Sino-EU Cooperation in the Field of Science and Technology (S&T) - Strength and Limits of Rational Choice Analysis

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Table of Content

List of Abbreviations

AMP	Advanced Manufacturing Partners Program
APSCO	Asia-Pacific Space Cooperation Organization
ASEAN	Association of Southeast Asian Nations
ASI	Italian Space Agency
BDI	Federation of German Industries
BRICS	Brazil, Russia, India, China and South Africa
CAI	Comprehensive Agreement on Investment
CAS	Chinese Academy of Sciences
CASS	Chinese Academy of Social Sciences
CBERS	China–Brazil Earth Resources Satellite program
CCCEU	European Union Chamber of Commerce in China
CDM	Clean Development Mechanism
CEN	European Committee for Standardization
CNES	National Center for Space Studies of France
CNSA	China National Space Administration
COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
CPC	Communist Party of China
CPPCC	Chinese People’s Political Consultative Conference
CSIS	Center for Strategic and International Studies
DLR	German Aerospace Center
EC2	Europe-China Clean Energy Centre project
EGNOS	European Geostationary Navigation Overlay Service
ERA	European Research Area

ERS	European Remote Sensing satellite
ESA	European Space Agency
FP	Framework Program
GEF	Global Environment Facility
GHG	Green House Gas
GJU	Galileo Joint Undertaking
GLONASS	Global Navigation Satellite System
GMR	Galileo Mass Market Receiver
GNSS	European Global Navigation Satellite Systems Agency
GPS	Global Positioning System
GSA	European GNSS Supervisory Authority
ICAO	International Civil Aviation Organization
ICPC	International Cooperation Partnership Countries
INCO	International Cooperation Program
IPR	Intellectual Property Rights
ISC	International Scientific Cooperation
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JRC	Joint Research Centre
MERICS	Mercator Institute for China Studies
NPC	National People's Congress
NRSCC	National Remote Sensing Centre of China
OECD	Organization for Economic Cooperation
PPS	Precise Positioning Service
R&D	Research and Development

RFSA	Russian Federal Space Agency
SAR	Synthetic Aperture Radar
SAS	Academy of Sciences of the Union of Soviet Socialist Republics
SPS	Standard Positioning Service
S&T	Science and Technology
STD	Science and Technology for development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
USSR	Union of Soviet Socialist Republics

List of Figures and Tables

Figures

Tables

Sino-EU Cooperation in the Field of Science and Technology (S&T) - Strengths and Limits of Rational Choice Analysis

Ying Li

Abstract

The dissertation attempts to explain how did the cost-benefit calculations of the interests of China and the interests of the EU influenced the institutionalization of their S&T cooperation. After a comparison between the EU and China's respective Science and Technology Policies, this dissertation assesses the institutionalization of EU-China S&T cooperation which is the dependent variable, by looking at the degree, intensity, and effectiveness of the institutionalization in three typical cases: Galileo project, The Europe-China Clean Energy Centre project (EC2), and the Dragon program. These three cases explain interrelated issues from different angles, creating a holistic image of the field of S&T cooperation. The cost-benefit explanations are insufficient for the institutionalization of Sino-EU S&T cooperation; other independent variables, such as path dependency and critical junctures, are also discussed in this dissertation. The thesis operates with six hypotheses based on rational choice institutionalism and historical institutionalism, which are discussed in depth, with some hypotheses verified, others falsified, and some requiring revision. While the main analysis concludes in January 2021, the epilogue examines developments until the year 2024, which may prompt some readers to question my findings, thereby highlighting the need to constantly reassess

theoretical frameworks and results in light of evolving international dynamics.

Key words: Sino-EU cooperation Sino-EU S&T cooperation

Cost-benefit calculation Galileo project

Rational Choice

Zusammenarbeit zwischen China und der EU in Wissenschaft und Technologie (W&T) - Stärken und Grenzen der Theorie der rationalen Entscheidungen

Ying Li

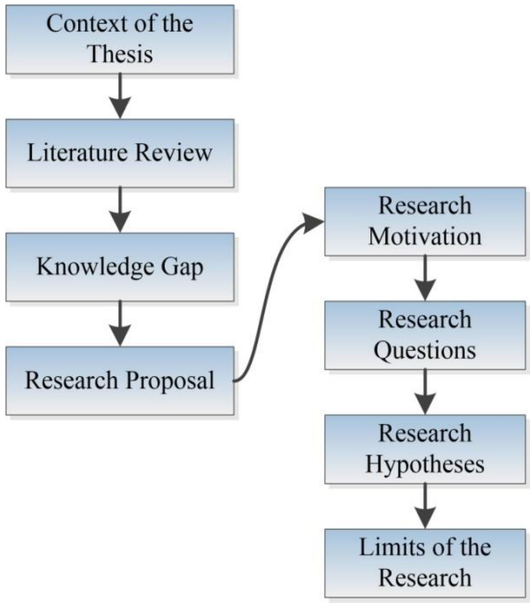
Zusammenfassung

Diese Dissertation versucht zu erklären, wie die Kosten-Nutzen-Rechnungen der Interessen Chinas und der Interessen der EU die Institutionalisierung ihrer wissenschaftlich-technischen Zusammenarbeit beeinflusst haben. Die Arbeit beginnt mit einem Vergleich der jeweiligen Wissenschafts- und Technologiepolitik von EU und China. Sie bewertet die Institutionalisierung der W&T-Zusammenarbeit zwischen der EU und China, welche die abhängige Variable darstellt, indem sie den Grad, die Intensität und die Effektivität der Institutionalisierung in drei typischen Fällen untersucht: Dem Galileo-Projekt, dem Europe-China Clean Energy Centre (EC2) Projekt und dem Dragon-Programm. Mit Hilfe dieser drei Fallstudien werden die miteinander verbundenen Aspekte aus verschiedenen Blickwinkeln erklärt, wodurch ein ganzheitliches Bild des Bereichs der W&T-Zusammenarbeit entsteht. Insbesondere zeigt sich, dass die Kosten-Nutzen-Rechnungen zur Erklärung der Institutionalisierung der W&T-Zusammenarbeit zwischen China und der EU nicht ausreichend sind; andere unabhängige Variablen, wie Pfadabhängigkeit und Kritische Momente, werden in dieser Dissertation daher ebenfalls herausgearbeitet. Die Dissertation arbeitet mit sechs Hypothesen, die auf dem rationalen und dem historischen Institutionalismus

aufbauen und die ausführlich diskutiert werden. Einige Hypothesen konnten verifiziert, andere falsifiziert werden, wiederum andere bedürfen der Überarbeitung. Während die Hauptanalyse im Januar 2021 endet, werden im Epilog Entwicklungen bis in das Jahr 2024 angesprochen, die ggf. einige Leserinnen und Leser dazu bringen könnten, die Ergebnisse der Arbeit in Zweifel zu ziehen. Letztlich unterstreicht der Epilog vor allem die Notwendigkeit, theoriegeleitete Zugänge und Erkenntnisse im Lichte sich verändernder internationaler Dynamiken immer wieder zu hinterfragen.

