUTVA). It states that the treatment of firm i affects only the outcome of firm i.[28]

The Difference-in-Difference Estimation Approach

To estimate the average treatment effect of CLR on limited liability firms in East Germany compared to West Germany, we apply a difference-in-difference (DID) estimation approach. The central feature of DID is the additive structure of potential outcomes that can be written as $Y = Y_c + EAST * (Y_t - Y_c)$. In particular, the expected outcome Y of firm j can be written as

$$E[Y_{jre}|r, e] = \alpha + \gamma_r + \lambda_e + \beta_{re} \tag{3.6}$$

where α is the average outcome for a full liability company in West Germany, the effect of limited liability entry adds a constant γ_r, firm location in East Germany adds λ_e and for corporate firms in East Germany the constant summand β_{re} is considered. Alternatively, the outcome variable can be written as

$$Y_{jre} = \alpha + \gamma_r + \lambda_e + \beta_{re} + \epsilon_{jre} \tag{3.7}$$

with $E[\epsilon_{jre} = 0]$. The difference of the difference between limited and full liability firms (treatment group t and control group c) in East and West Germany is a constant, β, and the causal effect of interest. It can be estimated using DID of the population means:

$$(E[Y_{jre}|r = 1, e = 1] - E[Y_{jre}|r = 0, e = 1]) - (E[Y_{jre}|r = 1, e = 0] - E[Y_{jre}|r = 0, e = 0])$$

$$[(\alpha + \gamma_r + \lambda_e + \beta_{re}) - (\alpha + \lambda_e)] - [(\alpha + \gamma_r) - (\alpha)]$$

$$= \beta \tag{3.8}$$

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[28]One can argue whether SUTVA is a feasible assumption in a transitory, off-steady-state market environment as East Germany where the market is not perfectly competitive. Nevertheless, a long-run equilibrium analysis for the two parts of the country is beyond the scope of this study. In our sample, we restrict firm size such that we can ensure that firms do not have market power and act independently, such that a single unit's outcome does not influence another unit's outcome.

The key assumption is that the outcome variables for corporate and non-corporate firms in East and West are the same if both parts of the country were at the same economic development level and had comparable entry regimes. If this were the case, no differential effect for regulation would be observable and consequently $\beta = 0$.

The Regression Analysis

Besides estimating the differential effect of CLR using the sample analogues of population means as in (3.8), one can also use regression analysis to estimate equation (3.7). We define the binary variables D_e which is one for firms in East Germany, and D_r which indicates firm incorporation (limited liability). The variable $D_{re} = D_e^* D_r$ equals one for East German limited liability companies. This leads to the following regression representation of equation (3.7) for the outcome variable Y of firm j:

$$Y_{jrez} = \alpha + \gamma D_r + \lambda D_e + \beta D_{re} + \Omega X_z + \epsilon_{jrez} \tag{3.9}$$

where the coefficient of interest, β, measures the differential effect of CLR between limited and full liability firms in East Germany compared to West Germany. α is a constant which captures the average outcome for West German non-corporate firms, γ is the base effect for firm incorporation and measures the location-independent differences between limited and full liability firms. λ is the outcome difference between firms in East and West Germany, independent from the liability status.

Depending on the aggregation level of the outcome variable, we include further control variables in X_z, where z stands for a flexible combination of: industry specific effects i, time effects t, as well as further firm and owner or county characteristics and interaction variables. The inclusion of further covariates allows to control more flexibly for systematic differences between East and West Germany and corporate and non-corporate firms than the mere inclusion of D_r and D_e. A stochastic error term ϵ_{jrez} is included with the usual distributional assumptions (iid).

The econometric analysis for the outcome variables entry and firm size builds on OLS estimation of the model in equation (3.9). Regressions for firm entry use aggregated county level data and the error terms are clustered conservatively at county level; size regressions use firm level data and we cluster them by 4-digit industry codes to allow for heteroscedasticity and serial correlation. Regressions employing firm level data include weights to correct for sample stratification (Wooldridge 2002).[29]

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[29]For county level regressions the weights are considered when generating the dependent variable as described in Section 3.5.

According to the hypotheses from Section 3.3, we expect $\beta < 0$ in the entry regressions and $\beta > 0$ in the regressions concerning firm size.

3.5 Data

Data Source, Restrictions and Entry Variable Generation

We employ a stratified random sample from panels of the Centre of European Economic Research (ZEW), Mannheim. Creditreform, the leading German credit agency, collects and provides representative and non-selective data on legally independent firms. A detailed description of the firm panel data, including the source, the sample drawing process, tests on representativeness, and stratification criteria[30] as well as the description of further telephone interviews that were conducted to complete the information, can be found in Almus et al. (2001) and Prantl (2003).

The dataset contains small owner-manager entrants and includes detailed firm level information. It covers all German regions, common legal forms and major industries (craft, construction, trade, transport & telecommunications, services). The data includes rich firm and owner information, for example the size of the firm, age and education of the owner, affiliations or subsidiary structures, etc..

We complement the firm data with county characteristics provided by federal research and statistic units (Böltken et al. 1995). Regional characteristics reflect the socio-economic situation at the time of entry which vary between East and West counties (Fritsch et al. 2006).[31] A short description of all variables used in the analysis is provided in Table B.1 in the Appendix section B.

The starting sample comprises 10,000 East German and 12,000 West German firms that enter the market between January 1, 1990 and December 31, 1993. We impose several data restrictions.[32] The final sample comprises 11,518 firm observations out of which 10,095 provide detailed owner information. The firms are located in 326 West German and 215 East German counties.

To measure entry, we aggregate the 11,518 firm observations at county level.[33] The outcome

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[30]Firms that are rated by Creditreform as having increased liquidation risk are oversampled about twofold according to known sampling rules for disproportional stratification. Therefore, we apply sampling weights in all regressions and tests that follow if not stated otherwise (Wooldridge 2002).

[31]Unfortunately, no reliable county level data is available for East Germany before 1992/93. The assumption of stable regional characteristics over an entry period of 3.5 years is admittedly not satisfactory but we still believe that they are at least good indicators for the region's economic and social situation at the time of unification.

[32]Table B.2 in the Appendix section B provides a detailed overview over the data restrictions.

[33]Aggregation at the county level leads to a loss of owner characteristics and therefore, we use all 11,518 observations independent from the existence of owner information. In contrast, the size analysis builds

variable E_{cr} sums all entrants by county c and liability status r.[34] We scale the entry variable by the working-age population between 18 and 65 years (in 1,000) which represents the pool of potential entrepreneurs of a county. The resulting entry variable is EPC_{cr}: entry per 1000 capita (p.c.) of the working age population by county c and regulatory status r. Additionally, different aggregation levels are used in order to provide data variation and the opportunity to control for time and industry effects in entry regressions despite aggregation. Besides EPC_{cr} we also generate EPC_{cri}, which is the sum of firms by county c, liability status r, and five 1-digit industry codes i, and EPC_{crt} that aggregates by c, r and half-year entry cohort t. All are measures weighted by the respective county population aged 18-65.

Data Description

East German counties are on average smaller and have less inhabitants than West German counties.[35] This motivates the scaling of the entry variable by the size of the working age population. The average EPC_{cr} in East German counties is 5.6 and on average about three times as high as in the Western counties which shows that East Germany is indeed a high-entry territory compared to the Western part of the country.[36] The higher East German per capita entry rates also hold at county-industry level (EPC_{cri} not reported). This ascertains that the identifying assumption of an high-entry environment in East Germany is not industry-specific and that the relation of high entry in East Germany and lower entry in West Germany is a general phenomena at that time.[37] A higher unemployment rate and lower wage levels in the Eastern territory are in line with the description of the economic situation in Section 3.2. The significantly larger share of female entrepreneurs in East Germany is little surprising given the traditionally high share of women in the work force.

Comparing the startup distribution across industries, two differences are remarkable: In East Germany, a total of 62% enter in construction and trade and only 20% in services

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on individual firm observations and we use the restricted sample of 10,095 firms that contains all relevant information.

[34]We take the frequency weights of firm observations into account when aggregating firm observations because the data is stratified.

[35]Tables B.3 and B.4 in the Appendix section B provide the descriptive statistics of county and firm level data, respectively.

[36]The data is representative for East and West Germany but its coverage is not known because no comprehensive database about all firms in Germany exists (only registered companies are counted in the official statistics). Nevertheless, regional comparisons are feasible because data collection happens without regional or temporal distortions (Almus et al. 2000).

[37]Other papers also build on such an order assumption with respect to regulatory entry barriers across countries or industries, e.g. Rajan & Zingales (1998), Capelleras et al. (2007), Fisman & Sarria-Allende (2010).

compared to 52% and 31% in West Germany, respectively, reflecting the different stages of infrastructure and economic development. The industry shares within the groups of corporate and non-corporate firms in East and West also vary. The literature has shown that industry variation of innovative activity influences the pattern of entry and exit dynamics (Audretsch 1995) such that industry control is an essential factor for further analysis.

In both parts of the country, about 23% of all firms have a team of founders and the fraction is higher among limited liability firms. Furthermore, the average main owner of a corporate firm is about 5 years older than entrepreneurs starting with full liability. Team foundations and older entrepreneurs can be associated with more financial resources, know-how, and experience.[38] The positive correlation of these factors with limited liability foundations could hint at the impact of regulation requirements on foundation activity.

3.6 Empirical Results

The empirical analysis of the hypotheses stated in Section 3.3 consists of three parts: First, we analyze the descriptive results of the outcome variables, secondly, we accomplish a detailed regression analysis and finally, we perform several robustness tests to check for potential biases and the appropriateness of the identification strategy.

3.6.1 Descriptive Results

The analysis centers on two outcome variables: the number of firm entries and their initial firm size. Table 3.1 presents the descriptive results for these two outcome variables across the four groups of interest: corporate and non-corporate firms in East and West Germany. Panel A includes the average number of county entrants per 1000 working-age inhabitants (EPC_{cr}), the absolute group differences between East and West and full and limited liability companies as well as the DID estimator β. In Panel B this information is provided for initial firm size, measured as the first reported number of employees (including the firm owner-manager).

The results in Panel A provide first evidence in favor of Hypothesis 1: The difference between limited and full liability entry is negative in East Germany and larger compared to West Germany. The estimate for β is -2.03, statistically significant at the 1% confidence interval and economically large, given that the average EPC_{cr} is 1.83 in West and 5.56 in East German counties (Table B.3).

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[38]Lazear (2005) argues that entrepreneurs need to be "jacks-of-all-trades". By entering as a team they bundle their skills and competencies, increasing the individual chance of becoming a successful entrepreneur.

Table 3.1: Average Firm Entry and Initial Firm Size by Liability Status and Firm Location

Panel A: Entry by County and Liability Status (EPC$_{cr}$)

	East	West	Diff East-West
Limited liability	1.427	0.575	0.852
	(0.053)	(0.022)	(0.057)
Full liability	4.140	1.258	2.882
	(0.097)	(0.035)	(0.104)
Diff Lim-Full	-2.713	-0.683	-2.030
	(0.108)	(0.036)	(0.114)

Panel B: Entry Size (Number of Employees)

	East	West	Diff East-West
Limited liability	8.361	4.099	4.262
	(0.194)	(0.107)	(0.222)
Full liability	2.970	1.919	1.052
	(0.056)	(0.032)	(0.065)
Diff Lim-Full	5.391	2.180	3.210
	(0.202)	(0.112)	(0.231)

Notes: Panel A is based on county level data (215 counties located in East and 326 in West Germany, containing 11,518 firm observations). Panel B is based on firm level data encompassing 10,095 companies. Entry is scaled by the size of the working-age population (age 18-65 years, in 1000). The table displays the means of the four groups of interest and the group differences including the DID estimate β. The standard errors are in parentheses. Weights are used to control for sample stratification.

On average, less limited than full liability firms enter in East and West Germany. This difference is larger in East Germany (-2.71 vs. -0.68), where on average more firms are founded in both liability statuses. The difference between East and West Germany is larger for non-corporate entries (a difference of 2.88 firm foundations vs. 0.85 for corporate foundations). These findings affirm Hypothesis 1 and also provide evidence on the validity of the expected base effects for the liability status and firm location.

Initial firm size is the second outcome variable that we consider for the evaluation of the regulatory impact on entrepreneurial activity. The descriptive results are displayed in Panel B. Hypothesis 2 states that the difference of firm size between limited and full liability firms is larger in East than in West Germany. The average West German startup employs about 2.7 people compared to an average of 4.4 in East Germany (not reported). East German corporate firms have on average 5.39 more employees than non-corporate firms. The respective difference is only 2.18 in West Germany. The DID is therefore 3.21 and significantly different from zero. This provides descriptive evidence for the second hypothesis: The difference in entry size between limited and full liability companies in East Germany is larger compared to West Germany.

3.6.2 Regression Results

After providing first descriptive results, we conduct a regression analysis to strengthen prior findings. We start with regressions explaining the number of firm entries and proceed in the second part with the estimation of entry size.

Firm Entry

The main entry measure is EPC_{cr} but we also use the more disaggregated measures EPC_{cri} and EPC_{crt} to include further control variables for industry affiliation and entry cohort, respectively. Using ordinary least square (OLS) regressions, we estimate equation (3.9) which assumes an additive structure between the base effects for CLR and firm location, the coefficient of interest β which measures the effect of CLR in East Germany, and all other controls. We cluster standard errors by county. The results are displayed in Table 3.2.

The *base* models (column (1), (3), (6)) include only the interaction term between liability status and firm location (D_{re}), the indicator variables for liability status (D_r) and firm location (D_e) to capture the respective base effects, and a constant term. The *extended* models contain county controls and, depending on the level and type of disaggregation, additional control variables X_z, including interaction variables. A more flexible regression setup including interaction variables with firm location and liability status leads to a more precise estimation of the causal effect. The interaction D_e*Cohort takes convergence between the Eastern and Western economy over time into consideration, D_e*Industry controls for structural differences of the industry composition in East and West. D_r*Industry accounts for the fact that some industries are especially prone to limited liability foundations and D_r*Cohort considers different entry patterns of limited and full liability companies that might occur over time.

Column (1) presents the results for the base model using the highest data aggregation level EPC_{cr}.[39] The coefficient of interest, β, is negative and significant at the 1% confidence level. During the entry period, the difference between limited and full liability entry per county is about 2 firms lower in East than in West Germany. This resembles the descriptive results of Table 3.1. The economic magnitude of this effect is large: According to

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[39] 11,518 firm level observations are aggregated over 541 counties and 2 liability statuses, leading to 1057 county/liability status observations of entry EPC_{cr}. 25 county/liability status cells do not contain firm observations and are not included in the main regression analysis. Technically, the scaling of the dependent variable by the working-age population imposes a coefficient of 1 on the scaling variable if it were included in the regression as an exogenous variable. The regression results are robust to different definitions of the dependent variable (total number of entries, the logarithm of per capita entry, the logarithm of total entry).

Table 3.2: Entry Regressions

	EPC_{cr}		EPC_{cri}			EPC_{crt}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D_{re} (β)	-2.015***	-2.014***	-0.388***	-0.402***	-0.438***	-0.242***	-0.242***	-0.245***
	(0.111)	(0.111)	(0.027)	(0.027)	(0.027)	(0.016)	(0.016)	(0.016)
D_r (γ)	-0.649***	-0.651***	-0.163***	-0.161***		-0.108***	-0.108***	
	(0.035)	(0.035)	(0.009)	(0.010)		(0.006)	(0.006)	
D_e (λ)	2.882***	3.194***	0.641***	0.706***		0.449***	0.468***	
	(0.104)	(0.150)	(0.026)	(0.039)		(0.017)	(0.028)	
Const (α)	1.258***	1.639***	0.371***	0.244***	0.850***	0.267***	0.318***	0.323***
	(0.035)	(0.112)	(0.010)	(0.034)	(0.065)	(0.007)	(0.027)	(0.028)

Control Variables (df): Wald-Statistic χ^2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
County		7.00(2)***		2.35(2)*	2.66(2)*		1.34(2)	1.35(2)
Industry				154.57(4)***	162.04(4)***			
Cohort							10.56(6)***	10.37(6)***
D_r*Industry					105.12(5)***			
D_e*Industry					106.82(5)***			
D_r*Cohort								51.26(7)***
D_e*Cohort								43.86(7)***

Regression Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
N	1057	1057	3556	3556	3556	4801	4801	4801
R^2	0.703	0.708	0.286	0.430	0.549	0.361	0.367	0.373

Notes: The table displays OLS regression results with the following dependent variables: EPC_{cr} is the number of entries per 1000 working-age capita by county and liability status, EPC_{cri} by county, liability status and five 1-digit industries, EPC_{crt} by county, liability status and half year entry cohort. D_r is the indicator variable for liability status (1: limited liability) and D_e for firm location (1: East). The reference group are full liability firms in West German counties (manufacturing, entry between 01/07/1990 and 31/12/1990). County controls are county area in km^2, and the unemployment rate in 9/1993. Industry controls included at 1-digit level, entry cohort at half yearly base. Standard errors clustered at county level. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

the regression results, an average of about 4.14 full liability firms enter in East German counties, compared to only 1.47 limited liability companies.[40] Out of this difference, only -0.65 are directly attributable to the general entry difference between limited and full liability firms, and the remaining difference of -2.02 is attributable to the stronger effect of CLR in East Germany. The coefficient for D_r indicates that on average about 0.65 less limited than full liability firms enter per county. This coefficient itself does identify the impact of CLR because it captures general differences between limited and full liability entry which may be caused by CLR but which could also be attributable to other differences between the legal forms that influence the entrepreneurial decision. In East German counties, about 2.88 more firms enter on average than in West German counties. The coefficient captures general entry differences between the two German territories and approves the identifying assumption of a high-entry economic environment in the Eastern part. In column (2) we include county control variables. This does not change the aforementioned results qualitatively. The results provide evidence that CLR decreases entry of corporate companies compared to other firms more in a transitory market environment than in a stable market. This affirms Hypothesis 1 and suggests that CLR hampers limited liability entry more in the transitory East German part of the country where firm creation and especially innovation is desperately needed after unification.

Columns (3)–(5) of Table 3.2 use EPC_{cri} as dependent variable, which leads to 3556 observations (out of 5410 cells) and allows to control for industry effects. In column (3), the coefficient of interest, β, is negative and highly significant. The total size of the differential CLR effect is smaller than in columns (1) and (2) because the firm observations are disaggregated such that the regression coefficients cannot be compared directly.[41] When including county and industry control variables in column (4), the coefficient of D_{re} decreases. The difference between corporate and non-corporate entrants per 1000 working-age inhabitants and 1-digit industry in East German counties is about 0.4 firms lower compared to the respective West German difference. This is the differential effect of CLR. The joint significance tests for the control variable groups reveal high significance and the measure of regression fit, R^2, increases remarkably upon the inclusion of industry control variables. The base effects for D_r and D_e expose the expected signs and significance in these two model specifications. In column (5) we finally introduce the interacted control variables between the industry affiliation and firm location as well as liability status. Again, the coefficient of interest, β, decreases by about 10% to -0.44 and the model fit

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[40]These numbers can be calculated as follows: $\alpha + \lambda = 4.138$ and $\alpha + \lambda + \gamma + \beta = 1.474$

[41]The number of aggregation units quintuples because we distinguish 5 industries. A multiplication of the coefficient by 5 yields about -1.94 which is close to the prior estimates at higher aggregation levels.

increases. Therefore, the differential effect of CLR increases if we use the industry inter-action control variables. They can model the industry specific differences between East and West Germany more flexibly what yields a more differentiated analysis. The tests for joint significance of the control variable groups are positive, they enter the regression significantly.

The third entry variable specification EPC_{crt} allows to control for time specific effects and the results are displayed in columns (6)–(8). The base estimation in column (6) and the estimation using a more extensive set of control variables in column (7) both lead to a negative coefficient of about -0.24 for the variable of interest D_{re}. The introduction of interaction controls in column (8) leads only to minor changes in the estimated coefficients and the model fit. Again, the coefficients cannot be directly compared to the total size of the prior coefficient estimates. Nevertheless, the differential effect of CLR is significantly different from zero with the expected sign. The inclusion of time interaction variables does not alter the results quantitatively or qualitatively, indicating that in our context the industry specific control variables are more relevant than time specific ones.

To summarize, the results in Table 3.2 affirm Hypothesis 1: The difference between the number of corporate and non-corporate entrants in East German counties is negative and larger compared to West Germany. The results suggest that the impact of CLR on limited liability entry is stronger in a high-entry, transitory economic environment hindering the entry of corporate firms relatively more.

Initial Entry Size

The regression results for the firm size at entry are displayed in Table 3.3. Firm size is measured by the number of employees at entry, including the manager-owner. We include only observations that provide owner/manager information (10,095 firms). Columns (1) to (3) are three model specifications with different sets of control variables.

The first regression contains only the interaction variable between firm location and liabi-lity status (D_{re}) and the corresponding base effects D_e and D_r, as well as a constant. The coefficient of interest is positive and highly significant. The difference in entry size bet-ween Eastern corporate and non-corporate companies is by 3.2 employees larger than the respective West German difference. Given that the average West German limited liability entrant has 4.1 employees, this difference is economically large. On average, East German firms enter with about one more employee than West German firms (λ), independent from their legal status. This strengthens the assumption that East Germany is off the long run steady state with firms seeking to enter large in order to capture market share and benefit

Table 3.3: Entry Size Regressions: Number of Employees at Entry

# Employees	(1)	(2)	(3)
D_{re} (β)	3.210***	2.525***	2.179***
	(0.307)	(0.247)	(0.249)
D_r (γ)	2.180***	1.855***	
	(0.153)	(0.166)	
D_e (λ)	1.052***	0.738***	
	(0.108)	(0.141)	
Const (α)	1.919***	0.640	-1.339*
	(0.069)	(0.896)	(0.774)

Control Variables (df): Wald-Statistic χ^2

Industry		11.60(26)***	26.04(26)***
Cohort		5.12(6)***	0.95(6)
County		3.92(3)***	3.81(3)**
Owner/Firm		17.55(11)***	16.98(11)***
Fed. State			8.39(11)***
D_r*Industry			13.27(25)***
D_e*Industry			11.11(26)***
D_r*Cohort			41.86(7)***
D_e*Cohort			2.95(6)***

Regression Statistics

N	10095	10095	10095
R^2	0.219	0.280	0.306

Notes: The dependent variable is the number of firm employees at entry. Only observations with owner/manager information are included. Reference firm in West Germany (Bavaria), full liability, general manufacturing (2-digit industry code 20), entry between 01/07/1990 and 31/12/1990. Industry controls included at 2-digit level, entry cohort at half yearly base. County controls are the unemployment rate in 9/93 and county location close to the innergerman border in East and West. Owner and firm characteristics are age, sex, and education of the main owner, dummies for team and franchise foundation. Probability weights used to account for sample stratification. Standard errors clustered at 4-digit industry level. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

from above-marginal-cost prices. The base effect for regulation shows that incorporated companies start on average larger than full liability companies. Corporate firms have to bear the cost for the regulatory requirements implied by CLR. The share of CLR-related costs relative to total entry cost decreases with entry size such that larger firms are more likely to bear regulation. This is independent from firm location since CLR applies to both territories.

The regression in column (2) includes further explanatory variables to refine the results. The coefficient of interest remains positive and highly significant. The inclusion of further control variables increases the model fit and all tests for joint significance of control groups indicate their relevancy.

The third column additionally contains interacted control variables between D_r/D_e and

industry/entry cohort dummies. The groups of interactions are highly significant. The joint test on D_r*Industry suggests that industry-specific dispositions for liability limitation exist. When including D_e*cohort and D_r*cohort, the non-interacted control group for entry cohort becomes insignificant. The measure of model fit, R^2, increases upon the introduction of interacted controls and the coefficient of interest slightly decreases. Nevertheless, the effect is still sizeable: The difference between corporate and non-corporate entry size in East Germany is about 2.18 employees higher than the respective difference in West Germany, even under a full set of control variables. This provides evidence for a positive differential effect of CLR on firm size.

Some firm and owner variables included in columns (2) and (3) have meaningful coefficients. Female founders have about 0.4 less employees than male ones. Eastern firms close to the inner-German border have less workers (though insignificantly) but West German companies close to the borderline occupy more than the average number of employees (significant at 5% level in (3)). This hints at spill-over effects from the under-supplied, high-entry economic environment in East Germany on the competitive market situation in West Germany. We will reconsider this aspect in the Robustness Section 3.6.3.

The results in Table 3.3 clearly support Hypothesis 2. The difference in entry size of East German incorporated companies compared to full liability firms is larger than the respective difference for West German startups. We find evidence that CLR leads to an increased entry size of limited liability firms in the East compared to the West German territory.

3.6.3 Robustness Analysis and Discussion

The empirical results are in line with the hypotheses and findings of other literature contributions concerning entry regulation. To strengthen the findings and allay concerns regarding the empirical analysis, we discuss and perform several robustness checks with respect to the identification assumptions, the database and data restrictions, and provide supplementary tests. Furthermore, we point out potential research extensions.

Identification Assumptions

The identification approach introduced in Section 3.4 is based on several assumptions: Firm assignment to the groups of corporate and non-corporate entrants occurs non-random. In other words, we assume a non-observable - but across East and West Germany stable - process of entrepreneurial self-selection which leads to the self-selection bias in Equation (3.2) and the need for a more sophisticated identification strategy. Furthermore, we assume

that firms are exogenously and randomly assigned to East and West Germany *and* that the process of entrepreneurial self-selection into the liability groups is independent from firm location. This way, ATT' can be identified according to Equation (3.5) because the selection biases in East and West cancel out as proposed in Equation (3.4). In the following, we will reconsider the validity of these assumptions.

Assignment to the Groups of Corporate and Non-Corporate Firms in East and West

Identification using difference-in-difference estimation requires that the composition of treatment and control group must not change as a result of the treatment (Angrist & Pischke 2009). In other words, the (unobserved) selection characteristics for entrepreneurs that influence the decision to start a full or limited liability company, have to be exogenous to firm location. This is a strong assumption given the economic and social differences between East and West Germany.[42]

Ardagna & Lusardi (2009), for example, find that stronger regulation leads to an increased entry of necessity entrepreneurs compared to opportunity founders. Necessity entrepreneurs enter the market due to the lack of regular employment opportunities and often include less qualified firm founders whereas opportunity entrepreneurs seek to realize profitable business ideas if they recognize a valuable chance. These characteristics might foster more limited liability entry amongst opportunity entrants compared to necessity foundations. Given the unequal economic situations in East and West Germany after unification, different group composition of entrepreneurs might be one aspect that could drive the results. Unfortunately, the data does not allow to differentiate between necessity and opportunity foundations.

Within the framework of our analysis, we perform probit and OLS regressions to investigate whether firm location can explain firm incorporation.[43] Ideally, the coefficient for East German location D_e is not significantly different from zero, showing that the selection process does not depend on firm location. The results are displayed in Table 3.4.

Columns (1) to (4) show that the probability for a corporate firm entry is significantly lower in East Germany. Nevertheless, the introduction of D_e*Owner/Firm interactions to control for firm-specific differences between East and West Germany renders the coefficient for D_e positive. This suggests that the decision for firm incorporation depends on different industry compositions and observable owner and firm characteristics in the two territories. The regressions in the main analysis in Table 3.2 and Table 3.3 include flexible control

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[42]Note that other studies, e.g. Djankov et al. (2002), estimate the effect of regulation on firm formation and entry size in an international framework and only consider limited liability firms in their data. They do not address the endogeneity problem of legal form choice at all.

[43]We use OLS regression models if we include interacted control variables.

Table 3.4: Firm Level Regression for Corporate Entry

	(1)	(2)	(3)	(4)	(5)	(6)
D_e	-0.079***	-0.225***	-0.169***	-0.215***	0.242**	0.250**
	(0.018)	(0.016)	(0.026)	(0.024)	(0.106)	(0.108)
Control Variables included						
County		yes	yes	yes	yes	yes
Industry		yes	yes	yes	yes	yes
Cohort		yes	yes	yes	yes	yes
Owner/Firm		yes	yes	yes	yes	yes
D_e*Industry			yes			yes
D_e*Cohort				yes		
D_e*Owner/Firm					yes	yes
Regression Statistics						
N	10095	10095	10095	10095	10095	10095
(Pseudo) R^2	0.006	0.283	0.307	0.308	0.342	0.342

Notes: The dependent variable is D_r which is 1 if the firm is incorporated and 0 otherwise. The table displays the marginal effects from probit regressions (columns (1) and (2)) and OLS coefficients (columns (3) to (6)) for firm location in East Germany, the robust standard errors in parentheses and indicates the included control variable groups. Industry controls included at 1-digit level, entry cohort at half yearly base. County control is the working-age population. Owner and firm characteristics are age and its square, sex and education of the main owner, dummies for franchise foundation and industry diversification on 5-digit industry level, entry size in log and its square. Standard errors clustered at the 4-digit industry level. Constant included. ***, **, and * indicate significance at 1%, 5%, and 10% confidence level, respectively.

variable variations with East German firm location which control for the effect and thus can alleviate the problem. Unfortunately, we cannot exclude that self-selection effects are also captured in other variables. A formal and thus preferable solution to the potential endogeneity problem of firm assignment in the two territories is to perform an instrumental variable estimation. Section B.5 describes this possible research extension.

Firm Location Treatment

Furthermore, the identification is based on random firm assignment to East and West Germany and the assumption that entrepreneurs do not actively choose where to set up their firm depending on entry dynamics. In our case this is plausible because firms in the sample are small and medium sized enterprises that are prone to operate on a regional base. Entrepreneurs are likely to set up at their place of residency which then determines firm location in East or West Germany. Given that personal mobility of DDR citizens was limited until unification, they have their social and economic ties in the Eastern part.[44] Despite unification and incipient migration processes, most entrepreneurs were likely to stay local where they knew the economic and social environment. In this case, the place of birth, which is clearly exogenous to the economic environment, determines where the

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[44]Although West German citizens were allowed to move to East Germany before 1989, they hardly had an incentive to do so such that entrepreneurs born in West Germany had their ties in this territory.

entrepreneur founds the startup.

The treatment of different entry dynamics in the two territories generates the necessary variation for effect identification. This requires that the entry dynamics are indeed unequal. Redding & Sturm (2008) show that in West Germany, due to the German division in 1949, the economic activity of border cities grew less. These areas could become high entry counties after reunification as the economic outreach of firms close to the borderline increases, interfering with our identification approach of comparing high and low entry regimes. The assumption of exogenous firm location assignment implies that entrepreneurs do not migrate from one part of the country to the another as a result of unification. More importantly, however, it is required that a firm's migration decision is independent from its liability status. To test whether specific entry dynamics at the border or entrepreneur migration potentially bias the results, we perform border robustness regressions.[45] First, we exclude the two county layers that are closest to the inner-German border in East and West Germany. Then, we repeat the regressions for firm entry and firm size using the restricted dataset. The results of these regressions are displayed in Table 3.5.

They do not differ qualitatively from the results in the main analysis, indicating that neither West German entry growth of border counties nor migration effects influence the results significantly.

CLR in East and West Germany

Up to now we have treated the CLR as being identical in East and West Germany, neglecting the lower minimum equity requirement for the time period between July 1990 until July 1992 in East Germany. Due to this circumstance our results provide a lower bound to the differential effect of CLR. To test whether the change of the minimum equity requirement over time had an influence on corporate firm formation within East Germany, we perform inner-East-German estimations of entry and entry size. Additionally, we use the original East-West identification approach and split the coefficient of interest by the two law periods. The regression results are displayed in Table 3.6 and show that the increase in the minimum equity requirement in East Germany does not have a significant impact on corporate entry or entry size.

This finding suggests that not only the minimum equity requirement has an impact on corporate entry and entry size, but also the overall increased complexity of the entry process leading to more administrative steps (some of them involving financial expenses)

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[45]An early work on East-West migration by Burda (1993) suggests that migration was high but not as massive as justifiable by the economic environment. High migration costs and the option value of waiting prevented higher levels of migration.

Table 3.5: Border Regressions for Entry and Size

	EPC_{cr}		EPC_{cri}		EPC_{crt}		Size	
D_{re}	-1.975***	-1.976***	-0.391***	-0.430***	-0.239***	-0.238***	3.211***	2.224***
	(0.130)	(0.131)	(0.032)	(0.031)	(0.019)	(0.020)	(0.353)	(0.262)
D_r	-0.657***	-0.658***	-0.162***		-0.110***		1.071***	
	(0.039)	(0.039)	(0.010)		(0.006)		(0.104)	
D_e	2.820***	3.172***	0.635***		0.436***		2.245***	
	(0.119)	(0.173)	(0.030)		(0.019)		(0.153)	
Control Variables included								
Federal State		yes						yes
County				yes		yes		yes
Industry				yes				yes
Cohort						yes		yes
Owner/Firm								yes
D_r*Industry				yes				yes
D_e*Industry				yes				yes
D_r*Cohort						yes		yes
D_e*Cohort						yes		yes
Regression Statistics								
N	858	858	2903	2903	3940	3940	8384	8384
R^2	0.695	0.702	0.275	0.553	0.353	0.362	0.225	0.310

Notes: Border robustness specification: Exclusion of counties that are close to the innergerman border. The table displays the coefficients, the robust standard errors in parentheses and indicates the included control variable groups. Base model specifications as well as model specification according to the most extensive set of control variables in the main regressions (Table 3.2 and Table 3.3). Standard errors clustered at the county level in entry regressions and at the 4-digit industry level in size regressions. Constant included. ***, **, and * indicate significance at 1%, 5%, and 10% confidence level, respectively.

Table 3.6: Change of Minimum Equity Requirement in East Germany

	East-time identification				East-West-time identification			
	EPC_{crt}		Size		EPC_{crt}		Size	
D_r*law	0.001	-0.004	-0.102	5.035***				
	(0.031)	(0.030)	(0.449)	(0.816)				
D_{re}*law1					-0.236***	-0.263***	3.442***	2.247***
					(0.018)	(0.021)	(0.368)	(0.299)
D_{re}*law2					-0.251***	-0.218***	2.820***	2.314***
					(0.019)	(0.025)	(0.380)	(0.389)
D_r	-0.351***	-0.348***	5.410***		-0.108***		2.180***	
	(0.020)	(0.020)	(0.351)		(0.006)		(0.153)	
law	-0.015	-0.027	-0.520***					
	(0.026)	(0.040)	(0.127)					
D_e					0.449***		1.052***	
					(0.017)		(0.108)	

Control Variables included

Federal State				yes				yes
County		yes		yes		yes		yes
Industry				yes				yes
Cohort		yes		yes		yes		yes
Owner/Firm				yes				yes
D_r*Industry				yes				yes
D_e*Industry								yes
D_r*Cohort				yes		yes		yes
D_e*Cohort						yes		yes

Regression Statistics

N	2084	2084	4688	4688	4801	4801	10095	10095
R^2	0.168	0.186	0.224	0.297	0.361	0.373	0.220	0.276

Notes: Minimum equity requirement change in East Germany: law1 is the period between July 1990 and July 1992 with the reduced minimum equity requirement in East Germany, law2 indicates the subsequent period with the same minimum equity requirement in both territories. law is a dummy variable equal to one in the second law-period. The table displays the coefficients, the robust standard errors in parentheses and indicates the included control variable groups. Base model specifications as well as model specification according to the most extensive set of control variables in the main regressions (Table 3.2 and Table 3.3) that is possible in this context, but regressions in column (4) and (8) include industry variables at the 1-digit level (instead of 2-digit level in the main regressions). The coefficients of D_{re}*law1 and D_{re}*law2 are tested for equality, which cannot be rejected in any of the regressions. Standard errors clustered at the county level in entry regressions and at 4-digit industry level in size regressions. Constant included. ***, **, and * indicate significance at 1%, 5%, and 10% confidence level, respectively.

and time involvement. Despite an increase of the minimum equity requirement by 150% (from €10,000 to €25,000), the differential effects remain stable in the second law-period.[46] The result is in line with the findings by Djankov et al. (2002) who also stress the role of non-pecuniary entry costs.[47]

Difference-In-Difference and Proportional Changes

One potential drawback of the standard DID framework is that it only considers total outcome differences between limited and full liability firms in East and West Germany. One might argue that the results are misleading because it is a comparison of two territories at different economic stages with different levels in outcome variables. The same total difference in outcome variables can mean significantly different proportional differences in the outcome relation between corporate and non-corporate firms in East Germany compared to West Germany. On the other hand, it is possible to find non-zero DID estimates although the proportions between outcomes of limited and full liability firms in East and West are constant. Therefore, we additionally investigate the relative relationship between corporate and non-corporate firms in East and West Germany to find out whether regulation has a proportional or disproportional effect on the outcome variables.[48]

We use the structure of the DID approach to identify not only the differential effect β but also the relative effect that we denominate τ. The following table shows how the estimated coefficients of the base effects, λ and γ, the constant α, and the DID estimator β, are related and how they can be used to calculate the proportional effect τ.[49]

	East=1	East=0	Difference	Ratio
CLR=1	$\alpha + \lambda + \gamma + \beta$	$\alpha + \gamma$	$\lambda + \beta$	$\frac{\alpha+\lambda+\gamma+\beta}{\alpha+\gamma}$
CLR=0	$\alpha + \lambda$	α	λ	$\frac{\alpha+\lambda}{\alpha}$
Difference	$\gamma + \beta$	γ	β	
Ratio	$\frac{\alpha+\lambda+\gamma+\beta}{\alpha+\lambda}$	$\frac{\alpha+\gamma}{\alpha}$		$\tau = \frac{\alpha(\alpha+\lambda+\gamma+\beta)}{(\alpha+\gamma)(\alpha+\lambda)}$

If CLR has no impact on firm entry and entry size, then the ratios for the outcome variables between limited and full liability companies would be the same in both territories, that is $\tau = 1$.[50] According to our hypotheses, CLR has a stronger impact on the outcome

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[46]Admittedly, this result needs careful consideration: The problem of a comparison across time is that the Eastern economic situation converges towards the West German standard, lowering the difference in entry-dynamics and reducing the identification power of our approach. Furthermore, the increase was announced by law such that startups could time their entry accordingly.

[47]Van Stel et al. (2007) and Becht et al. (2008) claim that mainly the minimum equity requirement matters for entry rates of limited liability companies and not the existence of non-pecuniary entry costs. Our results cast some doubt on the clear distinction of financial and non-financial costs but unfortunately, we cannot clearly attribute the effect to a particular part of the regulatory entry costs.

[48]Card & Krueger (1994) also consider the proportional changes of minimum wages over time to estimate the effect of higher minimum wages in New Jersey compared to Pennsylvania.

[49]We therefore stick to the linear estimation approach and use the results for the proportional analysis.

[50]The ratios would reflect a natural equilibrium outcome that is not influenced by CLR but determined

variables in the East German territory due to the high-entry environment. Therefore, we expect that CLR leads to relatively less limited liability entry which implies an expected $\tau < 1$ and relatively larger corporate firms leading to an expected $\tau > 1$ in East Germany relative to West Germany.

Table 3.7 picks up the descriptive entry and size results to calculate τ and in Table 3.8 we report τ based on the regression results displayed in Table 3.2 and Table 3.3. The test of the null hypothesis $\tau = 1$ reveals whether the relative relationship of the ratios in East and West Germany is proportional. The results draw a consistent picture: For entry, τ is smaller than one, and for size it holds that τ is greater than one. The analysis of proportional changes generally supports the results of our main analysis.

Table 3.7: Proportional Changes: Average Entry and Firm Size by Liability Status and firm location

Panel A: Entry per County and 1000 Inhabitants

	East	West	Ratio East/West
Limited liability	1.427	0.575	2.483
	(0.053)	(0.022)	(0.132)
Full liability	4.140	1.258	3.292
	(0.097)	(0.035)	(0.121)
Ratio Reg/Unreg	0.345	0.457	0.754
	(0.015)	(0.019)	(0.044)

Panel B: Entry Size (Number of Employees)

	East	West	Ratio East/West
Limited liability	8.361	4.099	2.040
	(0.194)	(0.107)	(0.071)
Full liability	2.970	1.919	1.548
	(0.056)	(0.032)	(0.039)
Ratio Reg/Unreg	2.815	2.136	1.317
	(0.084)	(0.066)	(0.057)

Notes: Panel A is based on county level data (215 counties located in East and 326 in West Germany, containing 11,515 firm observations). Panel B is based on firm level data encompassing 10,093 companies. Entry is scaled by the size of the working-age population (age 18-65 years, in 1000). The table displays the means of the four groups of interest and the respective ratios, including the proportional change estimate τ. The standard errors are in parentheses. Weights are used to control for sample stratification.

Further Robustness Test Concerning Data Specification

We use aggregated data to evaluate the effect of CLR on the number of entrants. By doing so, we lose information about individual firm and owner characteristics which is collected below the county level. One might be concerned that data aggregation influences our results. To provide evidence that this is not the case, we reestimate firm level regressions

by other differences between limited and full liability firms.

Table 3.8: Proportional Changes Calculated from Regression Analysis

Panel A: τ for entry based on results in Table 3.2

	EPC_{cr}	EPC_{cri}	EPC_{crt}
Regressions number	(1)	(3)	(6)
τ	0.737***	0.812***	0.858***
	(0.040)	(0.039)	(0.036)

Panel B: τ for size based on results in Table 3.3

Regression number	(1)	
τ	1.318***	
	(0.069)	

Notes: The notes of Table 3.2 and 3.3 apply. τ is calculated according to the table in Section 3.6.3 and is the ratio of relative changes. The significance levels refer to the test of H0: $\tau = 1$ vs. H1: $\tau \neq 1$.

for entry size at county level. This complements prior findings and shows that the results are similar across aggregation levels. We generate an aggregated size variable S_{cr} which is the average number of employees in county c and by regulatory status r. Table 3.9 shows that the results for size hold at an aggregate level.

Table 3.9: Robustness Check for Data Aggregation

	Size county		0 replace			
	S_{cr}	S_{cr}	EPC_{cr}	EPC_{cri}	EPC_{crt}	S_{cr}
D_{re}	3.260***	3.264***	-2.030***	-0.406***	-0.290***	3.224***
	(0.305)	(0.307)	(0.114)	(0.023)	(0.016)	(0.322)
D_r	2.318***	2.323***	-0.683***			2.077***
	(0.169)	(0.171)	(0.036)			(0.171)
D_e	0.891***		3.210***			
	(0.106)		(0.147)			
Control Variables included						
County		yes	yes	yes	yes	yes
Federal state		yes				yes
Industry				yes		
Cohort					yes	
Owner/Firm						
D_r*Industry				yes		
D_e*Industry				yes		
D_r*Cohort					yes	
D_e*Cohort					yes	
Regression Statistics						
N	1057	1057	1082	5410	7574	1082
R^2	0.507	0.512	0.708	0.533	0.311	0.458

Notes: The dependent variable for size at county level is S_{cr}: Average entry size of firms by liability status r in county c. In the section "0 replace", missing data points for entry rates and S_{cr} are replace by 0. The table displays the coefficients, the robust standard errors in parentheses and indicates the included control variable groups. Model specifications according to the most extensive set of control variables in the main regressions (Table 3.2 and Table 3.3). Standard errors clustered at the county level. Constant included. ***, **, and * indicate significance at 1%, 5%, and 10% confidence level, respectively.

A further concern about data aggregation may be that cells with missing data points of the

EPC_{cr}, EPC_{cri} and EPC_{crt} as well as S_{cr} matrix are not considered in our regressions. In an alternative approach, we replace the missing data points by zeros to cover the entire matrix of aggregation dimensions and repeat the regressions.[51] The results are displayed in the section "0 replace" of Table 3.9. The coefficient of interest remains negative and highly significant for entry and positively significant for firm size.

Final robustness checks consider alternative definitions of the dependent variables and relaxations of main data set restrictions. We regress the log(number of employees) as size measure and the log(number of firms) and the log(number of firms p.c.) per county and liability status as entry measures. The results are robust to these variations (not reported). To test the impact of data restrictions, we relax each restriction listed in Table B.2 separately and repeat the regressions. The results do not change qualitatively.

Potential Research Extensions

In this study we have shown that corporate law regulation has an impact on firm formation and entry size of limited liability firms in East Germany compared to West Germany. In the following, we suggest several extensions to the present study.

One direction could be the application of an instrumental variable estimation for the identification of the regulatory effect. The use of an alternative identification strategy could strengthen our results and relieve concerns about the identification assumptions of the difference-in-difference strategy applied in this study. Section B.5 provides a more detailed overview of the motivation and setup of this empirical method.

A future line of extension to our work could be an explicit consideration of labor market implications of corporate law regulation in the spirit of Griffith et al. (2007) and Bertrand & Kramarz (2002). Several literature sources find that corporate companies have higher growth rates compared to full liability firms and engage more in innovative activity. Both characteristics can have a stimulating effect on labor market outcomes. The reform of the German GmbHG in 2008 might provide suitable data for further investigations.

Finally, we have not addressed any behavioral aspects concerning the entry decision. Camerer & Lovallo (1999) show experimentally that overconfidence can lead to excess entry in competitive markets. Thus, experimentally one finds that overconfidence increases entry, whereas our empirical results show that regulation decreases entry. An interesting research extension therefore is, whether there is a relationship between entry regulation and entrepreneurial self-selection, that is whether regulation impacts entry rates via an

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[51]Both approaches have advantages and disadvantages. By dropping the respective cells from the sample we ignore their existence and restrict the outcome space. If we replace missing data points by zero, we pretend to have a total population sample. This potentially introduces a sampling error.

influence on entrepreneurial overconfidence. To our knowledge, there exists no such study. Yet, it could yield important insights into the working mechanism of entry regulation and provide strong policy implications with respect to the design and structure of regulatory provisions. In the following Chapter 4, we are going to close this gap and provide experimental evidence on the effect of entry regulation on entrepreneurial self-selection.

3.7 Conclusion

The aim of corporate law regulation in Germany is to protect society and especially future claimants from fraudulent entrepreneurs. Incorporation law requires that entrepreneurs follow a capital intensive and time consuming entry process to ensure their seriousness and minimum liquidity. While the minimization of welfare losses due to excessive limited liability entry is a desirable goal, our results suggest that CLR hampers entry dynamics especially in the expanding East German economy what may influence economic growth and development. The difference in the number of entrants between full and limited liability companies is larger in the transitory East German economy compared to the respective difference in the mature West German economy. Those limited liability firms that do enter in East Germany start with more employees than full liability firms and the difference is larger than in West Germany. These results of the impact of CLR on firm entry and firm size are shown to be significant and robust. In an expanding economy, CLR decreases corporate entry and increases corporate entry size more compared to a steady market economy.

Entrepreneurial activity fosters innovation and efficiency improvements and therefore influences the progress of a transitory economy in a positive way. The willingness of entrepreneurs to take risk and realize new, creative project ideas can be increased by the limitation of personal liability. Regulatory barriers increase the cost of liability limitation what may restrict the investment in projects with insecure outcomes to financially less constrained entrepreneurs. The example of Germany has shown that even a downward adjustment of regulatory requirements did not outweigh the relatively stronger effects of regulation on a transition environment. Policymakers thus should be careful when applying existing regulations to new territories, especially when transferring them from developed to transitory economies.

4 Experimental Investigation of Entry Regulation and Overconfident Entry

4.1 Introduction

Firm foundations are an essential part of economic life by stimulating competition and innovation, industry development, employment and growth (Audretsch 2003). Policy interventions such as entry regulation can interfere this process through different channels. Entry regulation was shown to decrease the rate of business creation, but it may also foster a shift in the type of entrants. Entrepreneurs are not all alike and entrepreneurial activity is not always desirable at the individual level (Ardagna & Lusardi 2009, Coelho et al. 2004). The motivation for entrepreneurial self-selection into markets plays a crucial role for the success of entry and the potential contribution to economic growth. For example, Ardagna & Lusardi (2009) differentiate between entrepreneurs who found due to a lack of employment opportunity (necessity founders), and those who actually pursue a business idea and who are more likely to push the process of creative destruction (opportunity founders). They show that entry regulation is in both cases detrimental to entrepreneurship, but it diminishes the returns to desirable personal characteristics more for opportunity founders, which suggests an impairment of the entrant pool in more regulated markets.

The present study focusses on another motivation for business creation, namely entrepreneurial overconfidence. Overconfidence and overoptimism are recognized as typical traits amongst entrepreneurs which determine entrepreneurial self-selection into markets. Little is known about the effect of entry regulation on the process of entrepreneurial self-selection with respect to overconfidence, mainly due to a lack of observability and data limitations. Yet, De Meza & Southey (1996) show in a theoretical model, that overoptimism can explain stylized facts about entrepreneurship, such as high failure rates.[1] There exists also some suggestive empirical evidence that overconfident entry is little conducive to economic success.[2] Åstebro (2003) investigates the return for Canadian inventive efforts. An in-

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[1] See Geroski (1995) for a literature survey providing stylized facts and empirical results about entry.

[2] Unfortunately, these empirical findings lack a precise control of whether entrepreneurial action is indeed

dependent organization rates the ideas with respect to their commercialization prospects. Overconfidence can explain why inventions of attested low quality are brought to market. These inventions exhibit a strong negative effect on the pooled return on inventive efforts and decrease it from 21% to 11.4%. Similarly, Lowe & Ziedonis (2006) show that commercialization efforts for unsuccessful university inventions are longer continued by startups than by established firms. This signals overconfidence at the stage of entry, and the increased adherence to unsuccessful projects wastes economic resources.

Therefore, it is of interest for policy makers to understand how entry regulation influences entrepreneurial self-selection with respect to overconfidence and actual skill. The process determines the composition of the entrant pool and thereby affects the economic consequences of entry regulation. So far, this behavioral aspect of entry regulation has not been investigated, although it can have strong policy implications because it concerns the quality of entrepreneurs. This study focusses on the impact of entry regulation on overconfident and skilled entry in order to improve the knowledge about entrepreneurial self-selection and to enhance the decision base for future policy interventions.

We conduct an experimental analysis and the research design builds on Camerer & Lovallo (1999) who investigate overconfidence and excess entry in market entry games. We introduce entry regulation to the experimental setting in order to investigate its effect on the entry decision. Using an experimental approach allows to control for alternative explanations of entry behavior such as risk aversion, capital restrictions, market capacity, or competition, which are difficult to observe or quantify in the field.

The concepts of overconfidence and overoptimism are often intermingled in the literature and difficult to separate in the empirical analysis. We follow Åstebro et al. (2007) and consider entrepreneurial overoptimism a more general phenomena than entrepreneurial overconfidence. We define overconfidence as positively biased beliefs in own skills and abilities, whereas overoptimism leads to a general overestimation of positive outcomes. The design of the experimental market entry game controls for overoptimism and allows to identify the effect of regulation on overconfident entry. The implemented skill tasks provide a proxy for actual individual skill levels. By including a skill proxy in our analysis, we attempt to further disentangle entry of confident, qualified subjects and overconfident entry.

Our results show that overconfident entry increases in regulated markets. The analysis with

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driven by entrepreneurial overoptimism in own skills (overconfidence). Or as Lowe & Ziedonis (2006) put it: "The difficulty of identifying overoptimism among alternative explanations in decision making [...] suggests that future research could seek more direct measures of overoptimism among individual decision makers." (p. 185).

respect to the skill level shows that qualified subjects are less likely to enter in regulated markets, which implies an impairment of the quality of the entrant pool. Although entry regulation decreases total entry, it increases entry in excess to the Nash equilibrium and therefore reduces market profits. Overall, our experimental results suggest that entry regulation is detrimental to the composition of the entrant pool with respect to overconfidence and skill, what may hamper economic growth and development in real world economies. This chapter is structured as follows. In Section 4.2, we present the experimental market entry game. Theory predictions are derived in Section 4.3. Thereafter, we discuss potential mechanisms how entry regulation could influence entrepreneurial self-selection. In Section 4.5 we present the main results. We start with findings about the general effects of regulation and overconfidence on entry, and continue with the results for the regulatory effect on overconfident entry. Finally, we consider subjects' skill level to derive further insights with respect to entrepreneurial self-selection. In Section 4.6, we perform robustness tests and discuss our results with respect to other literature findings. Finally, we conclude in Section 4.7.

4.2 An Experimental Market Entry Game with Regulation

We use an experimental market entry game in order to identify the effect of entry regulation on entrepreneurial overconfidence. After presenting the experimental setup and conduction, we thoroughly describe the features of our design which are dedicated to the investigation of the research question.

4.2.1 The Market Entry Game

The basic market entry game was introduced by Kahneman (1988). In his setup, n subjects decide simultaneously and without coordination, whether to enter a market with known market capacity c or not. The payoff from entry depends on market capacity c, the total number of entrants E and the parameters k and r such that subjects face the following individual payoff function Π_i:[3]

$$\begin{aligned} \Pi_i &= k & \text{if no entry} \\ \Pi_i &= k + rk(c - E) & \text{if entry} \end{aligned}$$

Kahneman (1988) finds that for the majority of rounds, the number of entrants fluctuates around the market capacity in a range of 2, even though subjects could not communicate.

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[3]Kahneman uses the parameter k=\$0.25 and r=2.

This game has been extended in several ways, e.g. for studying coordination and learning behavior (Sundali et al. 1995, Rapoport et al. 1998, 2002), or the role of task-difficulty on entry (Moore et al. 2007, Moore & Cain 2007).[4] In order to test how entry regulation affects entrepreneurial overconfidence, we build on the extension introduced by Camerer & Lovallo (1999). They analyze how entrepreneurial overconfidence leads to excess market entry by implementing rank-dependent payoffs. Subjects know that their rank relative to their competitors is determined either randomly or based on their performance in a skill task.[5] Better-ranked entrants receive a higher payoff than worse-ranked entrants. Entrants with a rank higher than the market capacity make a loss and those who do not enter, neither win nor loose.

The design of our experiment combines the idea of rank-dependent payoffs with regulatory entry costs such that it suits the investigation of overconfidence and regulation. We introduce the regulation treatment in the market entry game by defining two market types: In one market type, subjects have to pay fixed regulatory entry costs R and in the other market type, entry is free of cost. Each market type is played with the treatment of random- and skill-dependent rank assignment.

In our experiment, the maximum market profit is $I = 60$.[6] Each of the $n = 10$ participants per session receives an initial endowment of $k = 31$. In regulated markets, entrants have to pay regulatory entry costs of $R = 10$ upon entry. The payoff from entry depends proportionately on the individual rank r_i and the market's capacity $c = (2, 3, 4, 5)$. The following rank-dependent payout scheme applies to entrants with $r_i \leq c$:

Table 4.1: Individual Payoffs of Entrants with $r_i \leq c$

Rank r_i	Capacity c			
	2	3	4	5
1	40	30	24	20
2	20	20	18	16
3		10	12	12
4			6	8
5				4

Note: Payoffs are in EC. Regulatory entry costs and losses in case of $r_i > c$ are not included.

Subjects who enter and have a rank higher than the market capacity $(r_i > c)$ lose $L = 21$. Subjects who do not enter, neither win nor lose but keep their initial endowment k. To

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[4]Hoelzl & Rustichini (2005) find in a different setting that the difficulty of the task is mainly important if there is money at stake.

[5]In the Camerer and Lovallo study, participants' skill is elicited by letting them solve a puzzle or answering trivia questions after entry decisions were made.

[6]The units are Experimental Currency, EC, which is converted to € at a rate of 3:1.

summarize, the rank-dependent payoff function can be written as

$$
\begin{array}{ll}
\Pi_i = k & \text{if no entry} \\
\Pi_i = k + x(c - r_i + 1) - R & \text{if entry and } r_i \leq c \\
\Pi_i = k - L - R & \text{if entry and } r_i > c
\end{array}
$$

with $x = \frac{I}{\sum_{j=1}^{c} j}$ and $R = 0$ in markets without regulation.

4.2.2 Experimental Procedure

We conducted eight experimental sessions at the University of Hamburg during two weeks in the summer term 2010. The student subjects knew from the recruiting information that it is an experiment about startup foundation and that they can earn money depending on their success in the experiment.

Upon arrival, subjects were seated in the computer laboratory[7] and asked to turn off their mobiles and take off their watches. They received a folder with the experiment instructions, a schematic experiment overview, as well as paper and pencil to take notes if desired. Participants could not see each other's screens and communication was strictly prohibited throughout the experiment. The instructions explained the two rank assignment and market types, the payoff scheme, and gave a brief description of the skill tasks.[8] They were read aloud by the experimenter and questions could be asked. Furthermore, the money for final payoff was shown to the students to enhance motivation and assure the experimenter's sincerity. Participants had to answer comprehension questions before the market entry game started.

Subjects played a total of 32 market entry rounds, eight rounds in each treatment. The four treatments are abbreviated as follows: markets without regulation and random rank assignment $\rightarrow$ OR, markets without regulation and skill-based rank assignment $\rightarrow$ OS, markets with regulation and random rank assignment $\rightarrow$ WR, markets with regulation and skill-based rank assignment $\rightarrow$ WS. The order of treatment presentation varied across experimental sessions, whereas the order of capacities across rounds within a treatment was always the same to control for risk aversion and overconfidence between treatments (Table 4.2).

At the beginning of every round, participants received information about the current market and ranking system and the market capacity; then, they stated a prediction for the total number of entrants (including themselves) and decided whether to enter or not. After each round, subjects were informed about the total number of entrants and earned EC 0.9

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[7]The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).
[8]For a translated version of the instructions see Appendix Section C.1.

Table 4.2: Overview over Experimental Sessions

Session	n	Order of Treatment Combinations			
1	10	OR	OS	WR	WS
2	10	OS	OR	WS	WR
3	10	WR	WS	OR	OS
4	10	WS	WR	OS	OR
5	10	OR	WR	OS	WS
6	10	WR	OR	WS	OS
7	10	OS	WS	OR	WR
8	10	WS	OS	WR	OR

Note: All treatments were played for 8 rounds with the following order of market capacities: 2, 4, 5, 3, 2, 4, 5, 3.

for every correct guess.[9]

After all entry decisions were made, subjects had to answer six multiple choice quiz questions in the field of economics and six in general knowledge, as well as one tie-breaker question.[10] Furthermore, they had to estimate a time period of two minutes without a timing device. Subjects were ranked according to their performance in these three skill tasks. The random rank was assigned via a computerized algorithm.

At the end of the experiment, the computer randomly selected one out of all 32 markets for payment. The market payoff together with the endowment and the reward for the correct entry predictions determined the participant's final payment. The sum of these payoffs was converted from Experimental Currency into € using an exchange rate of 3:1, rounded up to the next €0.50 and paid out to the subjects in the lab.

4.2.3 Features of the Design

In this section we comment on the choice of our design features and parameter selections that are essential for the experiment.

The Market Entry Game

Entry Regulation in Form of Fixed Entry Cost. We implement entry regulation by imposing regulatory entry costs. Although real world entry regulations appear in different facets, e.g. mandatory educational standards (Prantl & Spitz-Oener 2009) or administrative burdens (Djankov et al. 2002), it was argued that monetary entry costs constitute the highest hurdle (Becht et al. 2008, Van Stel et al. 2007) because small firms often suffer from finan-

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[9]Appendix Section C.2 provides exemplary screen shots of the decision stage.

[10]We had a pool of 18 economic and general knowledge quiz questions and the tie-breaker changed in every experiment. For a detailed overview see Appendix Section C.3.

cial constraints (Audretsch 2003). The empirical literature argues that regulatory entry costs reduce market entry by mainly excluding financially constrained entrepreneurs. At the center of our study is an alternative explanation that relates regulation with entrepreneurial self-selection and overconfidence. Therefore, we exclude capital constraints from our analysis by experimental design. All subjects receive the same endowment $k > R$, such that all players have the financial means to overcome entry costs. We implement only one level of entry costs to keep the relative size of regulatory entry costs constant for all subjects.

Simultaneous Decision. Subjects enter simultaneously and without coordination. This most closely resembles the true startup decision where entrepreneurs cannot actively coordinate and have only limited information about potential competitors.

Feedback. Similar to the real world situation of observing ex post the private and competitors' decisions in the market and following Camerer & Lovallo (1999), we provide feedback about the total number of entrants, the own entry decision as well as the own expected number of entrants of the current treatment's past rounds.[11] This partial feedback about the aggregate number of entrants may allow for some learning with respect to the group behavior within a treatment, which represents an observation of the target market over time in real-world entry processes.[12]

Within-Subject Design. The combination of the ranking and regulation market characteristics leads to four regulation-ranking treatments. Every subject participates in each treatment (within-subject design) and within each treatment, the order of market capacities across rounds is the same. This setup provides a within-subject control for risk aversion (Camerer & Lovallo 1999) and overoptimism.[13]

Rank Allocation

Random Rank. A random number generator implemented in the experimental software z-tree (Fischbacher 2007) assigns random numbers between 0 and 1 to each participant at the very beginning of the experiment. These numbers are later ranked in ascending order.

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[11] We do not provide information about decisions in prior treatments to highlight the changes in the decision scenarios.

[12] We do not provide feedback on the performance in the skill tasks because entry decisions were made before the skill tasks which technically excludes the possibility of performance feedback as decision relevant information. Furthermore, it was shown that performance feedback has only limited effects on egocentrism and optimism (Moore & Cain 2007, Rose & Windschitl 2007).

[13] Given our experimental market entry game, we expect that overoptimism leads to positively biased expected payoffs in markets with random ranking and skill ranking alike. Using a differential investigation approach, we control for overoptimism as a fixed effect. Overconfidence in own skills influences only entry decisions in skill-based markets such that a differential analysis can identify this effect.

This is the most convenient way of generating random ranks in the experiment. Subjects know that all ranks between 1 and 10 are assigned randomly. Since it does not matter for the experimenter's expenses who gets which rank it is credible that the assignment is indeed random and thus fair.

Skill Rank. Subjects know that their skill rank depends on their achievements in three skill tasks. Like in real startup decisions, our subjects know in advance the type of skills required, but only after making entry decisions they have to proof their skills. Trivia quiz questions are most commonly used in experiments to elicit skill. Since we investigate entrepreneurial startup decisions, we also test economic knowledge. Ex ante, the task of answering quiz questions contains uncertainty about the specific questions, whereas the task of estimating two minutes time without a watch does not. Therefore, the mix of skill tasks is a well-balanced selection that takes different task difficulty and uncertainty into account. A rank is assigned for each task. These are summed up to skill scores which then are ordered to determine the final skill rank; in case of ties a tie-breaker question eventually decides. The sum of the three tasks is well suited to differentiate across subjects with respect to the skills required in the experiment. The best subjects do well in all three tasks and those with low ability are likely to perform poorly across the board. Since we have more than one task, good subjects who fail in one task can still get a proper rank to reflect their overall ability. Therefore, we consider the skill rank as a quality signal and use it as a proxy for general ability in our individual analysis.[14]

Parameter Selection

Number of Subjects and Market Capacity. The setup of our experiment is similar to the one employed by Camerer & Lovallo (1999) who recruit $n = (12, 14, 16)$ subjects and have market capacities $c = (2, 4, 6, 8)$. We run all sessions with $n = 10$ subjects who decide about entry in markets with capacities $c = (2, 3, 4, 5)$ for the following reasons: First, in winner-take-it-all markets it was shown that excess entry increases with group size (Fischbacher & Thöni 2008). To eliminate potential group-size effects, we keep the number of subjects constant. Second, there existed no established recruiting pool for economic experiments at the University of Hamburg at that time, so we aimed at a number of subjects that we deemed to be realistically recruitable. Therefore, we settled on $n = 10$. Furthermore, we set the capacities such that the relation between c and n is similar to the base experiment

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[14]Although one can argue that the skill rank does not reflect overall ability, we still believe that a mix of tasks provides a good approximation. It is plausible to assume a positive relationship between good ranks in the present tasks and performance in similar exercises.

of Camerer & Lovallo (1999) which makes the results somewhat comparable.

Endowment, Gains, and Losses. The aggregated market profit is set to $I = 60$ because, given the different market capacities, it yields integers as proportionate rank-dependent gains and facilitates calculations (see Table 4.1). The rank-dependent payoff scheme reflects the reality where the best entrepreneur earns more than good or mediocre startups, and low-performers make losses. Taking this payoff structure into account, we settled on regulatory entry costs of $R = 10$. We want to make regulatory entry costs substantial relative to the potential gains because they are argued to be a significant hurdle for real startups. The size of R is set such that it deters entry for high capacities compared to the situation without regulation. Furthermore, we choose the loss $L = 21$ such that three aspects are balanced: First, the number of equilibrium entrants depending on c should be unique in the pure-strategy Nash equilibrium (see Section 4.3). Second, we could observe negative average profits, even for $c = 5$.[15] Finally, we want to keep the loss L in a decent relation to the potential gains and entry costs R to keep the entry incentives balanced.[16] The endowment k is the sum of the regulatory entry cost R and the potential loss L. This endowment structure ensures that participants face a maximum loss of their endowment (and the opportunity cost of time).