Stichwörter: Kooperation zwischen EU und China, W&T Kooperation zwischen EU und China, Kosten-Nutzen-Rechnung, Gallileo-Projekt

Chapter 1 Introduction



1.1 Context of the Thesis

Globalization has made regions and countries increasingly interconnected. At the beginning of the book *Power and Interdependence: World Politics in Transition*, Robert Keohane and Joseph S. Nye mention that: "We live in an era of interdependence".[1] They developed the model of complex interdependence, which highlighted the emergence of transnational actors relative to states; they argued that the world has become more and more interdependent. Mario Telò explained the concept of the complex interdependence in the book *International Relations: A European Perspective*: "Whereas international relations concern states,

[1] Keohane, R. O. & Nye, J. S. (1977). "Power and Interdependence. World Politics in Transition". *Schlüsselwerke der Politikwissenschaft*, [Boston, Massachusetts: Little, Brown and Company] p. 205.

transnational relations include sub-state and extra-state actors and create ‘complex interdependence’ at the global system level. Within the framework of interdependence, international institutions’ impact on state prerogatives grows.”[2] After the Cold War, the world developed rapidly towards increasing interdependence in a post-hegemonic context. Power was diffused, and new international institutions were sought after by different actors in order to find new rules for global governance.

It is incontestable that strategically, China and the EU have and continue to pay close attention to science and technology (S&T) innovation and research and development (R&D) with the purpose of stimulating economic growth in the context of complex interdependence. In the current era, in order to achieve economic development, maintain security and advance global governance, countries and international organizations need to participate in international cooperation. The development of the EU-China partnership proves how strong this need is. After the creation of the *China-EU Comprehensive Strategic Partnership* in 2003, the cooperation in a wide range of areas continued to deepen and expand. In November 2013, the two parties signed the *China-EU 2020 Strategic Agenda for Cooperation*, intending to strengthen their cooperation in promoting peace, prosperity, sustainable development, cultural exchanges and other fields.

The field of science and technology (S&T) is one of the most influential and promising fields of cooperation between the EU and China.[3] The EU has been the

[2]Telò, M. (2016). *International relations: a European perspective*. Routledge, p. 84.
[3]Zhang, M. (2011). “What are the achievements and problems of China EU science and technology cooperation?”
<http://ies.cass.cn/Article/yjsjy/kyfd/201103/3614.asp> last visited on 6, 2019

most significant technical cooperation partner and the most prominent technology supplier for China.[4] EU-China S&T cooperation has three main channels: the S&T cooperation under the European Commission's Framework Program; the intergovernmental S&T cooperation between China and the EU member states; and Sino-EU technology trade. It is crucial for both sides to work together to meet global challenges. The EU and China started their S&T cooperation in the early 1980s. In 1998, they signed the formal framework agreement for scientific and technological cooperation[5]. With joint efforts from both sides, EU-China S&T cooperation has continuously improved and been enriched, and achieves remarkable results. However, although the EU and China launched comprehensive and pragmatic cooperation in the field of S&T, achieved gratifying results, there are still some problems that cannot be overlooked: export restrictions on high-tech products, trade friction, intellectual property rights, and so on. These frictions are not unique to the China-EU relationship but also appear in other bilateral trade agreements: for example, in the spring of 2018, the Trump administration of the United States imposed tariffs on 60 billion dollars' worth of goods imported from China, and China also took corresponding countermeasures. The Sino-US trade war began and influenced Sino-EU relations. The context of international relations changed from cooperative/competitive to competitive/cooperative.

This dissertation analyzes and juxtaposes the EU Technology Policy and China's

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[4]European Commission. (2019). "European Commission and HR/VP contribution to the European Council. EU-China: A strategic outlook" <https://ec.europa.eu/info/publications/eu-china-strategic-outlook-commission-contribution-european-council-21-22-march-2019_en> last visited on 1, 2021

[5] European Commission. (1998). "Communication from the Commission. Building a Comprehensive partnership with China" <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:51998DC0181&from=EN > last visited on 1, 2021

Science and Technology Policy, and attempts to explain how the respective cost-benefit calculations of China and the EU influence the institutionalization of their S&T cooperation. Throughout, there will be three typical case studies: (1.) the Galileo project; (2.) The Europe-China Clean Energy Centre project (EC2); and, (3.) the Dragon program. These three cases will unpack interrelated issues from different angles. This dissertation has further determined that the cost-benefit explanations are insufficient for the institutionalization of Sino-EU S&T cooperation; other independent variables are also mentioned in the following text.

1.2 Literature Review

1.2.1 International Cooperation

Cooperation refers to a joint action by individuals or groups towards a common goal. For international cooperation, a number of scholars have made related discussion: Keohane, a representative of the neoinstitutionalists, argues that "cooperation occurs when actors adjust their behavior to the actual or anticipated preferences of others, through a process of policy coordination."[6] That is to say, when a country's policy is considered by other countries as complementary to their own stated goals, cooperation among nations will occur. Cooperation is a situation

[6]Keohane, R. O. (2005). *After hegemony: Cooperation and discord in the world political economy*. Princeton University Press, p. 51.