Payoffs

Payoff for Correct Entry Predictions. Subjects earn money for the correct prediction of the number of market entrants in each round. This remuneration has several reasons. First, it provides an incentive to think more closely about the competitive landscape within the changing market characteristics and capacities, and to reveal the own prediction honestly. Second, if subjects learn between rounds due to entry feedback, they would use it for the prediction of entrants to earn money. This way the entry prediction captures learning indirectly. Third, it keeps the motivation high across all rounds because every round's prediction can contribute to the final payoff. Finally, the payoff for correct entry predictions is the only source of positive income if a regulated market is drawn for final payoff and an entrant makes a loss.[17]

Random Lottery Selection of Payoff Round. The computer randomly selects one out of

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[15]Subjects can easily calculate the number of entrants that leads to negative expected profits. The fact that the average entrants makes a loss provides a clear signal of excess entry.

[16]We neither want to invite excess entry because potential losses are too low, nor do we want to deter all risk averse entrants because expected payoffs are too low.

[17]In fact, one subject leaves the experiment with €1.00 and five subjects with €1.50 which solely stem from their correct guesses.

the 32 rounds for the final payoff. Subjects know that every single entry decision is independent from all other decisions made earlier or to be made. This remuneration scheme therefore supports the assumption of independent entry decisions which is necessary for the statistical analysis. Random lottery selection is a well-established remuneration mode and an accepted incentive mechanism to avoid portfolio and wealth effects (Cox 2010). Holt (1986) argues that if the independence axiom of the expected utility theory does not hold, this mechanism could lead to decision biases. This concern is relieved by Starmer & Sugden (1991) who show that in a behavioral context this is less of a problem. Therefore, we are confident that the random lottery selection mechanism supports the elicitation of true preferences.

Final Payoff. The final payoff consists of three parts: the endowment k, the entry game payoff $\Pi(r_i)$, and the accumulated earnings from predicting the correct number of entrants. Theoretically, a subject may leave the experiment empty-handed if the endowment $(k = 31)$ is settle against a loss $(L = 21)$ in a regulated market $(R = 10)$ and no entry prediction was correct. On the other hand, the maximum possible final payoff amounts to EC 99.80, or an equivalent of €33.50, consisting of the endowment $(k = 31)$, the first-ranked payoff in an unregulated market with $c = 2$ $(\Pi_1 = 40, R = 0)$ and the payoff for correct entry predictions in all 32 rounds $(0.9^*32 = 28.8)$. Subject who never enter a market, receive a safe payoff of EC 31 or €10.50, plus the gains from their correct entry predictions.[18] Based on a simulation of different gain-loss-scenarios we settled the conversion rate from EC to € at 3:1. The actual minimum and maximum payoffs were €1.00 and €23.50, and the average payoff per subject was €11.13 for on average 70 minutes experiment participation. This is comparable with the earnings for a student research job at the University of Hamburg.

4.3 Theoretical Entry Predictions

Although the focus is on a differential analysis of entry decisions across market settings, we set our results into a general context in order to understand the market implications. We derive theoretical benchmarks and evaluate the total number of entrants with respect to the social optimum and the Nash predictions.

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[18]We did not explicitly pay a show-up fee but the endowment k can be thought of as such. Never entering is a strategy that yields a safe minimum payoff. Interestingly, only one subject played the safe strategy throughout all markets.

The Social Optimum

The social optimum is reached if the aggregated payoffs, i.e. market profits, are maximized.[19] In unregulated markets, this is the case if the number of entrants equals the market capacity, i.e. $E = c$. If less startups enter, subjects do not realize full market profits, whereas more entry leads to losses which reduce aggregated payoffs.

In case of regulated markets, accumulated entry costs decrease market profits and therefore the optimal number of entrants can be below the market capacity. Table 4.3 shows the market profits in both market types and displays the number of entrants E^* necessary to reach the social optimum.

Table 4.3: Market Profits (in EC) and Social Optimum Entry E^*

	Without Entry Regulation Capacity c				With Entry Regulation Capacity c			
Entrants E	2	3	4	5	2	3	4	5
1	40.00	30.00	24.00	20.00	30.00	20.00	14.00	10.00
2	60.00	50.00	42.00	36.00	40.00	30.00	22.00	16.00
3	39.00	60.00	54.00	48.00	9.00	30.00	24.00	18.00
4	18.00	39.00	60.00	56.00	-22.00	-1.00	20.00	16.00
5	-3.00	18.00	39.00	60.00	-53.00	-32.00	-11.00	10.00
6	-24.00	-3.00	18.00	39.00	-84.00	-63.00	-42.00	-21.00
7	-45.00	-24.00	-3.00	18.00	-115.00	-94.00	-73.00	-52.00
8	-66.00	-45.00	-24.00	-3.00	-146.00	-125.00	-104.00	-83.00
9	-87.00	-66.00	-45.00	-24.00	-177.00	-156.00	-135.00	-114.00
10	-108.00	-87.00	-66.00	-45.00	-208.00	-187.00	-166.00	-145.00
E^*	2	3	4	5	2	2 & 3	3	3
	c	c	c	c	c	c & $c-1$	$c-1$	$c-2$

Note: The table shows the market profits depending on the market capacity, the presence of regulation, and the number of entrants. The optimal number of entrants E^* is reached if the market profit is maximized.

Entry beyond the social optimum still yields positive market and positive *expected* individual profits. Subjects make decisions under uncertainty about their rank. It can be individually rational to enter although the market capacity is exhausted.[20] Therefore, the Nash equilibrium might provide a more powerful benchmark.

The Nash Equilibrium

We derive the pure- and mixed-strategy Nash equilibria as benchmarks. In a Nash equilibrium, subjects enter as long as it is the best response to everybody else's decision and a deviation from this strategy does not pay. We assume risk neutrality and random ranking

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[19]The market entry game solely focusses on the entrepreneurial decision of entry. We set the consumer surplus to zero and neglect the public income from entry regulation.

[20]A more detailed discussion about the marginal entrant can be found in Moore et al. (2007).

for equilibrium prediction.[21]

Pure-Strategy Nash Equilibrium. Every subject can play the pure strategy 'entry' or 'no entry'. Amongst the resulting 2^n strategy combinations, there are many asymmetric pure-strategy Nash equilibria.[22] Since it is a game without coordination, one cannot tell which of them would materialize. However, our interest rests on the equilibrium number of entrants E^* rather than on the question of who exactly enters the market and who stays out. As it is a symmetric game, one can aggregate the strategy space by looking at the expected payoffs depending on the number of entrants E and the market capacity c to derive the equilibrium number of entrants E^* (Table 4.4).

Table 4.4: Pure-Strategy Nash Equilibrium: Expected Payoffs (in EC) and E^*

	Without Entry Regulation Capacity c				With Entry Regulation Capacity c			
Entrants E	2	3	4	5	2	3	4	5
1	40.00	30.00	24.00	20.00	30.00	20.00	14.00	10.00
2	30.00	25.00	21.00	18.00	20.00	15.00	11.00	8.00
3	13.00	20.00	18.00	16.00	3.00	10.00	8.00	6.00
4	4.50	9.75	15.00	14.00	-5.50	-0.25	5.00	4.00
5	-0.60	3.60	7.80	12.00	-10.60	-6.40	-2.20	2.00
6	-4.00	-0.50	3.00	6.50	-14.00	-10.50	-7.00	-3.50
7	-6.43	-3.43	-0.43	2.57	-16.43	-13.43	-10.43	-7.43
8	-8.25	-5.63	-3.00	-0.38	-18.25	-15.63	-13.00	-10.38
9	-9.67	-7.33	-5.00	-2.67	-19.67	-17.33	-15.00	-12.67
10	-10.80	-8.70	-6.60	-4.50	-20.80	-18.70	-16.60	-14.50
E^*	4	5	6	7	3	3	4	5
	$c+2$	$c+2$	$c+2$	$c+2$	$c+1$	c	c	c

Note: The table shows the average individual profits depending on the market capacity, the presence of regulation, and the number of entrants. The optimal number of entrants E^* is the highest number of entrants which allows for positive expected profits.

Subjects enter as long as the expected payoff from entry is positive. In markets without entry regulation, the equilibrium number of entrants is $E^* = c + 2$. In equilibrium, no entrant has an incentive to stay out because her payoff would fall to zero. Conversely, a non-entrant would not enter because this increases the number of entrants, leading to negative expected profits.

Regulatory entry costs decrease the number of firms that can be sustained by the market. Every entrant has to pay fixed entry costs[23] which are deducted from the expected payoffs.

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[21]Assuming risk neutrality for Nash equilibrium predictions is common because risk aversion requires precise assumptions about specific risk preferences in order to derive the equilibria (Camerer & Lovallo 1999).

[22]The Nash equilibria are asymmetric because symmetric players follow different strategies to come to the Nash equilibria.

[23]We consider constant regulatory entry costs and therefore players are symmetric. Rapoport et al. (2002) analyze the coordination behavior of asymmetric players in large groups. Players face individually

The number of equilibrium entrants drops to $c + 1$ if $c = 2$ and to c for the remaining capacities.

Mixed-Strategy Nash Equilibrium.[24] Alternatively, we derive the symmetric and unique mixed-strategy Nash equilibrium.[25] Given the other subjects' best responses, every player enters with probability p such that the expected payoff from entry is non-negative:[26]

$$\sum_{s=0}^{c-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} \sum_{i=0}^{s} x(c-i) - R \right) +$$

$$\sum_{s=c}^{n-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} (I - (s+1-c)L) - R \right) \geq 0$$

with $x = I / \sum_{j=1}^{c} j$ and $R = 0$ in non-regulated markets. The equilibrium is characterized by the entry probability p^* which leads to zero expected profits from entry. There is no closed-form solution to this problem but using Mathematica$^{\text{TM}}$ we derive numerical solutions for the given parameter constellation ($I = 60$, $k = 31$, $R = 10$, $L = 21$, $n = 10$, $\Pi_i(r_i)$). The equilibrium entry probability p^* as a function of the market capacity, and the equilibrium number of entrants E^* are displayed in Table 4.5.

Table 4.5: Mixed-Strategy Nash Equilibrium: Equilibrium Probabilities p^* and E^*

	Without Entry Regulation Capacity c				With Entry Regulation Capacity c			
	2	3	4	5	2	3	4	5
p^*	0.483	0.583	0.683	0.784	0.305	0.361	0.413	0.457
$n(p^*)$	4.825	5.828	6.834	7.844	3.05	3.611	4.125	4.568
E^*	4	5	6	7	3	3	4	4
	$c+2$	$c+2$	$c+2$	$c+2$	$c+1$	c	c	$c-1$

Note: The table shows the individual probability of entry in mixed strategies p^*, such that the average profit from entry is zero. The probabilities are calculated using Mathematica$^{\text{TM}}$. $n(p^*)$ is the theoretical optimal number of entrants, but subjects either enter or not, there is no option of partial entry. Therefore, the actual optimal number of entrants E^* is the down-rounded value of $n(p^*)$. By rounding down we ensure that the average profit is positive such that the entry condition holds.

In case of unregulated markets, the pure- and mixed-strategy Nash equilibria predict the same number of entrants. In regulated markets, there is a difference of one entrant at $c = 5$.

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different entry fees upon entering the market. Despite this asymmetry the (pure strategy) Nash equilibrium accounts well for the aggregated number of entrants in the market.

[24]I am indebted to Oliver Urmann for helpful comments and support with the derivation and proofs of the mixed-strategy Nash equilibrium in this section and the respective appendices. All errors are my own.

[25]Appendix Section C.4 provides the proof for uniqueness of the mixed-strategy equilibrium.

[26]Since it is a symmetric game, the mutually best response probabilities are the same across all subjects. This leads to a symmetric equilibrium probability p^* for all players.

For our further analysis, we are going to use the pure-strategy Nash equilibrium as benchmark if we investigate the number of total entrants. The literature has shown that it accounts well for the aggregate number of entrants in experimental market entry games (Sundali et al. 1995). Furthermore, it is the benchmark that predicts the highest number of entrants and therefore provides a lower bound to the definition of 'excess entry'.

4.4 Hypotheses about Regulation and Entrepreneurial Self-Selection

There exists ample empirical evidence that entry regulation leads to less firm foundations, but little is known about how precisely it influences entrepreneurial self-selection. To our knowledge, this is the first study that investigates whether entry regulation has an impact on overconfident or skill-based self-selection into entrepreneurship.

Entry Regulation and Entrepreneurial Overconfidence

Overconfidence and overoptimism are recognized traits amongst entrepreneurs and therefore important determinants of entrepreneurial self-selection into markets. Bénabou & Tirole (2002) provide an economic model of how individuals balance the positive effects of self-confidence against the risks of overconfidence. It is modeled as an endogenous memory with time-inconsistent individuals and limitations of memory, or a "game of strategic communication between the individual's temporal selves" [p. 875]. De Meza & Southey (1996) derive a model which incorporates entrepreneurs' overoptimism about their project's success probability to explain stylized facts such as high drop out rates, reliance on debt financing along with high collateral provision, credit rationing, and a higher failure rate of secured loans. Arabsheibani et al. (2000) test the model's implication with respect to financial expectations. They use data from a British household panel to show that all participants are optimistic about future income, but that self-employed are indeed more overoptimistic than employees, which let's them conclude that "the self-employed are the most over-optimistic of all" [p. 40]. Van den Steen (2004) develops the idea of "choice-driven overoptimism": Entrepreneurs sometimes over- and sometimes underestimate the success probability of actions. When given the choice, they realize more likely a project for which they have overly optimistic expectations compared to other agents.[27]

As pointed out before, the distinction between overconfidence and overoptimism is not

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[27]This study focusses on entrepreneurs but the phenomenon and effects of overconfidence are also known amongst CEOs who manage larger business units, see for example Malmendier & Tate (2005, 2008), Galasso & Simcoe (2010).

clear-cut. In our setting, we refer to overconfident entry if subjects enter systematically more in markets with skill-based rank assignment compared to markets with random rank assignment. Nevertheless, we keep in mind that it stems from overoptimistic beliefs in own skills.

Overconfidence with respect to the own position in the skill distribution leads to upwardly biased expected gains in skill-ranked markets. The more confident subjects are, the higher are the expected payoffs. Therefore, overconfident subjects enter markets although the expected gains would be negative under a realistic assessment of their true position in the skill distribution. This leads to excess entry in market entry games (Camerer & Lovallo 1999) and could also explain the high failure rate of young startups in real markets (De Meza & Southey 1996). There are two opposite ways how the introduction of fixed and known entry costs could influence entrepreneurial overconfidence and therefore the entry decision. On the one hand, entry regulation might *increase* overconfident entry. As pointed out before, more confidence in own skill leads to higher expected gains in markets with skill-based ranking. The presence of regulatory entry costs shifts the cutoff point for profitable entry towards a higher level of individually expected gains. Not any gain, but only a gain that is higher than the entry costs, makes market participation worthwhile. Therefore, realistic entrepreneurs retreat from entry under regulation if they realize that their expected payoffs do not cover entry costs, whereas more overconfident subjects still enter. By increasing the minimum gain necessary to render entry profitable, regulation would lead to a self-selection of entrepreneurs with higher levels of overconfidence in their own skills.

On the other hand, entry regulation might work as a debiasing mechanism and therefore *decrease* overconfident entry. Regulatory entry costs are sunk and entrepreneurs have to give up a non-recoverable part of their endowment for entry. The fact that people need to pay in order to enter might provide an incentive to think more thoroughly about the entry decision: How good are my skills compared to my competitors? Are the potential gains high enough to cover the entry costs? This may lead to a more realistic (re-)consideration of own skills relative to the competitors' because entrepreneurs put real money at stake and entry reduces payoffs irrevocably. Thus, regulatory entry costs may motivate a more realistic consideration of the relative rank position amongst competitors in the skill treatment and thereby decrease overconfident entry.

We investigate the effect of regulation on overconfident entry by considering the difference of entry in markets with skill and random ranking across markets with and without entry regulation.

Entry Regulation and Entrepreneurial Skill

Using individual data, we go one step further by controlling for the skill level. We use the skill rank determined in the skill tasks as a proxy for subjects' ability relative to their competitors. If we control for the skill level, we get a better estimate for the effect of entry regulation on overconfident entry. Entry in the skill treatment that cannot be explained by an appropriate, good skill rank can be imputed to overconfidence in the skill rank. Of course, the individual belief about own skills and the actual skill level are closely related determinants of the entry decision. The introduction of the realized skill rank in the analysis tackles the concern about the distinction between confident and overconfident entry. It can provide important insights about the drivers of the quality among entrants in the entrant pool.[28]

One can argue that there exist some (though imprecise) clues about the own skills relative to the competitors: Potential startups can talk to incumbent or other startup firms and observe their decisions in order to draw conclusions about their business skills. Similarly, our participants know that they are all university students but some might understand from prior exam results that they belong to the top quantiles of students what may lead them to the conclusion that a good rank is likely in the experiment, even in the presence of unknown fellow participants. Risk averse but able and confident subjects might not enter in the random-rank treatment, but would do so in markets with skill-based ranking. This type of behavior cannot be distinguished from the behavior of a risk averse but overconfident, less able subject. In the aggregate market analysis, we would correctly find evidence for overconfident entry if the number of entrants exceeds market capacity in skill-ranked markets.[29] Similarly, the regression analysis using individual data would yield a positive coefficient for the skill treatment. In order to disentangle confident and overconfident entry, we include our proxy for the actual skill level in the analysis. The inclusion of the individual skill rank provides an in-depth investigation of whether subjects enter due to realistic confidence in own skills (which reflects in the coefficients related to the skill rank) or due to overoptimistic skill-rank expectations and therefore payoff expectations.

We call subjects with a rank lower or equal to the market capacity "qualified", because given the market capacity, these subjects belong to the group of participants that maximize the quality of the entrant pool. Ideally, one would always want the highest skilled subjects to

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[28]At the aggregate level, we can state that overconfident entry occurs if we observe excess entry. Yet, we cannot assess which entrants are qualified with respect to own skills and whether regulation has an influence on these subjects' decisions.

[29]If the total number of entrants exceeds market capacity, there are obviously overconfident subjects among entrants. Considering the actual skill rank provides a refinement of the analysis with respect to the composition of the entrant pool.

enter a market, no matter whether ranks are randomly determined or based on skill, and whether market entry is regulated or not. Yet, entry regulation makes the entry decision more complex. Non-qualified subjects might be less able to understand and evaluate the entry situation in the presence of entry regulation. This can have two effects. On the one hand, they might not wholly understand the impact of entry regulation on market and individual profits and therefore do not adjust their entry behavior accordingly. Theory predicts that entry in regulated markets should be lower than in non-regulated markets. But if non-qualified subjects do not adjust their entry behavior sufficiently, relatively more qualified than non-qualified subjects desist from entry, leading to a decline in the quality of the entrant pool. On the other hand, less able subjects might refrain from entry if they realize that they have only a limited understanding of the consequences of entry regulation. This would lead to a relative improvement of the entrant pool in regulated markets.

4.5 Results

The aim of this study is to analyze the effect of entry regulation on entrepreneurial self-selection. The experimental markets are characterized by the presence of regulation and the ranking system which determine entrants' payoffs. First, we investigate the base effects of these two treatments separately and independent from each other. We compare total entry in regulated and unregulated markets with the theoretical benchmarks and test for the presence of overconfident entry. Thereafter, we analyze the impact of entry regulation on overconfident entry by accomplishing a difference-in-difference analysis of the two base effects. We define overconfident entry as excess entry in skill-based markets relative to markets with random ranking, and consider this difference across markets with and without entry regulation. Table 4.6 provides an overview over the identification idea.

Table 4.6: Treatments and the Differential Analysis

Ranking	Regulation		
	Without (O)	With (W)	
Random (R)	OR	WR	} Effect of overconfidence
Skill (S)	OS	WS	
	Effect of regulation		$\Downarrow$ $\Rightarrow$ **Effect of regulation on overconfident entry**

Note: The table shows how the two treatments "Entry Regulation" and "Entrant Ranking" are related to each other in order to identify the effect of regulation on overconfidence.

After an analysis at the aggregate market level, we turn to the investigation of individual entry decisions which takes individual characteristics into account. Specifically, we focus on the role of a subject's skill level by including the dummy variable for qualified entry in order to get a better understanding of entrepreneurial self-selection. Thereby, we attempt to disentangle confidence and overconfidence at the individual level.

4.5.1 A Separate Analysis of Regulation and Overconfidence

The analysis of the two base effects – regulation and overconfidence – provides the foundation for the investigation of the regulatory impact on overconfident entry.

Theory predicts a positive correlation between aggregate market entry and market capacity, as well as less entrants in case of regulatory entry costs compared to the free-entry case. Table 4.7 displays the average number of market entrants E and profits Π, as well as the respective pure-strategy Nash predictions (E^*, Π^*) by treatment groups (regulation O/W, ranking R/S) and market capacity. We employ a matched-pair t-test to investigate statistically the impact of the regulation and ranking treatment on market entry. The test exploits the elaborate experimental design: We compare the rounds of two sessions which only differ with respect to the treatment of interest, i.e. the other treatment is always the same in paired rounds.[30] Therefore, matched rounds have the same location in the experimental session, i.e. if learning occurs it does so over the same period, the rounds have the same underlying market capacity, as well as the same exposure to the other treatment. The matched rounds only differ with respect to the treatment of interest and therefore provide a reliable test for treatment effects. This way the test controls for effects of the period (learning), the subject pool, and exposure to the other treatment.

Entry Regulation Decreases Total Entry but Increase Excess Entry

In markets *without entry regulation* we find that entry (E_O) increases with market capacity as predicted by the Nash equilibrium (E_O^*). However, realized entry is on average 0.9 entrants higher than the Nash prediction which indicates excess market entry.[31] Consequently, 61% (or 78/128) of the markets yield negative, and only 39% (or 50/128) realize positive market profits.[32] The average market profit is EC -1.50, i.e. the average entrant makes a loss which is the economic result of excess entry.

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[30] According to Table 4.2, we match the rounds of sessions 1 & 2, 3 & 4, 5 & 7, 6 & 8 to identify the effect of overconfidence, and sessions 1 & 3, 2 & 4, 5 & 6, 7 & 8 to identify the effect of regulation.

[31] Tables C.10 and C.11 in the Appendix Section C.6 provide an overview over the total number of entrants and market profits for every single round.

[32] The market design of Camerer & Lovallo (1999) is similar to our setting without entry regulation. With slightly different experiment parameters, they find strictly negative profits in 24% of their markets, and strictly positive profits in 58%. Zero profit occurs in the remaining 18% of the markets.

Table 4.7: Average Market Entry and Profits by Treatment and Market Capacity

Market Entry

Capacity	Regulation Treatment					Ranking Treatment		
	E_O	E_W	$\Delta_{E_{reg}}$	E_O^*	E_W^*	E_R	E_S	$\Delta_{E_{rank}}$
2	5.41	4.59	0.81	4.00	3.00	4.34	5.66	-1.31
3	5.78	5.06	0.72	5.00	3.00	4.94	5.91	-0.97
4	6.97	6.28	0.69	6.00	4.00	6.13	7.13	-1.00
5	7.44	5.63	1.81	7.00	5.00	5.84	7.22	-1.38
Average	6.40	5.39	1.01***	5.50	3.75	5.31	6.48	-1.16***
			(0.192)					(0.189)

Market Profits in EC

Capacity	Regulation Treatment					Ranking Treatment		
	Π_O	Π_W	$\Delta_{\Pi_{reg}}$	Π_O^*	Π_W^*	Π_R	Π_S	$\Delta_{\Pi_{rank}}$
2	-11.53	-41.69	30.16	18.00	9.00	-9.88	-43.34	33.46
3	0.63	-37.16	37.79	18.00	30.00	-6.72	-29.81	23.09
4	-2.34	-54.66	52.32	18.00	20.00	-15.13	-41.88	26.75
5	7.25	-15.22	22.47	18.00	10.00	11.44	-19.41	30.85
Average	-1.50	-37.18	35.68***	18.00	17.25	-5.07	-33.61	28.54***
			(4.562)					(4.447)

Note: The table displays the average number of entrants E and market profits Π by treatment and market capacity as well as the average across capacities. The indices O/W indicate markets without/with entry regulation, R/S refer to the random/skill ranking treatment, respectively. The average is taken over all sessions and rounds with the respective capacity. The equilibrium benchmark is the pure-strategy Nash equilibrium. Standard errors of the matched-pair t-test are provided in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% confidence level, respectively.

In markets *with entry regulation*, the average number of entrants (E_W) is lower compared to non-regulated markets but does not decrease as much as predicted by the Nash equilibrium (E_W^*). The gap between the actual number of entrants and the Nash prediction widens relative to markets without entry regulation and thus regulation increases excess market entry. The average market profit drops to EC -37.18 with 73% (or 93/128) of the markets achieving negative profits. The fact of less entry indicates that subjects correctly understand that regulatory entry costs decrease expected profits, but aggregate market entry does not decrease sufficiently, and therefore excess entry increases. A matched-pair t-test for the effect of entry regulation on market profits yields a difference of EC 35.68 and t = 7.82 (dof = 127, p < 0.0001). Market profits are clearly lower in regulated markets and regulatory entry costs increase average excess entry by about one entrant.[33]

Overconfidence Increases Market Entry

The analysis of the ranking treatment reveals that subjects exhibit overconfident entry behavior. Total entry in markets with skill-based ranking (E_S) significantly exceeds entry in markets with random rank assignment (E_R) by on average 1.16 entrants (t = 6.14, dof = 127, p < 0.0001). We cannot find a clear relationship between the market's capacity and

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[33] A comparison of total entry yields a difference of 1.01 entrant which is significantly different from zero: t = 5.24, dof = 127, p < 0.0001.

the entry difference related to the ranking treatment, neither in total nor in relative terms. With random rank assignment, market profits are positive in 58 out of 128 rounds (45%), compared to only 27 rounds (21%) in the skill-based ranking treatment. This reflects in significantly lower average market profits with EC -5.07 vs. EC -33.61 (t = 6.42, dof = 127), respectively. Total entry exceeds market capacity in 121 out of 128 markets with skill ranking (94.5%) which can be considered as evidence that entry in the skill treatment is indeed related to overconfidence.

To summarize, we find that entry regulation in our experiment significantly decreases average market entry, but it widens the gap with respect to the Nash equilibrium, because subjects do not adjust their entry behavior sufficiently to the profit decreasing effect of entry regulation. Furthermore, we document that entry is driven by overconfidence in own skills. Subjects do not know each other's skills but on average, they seem to trust more in their own skills than in sheer luck when it comes to the rank assignment. This leads to more entry in rounds with skill ranking compared to random ranking. Yet, what remains open from the analysis of the base effects is whether they are somehow interrelated, i.e. whether regulation has an impact on overconfident entry. This is at the center of our interest and analyzed in the following section.

4.5.2 The Effect of Regulation on Overconfident Entry

The analysis builds on a difference-in-difference identification approach. In the previous section, matched-pair t-tests were used to test statistically the effect of regulation or overconfidence on total entry. We now apply the same idea and investigate regulation on overconfident entry by matching pairs of overconfidence measures in markets with and without regulation, holding the market capacity and position in the experiment (period) constant.[34]

Overconfident Entry Increases with Entry Regulation

Table 4.8 displays the average number of entrants E and market profits Π by treatment group. Column 4 shows that overconfident entry, i.e. the difference in entry between markets with random and skill ranking, increases by about 0.48 entrants if markets are regulated. The magnitude of this effect becomes more palpable if we set overconfident entry in relation to total market entry: In non-regulated markets, the increase in entry

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[34]Specifically, we compare overconfidence measures, i.e. the difference in total entry between markets with random and skilled ranking, between sessions 1/2 & 3/4 and 5/7 & 6/8.

due to overconfidence in skills is about 15.5% (6.86/5.94-1) whereas in regulated markets, overconfidence increases entry by 29.9% (6.09/4.69-1). Although the increase of overconfident entry by 0.48 entrants is not statistically different from zero (t = 1.231, dof = 63, p = 0.223), we find that regulation almost doubles the share of overconfident entry. The economic relevancy is more clearly reflected in average market profits. In markets without regulation, average market profits are positive in case of random ranking (Π_{OR}). On average, total entry exceeds market capacity but entrants gain from their decision ($0 < \Pi_{OR} < 60$). Yet, overconfidence in skills leads to negative average market profits (Π_{OS}). In regulated markets, profits are on average negative but the magnitude of losses is significantly higher if ranking is based on skill (Π_{WR} vs. Π_{WS}). The difference in market profits due to overconfident entry is larger in regulated markets: 0.48 more overconfident entrants in regulated markets translate into a decrease of market profits by EC 18.95, what equals 31.6% of distributable market profits. The economic loss due to the impact of regulation on entrepreneurial overconfidence is statistically significant in the matched-pair t-test with t = 2.136 (dof = 63, p = 0.037).

Table 4.8: Matched-Pair T-test for Market Entry and Market Profit

Market Entry				Market Profits in EC			
	E_R	E_S	$\Delta_{E_{rank}}$		Π_R	Π_S	$\Delta_{\Pi_{rank}}$
E_O	5.94	6.86	-0.92	Π_O	8.03	-11.03	19.06
E_W	4.69	6.09	-1.41	Π_W	-18.17	-56.19	38.02
$\Delta_{E_{reg}}$	1.25	0.77	0.48	$\Delta_{\Pi_{reg}}$	26.20	45.16	-18.95**
			(0.393)				(8.872)

Note: The table displays the average number of market entrants E and market profits Π by treatment. The indices O/W indicate markets without/with entry regulation, R/S refer to the random/skill ranking treatment, respectively. The average is taken over all sessions and rounds. The table provides the average differences between the treatment groups which indicate the impact of entry regulation and overconfidence, as well as the difference-in-difference estimate for the effect of entry regulation on overconfident entry. Standard errors of the matched-pair t-test are provided in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% confidence level, respectively.

Thus, in regulated markets not only the gap between actual and equilibrium entry is wider, but there is also a larger share of entrepreneurs whose entry decisions are driven by overconfidence in own skills. The economic consequence of more overconfident entry, measured in market profits, is significant and suggests that entry regulation is detrimental for markets via its impact on overconfident, excess entry.

The Blind Spot Hypothesis Cannot Explain Overconfident Entry

Our results with respect to overconfidence could also be explained by what Camerer & Lovallo (1999) introduced as the "blind spot hypothesis". Subjects might have wrong expectations about their fellow participants' entry decisions. If they enter more in skill-

ranked markets because they systematically underestimate the number of other entrants –
and therefore expect positive market and individual profits – their decision is not motivated
by overconfidence but by a wrong perception of the competitive environment. To analyze
the data with respect to the blind spot hypothesis, we consider the predicted number of
entrants E_p that subjects specify in every round before making their entry decision. We
calculate the predicted market profits Π_p by inserting the number of predicted entrants
into the payoff function stated in Section 4.2.1. If the blind spot hypothesis is true, then E_p
(Π_p) stated by subjects who enter should be lower (higher) in markets with skill ranking
compared to the random ranking treatment.

Table 4.9: Predicted Number of Entrants and Market Profits (in EC)

	OR	OS	WR	WS	Total
N	380	439	300	390	1509
Descriptive Statistics					
E_p	6.403	7.057	5.450	6.349	6.399
Π_p	2.184	-11.954	-35.590	-61.690	-25.947
$E_p > E^*$	212	318	242	354	1126
	55.79%	72.44%	80.67%	90.77%	74.62%
$E_p = E^*$	114	77	39	31	261
	30.00%	17.54%	13.00%	7.95%	17.30%
$E_p < E^*$	54	44	19	5	122
	14.21%	10.02%	6.33%	1.28%	8.08%
$E_p > E$	158	144	132	137	571
	41.56%	32.80%	44.00%	35.13%	37.84%
$E_p = E$	78	75	65	98	316
	20.53%	17.08%	21.67%	25.13%	20.94%
$E_p < E$	144	220	103	155	622
	37.89%	50.11%	34.33%	39.74%	41.22%
T-tests: Actual vs. predicted entry					
$E - E_p = 0$	-0.034	0.267***	-0.270**	0.092	0.039
	[-0.336]	[2.948]	[-2.274]	[0.974]	[0.778]
$\Pi - \Pi_p = 0$	0.258	-5.681***	6.943**	-3.056	-0.997
	[0.123]	[-3.020]	[2.004]	[-1.066]	[-0.786]

Note: The table displays the average expected number of market entrants E_p
and the implied expected market profits Π_p of subjects *who enter* by treat-
ment group. Expected entry is set in relation with the pure-strategy Nash
equilibrium E^* and with the actual realizations E. By definition, $E_p > E^*$
implies negative and $E_p \leq E^*$ positive expected profits. The t-test states
the difference between the investigated variables and the actual realization.
T-statistics are provided in brackets. ***, **, and * indicate statistical sig-
nificance at the 1%, 5%, and 10% confidence level, respectively.

As can be seen in Table 4.9, there is compelling evidence against the blind spot hypothesis.
Entrants' average predictions for the total number of entrants is higher in markets with skill
ranking. Entering subjects correctly anticipate the situation of increased entry but seem
to say: "I don't care how many of you enter because I am better anyways." Interestingly,
the predicted number of entrants reflects the increase in overconfidence under regulation:
whereas the predicted entry difference between the skill and the random treatment is 0.654

entrants in markets without regulation, it increases to 0.899 with regulation. Although the predicted level of overconfident entry is lower than the actual one, it clearly signals that the blind spot hypothesis cannot be supported. This is also reflected in the predicted market profits which are lower in the skill treatment. In fact, predicted market profits are remarkably often below zero ($E_p > E^*$). It seems as if subjects do not consider the scenario of a loss for themselves, and instead expect a rank high enough to make a gain. The most extreme case occurs in markets with regulation and skill ranking: 91% of all entrants predict entry in excess of the Nash equilibrium. This implies negative average profits – but they enter nevertheless. Taking these pieces of evidence, we cannot support the blind spot hypothesis but find further evidence for the overconfident entry explanation.[35] In markets with regulation, subjects make lower entry predictions but expect more often entry in excess of the Nash equilibrium. Thus, they adjust their predictions to the market environment but not in a sufficient way.

Another feature we investigate is the correctness of average entry predictions. Entrants expect in about 59% of the rounds the correct number of entrants or even more competition than actually realizes. They tend to overestimate entry in random and underestimate entry in skill-ranked rounds. The share of correct entry predictions is slightly higher if regulatory entry costs are in place. Despite differences in the predictive quality across treatments, the t-tests for equality of E and E_p as well as the resulting market profits Π and Π_p reveal that overall, entrants predict actual entry well. Therefore, they defy overconfident entry and negative expected profits open-eyed.

Regression Estimates Support Prior Findings

We complement the prior investigation by regression analysis. We start with data at market level before turning to the investigation of individual decisions in Section 4.5.3. Table 4.10 provides OLS regression estimates with total entry and market profits as dependent variables.[36]

Columns (1) and (4) are the regression representations of Table 4.8 and support our prior findings: Entry increases in markets with skill ranking, indicating entrepreneurs' overconfidence in their skills, and this effect is even stronger if regulatory entry costs need to be

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[35]Interestingly, the predicted number of entrants does not vary between entrants and non-entrants. If we add 1 to the prediction of non-entrants (subjects were asked to predict the number of entrants including themselves, therefore entrants should always count one more than a non-entrant with the same expectations about other players' behavior) and compare average predictions, we find no significant difference (diff = 0.003, t = 0.035, p = 0.972).

[36]Standard errors are clustered by experimental session to take into account that entry decisions may not be independent within an experimental session (Rapoport 1995, Fischbacher & Thöni 2008).

Table 4.10: Regression Analysis at Market Level

	Market Entry			Market Profits		
	(1)	(2)	(3)	(4)	(5)	(6)
Skill*Reg	0.484**	0.427**	0.390**	-18.953***	-17.672***	-16.451***
	(0.148)	(0.127)	(0.135)	(3.742)	(3.773)	(3.863)
Skill	0.922***	0.774**	0.828**	-19.063**	-15.763**	-16.569**
	(0.260)	(0.258)	(0.266)	(5.592)	(5.607)	(5.662)
Reg	-1.250***	-1.030***	-1.504***	-26.203***	-31.089***	-19.444***
	(0.143)	(0.112)	(0.211)	(2.447)	(2.307)	(3.777)
Capacity	0.580***	0.331**	0.533***	5.764***	11.300***	7.018***
	(0.069)	(0.126)	(0.085)	(1.428)	(2.515)	(1.578)
Entr. avg. E_p^-		0.240***			-5.342***	
		(0.068)			(1.529)	
Entr. avg. Π_p			-0.007*			0.193**
			(0.003)			(0.067)

Regression Statistics

Cluster (exp)	yes	yes	yes	yes	yes	yes
R^2	0.321	0.336	0.331	0.325	0.339	0.338
N	256	256	256	256	256	256

Note: The table reports OLS regression coefficients and standard errors in parentheses. The dependent variable is the total number of market entry E and the respective market profits Π. A constant is included. The data is clustered at the experimental session level. ***, **, and * for the regression coefficients indicate that they are significantly different from zero at the 1%, 5%, and 10% confidence level, respectively.

paid.[37] The interaction coefficient $Skill^*Reg$, which measures the effect of regulation on overconfident entry, is positive and significant. The increase in overconfidence due to entry regulation shows its economic impact in the significant decrease of market profits (column (4)).[38] To test the blind spot hypothesis in a regression analysis, we add the entrants' average prediction of the number of entrants minus the market capacity ($E_p^- = E_p - c$) per period in columns (2)/(5), and in columns (3)/(6) the average predicted market profits Π_p.[39] The more entry is predicted by entrants, the higher is the actual number of entrants and the lower are market profits. This contradicts the idea of the blind spot hypothesis which would suggest that total entry decreases if subjects make high predictions. The coefficients on predicted average market profits have exactly the opposite sign because high predictions of entry yield low predictions of market profits. The introduction of the control variables for the blind spot hypothesis does not significantly change the coefficients for the

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[37]We can claim to observe overconfident entry because Table 4.7 shows that average total entry exceeds market capacity such that the pool of entrants in the skill treatment has to consist to some part of non-qualified subjects being driven by overconfidence.

[38]If we cluster standard errors by experimental session, the number of truly independent observation drops to 8 but SE are robust to correlations of decisions within sessions. Without clustering, i.e. assuming independent individual decisions, the coefficient for the interaction $Skill^*Reg$ remains the same but becomes insignificant in the regression of total entry (1), with $SE = 0.374$, $t = 1.30$ and $p = 0.195$. The economic impact of regulation on overconfident entry, measured by regressions on market profits in (4), remains significant without clustering ($SE = 8.805$, $t = -2.15$, $p = 0.032$).

[39]We consider only entrants' predictions because they determine market entry and profits which are our dependent variables. Predicted entry is positively related to the market capacity. To disentangle these effects, we subtract the market capacity from the total predicted number of entrants for the regression analysis. We aggregate the individual data to market level data by taking every round's average entry prediction and the implied average profit prediction of all entrants.

two treatments and the interaction effect.

Regressions (1) - (3) show that the total number of entrants decreases in regulated markets. But the decline in entry is not sufficient to outweigh the impact of the accumulated entry costs on market profits. Albeit entry decreases in the presence of regulation, market profits do so as well (see columns (4) - (6)). Regulated markets are therefore further away from the social optimum (maximum market profits) than non-regulated markets.

To summarize, entry regulation seems to foster overconfident entry in our experimental markets: Entrants rely more on their own skills if they have to pay for market participation. The increase in overconfident entry decreases market profits significantly. Therefore, regulation decreases total entry, but increases overconfident entry and has a negative impact on realized market profits.

4.5.3 The Composition of the Entrant Pool under Regulation

So far, the analysis is based on market level data in order to investigate the impact of entry regulation on overconfident entry. Now, we turn to the individual level to distinguish between confident and overconfident entry and to analyze whether the quality of entrants, approximated by their skill rank, varies across market types.

Given a market's capacity and subjects' skill rank, we can determine in every round which subjects ideally enter the market to maximize the average skill level. We generate a dummy variable that is 1 if a subject has a skill rank less or equal to the market capacity. In the following, we call these subjects "competent" or "qualified".

In markets with random ranking, only 33.7% of all entrants belong to the group of qualified subjects.[40] Surprisingly, this share only slightly increases in markets with skill ranking (36.1%) although in this market setting the skill rank determines an entrant's payoff. A t-test reveals that the difference is not statistically significant (diff = -0.024, t = -0.969, dof = 1507). Therefore, the increase of total entry in skill-ranked markets cannot be attributed to an influx of competent subjects only, which implies that also non-qualified entry increases in markets with skill ranking. This strengthens the overconfidence interpretation derived in the market level analysis. A respective comparison between the regulation treatments indicates lower entrant quality in regulated markets with 33.2% qualified entrants vs. 36.5% in non-regulated markets. Yet again, the difference is not statistically significant (diff = 0.033, t = 1.347, dof = 1507) but suggests a negative impact of regulation on self-selection with respect to skill.

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[40]In markets with random ranking, the skill rank does not matter for an entrant's expected payoff. Therefore, we expect any subject to enter as long as this decision is in line with the individual risk aversion.

The descriptive results about skill levels across treatments are not conclusive. We continue with a regression analysis of individual entry decisions depending on the market setting and individual characteristics. The results are displayed in Table 4.11. The dependent entry variable is binary and 1 if a subject enters, 0 otherwise. We perform ordinary least square (OLS) regressions instead of using binary dependent regression models because they are less feasible in case of including interaction variables (Ai & Norton 2003). Since the observations within a session may not be statistically independent, we cluster standard errors by experimental session in regressions (1) and (2). Upon the inclusion of further variables in our regression models, the number of control variables exceeds the number of truly independent observations. In regressions (3)-(6), we therefore cluster at the subject level which is the next, more granular and plausible cluster.[41]

Column (1) reports the results of a regression that includes only the market characteristics as exogenous variables.[42] Subjects are significantly more likely to enter if payoffs from entry are assigned according to skill rather than on a random device, and this effect is even more pronounced in regulated markets. At the same time, the base effect of market regulation on entry is negative significant. This is plausible given the payoff reducing character of entry costs. As can be expected, a higher market capacity makes entry more likely.

In column (2) we include a dummy variable indicating qualified subjects, $D(r_i \leq c)$, as well as the variable E_{po}^- which measures how many *other* players a subject expects to enter in excess of the market capacity.[43] On average, a higher number of predicted other entrants significantly decreases the probability of entry.[44] This result does not contradict the rejection of the blind spot hypothesis, where we analyzed only the entrants' prediction.

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[41]After every round, subjects receive feedback about the total number of entrants. This may allow for learning about the group behaviour which could change the individual decision in the future and provides the reason for clustering at the experimental level. If we have to give up clustering at the experimental session, the next logical cluster is the individual. Subjects are told to consider every period as a single event, which we reinforce by the random round selection for payoff. If they learn, we assume that subjects try to make consistent decisions for themselves such that their own decisions across rounds are not independent. Therefore, we cluster in the next step at individual level. The investigation of learning in market entry games is not at the center of the study.

[42]In fact, we repeat regression (1) of Table 4.10 using individual rather than market level data.

[43]We ask subjects to predict the total number of entrants including their own decision. Therefore, an entrant's prediction is 1 higher than the prediction of a non-entrant with the same expectation about other's behaviour. Since we consider decisions of entrants and non-entrants in the regression, we adjust the predicted value of excess capacity entry E_p^- to E_{po}^- which excludes the own decision and focusses on the prediction of other subjects' entry decisions.

[44]Under the strong assumption, that subjects perfectly understand how other subjects' entry influences market profits, we calculate the expected market profit in case of *own and predicted other subjects' entry* $(E_{po} + 1)$. For the regression specification (2), the coefficient for expected market profit is positive significant (coeff: 0.002***, SE: 0.0004). The positive effect stands in contrast to the result by Camerer & Lovallo (1999) who find a negative significant coefficient on expected market profits. One reason could be that they calculate market profits based on the predicted number of entrants, without standardizing this variable across entrants and non-entrants.

Table 4.11: Entry Decision Regressions

	(1)	(2)	(3)	(4)	(5)
Skill*Reg	0.048**	0.052**	0.054	0.093**	0.094**
	(0.015)	(0.021)	(0.037)	(0.041)	(0.041)
Skill	0.092***	0.122***	0.122***	-0.021	-0.018
	(0.026)	(0.032)	(0.034)	(0.051)	(0.051)
Reg	-0.125***	-0.168***	-0.171***	-0.144***	-0.140***
	(0.014)	(0.020)	(0.032)	(0.040)	(0.041)
Capacity	0.058***	0.059***	0.060***	0.061***	0.062***
	(0.007)	(0.012)	(0.016)	(0.016)	(0.016)
$D(r_i \leq c)$		-0.030	0.053	0.114*	0.093
		(0.033)	(0.052)	(0.062)	(0.061)
$D(r_i \leq c)$*Skill				0.085	0.083
				(0.063)	(0.063)
$D(r_i \leq c)$*Reg				-0.137***	-0.132***
				(0.047)	(0.048)
(E_{po}^-)		-0.055***	-0.042***	-0.063***	-0.063***
		(0.013)	(0.014)	(0.019)	(0.018)
(E_{po}^-)*Skill				0.050***	0.049***
				(0.018)	(0.018)
(E_{po}^-)*Reg				-0.001	-0.004
				(0.015)	(0.015)
$D(r_i \leq c)$*(E_{po}^-)			-0.043**	-0.061***	-0.056***
			(0.021)	(0.021)	(0.021)

Regression Statistics

Ind. Charact.	no	no	no	no	yes
Cluster (exp)	yes	yes	no	no	no
Cluster (subj)	no	no	yes	yes	yes
R^2	0.043	0.068	0.071	0.081	0.099
N	2560	2560	2560	2560	2560

Note: The table reports OLS regression coefficients and standard errors in parentheses. The dependent variable is the Entry, which is binary and 1 if a subjects decides to enter a market and 0 otherwise. Individual characteristics include age, sex, apprent, foundex. A constant is included. The data is clustered at the experimental session or subject level. ***, **, and * for the regression coefficients indicate that they are significantly different from zero at the 1%, 5%, and 10% confidence level, respectively.

In this regression specification, the coefficient for qualified entry is positive but insignificant. In the following, we perform a close-up investigation of the skill rank and entry predictions by interacting the two variables with each other (column (3)), and further on also with the treatment variables *Skill* and *Reg* (column (4)). The reference group for these regressions are non-qualified subjects in random-ranked, non-regulated markets (OR) who predict entry equal to the market capacity.

Column (3) reveals that, although the probability to enter decreases if subjects predict entry in excess of the market capacity, it does so even stronger for qualified subjects. Thus, qualified subjects are less likely to engage in aggressive competition: Every predicted entrant in excess to the market capacity reduces the entry probability of qualified entrants by 0.043 (about 4.3%) more than of non-qualified subjects, yielding a total effect of -0.085 vs. -0.042, respectively.[45] This result suggests that qualified subjects are more able

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[45]An interpretation of OLS coefficients as percentage changes is statistically not correct, because we do not interpret marginal effects of a binary dependent model. Nevertheless, we discuss in the robust-

to internalize the effect of competition by other subjects' entry on individual expected profits, and adjust their entry behavior accordingly.

The investigation of qualified subjects' entry behavior across market settings in column (4) yields further valuable insights. Although the dummy coefficient for qualified entrants was not significant so far, column (4) shows that it was hiding two effects: In general, qualified subjects are more likely to enter than non-qualified subjects. The coefficient is positive and statistically significant at the 10% confidence level. Nevertheless, in markets with entry regulation, competent subjects enter significantly less likely than non-qualified subjects. Therefore, the average quality of entrants is lower in markets with regulation which indicates a negative impact of entry regulation on entrepreneurial self-selection with respect to skill.

Interestingly, competent subjects are as likely as other subjects to enter markets with skill ranking although they could realize positive payoffs from entry. Markets with skill-based ranking do not attract a positive self-selection of subjects with respect to skill, and the increase of total entry in the skill treatment can be attributed to overconfidence. Furthermore, we find that skill ranking enhances competition seeking behavior.

Although the general probability of entry decreases in the predicted number of excess-capacity entrants, we find that this is not true in markets with skill ranking. The interacted coefficient is positive and significant, i.e. the probability of entry is higher in skill-ranked markets compared to random-ranked markets if subjects predict entry in excess to market capacity. This strongly supports the rejection of the blind spot hypothesis. In other words, subjects are less likely to enter in markets with random ranking if they predict excess-capacity entry. It seems as if subjects rather avoid entry in expectedly crowded markets with random ranking, but do not mind competition in skills. This supports our interpretation of overconfident entry. The coefficient on the base effect for skill ranking ($Skill$) becomes insignificant upon the inclusion of its interaction with predicted entry. Interestingly, the influence of predicted entry on the entry decision does not depend on market regulation. The interaction coefficient is virtually zero and not significant which indicates that subjects treat excess entry predictions in both market types equal and do not internalize effects from other subjects' entry costs on market profits. Nevertheless, for skilled subjects this effect is captured by the negative and significant coefficients on $D(r_i \leq c)^*Reg$ and $D(r_i \leq c)^*(E_{po}^-)$, such that the insignificant coefficient on the interaction variable $(E_{po}^-)^*Reg$ relates to the decisions of non-qualified subjects.

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ness session that our results are close to the respective probit results and therefore we interpret the coefficients approximately.

Finally, we include individual characteristics in the regression analysis which increases the model fit but does not change the results discussed so far. Interestingly, subjects with an apprenticeship are significantly less likely to enter (coeff = -0.149, p = 0.007) whereas the coefficient for subjects with self-employment experience is not significant (coeff = -0.023, p = 0.703).

To summarize our experimental results, we find that entry regulation leads to an increase in overconfident entry and has a negative impact on the composition of the entrant pool. The coefficient for entry in regulated markets with skill-based ranking ($Skill^*Reg$) is positive and statistically significant. This effect is neither absorbed by coefficients that describe entry behavior of qualified subjects, nor by the coefficients for entry predictions. Therefore, we can conclude that entry regulation leads to an increase in overconfident entry. The probability to enter regulated markets is significantly lower for qualified subjects than for non-qualified subjects. This implies that the quality of the entrant pool is lower in regulated than in non-regulated markets. With respect to our hypotheses, our findings suggest that regulatory entry costs discourage entry from qualified subjects more than from non-qualified subjects. This leads to an impairment of the entrants' average quality under regulation and provides experimental evidence in favor of entry deregulation. The result suggests that qualified subjects have a better understanding of the relationship between the market conditions characterized by ranking and regulation, other subjects' entry, and their own expected payoffs from entry. They adjust their entry behavior more than non-qualified subjects. Although we proxy for subjects' actual skill level and therefore for 'confident' entry, we still find a significantly higher entry probability in skill-ranked than in random-ranked markets and this difference is larger in regulated than in non-regulated markets. Thus, regulation increases the entry probability of overconfident subjects, instead of working as a debiasing mechanism. The increase of the minimum gain necessary to make entry worthwhile seems to discourage entry from realistic or little overconfident subjects. In the light of our experimental findings, the current wave of deregulation described by Djankov (2009) is conducive to an improvement of entrepreneurial self-selection with respect to skill and overconfidence.

4.6 Robustness and Discussion

Before presenting robustness tests with respect to the main results presented in Table 4.11, we would like to address a general point of objection: One may be concerned about the independence of market entry decisions within sessions or individuals, especially in the

presence of feedback (Rapoport 1995, Fischbacher & Thöni 2008). As pointed out before, learning about group behavior may take place.[46] By using a random lottery selection for payoff, we provide an incentive for making independent decisions across rounds. Admittedly, these potentially independent decisions may be based on different information sets due to feedback provision, such that prior decisions could matter. Nevertheless, we vary the market capacity across rounds and every capacity is played only twice per treatment. Furthermore, only the aggregated number of entrants, and not other player's individual behavior is presented. These conditions make straightforward coordination through learning complicated. Nevertheless, we take care of potential violations of independence in our empirical analysis. If learning takes place, it is related to the progress of the experiment, i.e. to the round's position in the experiment. In the matched-pair t-test, we compare entry between rounds which have the same position. By taking the difference between the total number of entrants under the assumption that both groups were exposed to the same learning opportunity, we control indirectly for learning such that it does not influence our results. In the regression analysis, we cluster the standard errors either at session or individual level. Furthermore, we include the number of predicted entry in the regressions investigating the individual entry decision. If learning takes place, it reflects in the entry prediction which thus captures learning. Taking all these facts together, we are confident that our analysis does not suffer from biases due to a violation of the independence assumption.

4.6.1 Robustness Tests of the Main Regressions

Table 4.11 provides the central results and we perform several robustness tests with respect to the regression type and variable specification. First, we repeat the analysis using a probit model specification which takes the binary character of the dependent variable into account. We exclude all interaction control variables and keep only the interaction of interest, $Skill^*Reg$. Table C.12 in the Appendix Section C.6 reports the probit results including the corrected marginal effects and standard errors for the interacted variable (Norton et al. 2004). The probit regression results are very similar to the respective OLS results in the main table. Thus, estimating OLS models allows a more flexible specification with respect to the inclusion of interaction variables with little loss of accuracy.

Second, there is a tradeoff between clustering the data and controlling for individual fixed effects. Cluster take into account that entry decisions within an experimental session or

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[46]This study does not focus on the investigation of learning, but the interested reader is referred to Rapoport et al. (1998) who explicitly investigate entry in experimental market entry games using a learning model.

individual may not be independent. Nevertheless, it reduces the number of truly independent observations such that the inclusion of individual control dummy variables is only possible once we give up data clustering. To show that the coefficients are robust, we repeat regressions (1)-(4) of the main Table 4.11, but include individual dummies and do not cluster the data. The results are reported in Table C.13 in the Appendix Section C.6. The standard errors need to be considered with precaution, but the coefficients are unbiased. The coefficients for market type (Reg) and predicted entry are in line with our main results. Yet, when it comes to the influence of the skill rank, there are some remarkable differences. The coefficients for being a qualified entrant are negative, of high magnitude and significant in columns (2) and (3). The interacted variables with the qualification dummy are of similar magnitude as in the clustered regression, but the standard errors differ. Overall, we conclude that controlling for individual fixed effects and giving up clustering leads to more pronounced effects of subjects' skill qualification on the entry decision. Nevertheless, we deem the conservative results using clustered regression analysis more reliable.

Third, endogeneity concerns with respect to the skill rank as an explanatory variable for the entry decision might arise. The skill rank is determined in three skill tasks which are conducted *after* all entry decision have been made. We argue that the mix of tasks provides a good proxy for the actual skill level. Nevertheless, if subjects only enter in random ranked markets or not at all, they have no incentive for a good performance in the skill tasks. Thus, the ranks may be biased and no longer a reliable proxy for the actual skill level, because the prior entry decisions determine the skill rank, and not the other way around. To invalidate this argumentation, we look at the individual entry decisions and skill tasks. Only one subject does not enter at all, and a second one only enters in random-ranked markets. All other subjects enter at least three times in skill-ranked markets and thus have an incentive to perform well in the skill tasks.[47] For these two subjects we investigate the performance in the skill tasks a little bit closer. In their respective sessions, they are ranked 5th and 9th according to their performance in the skill tasks and both achieve the best rank in one of the tasks.[48] In addition, we ask all subjects which rank they expect to achieve in each task. Both subjects do not expect the last rank for themselves, although this would be the correct expectation in case of slack during the skill tasks.[49] These descriptive pieces of evidence enfeeble the theoretically justified concern of endogeneity for our experiment.

Fourth, we relax the benchmark for competent entry and define a subject as qualified, if she

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[47]For a detailed overview of individual entry decisions see Tables C.6-C.9 in Appendix Section C.6.

[48]The ranks for the economic quiz, general quiz, and time taking are as follows: 1, 6, 7 for subject 39 and 9, 1, 10 for subject 66, respectively.

[49]The expected ranks for the economic quiz, general quiz, and time taking are as follows: 8, 9, 5 for subject 39 and 8, 6, 4 for subject 66, respectively.

has a rank lower or equal to the Nash equilibrium. We change the dummy for qualified entry and repeat the main table's regression specifications of columns (2)-(5). Table C.14 shows that our results are robust to this less stricter measure of entry qualification. Alternatively, we test our results by including the actual skill rank variable instead of a dummy for qualified entry. The results are reported in Table C.15[50] and qualitatively similar to the ones from the main Table 4.11 although the (interacted) skill coefficients influence the entry decision at the most weakly significant.

Finally, we perform general robustness tests such as the inclusion of dummy variables for the rounds, which as a group do not enter the regression significantly. We also consider the impact of random ranks or predicted skill ranks on the entry decision. We include them in the regression instead of the skill rank variable. Random ranks are completely unknown to subjects at the moment of the entry decision. They are exogenously assigned and should not influence the entry decision. This is indeed what we find. All coefficients related to the random ranks are insignificant. We repeat the analysis using expected skill ranks, but they do not enter the regressions significantly either. This may have different reasons, e.g. that we elicit the expected rank *after* all entry decisions and *after* performing in the skill tasks, or that the effect of overconfident entry is better captured in the treatment variables. Overall, these results make us confident that the achieved skill rank is related to subjects' actual skill level which provides valuable insights for our analysis.

4.6.2 Discussion of the Results

In our experiment, total entry exceeds market capacity in all four treatment combinations.[51] In contrast to our results, Rapoport (1995) does not find total entry to be greater than market capacity, i.e. subjects react highly risk averse. We point out two reasons which can explain the difference to our results. First, Rapoport's subject pool consists of students who participate in his class, whereas our subjects self-selection into the experiment and dedicate extra time to experiment participation. We think that recruiting into an experiment reflects more closely the real process of entrepreneurial self-selection, but may also explain more entry. Second, he does not provide an endowment and therefore student subjects can make real losses. We do not implement such an explicit real loss device, but provide an initial endowment (a type of show-up compensation) which is credited to the subjects at the beginning of the experiment. In case of entry, they set this money at stake.

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[50]The interaction variable between skill rank and E_{po}^- would not lead to well interpretable results because both variables are not binary. Therefore, we keep $D(r_i \leq c)^* E_{po}^-$ in the regression and only replace the interactions with *Skill* and *Reg*.

[51]Out of 64 rounds, entry exceeds market capacity in OR: 59, OS: 63, WR: 40, WS: 58 rounds.

Therefore, they can actually make real losses as well, but it is framed in a different way. Furthermore, one might be concerned that our subjects are motivated by non-pecuniary benefits such as the thrill from gambling which may lead to excess entry.[52] Fischbacher & Thöni (2008) address the problem and provide a positive lottery with little payoff variance as a 'safe' entry alternative. Therefore, no matter whether subjects enter or not, they essentially select an uncertain payoff which, as they argue, controls for the excitement of gambling. We do not have such a device. Nevertheless, our analysis builds on a differential approach for the investigation of overconfidence and entry regulation which controls for the utility gain from gambling as a fixed effect.

Camerer & Lovallo (1999) show that overconfident entry increases if subjects self-select into the experiment based on recruiting information which explicitly states that payoffs depend on their skills. Subjects neglect that all participants self-select into the experiment because they believe to do well in the skill task. They call this phenomena reference group neglect. We do not have such a treatment in our experiment, but we ask our subjects at the beginning of the experiment, whether they would expect higher payoffs from entry if a market with random ranking or skill ranking is drawn. We use this variable to test indirectly for the effect of reference group neglect in our data. Subjects who believe to get higher payoffs from entry in skill-based markets would also self-select into an experiment that announces such a payoff scheme. In Table C.16 (Appendix Section C.6), we firstly repeat regression (4) of Table 4.11 separately for the subjects who prefer the skill treatment, and secondly include the binary variable $Prefskill$ and its interactions in the regressions using the full sample. The results for the separate sample are not very different from the ones in the main table, which can be attributed to the fact that 85% of the subjects would prefer the skill ranking. Interestingly, the model fit (R^2) increases in the restricted sample which means that subjects who prefer random ranking introduce more variance to the model that cannot be explained by the explanatory variables. Upon the inclusion of the variable $Prefskill$ and its interactions in the full sample, we find a shift in the coefficient for $Skill$: Subjects who do not prefer the skill treatment for payoff enter significantly less often in the skill treatment than those subjects who would like to have the skill treatment for payoff, i.e. the coefficient on $Prefskill^*Skill$ is positive significant. This is in line with the finding of Camerer and Lovallo who report significantly more overconfident entry among subjects who were recruited with the self-selection treatment.

In the literature, financial constraints are often discussed as a determinant of entrepreneu-

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[52]Blanchflower & Oswald (1998) show that entrepreneurship is often motivated by non-pecuniary benefits which explains the foundation of startups despite lower expected income than as wage earner.

rial self-selection and as a main obstacle for startup foundation,[53] which is aggravated in the presence of regulatory entry costs. Our experimental design excludes financial constraints as a source of entry deterrence or self-selection determinant. All subjects can afford to enter regulated markets because their endowment is set such that it exceeds regulatory entry costs. Yet, there are literature contributions that relate financial constraints, overconfidence, and entrepreneurial self-selection. In the light of unrealistic entrepreneurial optimism, De Meza (2002) questions whether subsidy policies for credit rationed entrepreneurs based on the argument of asymmetric information are welfare enhancing. He argues that it can lead to socially inefficient overlending if one takes overoptimistic entrepreneurial self-selection into account. In fact, he proposes subsidies to non-entrepreneurs which are financed by taxes imposed on entrepreneurs. He argues that it discourages overoptimistic entry and therefore improves the pool of entrepreneurs.[54] A similar line of argumentation is put forward by Coelho et al. (2004). They argue that startup subsidization encourages lending to otherwise redlined or capital-constrained entrepreneurs and thereby lures overly optimistic entrepreneurs into entrepreneurship. If this overoptimism leads to failure, it leaves the low-income people even worse-off than without giving them the entry opportunity. Whereas our experimental results suggest that deregulation with respect to fixed regulatory entry costs leads to more qualified and less overconfident entry, these theoretical literature contributions propose less startup subsidies in order to prevent overconfident entry. Taking these pieces together, the results might complement each other in favor of a reduction of policy interventions. Nevertheless, further research is needed to clarify the relationship between policy interventions, financial constraints and overconfident entry.

The empirical analysis of overoptimistic or overconfident entry is often limited because it cannot be directly observed and is difficult to identify. This circumstance motivates our experimental approach. We are aware of the limits of experimental data, but the results are very suggestive and could explain empirical findings. Ardagna & Lusardi (2009) provide empirical evidence about the effect of entry regulation via its impact on individual characteristics on opportunity and necessity entrepreneurs.[55] Amongst other characteristic traits, they investigate self-reported measures for business skills and fear of failure. Ardagna & Lusardi (2009) find that individuals who are afraid of failure become less likely opportunity founders, and in case of entry regulation this negative effect grows stronger.

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[53]Aghion et al. (2007) show that, especially for small firms, entry and post-entry growth is higher in countries with developed financial markets which enable entrepreneurs to overcome financial constraints.

[54]Similarly, in the insurance market asymmetric information is often used as an argument for compulsory insurance. Sandroni & Squintani (2007) replace this assumption by overconfidence and argue that compulsory insurance can be detrimental for low risk individuals and thus welfare-reducing.

[55]We concentrate on the findings for opportunity foundations because the entry decision in our experimental investigation is not driven by necessity.

If we assume that the measure for fear of failure is positively related to entrepreneurial realism, this result is in line with our experimental finding of more overconfident (=less realistic) entry in regulated markets. Furthermore, Ardagna & Lusardi (2009) show that individuals who report to have business skills are more likely to become opportunity entrepreneurs, but this effect is lower in regulated markets. Self-reported business skill can be considered as "a proxy for individual degree of self-confidence" (Ardagna & Lusardi 2008, p. 17) and is likely to represent a mix of actual and perceived skill levels. If we assume that subjects realistically report business skills, the results are in line with our findings about a lower entry probability of qualified subjects in regulated markets. Yet, the field data does not allow to disentangle these effects precisely and our re-interpretation is admittedly somewhat vulnerable.

We are aware of the limits of our study and one should be careful to overstrain the results. More entry may also foster more exit (Geroski 1995) and we do not investigate the economic outcome of deregulation with respect to bankruptcy costs or opportunity costs of resources. Furthermore, our experimental analysis provides tentative evidence on the effect of entry regulation on (over-)confident entry, but it might also influence the composition and quality of the entrant pool through other channels, such as through its impact on financially constrained entrepreneurs or self-selection of necessity and opportunity founders (Ardagna & Lusardi 2008, 2009, Van Stel et al. 2007). These channels are excluded from our investigation by experimental design.

4.7 Conclusion

The process of entrepreneurial self-selection cannot be observed directly. Different sources of motivation can explain why not all firm foundations are equally successful and conducive to economic development and growth. Entry motivated by overoptimistic revenue expectations, for example, can explain the high failure rate of startups and other stylized facts about entrepreneurship (De Meza & Southey 1996). There exists ample empirical evidence that entry regulation decreases the number of firm foundations, but little is known about how precisely it influences entrepreneurial self-selection. Therefore, an interesting question is whether less entry in regulated markets is necessarily worse, once we consider the quality of the entrant pool with respect to overconfidence and skill.