where through a harmonization process, policies are adjusted so as to obtain cooperation rather than discord; and behavioral patterns are altered via coordination to achieve cooperation. In the book *Contending Theories of International Relations: A comprehensive survey,* James Dougherty and Robert L. Pfaltzgraff defined international cooperation: "cooperation may occur when the behavior body adjust their behaviors in response to anticipated preferences of others. Countries can discuss their cooperation way in clear or default bargaining process. Cooperation can also be the result of the relationship between strong behavior body and weak behavior body".[7] The book *Interregionalism and the European Union: a post-revisionist approach to Europe's place in a changing world,* edited by Mario Telò, Louise Fawcett, and Frederik Ponjaert advances a novel theoretical 'post-revisionist' approach, expresses that interregionalism is again considered a key element of the multiplex world, and studies the influence of EU's interregional policy on other regional cooperation in the world.[8] Chinese Former Foreign Minister Qian Qichen also made a summary to the definition of international cooperation, he considered that international cooperation refers to the different levels of coordination, unity and mutual support among international political behavior bodies, because of their respective interests and objectives are consistent or partly consistent.[9] In parallel from the academic perspective, Li Shaojun, a researcher of Institute of World Economics and Politics of Chinese Academy of Social Sciences, put forward that international cooperation is voluntary policy adjustment act which the international political actors taken to coordinate the differences so as to achieve common

[7]Daugherty, J. E., & Robert L.(1981). *Contending theories of international relations: A comprehensive survey*. New York: Harper & Row, pp. 19-20.
[8]Telò, M. (2015). "Three Reasons for Reassuring the Autonomy of a Regionalist and Interregionalist Research Agenda", in Telò, M., Fawcett, L., & Ponjaert, F., *Interregionalism and the European Union: A Post-revisionist Approach to Europe's Place in a Changing World*. Routledge, pp. 67-71.
[9]Qian, Q. (2003). *Ten episodes in China's diplomacy*. World Affairs Press, p. 390. 钱其琛:外交十记

interests of all parties.[10] Generally, I reference the neo-institutionalist perspective more frequently, as all my cases are grounded in neoliberal institutionalism, and I am exploring avenues for further institutionalization.

1.2.2 EU-China Cooperation

China is the largest developing country and is considered the world's third largest economy, even in the scenario where the EU is considered as a single economy. The European Union has 28 member states; it is a supranational organization and one of the biggest trade groups globally. Along with the acceleration of the European integration process, the overall economic strength of the EU increased rapidly and its political influence is also growing. As a result, scholars began to pay close attention to the relationship between China and the European Union. Some works which comprehensively discussed China's relations with the EU include: *The European Union and China: A European Strategy for the Twenty-first Century* written by Richard L. Grant[11], which provides an in-depth analysis of the political and economic relations between the EU and China and offers some suggestions on the EU's policy towards China in the 21st century; *China and Europe since 1978: a European Perspective* written by Richard Louis Edmond[12], which studies the political, economic and cultural development of China after its reform and opening up, and gives an in-depth analysis of China-EU relations from the perspectives of

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[10]Li, S. (2004). "International Relations Theories and Reality". *World Economics and Politics*, 2 , pp. 20-26. 李少军：国际关系理论与现实

[11]Grant, R. L. (1995). *The European Union and China: A European Strategy for the Twenty-First Century*. Royal Institute of International Affairs, Asia-Pacific Programme

[12]Edmonds, R. L. (2002). "China and Europe since 1978: An Introduction" in Edmonds, R. L., *China and Europe since 1978: a European perspective*. Cambridge University Press. pp. 1-9.

diplomatic strategy and mutual recognition; and, *Deepening the EU-China partnership: Bridging institutional and ideational differences in an unstable world* edited by Mario Telò, Ding Chun, Zhang Xiaotong,[13] which brings together the research results of more than a dozen well-known Chinese and European scholars on China-EU relations and related policy fields, and explores the commonalities and differences between the EU and China in terms of ideas, politics, institutions, and interests. These three works are of great significance for European studies, Chinese studies, regional studies, and global governance. From China, the books which focus on the relations between China and the EU include the following: in *A Study of China-EU Cooperatio*n, Guo Guanyu analyzed the motivation and the current situation of China-EU cooperation from the perspective of international cooperation[14], by reviewing the history of cooperation between China and the European Community, China and the European Union, and looking into the current Sino-EU cooperation, Guo concretely analyzes the motivation of cooperation between China and the European Union after the cold War from four aspects: economy, politics, security and concept. Additionally, the book *China-Europe Relations: Perception, Policies and Prospects* edited by David Shambaugh, Eberhard Sandschneider and Zhou Hong, presents a collection of essays and covers the most important issues the in China-EU relations in a very systematic and comprehensive manner.[15] Also, *International System and Sino-European Relations* edited by Zhu Liqun[16], uses the international system view to study Sino-European relation and makes a comprehensive and systematic analysis and

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[13]Telò, M., Ding, C., & Zhang, X.(2017). *Deepening the EU-China partnership: Bridging institutional and ideational differences in an unstable world.* Routledge

[14]Guo, G. (2006). *A Study of China-EU Cooperation.* World Affairs Press 郭关玉:中国-欧盟合作研究

[15]Shambaugh, D., Sandschneider, E., & Hong, Z., (2007). *China-Europe relations: perceptions, policies and prospects*. Routledge

[16]Zhu, L. (2008). *International System and Sino-European Relations.* World Affairs Press 朱立群: 国际体系与中欧关系

discussion on the structure, interaction model and characteristics of Sino-EU relations, the internal and external factors influencing the development of Sino-EU relations, and the relations in different areas. In the book *The EU long-term policy towards China and China-EU economic and trade relations,* edited by Qiu Yuanlun and Wang He, focuses on the economic and trade cooperation[17], this book believed that both China and the EU are committed to removing obstacles for cooperation in the economic field, expanding the depth and breadth of cooperation, and taking active actions to this end. In addition, the Chinese Academy of Social Sciences published the European Development Report annually; the report also discussed China's relations with the EU.

1.2.3 International S&T Cooperation and EU-China S&T Cooperation

A review of the literature suggests that international relations scholars pay inadequate attention on the issue of EU-China S&T cooperation. The book *A Study of China-EU Cooperation* which written by Guo Guanyu involved China-EU cooperation in the field of science and technology, but it was a simple factual description rather than analysis. *Technology and international relations* edited by Otto Hieronymi[18], *Technology and international relations* written by John V. Granger[19], and *An introduction to strategic studies: military technology and*

[17]Qiu, Y., Wang H. (2000). *The EU long-term policy towards China and China-EU economic and trade relations*. Social Sciences Academic Press 裘元伦，王鹤：欧盟对华长期政策与中欧经贸关系
[18]Hieronymi, O.,(2015). *Technology and international relations*. Springer
[19]Granger, D. & John V. N. G. (1979). *Technology and international relations*. W. H. Freeman

international relations written by Barry Buzan[20], were more analytical but focused only on the specific relationships between selected areas of technology and international politics, such as agriculture, environmental protection, international trade, and military technology, etc.

Works on the relationship between technology and economy are mainly focused on technical economics mechanisms, but most of the technical economics mechanisms are focus on the micro level, such as the development mode of technology industry within a country, Research and Development and organizations, and rarely involve technical and economic strategic issues which at national level. In the book *Extending Great Wall – The Road to Chinese Space Technology Industrialization* which written by Du Zongchao, the industrialization of satellite navigation industry was mentioned. A good foundational resource, but published too early to involve the Galileo project.[21] Within China, the majority of articles that reference "Galileo project" are news reports and the specific technical analysis. Works take that highlight the Galileo project as an example to make concrete analysis of international relations are only the following: *Cooperation between EU and China: A perspective of Mercantile Realism* written by Chen Hui;[22] *Analysis of the triangular relationship of China, US and Europe* written by Ren Dashun;[23] *Contemporary China's Participation in International High Science-technology Cooperation from the view point of China-EU "Galileo Project" Cooperation*

[20]Buzan, B. (1987). *An Introduction to Strategic Studies: Military Technology and International Relations*. London: the Macmillan Press LTD

[21]Du, Z. (2000). *Extending Great Wall – The Road to Chinese Space Technology Industrialization*. Beijing: Beijing University of Posts and Telecommunications Press 杜宗超：延伸的长城:中国航天技术产业化之路

[22]Chen, H.(2006). "Cooperation between EU and China: A perspective of Mercantile Realism". *Journal of Shandong Institute of Business and Technology*, 20(2), pp. 8-12. 陈辉：重商现实主义视角下的中欧合作

[23]Ren D. (2007). "Analysis of the triangular relationship of China, US and Europe". *Journal of Science and technology information*, 7, pp. 56-57. 任大顺：中美欧三角关系研究

written by Liao Zhicong.[24] The first article mainly analyzes the economic benefits and the incentive of Galileo project: the balance behavior; although the second article talks about interaction issues of Sino-EU and Sino-US as a result of Galileo project, but the analysis is not in-depth; the third article analyzes the main international political issues in Galileo project and its value to China and the EU.

1.3 Gap in the Existing Literature

In the literature review, we can see relatively few studies on Sino–EU scientific and technological cooperation; political science scholars have paid inadequate attention to Sino–EU relations in the field of S&T. Researchers have mainly used economic methods to study it, while research methods in political science were seldom used. Also no research has been done regarding the theory of new institutionalism. Moreover, scholars have focused only on specific relationships between selected areas of technology and international politics, and the existing literature lacks a comprehensive analysis.

Currently, as China and the EU have become more interdependent, many research institutions in both the EU and China study Sino–EU relations. However, only a few of them have focused on the field of S&T.[25] China had a Science and

[24]Liao Z. (2008). "Contemporary China's Participation in International High Science-technology Cooperation from the view point of China-EU "Galileo Project" Cooperation". Renmin University MA Thesis, 2008. 廖智聪：从中欧"伽利略计划"合作看当前中国对国际高科技合作的参与

[25] Here, the field of S&T refers to comprehensive S&T, not a specific area such as energy.

Technology Policy Research Office in the Institute of European Studies at the Chinese Academy of Social Sciences, the only office that specializes in EU science and technology, but it does not exist now because of the subject reorganization of that institute.

Science and technology is increasingly essential; the first, second, third, and fourth scientific and technological revolutions have had a great impact on international politics. Before the wave of the fourth scientific and technological revolution, each country put forward their Industry 4.0 plans. In China, this was “Made in China 2025.” The field of science and technology has become more important, and cooperation between the two actors in this field is also crucial. Science and technology is one of the most influential and potential areas of cooperation between the EU and China. The EU has always been China’s largest technology partner and supplier.

1.4 Research Proposal

1.4.1 Research Motivation

From the early 1980s EU-China loose S&T cooperation, the 1998 EU-China S&T cooperative Framework agreement, to the 2013 China-EU 2020 strategic agenda for cooperation, the degree of cooperation between the EU and China is deeper and deeper. Why did EU and China begin to cooperate in the field of S&T? How did the cooperation start? And why they continue this cooperation?

Although the EU and China launched comprehensive and pragmatic cooperation in the field of Science and Technology, achieved gratifying results, there are still some problems we cannot ignore in the cooperation: the pressure from US, export restrictions on high-tech products, trade friction and non-governmental cooperation. Why there are problems in the S&T cooperation between the two sides? Why these problems occurred? Why do China and the EU keep cooperating? (Under much more difficult conditions)

The questions above are what triggered my interest in the whole issue; I would like to find out more about how and why are they cooperating. In order to turning these general interest questions into a political sciences research question, and making some contribution to the research gap in the field of Sino-EU S&T cooperation. New institutionalism is chosen as the theory tool. This dissertation attempts to explain Sino-EU S&T cooperation with the theoretical tool of rational choice institutionalism and historical institutionalism. Rational choice institutionalism and historical institutionalism are two theoretical approaches to institutional analysis in political and social sciences. They examine how institutions influence behavior and outcomes from different perspectives.[26]

From my point of view, the reason of Sino-EU S&T cooperation could be analyzed by cost-benefit analysis, but a pure calculation of gains and losses has limited the

[26] These concepts and theoretical approaches are introduced in more details in Chapter 2.

research to micro-level, it is not enough to explain the comprehensive scientific and technological cooperation. Any international cooperation cannot only be microcosmic or material. It has a broad sense, national interests, and also accompanied by political limitations.

1.4.2 Research Question

Since the adoption of the EU-China Comprehensive Strategic Partnership for mutual benefit in 2003, how and to what extent did the cost-benefit calculations of China and the EU influence the institutionalization of their S&T cooperation and are there further explaining variable to be taken into account?

In order to answer this research question, I am going to look at the relevant policies that have influenced and impacted bilateral S&T cooperation between the EU and China: specifically, I will analyze the EU Technology Policy and China Science and Technology Policy and compare the Chinese National medium and long term S&T development plan 2006-2020, "Made in China 2025" and the European Framework Program for Research and Development.

Within this dissertation, the following sub-questions will also be unpacked:

1) Which internal or external factors have influenced the cost-benefit calculation of China and the EU?