In this study, we use data from experimental market entry games to investigate the effect of entry regulation on entrepreneurial self-selection. To our knowledge, this is the first study that links entry regulation with entrepreneurial overconfidence and the quality of

the entrant pool. The advantage of an experimental approach is that we can control for the market setting and elicit a proxy measure for subjects' skill level. This way we disentangle confident and overconfident entry, while controlling for risk aversion and other individual characteristics.

We find that entry regulation decreases total entry, but more importantly, it exerts a negative effect on the composition of the entrant pool. Our results show that overconfident entry increases in regulated markets, whereas qualified subjects are significantly less likely to enter. Thus, we find evidence that entry regulation is detrimental to entrepreneurial self-selection with respect to overconfidence and skill.

Although it is beyond the scope of our study to provide specific policy recommendations, our results suggest that the current wave of entry deregulation, which was brought forward by the study of Djankov et al. (2002), may not only be conducive to foster entry in general, but specifically entry of qualified and less overconfident entrepreneurs. According to our results, this may lead to an improvement of the entrant pool and increase self-selection of entrepreneurs who are more likely to innovate and compete successfully.

Our study provides a missing piece in the puzzle of the determinants of entrepreneurial self-selection. It links empirical findings about the impact of entry regulation and theoretical contributions about overconfident entrepreneurship. Doing so, it constitutes a valuable contribution to the academic and political discussion about the effects of entry regulation.

A Appendix: Portfolio Selection and Framing

A.1 Investment Questions and Experiment Design Elements

The experiment was conducted in German. This section presents the English translation of the four central questions. Afterwards, the different design elements and their contribution to the analysis are explained in more detail.

A.1.1 Investment Questions

In this example, the subject was randomly assigned to the final asset value treatment (FT) and the order treatment group is ABC/ABC-AC (CB3).

Security Choice (SC):

Imagine you have saved €10,000 which you want to invest for the next two years. A portfolio can be constructed using the following three securities with different returns and risks:

	Historical Returns	Risk Category
Security A: Safe investment	3.1% p.a.	Safety-oriented
Security B: Stock investment fund	10.5% p.a.	Return-oriented
Security C: Call option on stocks	42.1% p.a.	Highly speculative

For simplification, assume that the investment costs for all three securities are equal. Which of the three securities would you include in your portfolio to invest €10,000 for a period of 2 years? (It is not a question of security shares in the final portfolio.)

○ A   ○ B   ○ C
○ A & B   ○ A & C   ○ B & C
○ A & B & C
○ Don't know

Portfolio Choice 1 (PC1):

Based on your prior decision, four portfolios were constructed for you and for each the following information based on historic development is given to you. Figures are provided for the entire 2-year investment period.

Portfolio	Expected portfolio value	Guaranteed minimum portfolio value	Minimum portfolio value
ABC1	€10,790	€10,300	
ABC2	€12,200		€8,460
ABC3	€11,300		€9,280
ABC4	€13,000		€7,390

In which of the portfolios would you invest your €10,000 for a period of 2 years?

○ ABC1   ○ ABC2   ○ ABC3   ○ ABC4

Portfolio Choice 2 (PC2):

Your investment advisor now offers you alternative portfolios, which may contain securities that you did not want as part of your portfolio beforehand. In the following you can decide between all the portfolios that are offered to you.

Portfolio	Expected portfolio value	Guaranteed minimum portfolio value	Minimum portfolio value
ABC1	€10,790	€10,300	
ABC2	€12,200		€8,460
ABC3	€11,300		€9,280
ABC4	€13,000		€7,390
AC1	€11,300		€9,870
AC2	€10,910	€10,300	
AC3	€13,000		€7,980
AC4	€12,200		€8,870

In which portfolio would you invest your €10,000 for a period of 2 years?

○ ABC1   ○ ABC2   ○ ABC3   ○ ABC4
○ AC1   ○ AC2   ○ AC3   ○ AC4

Portfolio Choice 3 (PC3):[1]

Unfortunately, you have just decided for a closed fund for which no more shares are available. Alternatively, in which portfolio would you invest your €10,000 for a period of 2 years?

Portfolio	Expected portfolio value	Guaranteed minimum portfolio value	Minimum portfolio value
ABC1	€10,790	€10,300	
ABC2	€12,200		€8,460
ABC3	€11,300		€9,280
ABC4	€13,000		€7,390
AC1	€11,300		€9,870
AC2	€10,910	€10,300	
AC3	€13,000		€7,980
AC4	€12,200		€8,870

◯ ABC1 ◯ ABC2 ◯ ABC3 ◯ ABC4
◯ AC1 ◯ AC2 ◯ AC3 ◯ AC4

A.1.2 Design Elements

Security Choice and the Setting of Investment Situation

Based on real world data, we provide security information in the Security Choice question. The return information for the "Safe investment" (A) is based on data from the Deutsche Bundesbank for the yield curve of stock-exchange listed German government securities with a time to maturity of two years. The "Stock investment fund" (B) is based on the development of the German stock index DAX30 and for the return information of the "Call option on stocks" (C), we calculated rolling 2-year at-the-money call option prices on the DAX30 using the Black-Scholes Formula.[2] We select these three security types because, firstly, their combination allows a wide range of risk and return profiles for the portfolio setup. Secondly, these are standard securities which most private investors are familiar with. Finally, a combination of securities (A) and (C) can generate a portfolio with a positive guarantee return and an upside market participation. This way we can test whether subjects have a basic idea of financial engineering. The verbal risk categories for the securities are in line with the ones provided by financial institutions. Since Germany is

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[1]We assume that portfolio AC2 was chosen in PC2. This portfolio is an inactive option in PC3, signaled by the gray font color.

[2]We use data from 12/2000 until 11/2005 to calculate the historical average returns for (A) and (B) and data until 11/2007 for (C), respectively. This time period covers about one business cycle and is therefore well suited for the estimation of the average annual returns.

in the highest sovereign rating class (AAA, see Standard&Poor's online), it is considered as a "safe" investment despite the (very small but theoretically existent) possibility of country default.

The time to maturity is chosen to be two years to avoid potential confusion about compound interest rate calculations, and subjects' expectations about the economic environment are more likely homogeneous over a short time horizon. Furthermore, we choose the two-year investment horizon to ensure that participants do not consider capital gain taxes. In 2008, German private investors did not have to pay taxes on capital gains of investments with a holding period longer than one year.[3] The investment sum of €10,000 is chosen such that it is a non-trivial but realistic investment sum for the average private investor. Furthermore, it is a round sum which makes a comparison of investment alternatives with respect to the investment sum easier. We frame the investment task as an investment of savings to signal that the current level of consumption is not affected by the investment sum or its outcome.

Portfolio Setup and Information

We construct portfolios with different risk-return profiles.[4] As can be seen in Table 1, the portfolio set AB consists of only three portfolios whereas the other two sets have four choices. The reason is that we impose a short-sale restriction to make sure that subjects understand the relationship between their security choice (SC) and the portfolio choice. Furthermore, most private investors face short-sale restrictions which makes the setting more realistic. A return level of 30% is not achievable with a combination of non-negative portfolio shares of securities (A) and (B). The smaller portfolio set does not influence our analysis with respect to the framing effect because we use a between-subject design and in both treatment groups the portfolio sets are identical with respect to the number of included portfolios.

We construct portfolios with four different return levels which cater to different levels of financial risk aversion. To facilitate the comparison within one set of portfolios, we state the risk information separately for the guarantee and risky portfolio selections. Across portfolio sets, we use only one dimension to indicate portfolio dominance because dominance in two dimensions (risk and return) is more difficult to detect (Lurie 2004). By keeping the task as easy as possible we want to avoid confounding effects which might blur the impact of

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[3]This was changed by the introduction of the "Abgeltungssteuer" (flat rate withholding tax) in 2009.

[4]We abstract from actual portfolio performance calculations including transaction costs and asset correlations. The aim of looking at real data in our context is to provide portfolio return information within a realistic range rather than to generate complex return simulations for different asset allocations.

information framing. The total number portfolios in the choice set is restricted to seven or eight alternatives to prevent adverse effects due to information overload.

The return information is given without stating probabilities for each state of the world. The presentation of probabilities (e.g. as percentages or in words) might interact with the main analysis. A subjective assessment of probability weights does not influence the qualitative properties of decision weights in prospect theory (Tversky & Kahneman 1981).

Portfolio Selections and Endogenous Assignment to Order Treatment

The three portfolio selections (PC1-PC3) are subject to the framing treatment. Therefore, we use these questions to identify the framing effect on rational portfolio selection and the choice of the respective risk level.

The first portfolio selection (PC1) aims at identifying the risk-return combination that a subject feels most attracted to, given the individual level of risk aversion. It provides a benchmark with respect to the framing treatment effect for the following decisions.

The second portfolio choice (PC2) is designed such that we can identify rational portfolio selection and observe changes in the return level. We investigate whether these two aspects are different in the two framing treatment groups to obtain further evidence of how framing influences portfolio selection.

One might be concerned with order effects in the presentation of portfolio sets: Selecting the identical portfolio in PC2 as in PC1 is rational if subjects receive first the set of dominating portfolios. If they see first the dominated set of portfolios, the same action leads to an inferior, irrational choice. Furthermore, since the risk-return combinations vary between the sets, a risk-return combination in one set might not be chosen whereas the same return level with a different risk might be preferred in another set. Therefore, the order of portfolios may have an effect on changes in the risk-return level and rational portfolio choice, depending on which set of portfolios subjects receive first.

To smooth these concerns, we introduce an order treatment by designing choice blocks (CB). These choice blocks are different combinations of portfolio sets. By comparing the answers with respect to rational decision making and return level changes across these choice blocks, we can control for order effects. There are several reasons to assign this treatment endogenously. Firstly, it increases the experiment's trustworthiness and credibility for subjects if they find that a prior answer can influence the course of their survey. In the SC decision the participants choose a combination of A (safe investment), B (stock fund) and C (call option). The portfolios are labeled such that the participants can recognize the included securities and compare them with their prior choice. By increasing the

overlap we want to stimulate truthful answers. Secondly, we assume that groups within the order treatment are more homogenous with respect to their level of risk aversion and other (unobservable) investor characteristics. Dominitz & Manski (2004) observe that it can be useful to analyze survey data within subgroups of respondents to obtain more detailed information about the underlying process. Finally, it adds realism to the investment task by first offering portfolios that are close to the desired combination of securities and then amending or reducing the range of portfolio securities according to the (advisor's or market's) offer.

Finally, in the third portfolio choice (PC3) we give subjects a chance to reconsider the choice set. All subjects, including those who – for rational reasons or idleness – repeated their decision from PC1 in PC2, are forced to make a new, active decision. This allows us to identify who selected a dominant portfolio by simply reselecting the first portfolio choice (idleness (CB2) or accident (CB1 and CB3)) and to test whether these forms of decision backgrounds vary across the framing treatment groups. We cannot find such evidence and therefore pool the data in our analysis. Furthermore, subjects who have made a rational decision in PC2 now have to decide whether to pick the most similar and foremost dominated portfolio with the same return in PC3 or to change both the risk and return level. This induces more return level changes which gives us the opportunity to test whether framing induces more or less risk-taking in subsequent portfolio selections.

Financial Literacy, Risk Aversion and Security Choice

Prior literature contributions have shown that financial risk aversion as well as financial literacy are determinants in the portfolio selection and financial decision-making process. Therefore, we need to control for these influences in our analysis of the framing treatment effect. To this end, we derive two measures of financial literacy (self-assessed vs. quiz) and financial risk aversion (general and specific investment context).

The self-assessment of financial literacy takes place before the four investment question are asked to avoid that subjects' self-perception is influenced by their decisions in the portfolio selection. We conduct the financial literacy quiz afterwards. The levels of the general and specific financial risk aversion are elicited after the investment decisions and the financial literacy quiz. Thus, subjects just have been in the situation of making financial investment decisions (general) and are familiar with the specific setting (specific) which makes it more likely that their statement reflects their actual levels of risk aversion. A detailed analysis of financial literacy and risk aversion complements the analysis of framing effects.

A.2 Variables in the Study

Table A.1: Variable and Data Description

Variable	Mean	SE	Description
Sociodemographic Variables			
age	43.785	13.382	Age
sex	0.851	0.356	D: Male
married	0.525	0.499	D: Married
single	0.234	0.423	D: Single, not in a permanent relationship
Education			
abi/prof.	0.336	0.472	D: Higher secondary education (German Abitur) or apprenticeship
academic	0.507	0.500	D: Academic degree
school	0.131	0.337	D: High school degree (German Real- or Hauptschule)
edu_no	0.026	0.161	D: No response to the education question
Household Income			
hhinc_50	0.374	0.484	D: Annual household income < €50,000
hhinc_50100	0.347	0.476	D: Annual household income €50,000 - €100,000
hhinc_100250	0.099	0.298	D: Annual household income €100,000 - €250,000
hhinc_250	0.014	0.118	D: Annual household income > €250,000
Professional Occupation			
freelancer	0.218	0.413	D: Freelancer
employee	0.463	0.499	D: Employee, wage earner
clerk	0.076	0.266	D: Clerk
student	0.077	0.266	D: Student
retiree	0.099	0.299	D: Retiree
housek./unempl.	0.031	0.172	D: Housekeeper or unemployed
finance	0.128	0.334	D: Occupied in the finance industry
Investment Experience			
invsafe	0.903	0.296	D: Safe Investment (savings/money market accounts, fixed income)
invstock	0.865	0.342	D: Stock Investment (stocks, mutual stock funds)
invderivative	0.208	0.406	D: Derivative Investment
Risk Aversion and Financial Literacy			
general risk	5.172	1.767	General financial risk aversion measure on a scale from 0 (no risk) to 9 (risk loving)
specific risk	4.210	1.921	Specific financial risk aversion measure for investing €10,000 over two years on a scale from 0 to 9
fin.lit. self	2.269	0.974	Self-perception of financial literacy on a scale from 0 (no knowledge) to 5 (expert)
fin.lit. quiz	4.072	1.119	Financial literacy quiz score: Correct answers (0-6)
Participation Time & Treatments			
time_t	1126.51	485.38	Time needed to answer the entire survey in seconds
time_PC1	59.15	66.32	Time needed to answer PC1 in seconds
time_PC2/3	99.65	75.24	Time needed to answer PC2 and PC3 in seconds
D_{final}	0.485	0.500	D: Framing treatment - Total asset values
CB1	0.715	0.451	D: Order treatment - choice block 1
CB2	0.060	0.237	D: Order treatment - choice block 2
CB3	0.225	0.418	D: Order treatment - choice block 3
Portfolio Decisions			
D_{inf2} / D_{inf3}			D: Inferior portfolio selection in PC2 / PC3

Notes: The table lists the central variables used in the empirical analysis, provides the mean and standard errors and a verbal description. "D" stands for dummy variable and we indicate what codes the value 1. We also have information about the sources of information (friends and family, newspaper, internet, financial advisor) and the frequency of consultation (daily, weekly, monthly, quarterly, seldom, never). We ask for a broad spectrum of financial asset to asses investment experience in the stated three groups.

A.3 Financial Literacy Quiz: Questions and Relation to the Literature

The financial literacy quiz consists of six questions with different degrees of difficulty. Before providing the descriptive results, we present the quiz questions. Afterwards, we relate the results from our quiz to other studies that used similar questions to measure financial literacy.

A.3.1 Questions

Question 1:

Today, €100 is deposited for five years in a savings account with an annual interest of 2%. How many € does one receive at the end of five years if all the money remains in the account for the entire period?

   ◯ €102.00   ◯ €110.00   ◯ €110.41   ◯ €112.40   ◯ Do not know

Correct answer: €110.41

Question 2:

€1,000 is invested in a money market fund today. Is it possible that one receives less than €1,000 if one withdraws the money after a two year holding period?

   ◯ Yes   ◯ No   ◯ Do not know

Correct answer: Yes

Question 3:

Which of the following statements is correct? Please note that only one statement is correct!

   ◯   Mutual investment funds are riskier than investments in single stocks.
   ◯   Mutual investment funds can change their investment policy over time and thus may become riskier.
   ◯   Mutual investment funds are tax-efficient, because they allow for a full evasion of capital gain taxes.
   ◯   None of the above
   ◯   Do not know

Correct answer:

Mutual investment funds can change their investment policy over time and thus may become riskier.

Question 4:

Which of the following statements is correct? Please note that only one statement is correct!

If somebody buys a bond of firm B:

◯ He owns a part of firm B.

◯ He has lent money to firm B.

◯ He is liable for firm B's debt.

◯ None of the above

◯ Do not know

Correct answer: He has lent money to firm B.

Question 5:

The return of a single stock is usually more secure than that of a mutual investment fund.

◯ True   ◯ False   ◯ Do not know

Correct answer: False

Question 6:

Suppose on January 2, 2007 you have invested €10,000 in a mutual investment fund with an additional payment of a front-end load of 5%. At the end of each year you have to pay a management fee of 1.9% and an administrative fee of 0.1%. In your first year of investment, the fund achieved a 10% return. Which amount of fees have you paid to the mutual fund provider by December 31, 2007?

◯ €200   ◯ €220   ◯ €500   ◯ €700 ◯ €720   ◯ Do not know

Correct answer: €720

A.3.2 Descriptive Results

Table A.2 reports the number and percentage shares of the correct answers for each single question. The questions have different levels of difficulty, with correct response rates between 95.4% for the easiest and 30.5% for the most difficult question.

We define the number of correctly answered questions by a subject as the quiz score. Table A.3 presents the quiz score distribution. Only 9% of the subjects achieve full score, but more than 91% answer at least half the questions correctly. The average score is 4.1.

Table A.2: Correct Answers to Single Questions

Question	N correct	% share correct
1	2,055	70.67
2	2,019	69.43
3	1,591	54.71
4	2,514	86.45
5	2,775	95.43
6	886	30.47

Table A.3: Number of Total Correct Answers

Quiz score	N	% share	% cum.
0	6	0.21	0.21
1	38	1.31	1.51
2	200	6.88	8.39
3	572	19.67	28.06
4	1,036	35.63	63.69
5	794	27.30	90.99
6	262	9.01	100.00
Total	2,908	100.00	100.00

A.3.3 Comparison to the Literature

Questions 4 and 5 were directly taken from other studies about financial literacy and questions 1 and 3 were adopted from research papers, but adjusted to a higher level of difficulty. In the following, we compare our results with the literature for each of these questions.

Question 4 is taken from the survey by Van Rooij, Lusardi & Alessie (2007) who investigate a representative sample of Dutch households with respect to their financial literacy and stock market participation. In their study, 56% answer this question correctly which is a remarkably lower share than in our sample.

Question 5 is essentially identical to a question used by Lusardi & Mitchell (2006, 2007*b*), and Van Rooij, Lusardi & Alessie (2007).[5] Lusardi & Mitchell (2006) investigate the financial literacy of a representative sample of elderly American (over the age of 50). About 52% of the 1269 subjects choose the correct answer. Using different data about subjects in their prime earning years and relatively high education and income levels, the share is higher and around 80% (Lusardi & Mitchell 2007*b*). In the Dutch sample analyzed by Van Rooij, Lusardi & Alessie (2007), 43% of the subjects answer this question correctly. Compared to a share of 95% in our survey, these results are rather weak.

Question 1 is a more complicated version of the following one introduced by Lusardi and Mitchell to test numeracy skills: "Suppose you had $100 in a savings account and the

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[5]"Do you think that the following statement is true or false? Buying a single company stock usually provides a safer return than a stock mutual fund."

interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow: more than $102, exactly $102, less than $102?"[6] About 67% and 93% of the respondents in the two studies mark the right answer (Lusardi & Mitchell 2006, 2007*b*). In the second questionnaire they additionally ask a very similar question: "Suppose you had $100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total? (i) More than $200; (ii) Exactly $200; (iii) Less than $200; (iv) DK; (v) Refuse." Only 76% answer correctly. These two questions were adopted by Van Rooij, Lusardi & Alessie (2007) and the respective shares of correct answers in the Dutch sample are 91% and 76% and therefore very similar to the findings from the US. Chen & Volpe (1998) investigate financial literacy among American college students and ask about their understanding of the compound interest rate concept asking: "If you invest $1,000 today at 4% for a year, your balance in a year will be A) higher if the interest is compounded daily rather than monthly. B) higher if the interest is compounded quarterly rather than weekly. C) higher if the interest is compounded yearly rather than quarterly. D) $ 1,040 no matter how the interest is computed. E) $ 1,000 no matter how the interest is computed." Only about 56% of the subjects answer the question correctly, although it is easier than the one we use here.

Question 3 tests knowledge about mutual fund investments. This topic was also covered by Lusardi & Mitchell (2007*b*) and Van Rooij, Lusardi & Alessie (2007) using the following question: "Which of the following statements is correct? (i) Once one invests in a mutual fund, one cannot withdraw the money in the first year; (ii) Mutual funds can invest in several assets, for example invest in both stocks and bonds; (iii) Mutual funds pay a guaranteed rate of return which depends on their past performance; (iv) None of the above; (v) DK; (vi) Refuse." The shares of correct answers are 72% and 67%. The answering options in our version are very different, which makes a direct comparison rather difficult.

Question 6 is unique in our survey and tests the knowledge about the costs involved in a mutual fund investment. The low share of correct answers indicates that it was the most difficult question. It also generated the highest feedback of participants who commented on the solution to this question.

Taken together, the financial literacy quiz results suggest that we have a positive sample

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[6]This question is easier than our version because it only tests the intuition for compound interest rates but does not require actual computation skills, as it is necessary to find the correct answer from our options. Furthermore, the chance of guessing the right answer is higher: one third compared to one quarter in our version.

selection bias in our sample. Question 4 and 5 were used identically in previous studies. The shares of correct answers are significantly higher in our sample. Since we anticipated this bias, we increased the difficulty of other questions that we adapted from the literature.[7] This makes a direct comparison difficult but the results suggest that the shares of correct answers are still high.

A.4 Additional Analysis of Financial Literacy, Risk Aversion, and Security Choice

Our data is well suited to obtain a more thorough understanding of financial literacy and risk aversion and how these factors relate to the choice of securities in the experiment. Therefore we run an in-depth analysis in order to point out the importance of using different risk aversion and financial literacy measures when investigating private investors' portfolio selection.

A.4.1 Financial Literacy

Subjects self-evaluate their financial knowledge on a scale from 0 (no knowledge) to 5 (expert knowledge), with the average score being 2.3. Additionally, we conducted a quiz for the assessment of an objective level of financial literacy. On average, subjects answered 4.1 out of the 6 questions correctly, but only 9% managed the total score. The quiz results are above average for comparable questions reported in the literature.[8] In line with Agnew & Szykman (2005) we find discrepancies between the two financial literacy measures: the majority of participants tends to be underconfident (44%) and only about 10% overrate their knowledge. Since financial decisions might be driven by what people believe to know rather than their actual knowledge (Lusardi & Mitchell 2007*b*), we consider both measures in our analysis.

Table A.4 displays regressions that relate individual characteristics with the level of financial literacy.[9] Participant's age as a proxy for life experience has a positive effect on financial literacy, though at a decreasing level. Male and better educated participants achieve higher financial literacy scores. Self-reported general financial risk aversion is positively related

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[7]This was necessary to ensure that we have enough variation in the quiz scores. Furthermore, changing the questions or answering options also allowed us to test financial knowledge related to the German system.

[8]The prior Appendix Section A.3 states the six quiz questions and provides a question-by-question analysis including the respective literature comparison.

[9]In fact, we are interested in the conditional expectation function and use OLS regression because it is the best linear approximation (Angrist & Pischke 2009). The results present correlation structures rather than causalities. The dependent variable is the number of correctly answered questions and is therefore censored. For robustness, we run tobit regression analysis which yields virtually the same results.

Table A.4: Regressions for Financial Literacy

Variables	Regressions		
	(1)	(2)	(3)
age	0.050***	0.049***	0.043***
	(0.009)	(0.009)	(0.009)
age2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
sex	0.318***	0.298***	0.288***
	(0.063)	(0.063)	(0.062)
married	-0.079*	-0.086*	-0.101**
	(0.046)	(0.047)	(0.047)
abi/prof.	0.191***	0.203***	0.200***
	(0.069)	(0.069)	(0.068)
academic	0.404***	0.398***	0.349***
	(0.063)	(0.063)	(0.063)
edu_no	0.135	0.166	0.147
	(0.147)	(0.148)	(0.146)
gen. risk	0.202***	0.177***	0.139**
	(0.060)	(0.060)	(0.061)
gen. risk2	-0.015***	-0.015***	-0.012**
	(0.006)	(0.006)	(0.006)
time_quiz	0.031***	0.031***	0.032***
	(0.006)	(0.006)	(0.006)

Control Variables (df): Wald-Statistic χ^2

Information		5.39(8)***	4.14(8)***
Investments			6.25(10)***

Regression Statistics

N	2908	2908	2908
R^2	0.065	0.079	0.099

Notes: The table reports OLS regression coefficients and robust standard errors in parentheses. The dependent variable is the number of correctly answered quiz questions (fin.lit. quiz). Information controls are two dummy variables for each of the four "sources of information" described in Table A.1: at least weekly use of the information source, seldom/no use. Investment controls are the variables listed under "investment experience" in Table A.1. A constant is included. ***, **, and * for the regression coefficients indicate that they are significantly different from zero at the 1%, 5%, and 10% confidence level, respectively.

to financial literacy. The source of financial information reveals an interesting patter (coefficients not reported individually): Reading financial information in newspapers or online on at least a weekly basis increases the quiz score, as does seeing an investment advisor seldom or never. This suggests that financial advisors do not educate their clients but are a substitute for individual knowledge.[10] Friends and family as a source of information have a negative impact on quiz results, as does being married. Thus, peer group information is related with lower financial literacy.[11] Regression (3) includes dummies coding investment

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[10]Van Rooij, Lusardi & Alessie (2007) also find a positive correlation between financial literacy and newspaper/internet information, but our results differ with respect to the consultancy of financial advisors.

[11]Duflo & Saez (2002) investigate the effect of peer group investment behavior and find that peer effects might be an important determinant in retirement savings decisions. Brown et al. (2008) identify community effects in stock market participation. In line with our results, Van Rooij, Lusardi & Alessie (2007) report that peer group information is more important for investors with low financial literacy.

experience. All coefficients are positive (not reported individually) and their inclusion in the model improves the model fit significantly (F(10, 2879): 6.25, p-value<0.001).

A.4.2 Risk Aversion

To obtain risk aversion measures, we asked our subjects to indicate their willingness to take risk (WTR) in a general investment context and the specific situation of investing €10,000 for two years, using a scale from 0 (no risk tolerance) to 9 (highly risk seeking). The average general WTR is 5.2 and is significantly higher than 4.2 in the specific investment situation (difference: 0.961 (0.032), t(2907)=30.26). Both measures are within the investment domain and the difference shows that intra-domain specifications are important besides general context issues (Nosić & Weber 2010, Van Rooij, Kool & Prast 2007).[12] The main reasons for the higher specific risk aversion are the short investment horizon (41%), the investment sum (11%) which is considered as too high or too low or a combination of the time horizon and investment sum (12%).

Table A.5 displays OLS regression results for the relationship between risk aversion and subject characteristics. Both risk measures are significantly higher for male participants and lower for married subjects. The inclusion of control variables for education, household income, the source of information and current occupation improves regression fit and renders the effect of age insignificant. Interesting differences between the general and specific risk aversion regressions emerge when considering actual and self-perceived financial literacy. *General* financial risk aversion is mainly related to what people believe to know rather than their actual financial knowledge. *Specific* risk aversion also increases with a higher self-perception of financial literacy, but to a smaller extent. Lower specific WTR is significantly more common across subjects with higher quiz scores and participants working in the financial sector have a particularly low specific WTR. Thus, actual financial literacy impacts highly upon risk aversion in the specific investment situation, whereas it is somewhat unrelated to general financial risk aversion. Column (5) reveals that if we include general risk aversion as the "baseline measure", the aforementioned determinants remain significant.

A.4.3 Security Choice

In the security choice question (SC), participants determine their preferred portfolio setup for an investment of €10,000 over 2 years. The most popular selections are the combina-

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[12]As a consequence, we use the specific financial risk aversion measure in regressions corresponding to the specific decision situation and the general financial risk aversion measure for not situation-related financial matters.

Table A.5: Regression Results for Risk Aversion Measures

Variable	gen. risk		spec. risk		
	(1)	(2)	(3)	(4)	(5)
sex	0.736***	0.632***	0.735***	0.658***	0.225***
	(0.088)	(0.087)	(0.098)	(0.100)	(0.085)
married	-0.170**	-0.145**	-0.297***	-0.270***	-0.171**
	(0.069)	(0.068)	(0.085)	(0.085)	(0.070)
age	0.030**	0.010	-0.005	-0.016	-0.023
	(0.014)	(0.018)	(0.016)	(0.020)	(0.017)
age2	-0.000***	-0.000	0.000	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
fin.lit. self	0.643***	0.474***	0.207***	0.102**	-0.222***
	(0.037)	(0.042)	(0.042)	(0.048)	(0.039)
fin.lit. quiz	0.054*	0.037	-0.066**	-0.077**	-0.102***
	(0.029)	(0.029)	(0.034)	(0.034)	(0.027)
finance	0.089	0.053	-0.432***	-0.391***	-0.427***
	(0.099)	(0.097)	(0.118)	(0.118)	(0.103)
gen. risk					0.686***
					(0.019)

Control Variables (df): Wald-Statistic χ^2

Education	2.24(3)*	3.33(3)**	1.35(3)	1.86(3)	0.93(3)
HH income		4.21(4)***		1.75(4)	1.07(4)
Information		16.57(8)***		6.65(8)***	1.94(8)*
Occupation		2.59(6)**		2.43(6)**	0.97(6)

Regression Statistics

N	2908	2908	2908	2908	2908
R^2	0.188	0.234	0.039	0.064	0.368

Notes: The table reports OLS regression coefficients and robust standard errors in parentheses. The dependent variables are general financial risk aversion (gen. risk) and specific financial risk aversion (spec. risk). Education controls are the dummies abi/prof., academic, and edu_no. Information controls are two dummy variables for each of the four "sources of information" described in Table A.1: at least weekly use of the information source, seldom/no use. Household income and occupation controls are the variables listed under "investment experience" in Table A.1. A constant is included. ***, **, and * for the regression coefficients indicate that they are significantly different from zero at the 1%, 5%, and 10% confidence level, respectively.

tion of the safe investment with the stock mutual fund (AB, 44.4%) followed by the safe investment (A, 14.6%), a combination of all securities (ABC, 13.5%) and the stock mutual fund only (B, 12.1%). 28.5% of the subjects include options in their portfolio.

We run multinomial probit regressions to understand the effects of specific risk aversion, financial literacy, and investment experience on the security selection (Table A.6).[13] The first regression shows that the likelihood of including options or the riskfree asset hinges significantly on the level of specific risk aversion. SC decisions without options are more likely to be chosen by subjects with low WTR. The coefficients for specific risk aversion are positively significant for SC decisions without the riskfree asset. The second regression reveals that higher financial literacy quiz scores decrease the probability to invest in portfolios including options[14] or pure stock investment. Taken together (regression 3), we

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[13]We choose "ABC" as the reference group because it contains all three assets. All results are reported relative to this group. Subjects in ABC have the second highest quiz score and the third highest WTR.