2) Whether their benefits are symmetric or asymmetric? What do symmetric or asymmetric benefits have to do with the effectiveness of cooperation?

3) Are these explanations insufficient? Which other independent variables should be taking into account?

There are many factors that can influence China-EU cooperation in the field of Science and Technology. According to rational choice institutionalism, the cooperation of states is only because of their interest, not because of the history, culture, discourse, perception, or any other factors whereas as discussed in the preceding section, historical institutionalists believe that historical factors affect the international cooperation. This dissertation deals with the cost-benefit calculation of the interest of the EU and China and chooses rational choice institutionalism as its main theoretical approach. Therefore the cost-benefit calculation of the interest of China and cost-benefit calculation of the interest of the EU as identified as the independent variables. But due to the limits of rational choice institutionalism, this dissertation also explores the historical institutionalism as one additional independent variable. It plays a role through path dependency and possible critical junctures and might affects the China-EU S&T cooperation. This dissertation tries to combine cost-benefit calculation and historical institutionalism to explain China-EU S&T cooperation.[27]

I am observing a certain amount of stability of cooperation in S&T, and improvement overtime of cooperation in S&T. After the EU and China cooperated on the sustained basis, there is an institutionalization emerging, that is giving the

[27] For the sake of clarity and focus, I decided to concentrate on historical and cost-benefit institutionalism, leaving out sociological institutionalism.

cooperation more stable guarantee.[28]

This dissertation accesses institutionalization which is the dependent variable (the institutionalization of EU-China S&T cooperation), by looking at the degree, intensity, and effectiveness of the institutionalization, the following are the definition of degree, intensity and effectiveness in this dissertation:

a) Degree

The degree of institutionalization is regarding how far it has been normalized: whether there is an official agreement which formally defined the two sides' specific rights and obligations; whether there is a regulatory agency for the management of the project; whether the administrative staffs of the project are fixed, specialized, and focus on the project; whether it is a very structured, very deeply developed project.

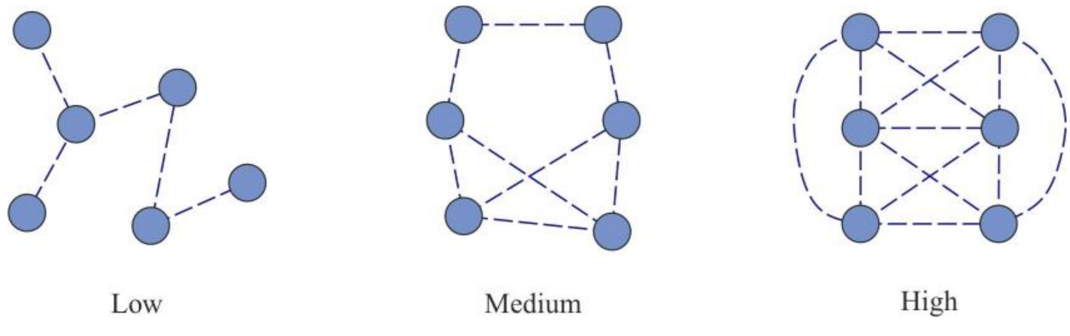


Figure 1.1 Degree

If there is no official agreement, the two sides' specific rights and obligations are

[28] About further definition on institutionalism, institutionalization, and cooperation, see Chapter 2.2.1 the choice of theory: institutionalism.

not clear in the cooperation, there is no regulatory agency and administrative staffs for the management, or the regulatory agency and administrative staffs cannot help to create effective links among the participants, the project is very loose, the level of degree of the institutionalization of the S&T cooperation is low.

If there is an official agreement defined the two sides' specific rights and obligations, there is a regulatory agency and/or administrative staffs for the management, they can provide some help to create links among the participants, the project is structured, the level of degree of the institutionalization of the S&T cooperation is medium.

If there is an official agreement formally defined the two sides' specific rights and obligations, they set a regulatory agency for the management, and the administrative staffs are specialized and focus on the project, they can provide enough help to create effective links among the participants, the project is very well structured, the level of degree of the institutionalization of the S&T cooperation is high.

b) Intensity

Intensity of institutionalization speaks of the depth and quality: the number of partners involved, whether larger or smaller; the diversity of partners involved (academic, business, local/central government etc.); whether the cooperation is only very narrow and specific on certain areas of S&T cooperation or does it include a large number of participating research facilities and scientists?

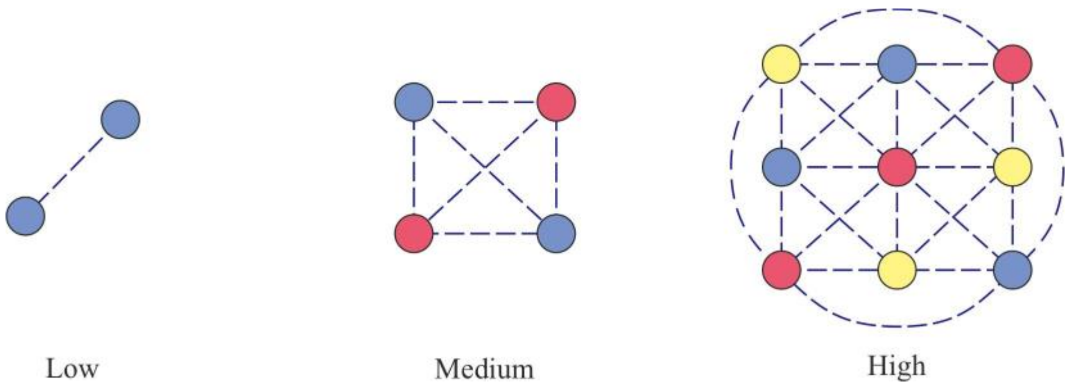


Figure 1.2 Intensity

If the project involves very few partners, the partners involved are less diverse, it is only very narrow and specific on certain areas, the level of intensity of the institutionalization of the S&T cooperation is low.

If the project involves some partners, and the partners involved are diverse, it covers some areas, the level of intensity of the institutionalization of the S&T cooperation is medium.

If the project involves many partners, the partners involved are very diverse (academic, business, local/central government etc.), it includes a large number of participating research facilities and scientists on different areas, the level of intensity of the institutionalization of the S&T cooperation is high.

c) Effectiveness

Effectiveness refers to the state of objectives of the S&T cooperation: whether these initially formulated objectives achieved or not.

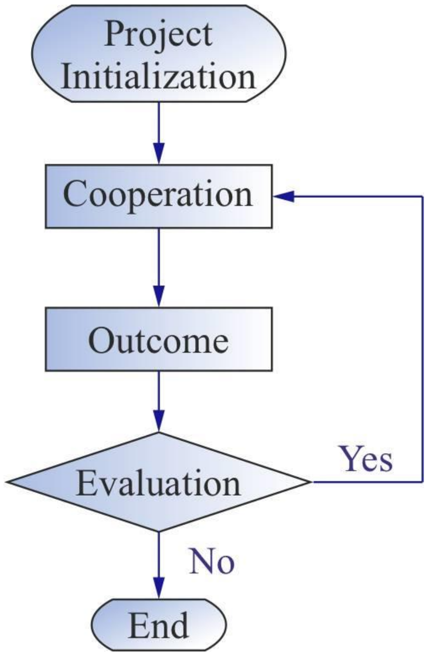


Figure 1.3 Effectiveness

If most of the initial formulated objectives are not achieved, both sides are unsatisfied and they stop further cooperation, then the level of effectiveness of the institutionalization of the S&T cooperation is low.

If the initial formulated objectives are partly achieved, both sides are not that satisfied, but they still find some possibility for future cooperation, the level of effectiveness of the institutionalization of the S&T cooperation is medium.

If the initial formulated objectives are fully achieved, both sides are satisfied and they start a new cooperation project, the level of effectiveness of the institutionalization of the S&T cooperation is high.

This dissertation studies the degree, intensity and effectiveness of the institutionalization of the S&T cooperation in 3 different cases over time.

1.4.3 Limits of the Research

Given the complexity of China's political science and EU's decision-making process, as well due to the limitation of the author's knowledge, time and ability, this study cannot completely describe the full-scale Sino-EU S&T cooperation.

This dissertation assumes that EU and China are rational actors, focused on cost-benefit calculation. However, the behavior of EU and China in real cooperation was influenced by many other factors, and the assumption is incomplete.

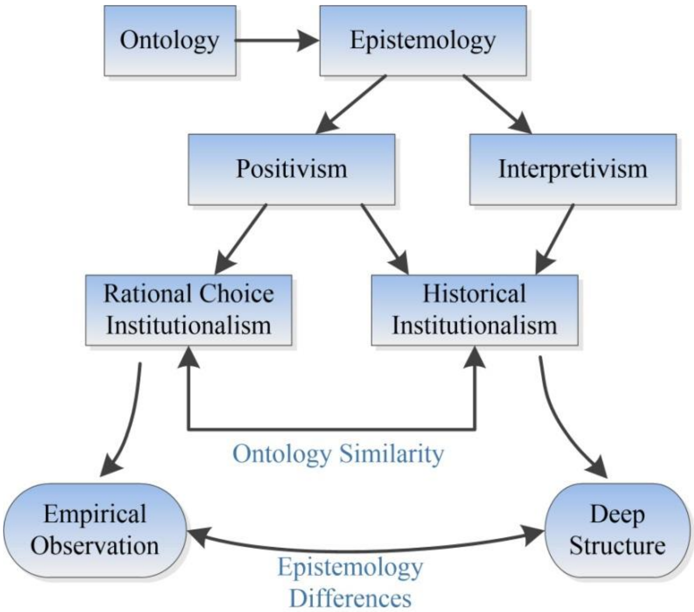
EU-China S&T cooperation has many channels: the S&T cooperation between China and the EU under the European Commission's Framework Program; the intergovernmental S&T cooperation between China and the EU member states; and cooperation among private enterprises. Also, due to the limit of volume and time, this dissertation only studies the EU lever cooperation with China, and the three cases are chosen based on this.

The EU is not a country; its decision-making was influenced by its internal member states and, sometimes, the US. In this dissertation, this is not mainly considered, the EU is still considered as an isolated rational actor.

Finally, the timeline of this dissertation is: from 2003, the EU-China comprehensive strategic partnership to January 2021, the completion of negotiation of the EU-China investment agreement. All three cases are selected after 2003.

Chapter 2 Research Design and Methodology

2.1 Ontological Consideration and Epistemological Consideration of the Research



Ontology explores the main problem of what we can know about the world, whether there is a real and objective existence of the external world. [29] Epistemology primarily concerned with whether and how we can and should understand the world. [30] From the relationship between ontology and epistemology, it is not difficult to find that different stances on ontology will directly lead to people's choice of different stances on epistemology, thus forming a close relationship

[29] Gruber, T. (1993). "What is an Ontology." pp. 1-11.
[30] Greco, John. (2017). "Introduction: What is epistemology?." The Blackwell guide to epistemology . pp. 1-31.

between ontology and epistemology which is difficult to be separated.

As far as positivist scholars are concerned, because they are deeply influenced by the thinking of natural science research, they affirm the objective existence of the real external world at the ontological level, and it will not be transferred by human consciousness. At the epistemology level, they believe that the objective world can be observed through direct experience, advocate the study of the social sciences can be according to the Causal analysis method and theoretical prediction path, also believe that if strictly apply scientific method, social sciences could develop social rule which is similar to natural science rule, without being limited by the external elements.[31]

As far as the scholars who hold the interpretivist position are concerned, there are fundamental and opposite views between the interpretivist and positivist. On the ontological side, the interpretivist completely deny the objective existence of the real external world, they believe that the world is presented in the way it is explained by human thought and practice. In other words, it is the belief that the whole world is artificially constructed and that social phenomena do not exist independently of our interpretation of them. On the contrary, it is the artificial discourse interpretation of social phenomena that affects people's cognitive results of the world. Therefore, in the aspect of epistemology, the interpretionists deny the idea of understanding the world from the perspective of explaining the causal relationship between social phenomena, and advocate that they should focus on identifying artificial discourses and traditions, engaging in interpretation and

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[31] Alharahsheh, H. and Abraham P. 2020） "A review of key paradigms: Positivism VS interpretivism." Global Academic Journal of Humanities and Social Sciences 2.3 pp. 39-43.

exploring their meanings attached to social phenomena.[32]