[14]This refers to option combinations except the ABC reference group. The results suggests that subjects

Table A.6: Security Choice: Multinomial Probit Regressions

				Security Choice				Regression Stat.	
	A	B	C	AB	AC	BC	DK	N	Wald χ^2(df)
Distribution of Answers									
N	423	353	47	1,292	127	261	12		
in %	14.55	12.14	1.62	44.43	4.37	8.98	0.41		
Multinomial Probit Regressions									
spec. risk	-0.587***	-0.049*	0.281***	-0.238***	-0.036	0.173***	-0.355***	2908	644.16(7)
	(0.030)	(0.027)	(0.054)	(0.023)	(0.032)	(0.031)	(0.077)		
fin.lit. quiz	0.015	-0.072*	-0.108*	-0.021	-0.133***	-0.131***	-0.439***	2908	37.92(7)
	(0.040)	(0.041)	(0.064)	(0.036)	(0.049)	(0.043)	(0.101)		
spec. risk	-0.587***	-0.048*	0.282***	-0.238***	-0.036	0.176***	-0.327***	2908	674.05(14)
	(0.030)	(0.027)	(0.054)	(0.023)	(0.032)	(0.031)	(0.079)		
fin.lit. quiz	0.005	-0.075*	-0.118*	-0.016	-0.135***	-0.146***	-0.429***		
	(0.045)	(0.042)	(0.071)	(0.037)	(0.051)	(0.046)	(0.104)		
spec. risk	-0.592***	-0.034	0.286***	-0.230***	-0.026	0.170***	-0.292***	2908	826.17(35)
	(0.031)	(0.028)	(0.056)	(0.024)	(0.033)	(0.031)	(0.083)		
fin.lit. quiz	-0.009	-0.052	-0.084	-0.018	-0.122**	-0.138***	-0.370***		
	(0.046)	(0.043)	(0.073)	(0.038)	(0.052)	(0.047)	(0.108)		
invsafe	0.051	-0.257*	-0.469**	0.507***	0.030	-0.593***	-0.143		
	(0.178)	(0.152)	(0.218)	(0.146)	(0.190)	(0.153)	(0.373)		
invstock	0.289	0.247*	-0.518**	0.283**	-0.427***	0.115	-0.442		
	(0.150)	(0.146)	(0.216)	(0.126)	(0.159)	(0.160)	(0.301)		
invderiv	-0.053***	-0.824***	0.051	-0.464***	0.078	0.049	-0.237		
	(0.122)	(0.128)	(0.185)	(0.099)	(0.134)	(0.118)	(0.411)		

Note: The table shows the distribution of the security choice (SC) and the results of a multinomial regression analysis. The dependent variable is SC, which has the expressions A, B, C, AB, AC, BC, ABC (reference group, N=393=13.51%), DK. The four regressions are separated by horizontal lines. The table reports the marginal effects and the respective robust standard errors in parentheses. A constant is included. ***, **, and * for the marginal effects indicate that they are significantly different from zero at the 1%, 5%, and 10% confidence level, respectively.

find that a combination of high WTR and low financial literacy increases the probability to include options in the portfolio. It seems that options are mainly perceived as risky portfolio components and not as risk hedging devices. For example, the combination of a riskfree asset and a call option (AC) can generate a capital protected portfolio with upside market participation. This is an interesting combination for risk-averse but return-oriented investors. Nevertheless, we find that subjects choosing AB to have a significantly higher risk aversion and financial literacy than those who select AC.[15] It suggests that even well informed private investors with above average financial knowledge lack understanding of basic financial engineering, an insight which is not captured by the financial literacy quiz score. The last regression includes control variables for actual investment experience. Participants chose security combinations that are highly correlated to their actual portfolio setup. This signals serious and truthful consideration of the experimental survey. The effect of financial literacy is slightly mitigated upon including investment experience, an indicator that financial knowledge is related to learning-by-doing.

A.5 Robustness Tests: Tables

A.5.1 Saturated OLS Models

In the following tables we present saturated OLS models for the analysis of inferior portfolio selection (Table A.7) and initial portfolio selection by return level (Table A.8). These model specifications include a full set of interactions between the order treatment indicator variables CB2 and CB3 (CB1 being the reference group) and all other control variables in the regressions specification.

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who include all three security types in their portfolio (ABC) seem to strive for diversification across asset classes which is in line with their high financial literacy score.

[15] The difference on the 10-point scale for risk aversion is 1.000 (0.151) with $t(1417)=6.579$. Subjects choosing AB, answer on average 0.253 (SE=0.010, $t(1417)=2.541$) more quiz questions correctly compared to subjects selecting the combination AC.

Table A.7: Inferior Portfolio Selection (PC2 and PC3): Saturated OLS Models

	PC2	PC3
	(1)	(2)
D_{final}	0.058***	0.046***
	(0.016)	(0.013)
D_{inf2}		0.169***
		(0.019)
spec. risk	0.002	0.003
	(0.005)	(0.004)
fin.lit. quiz	-0.030***	-0.008
	(0.007)	(0.006)
fin.lit. self	-0.002	-0.011
	(0.009)	(0.007)
13% return	0.054**	-0.043**
	(0.022)	(0.018)
22% return	0.100***	-0.140***
	(0.036)	(0.028)
30% return	-0.036	-0.219***
	(0.035)	(0.031)
Return Increase	-0.137***	0.200***
	(0.026)	(0.024)
Return Decrease	0.036	0.279***
	(0.039)	(0.018)
CB2*D_{final}	0.011	0.036
	(0.060)	(0.057)
CB3*D_{final}	0.019	0.005
	(0.036)	(0.030)

Control Variables (df): Wald-Statistic χ^2

	PC2	PC3
Ind. Charac.	15.89(4)***	5.18(4)***
HH income	2.90(4)**	0.68(4)
Investments	5.76(3)***	1.22(3)
Education		1.97(3)
CB2/CB3	1.75(2)	0.23(1)
CB2 int.	2.05(19)***	2.46(22)***
CB3 int.	1.62(19)**	1.89(23)***

Regression Statistics

	PC2	PC3
N	2908	2908
(Pseudo) R^2	0.107	0.221

Notes: These are the regressions with the saturated model specification. The notes of the main Table 2.4 apply accordingly. The control variable sets "CB2 interacted" and "CB3 interacted" contain all interaction variables between the choice blocks and the other control variables included in the model specification.

Table A.8: First Portfolio Choice (PC1): Saturated OLS Models by Return

	3%		13%		22%		30%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regression Coefficients								
D_{final}	-0.075***	-0.093***	0.071***	0.060***	0.000	0.033***	0.045*	0.081
	(0.016)	(0.021)	(0.018)	(0.021)	(0.012)	(0.009)	(0.024)	(0.061)
CB2		-0.525***		0.297		0.412*		
		(0.177)		(0.243)		(0.215)		
CB3		-0.659***		0.299*		0.353**		0.191
		(0.119)		(0.168)		(0.152)		(0.232)
CB2*D_{final}		0.152***		-0.139*		-0.093		
		(0.058)		(0.074)		(0.069)		
CB3*D_{final}		0.016		-0.002		-0.051		-0.044
		(0.030)		(0.044)		(0.040)		(0.066)
Control Variables (df): Wald-Statistic χ^2								
Individ	2.71(5)**	2.43(5)**	1.32(5)	2.01(5)*	2.75(5)**	1.05(5)	1.63(5)	2.36(5)**
Education	0.71(2)	0.77(2)	3.56(2)**	1.36(2)	1.83(2)	0.87(2)	3.06(2)**	1.40(2)
Inv. Exp.	0.66(3)	1.16(3)	3.18(3)**	0.49(3)	3.79(3)***	1.91(3)	0.59(3)	0.50(3)
CB2 int.		5.31(14)***		11.87(14)***		0.99(14)		
CB3 int.		9.11(14)***		10.48(14)***		0.80(14)		1.51(14)
Regression Statistics								
N	2908	2908	2908	2908	2908	2908	828	828
Pseudo R^2	0.209	0.278	0.039	0.124	0.085	0.204	0.084	0.126

Notes: The dependent variables are indicator variables where 1 stands for the selection of the respective return (risk) level. Subjects in the order treatment group CB1 do not have a portfolio offering 30% return and therefore regressions (7) and (8) contain only the observations from CB2 and CB3. The reference group for the regressions (1)–(6) is CB1 and for (7)–(8) CB2. The joint test for D_{final}+CB2*D_{final} in column (2) yields a coefficient of 0.059 (0.054) and in column (3) the respective numbers are -0.079 (0.070). Individual control variables include spec. risk, fin.lit. quiz, fin.lit. self, time_PC1, age, sex, single, married, and finance. Education controls are abi/prof. and academic. Investor experience variables are invsafe, invstock, and invderivative. The control variable sets "CB2 interacted" and "CB3 interacted" contain all interaction variables between the choice blocks and the other control variables included in the model specification. A constant is included. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

A.5.2 Descriptive and Regression Results by Choice Blocks

Furthermore, we run the analysis separate for each choice block to investigate whether the framing effect changes or even reverses between the order treatment groups. It is important to note that the group size can influence regression fit because small sample analysis suffers more from noisy data.

Table A.9: Inferior Portfolio Selection (PC2): Probit Regressions by Order Treatment

	CB1		CB2		CB3	
D_{final}	0.054***	0.053***	0.089*	0.093*	0.100***	0.085***
	(0.015)	(0.015)	(0.055)	(0.050)	(0.033)	(0.033)
Control Variables (df): Wald-Statistic χ^2						
Ind. Char.	51.50(7)***	53.41(7)***	16.92(7)**	15.21(7)**	12.17(7)*	14.35(7)**
Education	7.21(3)*	6.80(3)*	8.00(3)**	8.93(3)**	1.80(3)	1.76(3)
Occupation	2.19(6)	2.41(6)	7.96(6)	8.29(6)	17.79(6)***	19.34(6)***
HH income	9.35(4)*	9.63(4)**	1.78(4)	2.79(4)	7.79(4)*	8.57(4)*
Investments	14.25(3)***	12.72(3)***	4.34(3)	4.31(3)	1.81(3)	1.67(3)
Return Level	3.81(2)	16.99(2)***	4.20(3)	3.47(3)	9.29(3)**	6.10(3)
Return Change		44.54(2)***		19.00(2)***		19.77(2)***
Regression Statistics						
N	2080	2080	174	174	654	654
Pseudo R^2	0.099	0.126	0.215	0.316	0.112	0.143

Notes: The dependent variable is the indicator variable D_{inf2} and the table reports the marginal effects and the respective standard errors in parentheses. The sets of control variables resemble the ones used for the main analysis, see Notes of Table 2.4 except the interaction variables. A constant is included. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

Table A.10: Inferior Portfolio Selection (PC3): Probit Regressions by Order Treatment

	CB1		CB2		CB3	
D_{final}	0.059***	0.051***	0.073	0.049	0.044	0.021
	(0.013)	(0.013)	(0.057)	(0.052)	(0.029)	(0.028)
D_{inf2}		0.128***		0.217***		0.210***
		(0.024)		(0.096)		(0.045)
Control Variables (df): Wald-Statistic χ^2						
Ind. Char.	46.16(7)***	28.77(7)***	16.51(7)**	17.32(7)**	10.81(7)	6.93(7)
Education	5.92(3)	5.91(3)	0.11(3)	0.86(3)	2.54(3)	3.85(3)
HH income	3.51(4)	2.54(4)	5.90(4)	6.38(4)*	0.54(4)	0.70(4)
Investments	2.63(3)	2.53(3)	7.44(3)*	10.03(3)**	0.69(3)	0.34(3)
Return Level	11.82(2)***	11.73(2)***	0.68(3)	1.11(3)	13.00(3)***	17.02(3)***
Return Change	0.03(1)	0.04(1)	0.20(1)	0.33(1)	3.48(1)*	3.14(2)*
Regression Statistics						
N	2080	2080	169	169	654	654
Pseudo R^2	0.072	0.104	0.184	0.235	0.050	0.104

Notes: The dependent variable is the indicator variable D_{inf3} and the table reports the marginal effects and the respective standard errors in parentheses. The sets of control variables resemble the ones used for the main analysis, see Notes of Table 2.4 except the interaction variables. A constant is included. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively. In CB2: edu_ka and hhek_250 predict failure perfectly such that 5 observations are dropped.

Table A.11: First Portfolio Choice (PC1): Ordered Probit by CB

	CB1	CB2	CB3
Regression Coefficient			
D_{final}	0.292***	0.047	0.204**
	(0.054)	(0.187)	(0.087)
spec. risk	0.293***	0.341***	0.192***
	(0.017)	(0.051)	(0.029)
fin.lit. quiz	-0.000	-0.011	0.005
	(0.027)	(0.070)	(0.039)
fin.lit. self	-0.035	-0.143*	-0.098**
	(0.035)	(0.085)	(0.050)
Marginal Effects for D_{final} by Return			
3%	-0.116	-0.008	-0.029
	(0.021)	(0.031)	(0.013)
13%	0.097	-0.011	-0.052
	(0.018)	(0.043)	(0.022)
22%	0.019	0.007	0.046
	(0.004)	(0.027)	(0.020)
30%		0.012	0.035
		(0.047)	(0.016)
Control Variables (df): Wald-Statistic χ^2			
Individ	13.40(6)**	14.10(6)**	10.54(6)
Education	1.79(3)	1.30(3)	7.98(3)**
Inv. Exp.	6.15(3)	0.55(3)	3.53(3)
Regression Statistics			
N	2080	174	654
Pseudo R^2	0.120	0.136	0.053

Notes: The dependent variable e1_h is ordinal scaled with the parameter values 3%, 13%, 22%, and 30%. The regression are run separately by order treatment groups. CB1 does not contain a portfolio with a 30% return level. The table reports the regression coefficients for selected variables and the marginal effects for the framing treatment. The respective robust standard errors in parentheses. A constant is included. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

Table A.12: Regression Analysis For Keeping or Changing Risk-Return Level by CB

	CB1		CB2		CB3	
	marg. eff.	N	marg. eff.	N	marg. eff.	N
	(SE)	[Pseudo R^2]	(SE)	[Pseudo R^2]	(SE)	[Pseudo R^2]
Panel A: Constant Return Level						
PC1/PC2	-0.019	2020	0.035	174	0.157***	654
	(0.021)	[0.033]	(0.074)	[0.072]	(0.038)	[0.040]
PC2/PC3	-0.019	2020	0.108	174	0.141***	654
	(0.025)	[0.240]	(0.069)	[0.135]	(0.038)	[0.040]
Panel B: Decreasing Return Level						
PC1/PC2	-0.063***	1025	-0.137*	149	-0.135***	593
	(0.020)	[0.066]	(0.079)	[0.112]	(0.031)	[0.134]
PC2/PC3	-0.125***	1177	-0.404***	135	-0.231***	574
	(0.032)	[0.165]	(0.101)	[0.206]	(0.042)	[0.123]
Panel C: Increasing Return Level						
PC1/PC2	0.051**	1952	0.067***	135	-0.027	580
	(0.021)	[0.029]	(0.031)	[0.368]	(0.034)	[0.085]
PC2/PC3	0.079***	2020	0.195**	142	0.046	555
	(0.021)	[0.081]	(0.095)	[0.125]	(0.045)	[0.102]

Notes: Every marginal effect represents one probit regression. Control variables included in all regressions: spec. risk, fin.lit. quiz, fin.lit. self, age, sex, married, time_PC1, time_PC2/3m, return level controls (PC1/PC2 return level of the first decision, PC2/PC3 return level of the second decision), investor experience controls. The number of observations for decreasing (increasing) return level regressions is reduced, because subjects choosing the lowest (highest) return level in the previous decision are excluded from the sample (failure predicted perfectly). Subjects who choose the 30% return level in CB1 are excluded from the sample. A constant is included. ***, **, and * indicate significance at the 1%, 5%, and 10% confidence level, respectively.

B Appendix: Incorporation Law and Entry

B.1 German Corporate Law: History and Regulation

This appendix section aims at a more detailed overview over the foundation requirements necessary for a limited liability company. Furthermore, the implementation of West German law to the East German territory in the process of unification is documented. The following table lists the most frequently used abbreviations used in the literature and this appendix. The major references for this appendix section are Rowedder et al. (1990), Horn (1991), and Köhler & Streich (1990).

B.1.1 History of the Limited Liability Company Law - GmbHG

The GmbHG was established by the parliament of the German Reich in the year 1892 (RGBl. page 477). It introduced the 'Gesellschaft mit begrenzter Haftung' (GmbH) as a legal form that allowed small and medium sized entrepreneurs to work under limited liability by combining characteristics of non-incorporated firms and stock companies.

East Germany

In East Germany, the GmbHG played only a minor role. After World War II, the version of May 8, 1945 remained in place and was not altered thereafter. The number of privately owned companies was limited in the socialist planning system and thus the number of firms using the legal form of a GmbH was negligible. For state companies, the legal form of a GmbH was scarcely used, mainly for foreign trade companies. The valid version of the GmbHG in East Germany before unification can be found in Köhler & Streich (1990).

West Germany

In West Germany, the GmbhG underwent only minor changes after the separation of the country, until a major amendment was passed in July 1980. Amongst others, this amendment increased the minimum equity requirement from DM20,000 to DM50,000. The

Abbreviation	Complete German Term and English Translation/Meaning
BRD	Bundesrepublik Deutschland
	Federal Republic of Germany (FRG)
	The abbr. "BRD" was mainly used during the separation of Germany
	to refer to the West German part
DDR	Deutsche Demokratische Republik
	German Democratic Republic (GDR)
D	Deutschland
	Germany (GER)
	After reunification the abbreviation "D" is used for whole Germany
GmbHG	Gesetz betreffend die Gesellschaften mit beschränkter Haftung
	Limited Liability Company Law
HGB	Handelsgesetzbuch
	German Commercial Code
BGB	Bürgerliches Gessetzbuch
	German Civil Code
RGBl.	Reichsgesetzblatt
	National Law Gazette of the German Reich
	Publication instrument for laws passed by the German Parliament
	between 1871 and 1945 needed to be published here
BGBl.	Bundesgesetzblatt
	Federal Law Gazette of the BRD and D
	Publication instrument for laws passed by the BRD and German
government	between 1949 and 1990 & 1990 until today need to be
	published here
GBl.	Gesetzblatt
	Federal Law Gazette of the DDR
	Publication instrument for laws passed by the DDR government
	between 1949 and 1990 needed to be published here

1980 version of the GmbHG was, with the exception of minor changes, still in place at the time of the German unification and the one we are referring to.[1]

In general, the HGB and the BGB apply for limited liability companies: A GmbH fulfills by definition the requirements for a trading company (§6 HGB) and the BGB rules concerning contracting etc. are part of the civil code. The GmbHG is a "lex specialis" that is superordinated to the more general HBG and BGB for the special belongings of a limited liability company. It rules all legal affairs that are not covered by the general laws or overrules them if it has more specific passages. Nevertheless, the BGB as well the as the HGB contain laws especially for limited liability companies what can lead to ambiguous dependencies (Rowedder et al. 1990).

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[1]The last changes after the amendment of 1980 (BGBl. I S. 836) were the changes in §52 to facilitate firm merger (1982, BGBl. I S. 1425), §29, §33, §40-42a, §52, §71, §79, §82 in 1985 concerning accounting rules (BGBl. I S. 2355) and §64 in 1986 to prevent business crime (BGBl. I S. 721). We are referring to the GmbHG as of 1990 because this was the version during the observation period 7/1990 - 12/1990 covered by the data.

The GmbHG defines the limited liability as (Rowedder et al. 1990)

- a trading company (§13, para. 3) that can be established for all legal purposes (§1),

- with a juristic personality (corporation) (§13, para. 1),

- that is registered in the trade register (§11),

- and whose members hold shares of the (minimum) equity (§3) but are not personally liable for the company's outstanding debt (§13, para. 2).

B.1.2 German Unification

In the process of the German unification, several laws and treaties were passed by the East and West German government. The most important ones for the the present study are sketched in the following.

- DDR, March 7, 1990: Gesetz über die Gründung und Tätigkeit privater Unternehmen und über Unternehmensbeteiligungen (UnternehmensG, GBl. I S. 141, effective March 16, 1990; also in Köhler & Streich (1990))

  It is a law about firm formation in the private economy and firm participation. The aim was the stimulation of entrepreneurship and the development of the private economy by encouraging the formation especially of small and medium sized enterprises in East Germany. It stresses the application of the GmbHG for foundations of limited liability companies (which was still in the version of 1945 in East Germany).

- DDR and BRD, May 18, 1990: Vertrag über die Schaffung einer Währungs-, Wirtschafts- und Sozialunion (BGBl. 1990 II S. 518, GBl. 1990 I S. 331)

  This is the Treaty to establish a Monetary, Economic and Social Union. With this treaty, both German states agree amongst other points to the introduction of the West German Deutsch Mark (DM) for the entire German territory (chapter II, appendix I), and the application of most West German law codes to the East German territory, amongst them the GmbHG, the HGB and the BGB which are essential for limited liability companies (chapter III, appendices II-IV). Appendix I contains the regulation about the monetary union and currency changeover in East Germany: Private persons have a personal allowance to change East German Mark for West German Mark 1:1 depending on their age, the remaining wealth is converted 2:1; juristic persons have to change corporate wealth at the rate 2:1. Following the treaty, several laws were passed to transfer the content of the appendices II-IV to the legal systems.

- DDR, June 21, 1990: Gesetz über die Inkrafttretung von Rechtsvorschriften der BRD in der DDR (GBl. I S. 357, effective July 1, 1990)

  Law to implement the agreement of the treaty about the implementation of West German law in East Germany.

- DDR, July 6, 1990: Gesetz über die Änderung des Gesetzes vom 21. Juni 1990 über die Inkraftsetzung von Rechtsvorschriften der Bundesrepublik Deutschland in der Deutschen Demokratischen Republik (GBl. I S. 713, effective July 1, 1990 until June 31, 1992)

  This law makes an exception of GmbHG in the East German territory: The minimum equity requirement of DM50,000 in the West German territory was lowered to DM20,000 for the East German territory over a two-year period. In our context, this is interesting because it suggests a political awareness of the DM50,000 requirement as an entry barrier, which was probably set down to stimulate entry. Furthermore, it enfeebles the argument of lower East German private wealth leading to less limited liability entrants. Finally, this adjustment of the GmbHG provides us with a natural experiment within natural experiment.

B.1.3 Regulation of Firm Incorporation

Only the first section of the GmbHG (§1 - §12) is of interest for the investigation of legal requirements as entry regulation for corporate firms. This section is concerned with the establishment of a corporate company. Depending on the choice of the alternative full liability legal form, certain entry costs may also apply to other legal forms (e.g. sole proprietorships also have to register in the trade register). Nevertheless, non-corporate firm do not have to fulfill the entire set of requirements described below. Especially the deposit of a minimum equity (§5) is unique for limited liability companies and aims at the protection of future claimants. Regulatory entry costs are caused by:

- §2 & §3: Foundation contract

  A written form document as a foundation contract is necessary (the minimum content is fixed by law, additional paragraphs can be included to suit the need of the partners), which requires a notary form. Signatures of all members are necessary, a signature by an authorized person is only with notarial or otherwise authenticated mandate possible.

- §4: Name of the company

  The name of the company is part of the foundation contract. The chosen name needs

the approval of the registering court to ensure regional uniqueness of the name. This process takes time and is not free of charge.

- §5: Minimum equity requirement

  A minimum equity of DM50,000 and a minimum share per partner of DM500 is required. Partners can contribute different amounts to the equity, the precise distribution must be reported in the foundation contract. Cash and non-cash (in kind) contributions are possible. In case of assets a "Sachgründungsbericht" (fairness report on the formation using contributions in kind) needs to verify the value of the contribution. An in-kind contribution needs to be explained in the foundation contract. For in-kind contributions §9 is applied if the documented value is not reached until the registration day (the gap needs to be closed by money contribution).

- §6: Managing director

  The members of the GmbH need to appoint one or several managing directors. It can be one of them or an external manager (para. 3). It has to be a natural person with full legal capacity (para. 2).

- §7: Application for Trade Registration

  An application needs to be handed in in person by the managing director(s) at the county's court and requires a public notarization. At the time of application for registration, at least a quarter of each partner's pecuniary contribution to the minimum equity has to be at the disposal of the managing director. All in-kind contributions must be made before a firm can apply for registration. Overall, a minimum of DM25,000 is required at the application for registration date. In case of a single-member foundation, the founder additionally has to provide an assurance for the outstanding amount of minimum equity.

- §8: Content of the application

  The content of the application is dictated as follows (para. 1): foundation contract, legitimization of the managing director, list of members' names, addresses, and equity share, "Sachgründungsbericht", verification of the value of in-kind contributions, legal authorization of the state ("Genehmigungsurkunde") in case of business that is subject to state approval. Furthermore, an affirmation of equity deposits, the managing director's full legal capacity and a substitution rule for the managing director need to be verified and an authorized signature sample of all managing directors has to be handed in.

- §10: Registration in the trade register and publication

  The registration needs to be published in the "Bundesanzeiger" and at least one other paper which causes publication costs.

In addition to the complexity of the entry process described above, further questions concerning taxation need to be clarified by the entrepreneurs. Most founders consult a lawyer and/or a tax advisor what causes additional costs.

B.2 Motivation of the Hypotheses: Cournot Model

The hypotheses stated in section 3.3 are derived using the Cournot model of oligopolistic markets. This part of the appendix explains the theoretical background of the hypotheses more in detail. The references are standard text books, e.g. Shapiro (1989) or Wolfstetter (2002).

Model Setup

- Symmetric firms compete in quantity to maximize profits

- Homogenous good

- Demand function: $P(q) = a - bq$
  with $q = \sum q_i = q_{-i} + q_i \ \forall i...n, b > 0$

- Cost function: $C_i(q_i) = c_i q_i + R + K$
  with $c_i q_i$ as variable costs, c_i as marginal cost ($c_i \ \forall i...n, c_i \geq 0, a > c_i$), $R \geq 0$ as regulatory entry costs, $K \geq 0$ as other entry costs or barriers to entry

Profit Maximization of Firm $i \Rightarrow q_i^*$

Profit function:

$\Pi_i = P(q)q_i - C_i(q_i)$

$\Pi_i = (a - bq)q_i - c_i q_i - R - K$

$\Pi_i = (a - bq_{-i} - bq_i - c_i)q_i - R - K$

Profit maximization with respect to output:

$$\frac{\partial \Pi_i}{\partial q_i} = a - bq_{-i} - 2bq_i - c_i \overset{!}{=} 0$$

$$q_i^* = \frac{a - c_i - bq_{-i}}{2b}$$

Symmetry of firms:

$$q = nq_i = q_{-i} + q_i = (n-1)q_i + q_i$$

$$q_i^* = \frac{a - c_i - b(n-1)q_i^*}{2b}$$

$$q_i^* = \frac{a - c_i}{b(n+1)}$$

Total Output q^* and Price $P(q^*)$

$$q^* = nq_i^* = \left(\frac{n}{n+1}\right)\left(\frac{a - c_i}{b}\right)$$

$$P(q^*) = a - bq^* = a - b\left(\frac{n}{n+1}\right)\left(\frac{a - c_i}{b}\right) = \frac{a + c_i n}{n+1}$$

Profit of Firm i given $P(q^*)$ and q^*

$$\Pi_i(P(q^*), q_i^*, n) = P(q^*)q_i^* - C_i(q_i^*) = \Pi_i^*(n)$$

$$\Pi_i^*(n) = \left(\frac{a + c_i n}{n+1}\right)\left(\frac{a - c_i}{b(n+1)}\right) - c_i\left(\frac{a - c_i}{b(n+1)}\right) - R - K$$

In order to enter profitably, $\Pi_i^*(n) \geq 0$ has to hold. We can rewrite this condition as a function $N(c_i, R, K)$ such that N fulfills the zero-profit condition. N is the number of firms that is sustainable in equilibrium such that $\Pi_i^*(n) \geq 0$ holds and it depends on c_i, R, K.

Equilibrium Number of Firms $N(c_i, R, K)$

$$\Pi_i^*(n) = \left(\frac{a + c_i n}{n+1} - c_i\right)\left(\frac{a - c_i}{b(n+1)}\right) - R - K \overset{!}{\geq} 0$$

This can be written as an 'inverse strict zero-profit function in N'.

$$R + K = \left(\frac{a + c_i n - c_i n - c_i}{n+1}\right)\left(\frac{a - c_i}{n+1}\right)\left(\frac{1}{b}\right)$$

$$b(R + K) = \left(\frac{a - c_i}{n+1}\right)^2$$

$$n + 1 = \left(\frac{a - c_i}{\sqrt{b(R + K)}}\right)$$

$$\Rightarrow N(c_i, R, K) = \frac{a - c_i}{b^{0.5}(R + K)^{0.5}} - 1$$

Entry Hypothesis: Derivatives with Respect to R and K

$$N(c_i, R, K) = (a - c_i)b^{-0.5}(R + K)^{-0.5} - 1$$

$$\frac{\partial N}{\partial R} = \frac{\partial N}{\partial K} = (a - c_i)(b^{-0.5})(-0.5)(R + K)^{-1.5} < 0$$

$$\frac{\partial^2 N}{\partial R \partial K} = (a - c_i)(b^{-0.5})(-0.5)(-1.5)(R + K)^{-2.5} > 0$$

As the regulatory cost R increases, the equilibrium number of firms decreases ($\partial N/\partial R < 0$), but this negative effect is mitigated with higher levels of K ($\partial^2 N/\partial R \partial K > 0$). At the time of German unification, the West German economy is in a more competitive state than the transitory East German economy, i.e. entry barriers are lower in East Germany. In other words, the negative effect of entry regulation is less pronounced in the West German territory compared to the East German territory because less potential limited liability firms exist at all.

Size Hypothesis: Derivatives of the Average Output with Respect to R and K

Under the assumption that firm size correlates positively with firm output, we derive the average output as a function in R and K.

$$\left(\frac{q^*}{N}\right) = \left(\frac{N}{N + 1}\right)\left(\frac{a - c_i}{b}\right)\left(\frac{1}{N}\right) = \left(\frac{a - c_i}{(N + 1)b}\right) \equiv x$$

$$x = \frac{a - c_i}{b}\left[\frac{a - c_i}{b^{0.5}(R + K)^{0.5}} - 1 + 1\right]^{-1}$$

$$x = \frac{b^{0.5}(R + K)^{0.5}}{b} = \left(\frac{R + K}{b}\right)^{0.5}$$

$$\frac{\partial x}{\partial R} = 0.5\left(\frac{R + K}{b}\right)^{-0.5}\frac{1}{b} > 0$$

$$\frac{\partial^2 x}{\partial R \partial K} = -0.25\frac{1}{b^2}\left(\frac{R + K}{b}\right)^{-1.5} < 0$$

This result can be interpreted as follows: The average output per firm increases under regulation ($\partial x/\partial R > 0$), but this positive effect is mitigated in low-entry markets (high entry barriers K; $\partial^2 x/\partial R \partial K < 0$). Therefore, we expect that corporate firms enter larger than non-corporate firms, but this effect should be more pronounced in the high-entry East German territory compared to the West German territory.

B.3 Variable Descriptions and Data Restrictions

Table B.1: Variable Description for all Variables used in the Regressions and Text

Variable	Definition
Outcome Variables	
E_{cr}	Number of firms by county c and liability status r (frequency weights applied)
EPC_{cr}	Number of firms by county c and liability status r (frequency weights applied) divided by the county's working-age population (18-65 years) in 1,000
EPC_{cri}	Number of firms per 1,000 inhabitants of age 18-65 by c, r, and 1-digit industry i (frequency weights applied)
EPC_{crt}	Number of firms per 1,000 inhabitants of age 18-65 by c, r, and half-year entry cohort t (frequency weights applied)
Size	Number of employees in full-time equivalents at the moment of market entry including the owner-manager
DFL	D: 1 Firm exit due to insolvency between firm entry and 31/12/1999 (end of observation period)
I_{cr}	Insolvency rate: Number of firms that exit due to insolvency per county c, regulatory status r (frequency weights applied) divided by the number of entrants E_{cr}
I_{cri}	Insolvency rate: Number of firms that exit due to insolvency by c, r and 1-digit industry i (frequency weights applied) divided by the number of entrants E_{cri}
I_{crt}	Insolvency rate: Number of firms that exit due to insolvency by c, r and half-year entry cohort t (frequency weights applied) divided by the number of entrants E_{crt}
Base Variables	
D_e	D: 1 Firm is founded in Eastern part of Germany (territory of former DDR)
D_r	D: 1 Firm enters with limited liability, complying with CLR
D_{re}	D: 1 Firm enters in East Germany with limited liability ($D_r * D_e$)
Owner/Firm Characteristics	
Age	Age of the managing/owning person at market entry
Sex	D: 1 Managing/owning person is female
Edu_no	D: 1 No educational information given
Edu_low	D: 1 Low education
Edu_app	D: 1 Apprenticeship education
Edu_mc	D: 1 Master craftsman's degree
Edu_bus	D: 1 Academic degree in Business Administration
Edu_ing	D: 1 Academic degree in Engineering
Edu_oth	D: 1 Other type of academic degree
Franchise	D: 1 Firm enters as a franchisee
Team	D: 1 More than one managing owner/founder in the firm
1-Digit Industries and Entry Cohorts	
Manufacturing	D: 1 Manufacturing industry (contains ten 2-digit industries)
Construction	D: 1 Construction industry (contains two 2-digit industries)
Trade	D: 1 Trading industry (contains four 2-digit industries)
News&Transport	D: 1 Transportation and shipping industry, communication (contains two 2-digit industries)
Services	D: 1 Service industry (contains nine 2-digit industries)
Cohort 90	D: 1 Entry year 1990 (only 01/06-31/12/1990, one half-year entry cohort)
Cohort 91	D: 1 Entry year 1991 (two half-year entry cohorts)
Cohort 92	D: 1 Entry year 1992 (two half-year entry cohorts)
Cohort 93	D: 1 Entry year 1993 (two half-year entry cohorts)
County Characteristics & Federal States	
Area	Size of county area in km^2 in 1992
Inhabitants 18-65	Number of inhabitants of age 18-65 in 1,000 per county in 1992 (working-age population)
Unemployment	Percentage of unemployed inhabitants per county in 9/1993

Continued on next page ...

Variable	Definition
Border East	D: 1 County in East Germany first or second layer to innergerman border
Border West	D: 1 County in West Germany first or second layer to innergerman border
Dblsh	D: 1 Schleswig-Holstein (West)
Dblhhbns	D: 1 Hamburg, Bremen, Lower-Saxony (West)
Dblrhpsl	D: 1 Rhineland-Palatinate, Saarland (West)
Dblbw	D: 1 Baden-Württemberg (West)
Dblby	D: 1 Bavaria (West)
Dblhs	D: 1 Hesse (West)
Dbls	D: 1 Saxony (East)
Dblbb	D: 1 Brandenburg (East)
Dblth	D: 1 Thuringia (East)
Dblmv	D: 1 Mecklenburg-Western Pomerania (East)
Dblsa	D: 1 Saxony-Anhalt (East)

Notes: "D" stands for dummy variable. Human capital and other manager characteristics are given for the managing person holding the highest ownership share (in case of ties or team management: oldest managing person). The precise definitions of the 2-digit industries are available upon request.

Table B.2: Sample Construction Leading to Main Sample

		Exclusions	Firms
Size of the stratified random sample:			**22,000**
Exclusion of firms...			
...	with missing location information	4288	
...	that are affiliated to other firms	3552	
...	that entered between Jan 01, 1990 and June 30, 1990	1648	
...	with location in Berlin East or West	672	
...	with more than 30 employees or stock companies (AG)	227	
...	with invalid industry code of main occupation	95	
		10482	
Size of sample incl. firms with missing owner information			**11,518**
...	with missing owner information	1423	
		1423	
Size of sample excl. firms with missing owner information			**10,095**

Notes: This table shows the data restrictions applied to the main dataset. Alternative specifications are tested for robustness. The order of exclusion restrictions are listed as they were applied to the original sample. The sample including firms with missing owner characteristics will be used if data is aggregated to county level (firm level information gets lost in that case anyways), regressions based on firm level data use the sample excluding firms with missing owner information.

The main exclusion criteria are motivated as follows: First, firms with missing location information are excluded because this is central to the identification approach. Second, only independent startups remain in the dataset. Observations that are subsidiaries, part of a consolidated company, continue under new management after a takeover, or that have other firm affiliations are dropped. By keeping only "de novo" firms we focus on the impact of CLR on new entrants that act legally independent from other firms. Third, firms entering before the introduction of a common currency and the adoption of the most important laws in the Eastern territory on July 1, 1990 are dropped from the sample (see Section 3.2). Fourth, startups from Berlin are eliminated. The identification strategy relies on comparing East and West Germany but the special political history with the city's post-war separation potentially blurs identification. Berlin always had a special status due to its segmentation by the Allies after World War II and its separation by the Berlin Wall in 1961. West Berlin was basically a Western island in the East German territory and highly subsidized by the BRD. Redding & Sturm (2008) exclude Berlin for the same reasons as we do. Fifth, firms entering with more than 30 employees are excluded. This restriction avoids that in East Germany trust administrated firms remain in the sample. The main interest focuses on regulation effects on small entrants because large startups usually have different financing restrictions and firm setups. Oviedo (2004) provides empirical evidence that small firms benefit relatively more from deregulation what in turn suggests that they suffer relatively more from regulation. Finally, firms with wrong industry information are eliminated.

B.4 Descriptive Statistics at County and Firm Level

Table B.3: County level: Descriptive Statistics

| | Germany | West | East | MCT | |
	mean	mean	mean	West-East	p-value
# of counties	541	326	215		
E_c total	236.80	239.21	233.15	6.07	0.77
EPC_{cr}	3.32	1.83	5.56	-3.73	0.00
Area (1992, in km^2)	658.04	760.96	501.99	258.97	0.00
Inhabit. 18-65 (1992, in 1000)	93.70	127.27	42.80	84.47	0.00
Wage (1993, in 1000)	3.93	4.78	2.64	2.15	0.00
Unemploym. (9/1993, in %)	11.52	7.91	16.99	-9.08	0.00

Notes: Mean Comparison Test (MCT) H0: Mean(West)-Mean(East)=0. E_c: number of entries per county c.

Table B.4: Firm level: Descriptive Statistics

| | West | | | East | | | MCT | |
| | all | full | lim | all | full | lim | Diff all | p-value |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm Characteristics								
Manufact.	0.12	0.09	0.16	0.11	0.08	0.17	0.01	0.17
Construct.	0.13	0.12	0.13	0.19	0.15	0.30	-0.07	0.00
Trade	0.39	0.41	0.35	0.43	0.47	0.30	-0.04	0.00
News & Transp.	0.06	0.07	0.05	0.07	0.08	0.05	-0.01	0.16
Services	0.31	0.31	0.31	0.20	0.21	0.17	0.11	0.00
Cohort 1990	0.17	0.16	0.17	0.15	0.15	0.16	0.01	0.06
Cohort 1991	0.28	0.26	0.31	0.29	0.29	0.30	-0.01	0.15
Cohort 1992	0.23	0.22	0.24	0.26	0.26	0.29	-0.04	0.00
Cohort 1993	0.33	0.35	0.28	0.29	0.31	0.25	0.04	0.00
Team	0.23	0.15	0.38	0.23	0.14	0.49	-0.00	0.74
N	6,175	3,637	2,538	5,343	3,740	1,603		
Owner Characteristics								
Age	36.65	35.15	39.57	38.29	37.00	41.93	-1.63	0.00
Sex	0.05	0.01	0.14	0.22	0.26	0.09	-0.16	0.00
Edu: low, app.	0.40	0.36	0.47	0.32	0.33	0.31	0.08	0.00
Edu: master	0.09	0.09	0.09	0.12	0.11	0.15	-0.03	0.00
Edu: acad.	0.09	0.04	0.18	0.17	0.11	0.33	-0.08	0.00
N	5,407	3,232	2,175	4,688	3,297	1,391		

Note: Mean Comparison Test (MCT) H0: Mean(West)-Mean(East)=0. Means of indicator variables represent the % share of the sample population exhibiting the attribute. Cohort 90 covers only the second half year of 1990. Probability weights used for calculation of means and test statistics to take stratification into account. N: unweighted number of sample observations, not all observations provide firm owner information.

B.5 Instrumental Variable Estimation

As pointed out in Section 3.6.3, the independence of firm location and the assignment to the groups of limited and full liability firms is crucial for our difference-in-difference estimation approach. It ensures that the process of entrepreneurial self-selection, which may be influenced by CLR, is the same in both territories and thus cancels out. Nevertheless, one can argue that the assignment to the group of corporate firms is not only non-random, but *endogenously* chosen by the entrepreneur depending on observable and unobservable firm, owner, and location characteristics. This causes problems if the self-selection mechanism leads to systematically different group characteristics. It makes a comparison of corporate and non-corporate firms in East and West invalid because they are not appropriate counterfactuals, e.g. $E[y_c|r=1,e=1] \neq E[y_c|r=1,e=0]$.[2]

The inclusion of the control variables X_z allows to control for observable characteristics. Yet, this only solves the endogeneity problem if self-selection takes place on observable characteristics. Our argumentation in the robustness section was along this line of reasoning. Nevertheless, it is likely to have self-selection based on unobservables, in this case controlling for X_z does not make the trick. An alternative way that circumvents this problem is to estimate the ATT' using instrumental variables.

Setup

From Section 3.4 the following equation is known:

$$Y_{jrez} = \alpha + \gamma D_r + \lambda D_e + \beta D_{re} + \Omega X_z + \epsilon_{jrez} \tag{9a}$$

So far, we have assumed that $E(\epsilon_{jrez}) = 0$ and $Cov(x_z, \epsilon_{jrez}) = 0$ for all z as well as $Cov(D_k, \epsilon_{jrez}) = 0$ for $k \in [r, e, re]$.

If there exist unobservable variables which are related to entrepreneurial self-selection into the group of corporate firms *and* firm location (e.g. economic project risk, capital endowment, owner traits of character depending on socialization...), our regression suffers from endogeneity due to omitted variables.[3] In that case, $Cov(D_e, \epsilon) \neq 0$ (and as a consequence $Cov(D_{re}, \epsilon) \neq 0$) leads to inconsistent OLS estimates of all coefficients.

To solve the endogeneity problem, the instrumental variable (IV) approach employs an instrumental variable i_1 (or a set of instrumental variables) that fulfills two conditions:

---

[2]If the assignment is endogenous and depends on firm location, then the composition of treatment and control group is different in the two territories.

[3]In general, further reasons for endogeneity are measurement errors and the simultaneity bias (Wooldridge 2002). In our context, these sources are of minor relevancy.

First, it must not be correlated with the error term, i.e. $Cov(i_1, \epsilon) = 0$, and second, it is endogenous to D_e. Thus, we need an exogenous variable which is strongly related to D_e and therefore can explain the outcome in equation (9a), and which does *not* depend on unobserved location specific determinants of self-selection.

The condition $Cov(i_1, \epsilon) = 0$ must be maintained, it cannot be tested. One needs good economic argumentation why the chosen instrument is not related to the unobserved factors (omitted variables) that influence D_e and D_{re} and thus cause correlation with ϵ.

The second condition – D_e being a linear projection on all variables and the instrument – can be tested by estimating the following equation:

$$D_e = \delta_0 + \delta_1 x_1 + ... + \delta_{k-1} x_{k-1} + \omega_1 i_1 + r_e \tag{9b}$$

with x_j being the exogenous variables in Equation (9a), $E(r_e) = 0$ and $Cov(x, r_e) = 0$ and $Cov(i, r_e) = 0$. This is the reduced form equation that does not need to be structural or causal (Wooldridge 2002). Obviously, $\omega_1 \neq 0$ has to hold in order to use i_1 as instrument for D_e. Finally, one plugs Equation (9b) into Equation (9a). An estimation of

$$Y_{rez} = \alpha' + \gamma' D_r + \lambda' i_1 + \beta' (i_1 * D_r) + \Omega' X_z + \epsilon'_{rez} \tag{9c}$$

yields coefficient estimates denoted by " $'$ " and solves the identification problem. The equation can be estimated consistently using OLS.

Application

The main challenge is to find a good instrument that fulfills the two aforementioned conditions. Since the second condition can be proved, one crucial factor is to have good arguments why the first condition can be maintained.[4] The set of feasible instrumental variables is usually restricted by data availability. In our analysis, we could for example use the entrepreneur's place of birth as an instrument for firm location. It is exogenous to the firm's outcome but highly correlated with the place of firm foundation as we argued in Section 3.6.3. Unfortunately, this data is not available to us. Nevertheless, the search for a good and available instrument and a subsequent IV estimation could be part of a follow-on investigation.

---

[4] A bad instrument can weaken the analysis by introducing more biases (see Angrist & Pischke (2009) and the literature cited therein).

C Appendix: Entry Regulation and Overconfident Entry

C.1 Instructions

Introduction

Thank you for your participation in the business start-ups experiment. In the experiment, you will be playing for real money, which is provided by the institute "Verein zur Förderung der wissenschaftlichen Aus- und Fortbildung im Bereich der Bank- und Finanzwirtschaft e.V.".

In the course of the experiment, you will decide in several, independent rounds whether you would like to establish a start-up company in a particular market, or not. At the start of each round, participants will be shown the figure C on their screens. "C" indicates the market capacity and will be the same for all participants. To illustrate; a market capacity of C = 3 indicates that three participating players will be **successful** and will make a **profit**. All other participating players will be **unsuccessful** and will make a **loss**.

For taking part, you will be given an **endowment** of **31 units experimental currency (EC)**. The **income** for **successful** participating players depends on the **market capacity (C)** and their **rank** relative to the other players (the allocation of ranks is explained more clearly below). The payouts are depicted in the following table:

Rank	C=2	C=3	C=4	C=5
1	40	30	24	20
2	20	20	18	16
3		10	12	12
4			6	8
5				4

All **unsuccessful** participating players will make a **loss** of **21 EC**. Players who do not participate will make neither a profit nor a loss.

There are two **types of market**. In one market, entry is **free**, whereas in the other, there are **entry costs** of **10 EC**. This amount is only to be paid if you decide to establish a start-up in that particular market.

Example

Assume that you are in a market with entry costs and a market capacity of C = 2. To establish a start-up, you will have to pay out 10 EC from your starting capital of 31 EC to cover the entry costs. If you have the highest rank from all the entrants, you will receive the sum of 40 EC. If this round were drawn, you would therefore realize a total of 61 EC. (31 EC - 10 EC + 40 EC = 61 EC)

The participating player with the second highest rank would win 20 EC and would receive 41 EC in total. (31 EC - 10 EC + 20 EC = 41 EC)

All other participants, who are in rank 3 or worse, would lose 21 EC and realize a total of 0 EC if this round were drawn. (31 EC - 10 EC - 21 EC = 0 EC)

Players who do not participate will neither win nor lose anything.

Allocation of Ranks

Your **rank** will be allocated in relation to other players. There are two types of rank allocation. With **"random allocation"**, the computer will decide your rank using a random number generator. You will therefore be unable to actively influence your rank.

Allocation **"according to skill"** is based on your personal knowledge and abilities. Once the start-up decisions have been taken, you will be asked to complete the following activities:

- Answer 6 'economics' quiz questions

- Answer 6 'general knowledge' quiz questions

- Judge a 2 minute time period (stop when you think that 2 minutes have elapsed)

According to your results in relation to those of other players, you will be allocated a rank for each activity (position 1 for the best, position 2 for the second best etc.). The average score from all activities will decide your overall 'according to skill' rank. The better you complete the activities, the better your rank will be. Consequently, you will have an active influence on whether you will be one of the winners or losers when you establish a company.

Execution of the individual rounds

Once you have been shown figure C for the particular market, you will be asked for two pieces of information for each decision. Firstly, you will be asked to give an estimation of how many of the players in attendance (including yourself) will decide to opt for a start-up in that particular round. For **each** correct estimation, you will receive 0.9 EC. Afterwards, you will be asked for your own decision: click to declare whether you would like to enter the market or not.

Each player will have to make decisions for both types of market (with and without entry costs) and with both types of rank allocation (random and according to skill) and there will be several rounds for each. You will always be informed which type of market and which type of rank allocation is applicable in each round.

Payout

At the end of the experiment, the **computer will randomly choose ONE round** to be played out. The payments from that round will then be settled against your endowment (see 'Example'). Your winnings for all correct market entrants estimations will then be added. Each unit from the experimental currency will be exchanged into € following an **exchange rate of 3:1**. The sum will then be rounded up to the nearest €0.50 (your opening balance of 31 EC is therefore worth €10.50) and will be paid out immediately.

Any questions relating to these experiment instructions should be asked once everyone has finished reading. Throughout the entire experiment, it is forbidden to communicate with one another. Please do not press any keys, or combinations of keys, unless directed in the experiment to do so. You will find the instructions in paper form at your workplace so that you can refer to them throughout the experiment. Additionally, you will receive a schematic representation of the course of the experiment as well as a blank sheet of paper and a pen, so that you can make notes if you require.

C.2 Screen Shots

The experiment was programmed and conducted with the software z-tree (Fischbacher 2007). The following screen shots provide an overview over the information provided on the screens during and between the market entry decisions.
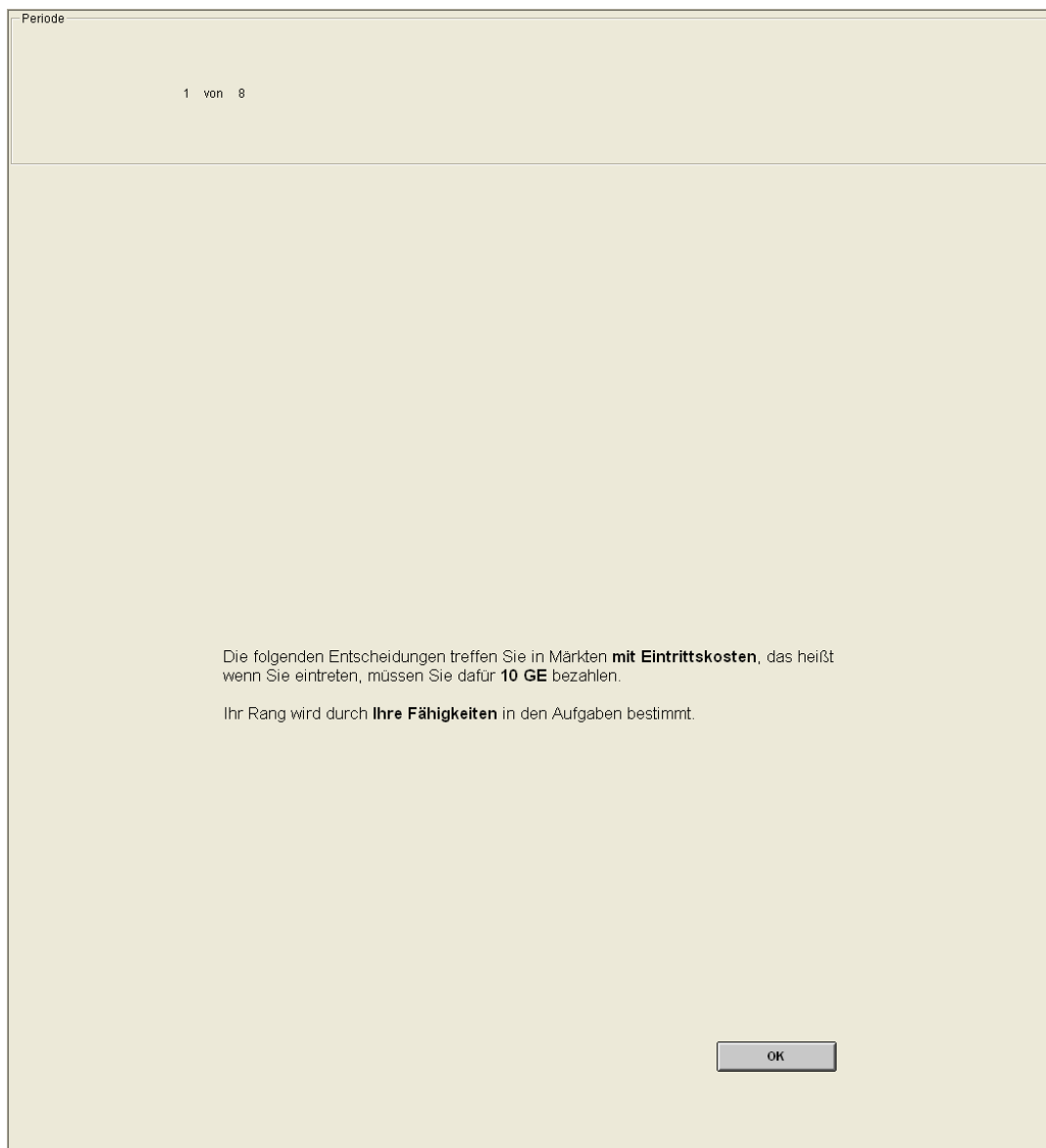
Figure C.1: Description of the Market Setting for the Following Rounds

Figure C.2: Input Screen for Expected Number of Entrants and Own Entry Decision

Periode

8 von 8

Ihre Schätzung der Anzahl der Startups in dieser Runde war   richtig

Periode	Kapazität	Erwartete Anzahl aller Startups	Ihre Entscheidung	Anzahl aller Startups
1	2	2	Eintritt	2
2	4	5	Kein Eintritt	0
3	5	4	Eintritt	2
4	3	2	Eintritt	2
5	2	2	Eintritt	2
6	4	2	Kein Eintritt	0
7	5	2	Eintritt	2
8	3	2	Eintritt	2

OK

Figure C.3: Final Feedback Screen at the End of a Treatment

C.3 Quiz Questions

Subjects had to answer 6 questions in the field of general knowledge and 6 questions in the field of economics, of which we present the English translation in this section. We had a pool of 18 questions for both domains such that the set of questions varied between the experimental sessions. The questions for the general knowledge were chosen from the game "Trivia Pursuit" (German Genus Edition), three from each of the following fields: geography, entertainment, history, art and literature, science and technology, sports and amusement. The Trivia Pursuit questions are open but we change them to multiple choice questions. Therefore, we test knowledge by passive recognition of the correct answer rather than demanding the active recollection of knowledge. We expect that this provides more variation in the number of correctly answered quiz questions which allows a better rank allocation based on quiz results. The tie breaker questions varied between experimental sessions and subjects were encouraged to guess as precise as possible.

C.3.1 General Knowledge

1. What is the capital city of Indonesia?
   Bangkok; Jakarta; Kuala Lumpur; Manila; Phnom Penh; Vientiane

2. Who played the role of James Bond in the film "Never say Never Again"?
   Pierce Brosnan; Sean Connery; Daniel Craig; Timothy Dalton; George Lazenby; Roger Moore

3. What was the name of the largest and strongest ship in the German Navy, that was sunk in WWII?
   Admiral Graf Spee; Bismarck; Gneisenau; Gorch Fock; Hiddensee; Kaiser Friedrich III

4. Who coined the term "categorical imperative"?
   Kant; Macchiavelli; Marx; Nietzsche; Schopenhauer; Socrates

5. How many teats does a cow's udder have?
   2; 3; 4; 5; 6; 7

6. Which Bundesliga football team plays its home matches in the stadium formerly known as the "Volksparkstadion"?
   Borussia Dortmund; FC Bayern München; FC Schalke 04; Hamburger SV; VfB Stuttgart; Werder Bremen

7. Which of these would you see if you took the Broadway as far as 42nd Street?

   Columbus Circle; Empire State Building; Ground Zero; Rockefeller Center; Times Square; Union Square

8. Who said "Denke daran, dass du am jüngsten Tag alle deine Filme vorgeführt bekommst."?

   Charlie Chaplin; Tom Cruise; Cameron Diaz; Arnold Schwarzenegger; Sharon Stone; Kate Winslet

9. What was the name of John F. Kennedy's father?

   David Anthony Kennedy; Fitzgerald Herald Kennedy; John Ernest Kennedy; Joseph Patrick Kennedy; Robert Francis Kennedy; Thomas Martin Kennedy

10. What was the name of the wizard in King Arthur's court?

    Gandalf; Johann Faust; Merlin; Miraculix; Pan Tau; The Wizard of Oz

11. What kind of animal is a linnet?

    finch; rabbit; dog; pony; chimpanzee; spider

12. What is the maximum number of sets that can be played in a men's tennis match?

    2; 3; 4; 5; 6; 7

13. Which animal appears on the Berlin coat of arms?

    eagle; bear; griffin; lion; horse; bull

14. What was the name of the slightly sappy detective played by Peter Falk?

    Columbo; Inspector Wallander; Lieutenant Horatio Caine; MacGyver; Monk; Sledge Hammer

15. Which of these has not been awarded the Nobel Peace Prize?

    Kofi Annan; Al Gore; Che Guevara; Barack Obama; Schimon Peres; Muhammad Yunus

16. Who wrote the text for "Ode to Joy", melodized by Beethoven in his 9th symphony?

    Goethe; Fontane; Schiller; Schopenhauer; Storm; Voltaire

17. Which of these planets is the largest in our solar system?

    Jupiter; Mars; Mercury; Saturn; Uranus; Venus

18. Which of these cities hosted the 2000 summer Olympic Games?

    Athens; Atlanta; Barcelona; Peking; Seoul; Sydney

C.3.2 Economic Knowledge

1. At what level did the DAX close on May 28th 2010?

   4,589 Points; 4,816 Points; 5,002 Points; 5,357 Points; 5,642 Points; 5,946 Points

2. Which of these countries doesn't (or didn't, before the introduction of the Euro,) have the Crown as its currency?

   Denmark; Estonia; Iceland; Norway; Sweden; Slovenia

3. Which of these DAX listed companies had the highest market capitalization on May 28th 2010?

   BASF; Bayer; Daimler; E.ON; SAP; Siemens

4. What was the GDP of Germany in 2009?

   967 billion Euros; 1315 billion Euros; 1979 billion Euros; 2407 billion Euros; 3045 billion Euros; 4302 billion Euros

5. Which of these is NOT a possible component of Shareholders' Equity on a German balance sheet?

   Retained Income; Profit carried forward; Subscribed Capital; Capital Reserve; Annual deficit; Property, Plant & Equipment

6. How many German marks would €13 get you?

   23.59 DM; 24.17 DM; 25.43 DM; 26.27 DM; 27.01 DM; 27.77 DM

7. Which of these countries is not a member of OPEC?

   Iraq; Iran; Yemen; Qatar; Kuwait; Saudi Arabia

8. Which of these German cities does NOT have an exchange (Börse) as an active trading center?

   Berlin; Dresden; Düsseldorf; Hamburg; Munich; Stuttgart

9. What is the standard VAT rate in Germany?

   14%; 15%; 16%; 17%; 18%; 19%

10. How many income tax brackets/classes are there currently for employees in Germany?

    3; 4; 5; 6; 7; 8

11. Which of these is not a stock index?

    Bovespa; CAC 40; FTSE All-Share; Hang Seng; Topix; Viet MEI

12. How many Euros would you currently need to buy 1 British pound (GBP)?

    €0.87; €1.02; €1.18; €1.46; €1.67; €1.92

13. Who is the current German Minister for Economics?

    Rainer Brüderle; Karl-Theodor zu Guttenberg; Philipp Rösler; Norbert Röttgen; Wolfgang Schäuble; Guido Westerwelle

14. According to the Stability and Growth Pact, what is the maximum national debt, as a percentage of GDP, that a Eurozone country should not exceed?

    35%; 40%; 45%; 50%; 55%; 60%

15. Which state was the largest net-receiver in the 2009 German state fiscal equalization?

    Berlin; Bremen; Hamburg; Mecklenburg Vorpommern; Niedersachen; Sachsen Anhalt

16. What is the current employee contribution to the German statutory public pension scheme?

    14.4%; 15.5%; 16.6%; 17.7%; 18.8%; 19.9%

17. To which of these countries did Germany export the most goods and services (by value) in 2009?

    China; France; Italy; The Netherlands; USA; UK

18. The Sparda-Bank was originally the cooperative bank for which of these professions?

    Construction workers; miners; railway workers; farmers; metalworkers; postal workers

C.3.3 Tiebreaker

1. How long is Europe's longest river, the Volga? (in km)

   3,534km

2. How high is the Brocken in Harz? (in m)

   1,141m

3. How deep is the Mariana Trench? (in m)

   11,034m

4. According to the population register, how many inhabitants were living in the district Hamburg-Altona on December 31, 2009?

   250,172

5. How high is the Fichtelberg? (in m)

   1,215m

6. How many mosques has Istanbul?

   3,028

7. According to Google Maps, how far is it by car driving from Miami Beach, Florida to Boston, Massachusetts? (in km)

   2,413km (1,500 miles)

8. How high is the Berlin television tower? (in m)

   368,03m

C.4 Uniqueness of the Mixed-Strategy Nash Equilibrium

The necessary condition for entry is that the expected payoff from entry is non-negative. In the mixed-strategy Nash equilibrium, the entry probability p^* is such that the expected payoff from entry is 0. This condition can be written as

$$
\begin{aligned}
E[\Pi(p)] = f(p) &= \sum_{s=0}^{n-1} P(y=s) E[\Pi \,|\, y=s] \\
&= \sum_{s=0}^{n-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} E[\Pi \,|\, y=s] \\
&= \underbrace{\sum_{s=0}^{c-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} \sum_{i=0}^{s} x(c-i) - R \right)}_{A_1} \\
&\quad + \underbrace{\sum_{s=c}^{n-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1}(I - (s+1-c)L) - R \right)}_{A_2} \\
&\overset{!}{=} 0
\end{aligned}
$$

for a market entry game with payoffs conditional on the number of other entrants y, entry probability p, industry profit I, market capacity c, $x = I/\sum_{j=1}^{c} j$, loss from unsuccessful entry L, and regulatory entry cost R. The entry probability p is equal for all players because it is a symmetric game.

To show that only one mixed-strategy Nash equilibrium p^* exists, we use the following steps:

1. Show the existence of $p^* \in [0, 1]$.

2. Show monotonicity of $f(p)$ in p.

Existence of $p^* \in [0, 1]$

We first consider the corner solutions for $p = 0$ and $p = 1$. The expected payoffs from entry for these corner solutions provide the upper and the lower bound for the payoffs from entry.

$$p = 0 \rightarrow A_1(0) = xc - R$$
$$\rightarrow A_2(0) = 0$$

$$p = 1 \rightarrow A_1(1) = 0$$
$$\rightarrow A_2(1) = 1/n(I - (n - c)L) - R$$

For parameters $R < xc \qquad \rightarrow A_1(0) > 0 \qquad \rightarrow f(p) > 0$, i.e. if one player enters by himself, he makes a positive expected profit. This holds true in our setting.

For parameters $I < nR + L(n - c) \qquad \rightarrow A_2(1) < 0 \qquad \rightarrow f(p) < 0$, i.e. if all players enter, they make a negative expected profit. Again, this holds true in our setting.

Since $f(p)$ is continuous in p, we can apply the Intermediate Value Theorem and state the existence of $p^* \in (0, 1)$ such that $f(p^*) \stackrel{!}{=} 0$.

Monotonicity of $f(p)$ **in** p

To proof that only one mixed-strategy Nash equilibrium p^* exists, we show that $f(p)$ is a strictly decreasing function between the two corner solutions, i.e. in the interval $p^* \in (0, 1)$.

$$f(p) = \sum_{s=0}^{n-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} E\left[\Pi \mid y = s\right]$$

$$\frac{\partial f(p)}{\partial p} = \sum_{s=0}^{n-1} \binom{n-1}{s} E\left[\Pi \mid y = s\right] \left[sp^{s-1}(1-p)^{n-1-s} - p^s(n-1-s)(1-p)^{n-2-s}\right]$$

$$= \sum_{s=0}^{n-1} \binom{n-1}{s} E\left[\Pi \mid y = s\right] p^{s-1}(1-p)^{n-2-s} \left[s(1-p) - p(n-1-s)\right]$$

$$= \sum_{s=0}^{n-1} \binom{n-1}{s} E\left[\Pi \mid y = s\right] p^{s-1}(1-p)^{n-2-s} \left[s - p(n-1)\right] \stackrel{!}{<} 0$$

Therefore, for monotonicity the following has to hold:

$$\Leftrightarrow \sum_{s=0}^{n-1} \binom{n-1}{s} E\left[\Pi \,|\, y = s\right] p^{s-1}(1-p)^{n-2-s} s$$

$$< \underbrace{\sum_{s=0}^{n-1} \binom{n-1}{s} E\left[\Pi \,|\, y = s\right] p^{s}(1-p)^{n-2-s}(n-1)}_{=\frac{n-1}{1-p} E[\Pi] \qquad \text{for } p \overset{!}{<} 1}$$

$$\Leftrightarrow \underbrace{\sum_{s=0}^{n-1} \binom{n-1}{s} E\left[\Pi \,|\, y = s\right] p^{s-1}(1-p)^{n-1-s} s}_{=0 \text{ for } s=0 \to \text{ set index to } s=1} < (n-1)E\left[\Pi\right]$$

$$\Leftrightarrow \sum_{s=1}^{n-1} \frac{(n-2)!}{\underbrace{(s-1)!}_{1/s!*s=1/(s-1)!} \underbrace{(n-1-s)!}_{=n-2-(s-1)}} E\left[\Pi \,|\, y = s\right] p^{s-1}(1-p)^{n-1-s} < E\left[\Pi\right]$$

$$\Leftrightarrow \sum_{s=1}^{n-1} \binom{n-2}{s-1} p^{s-1}(1-p)^{n-1-s} E\left[\Pi \,|\, y = s\right] < E\left[\Pi\right]$$

$$\Leftrightarrow \underbrace{\sum_{s=0}^{n-2} \binom{n-2}{s} p^{s}(1-p)^{n-2-s} E\left[\Pi \,|\, y = s+1\right]}_{\text{shift}} < E\left[\Pi\right]$$

$$\Leftrightarrow E\left[\Pi \,|\, \text{at least one other player enters}\right] < E\left[\Pi \,|\, \text{no other player enters for sure}\right]$$

This holds true for our parameter setting. The expected payoff $E\left[\Pi\left(p\right)\right]$ strictly decreases in p and therefore it exists only one mixed-strategy Nash equilibrium $p^* \in [0,1]$ which satisfies $E\left[\Pi\left(p^*\right)\right] = 0$.