Rational choice institutionalists are mostly positivists. Its scholars, born out of rational selection, seek to identify the preferences of individual actors and, after the event, try to show how institutions can be understood as the result of rationally calculated actions. They usually first design some kind of institutional function with the pattern norm, and then explain the necessity of institutional existence by pointing out the value of the institutional function that has the influence on the actors. Their logical starting point is deductive, its point of view is from the general deduction to the special, advocate using empirical facts to prove the theoretical hypothesis model, and to predict the next development of things.[33]

Historical institutionalists do not emphasize elaborate theoretical frameworks, but emphasize the continuous influence of rules, norms and operating procedures on the outcome of decisions. They believe that it is the deep and long-lasting institutional structure itself that plays an important role in political life. The research logic is inductive rather than deductive.[34]

Ontologically, I am an institutionalist, in terms of researching topics international relations; my main research approach in epistemology approach in this dissertation is positivism, where I believe that truth can be found through investigation. However, during the process of analysis, there are something could not be

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[32] Alharahsheh, H. and Abraham P. 2020） "A review of key paradigms: Positivism VS interpretivism." Global Academic Journal of Humanities and Social Sciences 2.3 pp. 39-43.
[33] Udehn, L.(2003). "The methodology of rational choice." The Blackwell guide to the philosophy of the social sciences pp. 143-165.
[34] Prasch, Robert E. (2000) "An institutionalist perspective." Complexity and the History of Economic Thought p. 215.

quantified and measured, they need to be interpreted, especially the history background. Interpretivism also functioned in my dissertation.

2.2 Theoretical Framework

2.2.1 The Choice of Theory: Institutionalism

The external action of a state is taken on the basis of promoting the interests of the state. According to rational choice, a state always chooses actions that maximize their possibility of achieving their national goals. Neo-institutionalists believe that under the environment of international interdependence, states can get more benefit from cooperation among states: there is a larger cost not to cooperate. International cooperation needs the assistance of international institutions in order to increase the international flow of information, and promote the mutual consultation among countries, increase the chance of cooperation. In other words, if countries have common interests and have cooperation intention, building institutions is a feasible option.

Keohane defined international institutions as a set of formal and informal rule systems which stipulate the behavior responsibility, restrict the action, and influence the expectation of the actors. The formal and informal rule systems are lasting and connected with each other.[35]

International institutions are an effective mechanism and act as an institutional guarantee for the realization of international cooperation. International institutions can exert its consultative mechanism, assist the states to reach an agreement, promote their common interests. International institutions have several functions and features. First, to reduce the cost of international communication. Without an existing mechanism and set standards for interaction within the international community, all negotiations would start from the beginning and it would be a significant cost to different countries. The interdependent degree of international community has increased a lot, with more and more consultation activities, and the demand for international institutions has therefore also increased.[36] Second, to provide the basis of legal framework: the international institutions are not mandatory legal norms, but support established principles, norms, rules and decision-making procedures, which members are expected to abide by and therefore can contribute to international agreements. Third, to provide sufficient information: insufficient information is a major obstacle to international cooperation, it places the international community in an uncertain position with mutual suspicion. International institutions can provide the participating countries with reliable and high-quality information; members can get sufficient information and have higher predictability for each other. The more transparent and more reliable information they have, the greater chance for them to promote international cooperation. Fourth, exert supervisory function: the establishment of international

[35]Keohane, R. O. (1988). "International institutions: Two approaches". *International studies quarterly*, pp. 382-384.
[36]Keohane, R. O. (1982). "The demand for international regimes". *International organization*, 36(2), pp. 331-334.

standards can be taken as the basis of the evaluation of national behavior. To the offender of the international standards, we can use the system specifications or external pressure to increase the cost of it, force it to correct violations. Fifth, international institutions can affect and change national behavior: the interactive relations between international institutions and national behavior can be used as dependent variables and independent variables. The change of the expectations and procedures which bring by the international institutions can have a profound impact to the countries. [37] States are willing to use the rules and decision-making procedures within the system to resolve the international problems, or use institutional norms for national diplomatic goals. International institutions could adjust and develop along with the changes of the international environment and the needs from the members; it could expand the original goals and play more roles. If international institutions cannot produce the expected value, or there are significant changes from environmental factors, the international institutions will tend to be weakened or even collapse.

Since 1998, when China and EU opened bilateral science and technology exchange as a result of globalization, to now, they have formed a highly interdependent relationship. However, because of the different political platforms between the European Union and China, the two sides still lack a thorough institutional consultation mechanism, and this hinders the further development of cooperation. Along with the further deepening of scientific and technological cooperation between China and EU, institutionalized consultation mechanisms are needed to deal with derivative problems through communication. In December 1998, the two

[37]Keohane, R. O. (1989). *International Institutions and State Power*. Essays in International Relations Theory. Avalon Publishing, p. 77.

sides signed a historical science and technology agreement, their first cooperative framework agreement. The most significant aspect of the cooperative framework agreement was that the European Union and China "institutionalized" their negotiation, they all agreed on a win-win and mutually beneficial cooperation direction, and considered that the institutionalization of negotiation can deepen cooperation, increase mutual trust, and pursue long-term common interests.

In the book *After Hegemony: Cooperation and Discord in the World Political Economy*, Keohane defined cooperation: "cooperation occurs when actors adjust their behavior to the actual or anticipated preferences of others, through a process of policy coordination. To summarize more formally, intergovernmental cooperation takes place when the policies actually followed by one government are regarded by its partners as facilitating realization of their own objectives, as the result of a process of policy coordination."[38]

Institutionalization is normally looked at by international relations scholars, like Keohane, only referring to the state domain, international organizations. In this dissertation, institutionalization can also take place in a rapid increasing private to private or private to semi-private institutions that do cooperate. My reference partners are mainly S&T research institutions of China and the EU, the institutionalization would show mainly in the form of private to private cooperation that follows up of the S&T cooperation.

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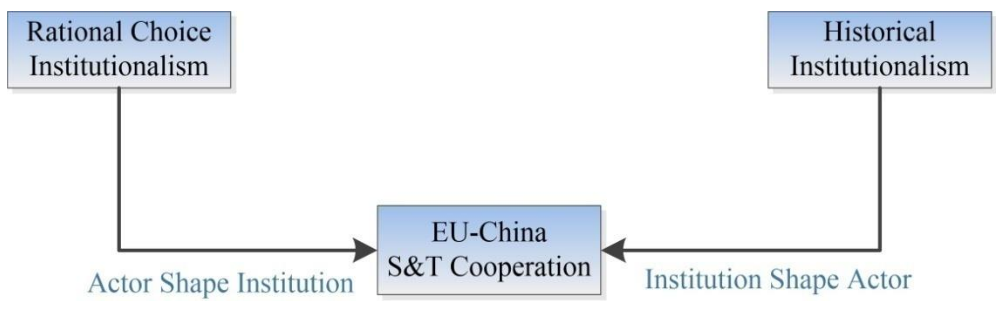
[38] Keohane, R. O.(2005). *After hegemony: Cooperation and discord in the world political economy*. Princeton University Press, pp. 51-52.