C.5 Nash Equilibria in Camerer and Lovallo (1999, CL99)

Camerer & Lovallo (1999) state the number of entrants in a pure strategy Nash equilibrium and an approximately mixed strategy Nash equilibrium for a market entry game with rank-dependent payoffs (p. 310). They do so without explicitly stating the underlying payoff function that applies to their experiment. Instead, they derive it verbally based on the payoff function for the basic market entry game introduced by Kahneman (1988). From this description it is not clear which payoffs apply if there are less entrants than market capacity. CL99 could either pay out the entire industry profit and distribute it amongst those who enter, or they pay exactly according to the rank-dependent payoff matrix (p. 308, Table 1).

In the following, we are going to show the equilibrium derivations for both cases. CL99

assume risk-neutral subjects and the random-ranking condition. Therefore, the expected payoff relevant rank is the average rank amongst all entrants. The parameters used in CL99 are $n = (12, 14, 16), k = 10, c = (2, 4, 6, 8), I = 50$, individual payoffs from entry are rank dependent and listed in CL99 Table 1.

C.5.1 Equilibrium: Full Industry Profit Distribution in Case of $E < c$

CL99 do not state what they pay out in case of $E < c$. In case they distribute the entire industry profit, the expected individual payoff function is as follows:

$$
\begin{aligned}
E[P_i] &= k & \text{if no entry} \\
E[P_i] &= k + (I)/E & \text{if entry and } E < c \\
E[P_i] &= k + (I + k(c - E))/E & \text{if entry and } E \geq c
\end{aligned}
$$

Pure-Strategy Equilibrium

Table C.1 provides an overview over the expected payoffs in the random-ranking condition depending on the market capacity and the number of entrants. The Nash equilibrium is characterized as a situation when no entrant has an incentive not to enter and no non-entrant has an incentive to enter.

Table C.1: Full Profit Distribution: Expected Payoffs

E	Capacity							
	\multicolumn{2}{c}{2}	\multicolumn{2}{c}{4}	\multicolumn{2}{c}{6}	\multicolumn{2}{c}{8}
	M	P_i	M	P_i	M	P_i	M	P_i
1	50	50	50	50	50	50	50	50
2	50	50/2	50	50/2	50	50/2	50	50/2
3	40	40/3	50	50/3	50	50/3	50	50/3
4	30	30/4	50	50/4	50	50/4	50	50/4
5	20	20/5	40	40/5	50	50/5	50	50/5
6	10	10/6	30	30/6	50	50/6	50	50/6
7	0	0	20	20/7	40	40/7	50	50/7
8	-10	-10/8	10	10/8	30	30/8	50	50/8
9	-20	-20/9	0	0	20	20/9	40	40/9
10	-30	-30/10	-10	-10/10	10	10/10	30	30/10
11	-40	-40/11	-20	-20/11	0	0	20	20/11
12	-50	-50/12	-30	-30/12	-10	-1/12	10	10/12
13	-60	-60/13	-40	-40/13	-20	-20/13	0	0
14	-70	-70/14	-50	-50/14	-30	-30/14	-10	-10/14
15	-80	-80/15	-60	-60/15	-40	-40/15	-20	-20/15
16	-90	-90/16	-70	-70/16	-50	-50/16	-30	-30/16

Note: The table shows the expected market (M) and individual (P_i) payoffs excluding the constant endowment k. To enter profitably, the expected payoff from entry needs to be positive.

There are many asymmetric Nash equilibria in pure strategies within the strategy space which encompasses 2^n combinations of the pure strategies "entry" and "no entry". What CL99 state for the market entry game are not the various Nash equilibria but the equilibrium number of entrants.[1] Subjects enter as long as their expected payoff is greater or equal to zero. In the parameter setting of CL99 this is true for $E^* = c + 4$ and $E^* = c + 5$. If $c + 4$ subjects enter, all entrants have a positive expected payoff. Therefore, none of the entrants has an incentive not to enter (in which case they would receive a payoff of zero). On the other hand, none of the non-entrants has an incentive to enter, since it this case E^* increases to $c + 5$ and the expected profit would be zero. A similar argumentation applies to the situation where the equilibrium number of entrants is $c + 5$: Entrants receive an expected payoff of zero and cannot increase it by not entering, and non-entrants have no incentive to enter because in this case the expected payoff becomes negative.[2]

Therefore, the number of entrants in the pure-strategy equilibrium can be calculated as follows:[3]

$$I + k(c - E) \overset{!}{\geq} 0$$

$$E^* = \frac{I + kc}{k} = c + \frac{I}{k}$$

If E^* is not an integer, then the Nash equilibrium number of entrants is the down-rounded value of E^* and if E^* is an integer there are two values for the equilibrium number of entrants: E^* and $E^* - 1$.

The occurring equilibria are necessarily asymmetric and one cannot tell ex ante which one would materialize. Yet, for the analysis of overconfidence in the market entry game only the equilibrium number of entrants is of interest.

Mixed-Strategy Equilibrium

In contrast to the multiple pure strategy equilibria, there is only one symmetric mixed-strategy Nash equilibrium. Again, subjects enter as long as the expected profit from entry is greater than the payoff from non-entry which is zero. Considering the fact that the aggregated payoff equals I if $E < c$ and $I + k(c - E)$ if $E \geq c$ one can write the condition for the Nash equilibrium in mixed strategies as follows:

$$\sum_{s=0}^{c-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} I \right) +$$

---

[1] The information about which of the subjects enter is important to find each of the numerous asymmetric Nash equilibrium but not to determine the equilibrium number of entrants.

[2] In fact, the marginal entrant at $c + 5$ is indifferent between entering or not.

[3] A situation of $E < c$ would not occur in equilibrium because in that case entry would always render and therefore this is not an equilibrium.

$$\sum_{s=c}^{n-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} (I - k(s+1-c)) \right) \geq 0$$

where p is the probability of entry. Subjects are expected to randomize between entry and non-entry with entry probability p and therefore one can calculate the equilibrium number of entrants by n^*p.

The following Table C.2 provides the equilibrium probabilities depending on the number of players and the capacity.[4]

Table C.2: Full Profit Distribution: Mixed-Strategy Equilibrium (p, n^*p)

				Capacity				
	2		4		6		8	
n	p	n^*p	p	n^*p	p	n^*p	p	n^*p
12	0.583	6.999	0.750	9.000	0.917	11.000	1.084	13.005
14	0.500	7.000	0.643	8.998	0.786	10.999	0.929	12.962
16	0.437	6.998	0.562	8.997	0.687	10.997	0.812	12.999

We find that the values for n^*p, and therefore the equilibrium number of entrants, can be approximated by $c + 5$, which is the solution that is provided by CL99.

C.5.2 Equilibrium: Partial Industry Profit Distribution in Case of $E < c$

Alternatively, it may be the case that CL99 do not distribute the total industry profit I if $E < c$ but only the payoffs for the ranks which are actually occupied. In this case, the rank-dependent payoff function according to the verbal description and the payoff table in the paper is as follows:

$$
\begin{array}{ll}
E[P_i] = k & \text{if no entry} \\
E[P_i] = k + \sum_{r_i=1}^{E} [(I / \sum_{j=1}^{c} j)(c - r_i + 1)]/E & \text{if entry and } E < c \\
E[P_i] = k + (I + k(c - E))/E & \text{if entry and } E \geq c
\end{array}
$$

with $(I / \sum_{j=1}^{c} j)(c - r_i + 1)$ rounded to the next integer.

Pure-Strategy Equilibrium

Compared to the pure-strategy equilibrium consideration, the expected individual payoffs for $E < c$ change. Yet, Table C.3 reveals that although the expected payoffs are lower, it does not matter for the pure-strategy equilibrium number of entrants how one treats the payoffs in case of $E < c$. E^* is still $c + 4$ and $c + 5$.

---

[4]There might be impreciseness due to rounding. We use the program Mathematica to solve the optimization problem numerically.

Table C.3: Partial Profit Distribution: Expected payoffs

					Capacity			
		2		4		6		8
E	M	P_i	M	P_i	M	P_i	M	P_i
1	33	33	20	20	14	14	11	11
2	50	50/2	35	35/2	26	26/2	21	21/2
3	40	40/3	45	45/3	36	36/3	29	29/3
4	30	30/4	50	50/4	43	43/4	36	36/4
5	20	20/5	40	40/5	48	48/5	42	42/5
6	10	10/6	30	30/6	50	50/6	46	46/6
7	0	0	20	20/7	40	40/7	49	49/7
8	-10	-10/8	10	10/8	30	30/8	50	50/8
9	-20	-20/9	0	0	20	20/9	40	40/9
10	-30	-30/10	-10	-10/10	10	10/10	30	30/10
11	-40	-40/11	-20	-20/11	0	0	20	20/11
12	-50	-50/12	-30	-30/12	-10	-1/12	10	10/12
13	-60	-60/13	-40	-40/13	-20	-20/13	0	0
14	-70	-70/14	-50	-50/14	-30	-30/14	-10	-10/14
15	-80	-80/15	-60	-60/15	-40	-40/15	-20	-20/15
16	-90	-90/16	-70	-70/16	-50	-50/16	-30	-30/16

Note: The table shows the expected market (M) and individual (P_i) payoffs excluding the constant endowment k. To enter profitably, the expected payoff from entry needs to be positive.

Mixed-Strategy Equilibrium

The condition for the mixed-strategy equilibrium changes if we assume the alternative individual payoff function. For any c, n, k, I, and $x = \frac{I}{\sum_{j=1}^{c} j}$ the problem can be written as follows:

$$\sum_{s=0}^{c-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} \sum_{i=0}^{s} x(c-i) \right) +$$

$$\sum_{s=c}^{n-1} \binom{n-1}{s} p^s (1-p)^{n-1-s} \left(\frac{1}{s+1} (I - (s+1-c)k) \right) \geq 0$$

The according equilibrium probabilities and number of entrants in the Nash equilibrium are shown in Table C.4.

Taking the results from Table C.4 we find again that n^*p is approximately $c+5$ as predicted by CL99 as mixed-strategy Nash equilibrium number of entrants.

Table C.4: Partial Profit Distribution: Mixed-Strategy Equilibrium (p, n^*p)

	Capacity							
	2		4		6		8	
n	p	n^*p	p	n^*p	p	n^*p	p	n^*p
12	0.583	6.999	0.750	8.999	0.917	11.000	1.084	13.005
14	0.500	6.997	0.643	8.998	0.786	10.999	0.929	13.000
16	0.437	6.996	0.562	8.995	0.687	10.996	0.812	12.999

C.5.3 Summary

To summarize, we can state that for the CL99 derivation of the equilibrium number of entrants it does not matter how they treat the situation of $E < c$ in their payoff function. We can replicate their equilibrium predictions using both types of possible payoff function.

C.6 Tables

Table C.5: Variable Description

Variable	Description
Skill	1: Market with skill-based ranking
Reg	1: Market with entry regulation
Capacity (c)	Market capacity $\in [2,3,4,5]$
E	Total number of market entrants
E^*	Equilibrium number of market entrants (respective benchmark in the text)
E_p	Predicted number of market entrants (including own decision)
E_p^-	$E_p - c$: Predicted excess entry (including own decision) with respect to market capacity
E_{po}	Predicted number of market entrants (excluding own decision, i.e. $E_{po} = E_p$ if no entry and $E_{po} = E_p - 1$ if entry)
E_{po}^-	$E_{po} - c$: Predicted excess entry (of others) with respect to market capacity
Π	Market profit
Π_i	Individual payoff
Π_p	Predicted market profit
$D(r_i \leq c)$	1: Skill rank is lower or equal to market capacity (qualified/competent subject)
$D(r_i \leq E^*_{Nash})$	1: Skill rank is lower or equal to the pure-strategy Nash equilibrium number of total entry (qualified/competent subject)
Rank skill	Individual skill rank $r_i \in [1 - 10]$
D_{subj_i}	Dummy variable for each subject i
Age	Age of subjects
Sex	Gender of subject
Apprent	1: Has apprenticeship, professional education
Foundex	1: Has founded a firm or been self-employed
Prefskill	1: Preference for remuneration according to skill rank

Note: The table presents and describes the variables used in the empirical analysis.

Table C.6: Individual Entry Decisions by Round: Sessions 1 & 2

The table reports individual entry decisions (1 = entry, 0 = no entry) by round for each subject, grouped by treatment. Owing to the density of the original grid, the per-subject totals (T) for each treatment that can be read reliably are reproduced below.

Sessions 1 (subjects 1–10) — treatment order: OR, OS, WR, WS

ID	OR (T)	OS (T)	WR (T)	WS (T)	T
1	7	8	3	8	26
2	2	3	2	3	10
3	7	5	4	5	21
4	4	6	8	8	26
5	5	4	5	5	19
6	4	3	2	1	10
7	6	6	4	4	20
8	1	5	0	3	9
9	4	6	4	4	18
10	3	3	4	5	15
T	43	49	36	46	174

Session 2 (subjects 11–20) — treatment order: OS, OR, WS, WR

ID	OS (T)	T (grand)
11	5	10
12	5	21
13	6	22
14	5	22
15	8	22
16	8	20
17	6	20
18	6	19
19	6	23
20	5	23
T	60	204

Treatment totals (session 2): OS = 60, OR = 51, WS = 53, WR = 40.

Note: The table displays the individual entry decisions, where 1 stands for entry and 0 for no entry. ID stands for subject ID, c shows the market capacity of the respective rounds. The order of treatments is reported as they occurred in the experiment. The table indicates the total number of entrants T by round, subject, treatment, and session for sessions 1 & 2.

Table C.7: Individual Entry Decisions by Round: Sessions 3 & 4

Sessions (IDs 21–30)

ID		WR						T	WS						T	OR						T	OS						T	T
c		2	3	4	5	3			2	3	4	5	3			2	3	4	5	3			2	3	4	5	3			
21		0	0	0	1	0		1	0	0	0	1	0		3	0	0	0	1	0		2	0	0	0	1	0		2	8
22		0	0	1	0	0		4	0	0	1	0	1		2	0	1	0	0	1		3	1	1	1	0	0		4	13
23		1	1	1	1	0		7	1	0	0	0	1		7	0	1	1	1	1		8	1	1	1	1	1		6	28
24		0	0	0	0	0		0	0	0	0	0	0		2	1	0	0	0	0		3	1	1	1	0	1		7	12
25		1	1	1	1	1		6	1	1	0	1	1		4	0	0	1	1	1		6	1	1	1	1	1		8	24
26		1	1	1	1	0		5	0	0	1	1	1		7	0	1	1	1	1		7	0	0	1	1	1		5	24
27		1	1	1	1	1		4	1	0	0	1	1		5	1	0	1	1	0		5	1	1	1	1	1		7	21
28		0	1	0	1	0		1	1	1	1	1	1		8	0	1	1	0	0		2	0	1	1	1	1		8	19
29		0	0	1	0	0		2	0	1	0	0	0		7	0	0	0	0	0		1	1	0	1	1	0		5	15
30		0	1	1	1	1		6	1	0	1	0	1		5	1	1	1	1	1		8	1	1	1	1	1		7	26
T		1	7	2	7	4	5	36	5	7	7	6	5	5	50	4	5	6	7	6	7	45	7	7	8	9	8	7	59	190

Sessions (IDs 31–40)

ID		WS						T	WR						T	OS						T	OR						T	T
c		2	3	4	5	3			2	3	4	5	3			2	3	4	5	3			2	3	4	5	3			
31		1	1	1	1	0		7	0	0	0	1	0		5	0	1	1	1	0		5	0	1	1	1	0		5	24
32		0	1	0	1	0		2	0	0	0	0	0		0	0	1	0	1	0		0	0	0	1	1	0		4	11
33		0	0	1	1	0		4	1	0	0	1	1		3	1	1	0	1	1		3	0	0	0	1	1		4	15
34		1	1	1	1	1		8	0	0	0	0	0		0	0	0	1	1	0		6	0	1	1	1	0		2	16
35		1	1	1	1	1		8	0	1	0	1	1		7	1	0	1	1	1		6	0	1	1	1	1		7	28
36		0	1	1	1	1		7	1	1	1	1	1		8	1	1	1	1	1		8	1	1	1	1	1		8	31
37		1	1	1	0	0		8	0	0	0	0	0		0	0	0	0	0	0		8	0	1	1	1	0		0	16
38		1	1	1	1	1		7	1	1	1	1	0		7	1	1	1	0	1		7	1	1	1	0	1		6	27
39		0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0		0	0
40		1	0	1	0	1		5	1	1	1	1	1		8	1	1	1	1	1		8	1	1	1	1	1		8	29
T		6	8	8	7	5	4	56	4	4	5	6	5	4	38	7	6	9	8	9	5	59	3	6	6	7	6	4	44	197

Note: The table displays the individual entry decisions, where 1 stands for entry and 0 for no entry. ID stands for subject ID, c shows the market capacity of the respective rounds. The order of treatments is reported as they occurred in the experiment. The table indicates the total number of entrants T by round, subject, treatment, and session for sessions 3 & 4.

Table C.8: Individual Entry Decisions by Round: Sessions 5 & 6

Sessions 5 (IDs 41–50)

ID	c	OR T	WR T	OS T	WS T	T
41		8	5	6	7	26
42		4	5	5	4	18
43		3	0	7	6	16
44		5	5	5	4	19
45		8	1	4	7	20
46		0	3	6	5	14
47		5	6	6	7	24
48		5	4	5	4	18
49		4	6	6	5	21
50		8	4	6	4	22
T		**50**	**39**	**56**	**53**	**198**

Session 6 (IDs 51–60)

ID	c	WR T	OR T	WS T	OS T	T
51		3	1	3	0	7
52		3	2	3	3	11
53		0	5	0	8	13
54		5	6	6	6	23
55		2	3	4	4	13
56		6	4	5	6	21
57		2	7	6	4	19
58		5	5	4	5	19
59		0	7	3	4	14
60		6	4	4	5	19
T		**32**	**44**	**38**	**45**	**159**

Note: The table displays the individual entry decisions, where 1 stands for entry and 0 for no entry. ID stands for subject ID, c shows the market capacity of the respective rounds. The order of treatments is reported as they occurred in the experiment. The table indicates the total number of entrants T by round, subject, treatment, and session for sessions 5 & 6.

Table C.9: Individual Entry Decisions by Round: Sessions 7 & 8

Sessions 7 & 8 — Subjects 61–70

Each treatment block (OS, WS, OR, WR) reports the individual entry decisions by round and the treatment total (T); the final column gives the grand total (T).

ID	OS (T)	WS (T)	OR (T)	WR (T)	T
61	6	8	6	4	24
62	5	7	5	4	21
63	7	7	5	5	24
64	4	5	3	4	16
65	7	5	4	4	20
66	0	6	0	2	8
67	7	4	4	2	17
68	2	0	3	2	7
69	4	3	2	1	10
70	5	4	8	5	22
T	**47**	**49**	**40**	**33**	**169**

Subjects 71–80

ID	WS (T)	OS (T)	WR (T)	OR (T)	T
71					28
72					16
73					22
74					19
75					25
76					9
77					28
78					25
79					20
80					25
T	**54**	**63**	**46**	**54**	**217**

Note: The table displays the individual entry decisions, where 1 stands for entry and 0 for no entry. ID stands for subject ID, c shows the market capacity of the respective rounds. The order of treatments is reported as they occurred in the experiment. The table indicates the total number of entrants T by round, subject, treatment, and session for sessions 7 & 8.

Table C.10: Total Entry by Round

OR: Without Regulation, Random Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	3	5	4	6	6	7	7	5	5.38
2	5	7	3	6	7	7	9	7	6.38
3	5	5	4	5	7	6	7	6	5.63
4	3	5	6	4	6	6	7	7	5.5
5	5	4	7	4	8	8	8	6	6.25
6	7	3	5	8	8	5	4	4	5.5
7	4	6	3	7	7	6	8	8	6.13
8	4	6	8	5	8	9	6	8	6.75
Avg.	4.81		5.31		6.94		6.6		5.94

OS: Without Regulation, Skill Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	3	3	6	5	8	7	8	9	6.13
2	9	5	6	7	9	7	10	7	7.50
3	7	7	7	7	9	8	6	8	7.38
4	7	6	9	5	7	8	8	9	7.38
5	8	5	8	4	5	8	9	10	7.13
6	3	7	7	2	6	5	7	8	5.63
7	6	5	5	6	5	5	7	8	5.88
8	9	6	7	9	7	8	7	10	7.88
Avg.	6.00		6.25		7.00		8.19		6.86

WR: With Regulation, Random Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	5	2	7	4	3	5	5	5	4.50
2	3	3	5	6	6	7	5	5	5.00
3	1	2	7	3	7	7	4	5	4.50
4	4	5	5	4	4	5	6	5	4.75
5	4	4	5	5	6	6	4	5	4.88
6	2	6	1	4	6	6	5	2	4.00
7	4	7	3	2	1	6	5	5	4.13
8	5	5	5	7	5	5	7	7	5.75
Avg.	3.88		4.56		5.31		5.00		4.69

WS: With Regulation, Skill Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	4	4	5	6	8	7	7	5	5.75
2	7	3	7	7	7	9	5	8	6.63
3	7	5	5	5	8	7	6	7	6.25
4	6	6	8	6	8	8	7	7	7.00
5	6	6	5	6	7	8	8	7	6.63
6	5	3	5	3	7	5	6	4	4.75
7	3	6	5	4	6	7	5	4	5.00
8	7	7	5	7	6	8	8	6	6.75
Avg.	5.31		5.56		7.25		6.25		6.09

Note: The table displays the total number of entrants E by treatment and round.

Table C.11: Market Profits by Round

OR: Without Regulation, Random Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	39	-3	39	-3	18	-3	18	60	20.63
2	-3	-45	60	-3	-3	-3	-24	18	-0.38
3	-3	-3	39	18	-3	18	18	39	15.38
4	39	-3	-3	39	18	18	18	18	18.00
5	-3	18	-24	39	-24	-24	-3	39	2.25
6	-45	39	18	-45	-24	39	56	56	11.75
7	18	-24	60	-24	-3	18	-3	-3	4.86
8	18	-24	-45	18	-24	-45	39	-3	-8.25
Avg.	0.94		11.44		-1.69		21.44		8.03

OS: Without Regulation, Skill Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	39	39	-3	18	-24	-3	-3	-24	4.88
2	-87	-3	-3	-24	-45	-3	-45	18	-24.00
3	-45	-45	-24	-24	-45	-24	39	-3	-21.38
4	-45	-24	-66	18	-3	-24	-3	-24	-21.38
5	-66	-3	-45	39	39	-24	-24	-45	-16.13
6	39	-45	-24	50	18	39	18	-3	11.50
7	-24	-3	18	-3	39	39	18	-3	10.13
8	-87	-24	-24	-66	-3	-24	18	-45	-31.88
Avg.	-24.00		-10.19		-3.00		-6.94		-11.03

WR: With Regulation, Random Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	-53	40	-94	-1	24	-11	10	10	-9.38
2	9	9	-32	-63	-42	-73	10	10	-21.50
3	30	40	-94	30	-73	-73	16	10	-14.25
4	-22	-53	-32	-1	20	-11	-21	10	-13.75
5	-22	-22	-32	-32	-42	-42	16	10	-20.75
6	40	-84	20	-1	-42	-42	10	16	-10.38
7	-22	-115	30	30	14	-42	10	10	-10.63
8	-53	-53	-32	-94	-11	-11	-52	-52	-44.75
Avg.	-20.69		-24.88		-28.56		1.44		-18.17

WS: With Regulation, Skill Ranking

Exp	c=2		c=3		c=4		c=5		Avg.
	1	5	4	8	2	6	3	7	
1	-22	-22	-32	-63	-104	-73	-52	10	-44.75
2	-115	9	-94	-94	-73	-135	10	-83	-71.88
3	-115	-53	-32	-32	-104	-73	-21	-52	-60.25
4	-84	-84	-125	-63	-104	-104	-52	-52	-83.50
5	-84	-84	-32	-63	-73	-104	-83	-52	-71.88
6	-53	9	-32	30	-73	-11	-21	16	-16.88
7	9	-84	-32	-1	-42	-73	10	16	-24.63
8	-115	-115	-32	-94	-42	-104	-83	-21	-75.75
Avg.	-62.69		-49.44		-80.75		-31.88		-56.19

Note: The table displays the market profits II by treatment and round.

Table C.12: Regression Entry Decision: Probit Models

	(1)	(2)	(3)*
Skill*Reg	0.048***	0.055*	0.055*
	(0.003)	(0.037)	(0.038)
Skill	0.098***	0.132***	0.135***
	(0.027)	(0.036)	(0.037)
Reg	-0.124***	-0.171***	-0.175***
	(0.015)	(0.033)	(0.034)
Capacity	0.060***	0.062***	0.064***
	(0.016)	(0.017)	(0.017)
$D(r_i \leq c)$		-0.030	-0.041
		(0.045)	(0.047)
E_{po}^{-}		-0.057***	-0.059***
		(0.013)	(0.013)
Regression Statistics			
Ind. Charact.	no	no	yes
Cluster (exp)	yes	no	no
Cluster (subj)	no	yes	yes
Pseudo R^2	0.032	0.051	0.066
N	2560	2560	2560

Note: The dependent variable is the Entry, which is binary and 1 if a subjects decides to enter a market and 0 otherwise. The table reports marginal effects of Probit regressions and standard errors in parentheses. We use the inteff command implemented in STATA to correct the interacted variable. Variable specifications of (1) and (2) same as in main Table 4.11. Column (3)* provides the same specification as (2) but in addition individual characteristics which include age, sex, apprent, foundex. A constant is included. The data is clustered at the experimental session or subject level. ***, **, and * for the marginal effects indicate that they are significantly different from zero at the 1%, 5%, and 10% confidence level, respectively.

Table C.13: Regression Entry Decision: No Cluster But Individual Fixed Effects

	(1)	(2)	(3)	(4)
Skill*Reg	0.048	0.053	0.054	0.086**
	(0.035)	(0.035)	(0.035)	(0.036)
Skill	0.092***	0.126***	0.126***	0.011
	(0.025)	(0.024)	(0.024)	(0.040)
Reg	-0.125***	-0.173***	-0.176***	-0.138***
	(0.025)	(0.025)	(0.025)	(0.036)
Capacity	0.058***	0.072***	0.073***	0.075***
	(0.008)	(0.009)	(0.009)	(0.009)
$D(r_i \leq c)$		-0.163***	-0.092**	-0.031
		(0.038)	(0.046)	(0.053)
$D(r_i \leq c)$*Skill				0.085**
				(0.036)
$D(r_i \leq c)$*Reg				-0.135***
				(0.036)
(E_{po}^-)		-0.062***	-0.050***	-0.061***
		(0.007)	(0.008)	(0.013)
(E_{po}^-)*Skill				0.037***
				(0.013)
(E_{po}^-)*Reg				-0.005
				(0.013)
$D(r_i \leq c)$*(E_{po}^-)			-0.039***	-0.059***
			(0.015)	(0.015)

Regression Statistics

D_{Subj_i}	yes	yes	yes	yes
R^2	0.198	0.230	0.232	0.240
N	2560	2560	2560	2560

Note: All notes of Table 4.11 apply except that in this table we do not cluster the data but include subject dummy variables to control for individual fixed effects.

Table C.14: Regression Entry Decision: Skill rank $\leq E^*_{Nash}$

	(2)	(3)	(4)	(5)
Skill*Reg	0.052**	0.052	0.110**	0.110**
	(0.021)	(0.037)	(0.044)	(0.044)
Skill	0.123***	0.122***	-0.039	-0.036
	(0.032)	(0.034)	(0.058)	(0.057)
Reg	-0.170***	-0.172***	-0.128***	-0.126***
	(0.017)	(0.032)	(0.046)	(0.046)
Capacity	0.057***	0.058***	0.059***	0.060***
	(0.010)	(0.016)	(0.016)	(0.016)
$D(r_i \leq E^*_{Nash})$	-0.012	0.068	0.124**	0.107*
	(0.037)	(0.049)	(0.062)	(0.058)
$D(r_i \leq E^*_{Nash})$*Skill			0.078	0.075
			(0.058)	(0.058)
$D(r_i \leq E^*_{Nash})$*Reg			-0.123**	-0.120**
			(0.054)	(0.052)
(E^-_{po})	-0.055***	-0.038**	-0.053***	-0.054***
	(0.013)	(0.015)	(0.020)	(0.020)
(E^-_{po})*Skill			0.051***	0.050***
			(0.018)	(0.018)
(E^-_{po})*Reg			-0.010	-0.013
			(0.015)	(0.015)
$D(r_i \leq E^*_{Nash})$*(E^-_{po})		-0.042**	-0.059***	-0.054***
		(0.019)	(0.020)	(0.020)
Regression Statistics				
Ind. Charact.	no	no	no	yes
Cluster (exp)	yes	no	no	no
Cluster (subj)	no	yes	yes	yes
D_{Subj_i}	no	no	no	no
R^2	0.067	0.071	0.081	0.098
N	2560	2560	2560	2560

Note: All notes of Table 4.11 apply.

Table C.15: Regression Entry Decision: Skill rank

	(2)	(3)	(4)	(5)
Skill*Reg	0.052**	0.054	0.091**	0.092**
	(0.021)	(0.037)	(0.041)	(0.041)
Skill	0.122***	0.122***	0.099	0.100
	(0.032)	(0.034)	(0.069)	(0.068)
Reg	-0.168***	-0.171***	-0.269***	-0.260***
	(0.021)	(0.032)	(0.060)	(0.061)
Capacity	0.056***	0.064***	0.067***	0.066***
	(0.009)	(0.016)	(0.016)	(0.016)
Rank skill	0.002	-0.007	-0.009	-0.006
	(0.007)	(0.008)	(0.009)	(0.009)
Rank skill*Skill			-0.016	-0.016
			(0.010)	(0.010)
Rank skill*Reg			0.014*	0.014*
			(0.008)	(0.008)
(E_{po}^{-})	-0.055***	-0.044***	-0.068***	-0.067***
	(0.013)	(0.014)	(0.019)	(0.018)
(E_{po}^{-})*Skill			0.049***	0.048***
			(0.018)	(0.018)
(E_{po}^{-})*Reg			0.000	-0.004
			(0.015)	(0.015)
$D(r_i \leq c)^{*}(E_{po}^{-})$		-0.038*	-0.045***	-0.042**
		(0.020)	(0.021)	(0.020)
Regression Statistics				
Ind. Charact.	no	no	no	yes
Cluster (exp)	yes	no	no	no
Cluster (subj)	no	yes	yes	yes
R^2	0.067	0.071	0.080	0.098
N	2560	2560	2560	2560

Note: All notes of Table 4.11 apply.

Table C.16: Regression Entry Decision: Prefskill

	(4a)	(4b)
Skill*Reg	0.080*	0.087**
	(0.046)	(0.041)
Skill	0.008	-0.163**
	(0.051)	(0.073)
Reg	-0.132***	-0.139**
	(0.044)	(0.063)
Capacity	0.060***	0.061***
	(0.016)	(0.016)
$D(r_i \leq c)$	0.112	0.109*
	(0.068)	(0.062)
$D(r_i \leq c)$*Skill	0.070	0.080
	(0.067)	(0.061)
$D(r_i \leq c)$*Reg	-0.165***	0.080
	(0.049)	(0.061)
(E_{po}^-)	-0.076***	-0.065***
	(0.020)	(0.019)
(E_{po}^-)*Skill	0.058***	0.045***
	(0.019)	(0.017)
(E_{po}^-)*Reg	-0.002	0.002
	(0.017)	(0.016)
$D(r_i \leq c)$*(E_{po}^-)	-0.054**	-0.059***
	(0.021)	(0.021)
Prefskill		0.032
		(0.082)
Prefskill*Skill		0.184***
		(0.056)
Prefskill*Reg		-0.013
		(0.058)

Regression Statistics

Cluster (subj)	yes	yes
R^2	0.097	0.093
N	2176	2560

Note: All notes of Table 4.11 apply. Regression (4a) is restricted to those subjects who would prefer a ranking according to their skills (prefskills=1).

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