Institutionalization, other than that, refers to treaties. There are some treaties in the early 21st century; Sino-EU S&T cooperation is established on a new legal basis. On the basis of new cooperation agreement, a lot of private to private, and private to semi-private forms of S&T cooperation emerged. Institutionalization is a basic agreement and from then on, a multiplicity of other forms of cooperation that emerged. In order to reach such an agreement, the EU and China have to cooperate, the two sides have to have general interest in finding common ground, in agreeing on some cooperation bilateral agreements, and fixing them it in international legal terms, that is the institutionalization of their cooperation.

Every process of institutionalization will demand some form of cooperation. They are not the same, but they are linked. It is impossible to get to institutionalization unless there is profound cooperation. The institutionalization is no prediction to the success of cooperation, there are lots of intervening variables also come into play. Some components of institutionalization can be measured[39], this dissertation will study on the degree, intensity, and effectiveness of the institutionalization.



Rational choice institutionalism focuses on actor choice, it is based on choices

[39] Keohane, R. O. (1969). "Institutionalization in the United Nations general assembly". *International Organization*, *23*(4), p. 860.

among rational actors. In this dissertation, EU and China are supposed to be rational actors, they pursue rational interest. Historical institutionalism emphasized on that institution shape actor, this is the opposite of rational choice institutionalism. Common interest pushed China and EU to cooperate in the field of S&T. Meanwhile, the cooperate institution they built also shaped their behavior, the two theories explained Sino-EU S&T cooperation from two aspects: actor and institution. For example, the 2003 EU-China Comprehensive Strategic partnership, it institutionalized the cooperation. It played a great role in restraint the two sides' behavior and shaped the foreign policy of the two sides. This dissertation will analyze Sino-EU S&T cooperation from two perspectives: Actor and Institution, with the theoretical tool of rational choice institutionalism and historical institutionalism.

2.2.2 Strand 1 - Rational Choice Institutionalism

In the book *The Twenty Years' Crisis, 1919-1939: an introduction to the Study of International Relations*, Edward Carr put forward the basic idea of the earliest realism: power is the core factor of politics.[40] Later on, at the end of the Second World War, Morgenthau concluded six principles of realism in his book: *Politics Among Nations* and defined the interest of the state as power.[41] Classical realism has put too much emphasis on the pessimistic side of human nature and the objectivity of things, conflicts between countries under anarchy, so it is hard to use

[40]Carr, E. H. (2016). *The Twenty Years' Crisis, 1919-1939: Reissued with a new preface from Michael Cox*. Springer, p. 97.
[41]Morgenthau, H. J. (1985). "Politics Among Nations", revised by Kenneth W. Thompson. *New York: KnOpt*, pp. 4-15.

it to explain the existing and possible cooperation in international relations. There is not only conflict and confrontation, but also various forms of cooperation among states. So, it left a space for the emergence of new realism.

In 1979, Kenneth Waltz published his *Theory of international politics*, focused international relations research on the structure of the system. Compared with classical realism, neorealists believe that power is still a core strength, but it is not the goal, only a necessary and inevitable part of political relationship and a useful means for states to achieve their goals. The national pursuit of the ultimate goal is not power, but safety.[42] By the mid-1990s, neo-classical realism appeared. Their opinion is that, although the national power and the position of the state in the international system definitely affect the choice of the country, other factors such as cognition and values can also influence the foreign policy. They emphasize the importance of the international institutions; believe that countries could use the international institutions to reduce the impact of international anarchy.[43]

Rational choice institutionalism was inspired by neo-realist arguments.[44] In the book *After hegemony*, Keohane provided a new theoretical angle based on institutional economics. He believed that all the efforts relevant to international cooperation was carried out under the background of an institution. Cooperation would occur only when the minimum institutional structure support framework was met.[45] In another book: *International institutions: Can interdependence work?* He

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[42]Waltz, K. N. (2010). *Theory of international politics*. Waveland Press, p. 194.
[43]Daugherty, J. E., & Robert L.(1981). *Contending theories of international relations:A comprehensive survey*. New York: Harper & Row, pp. 62-63.
[44]Telò, M. (2016). *International relations: a European perspective*. Routledge, p. 99.
[45]Keohane, R. O.(2005). *After hegemony: Cooperation and discord in the world political economy.* Princeton University Press, p. 30.

also mentioned that international institutions gave countries the ability to cooperate, in order to reduce transaction costs and achieve mutual benefits.[46] Different from traditional realism, rational choice institutionalists believe that the existence of institutions is the core factor for cooperation. Institutions are instruments of the state; they are not autonomous but dependent on interest. Actors calculate their cost-benefit to make their choice in favor of cooperation.

In neo-institutional theory, rational choice institutionalism is an important genre: it sets up a theoretical system to explain the rational choice of political actors in institutions. The logical premise of rational choice takes rational people with the cost-benefit calculation ability as a starting point, and from there provides a microeconomic foundation for the study of political behavior. Rational choice theory does not deny the multiple motives of human behavior, but it believes that the economic incentive is the most stable influencing factor.[47] Under the premise of inheriting rational analysis, rational choice institutionalism emphasizes the restraining effect of institutional structure on the strategy choice and the result of behavior. The relationship between the intrinsic preference, external behavior and the institutional situation are the main research contents. Due to the hypothesis of rational person, decision-making can only affect the cost-benefit calculation of the actors, in order to avoid collective dilemma between the actors, the design of incentive mechanism builds the system of strategy selection.[48] Rational choice institutionalists choose the individual, or some analogue of the individual, as the

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[46]Keohane, R. O. (1998). "International institutions: Can interdependence work?". *Foreign Policy*, p. 86.
[47]Hall, P. A., & Taylor, R. C. (1996). "Political science and the three new institutionalisms". *Political studies*, *44*(5), pp. 947-948.
[48]Peters, B. G. (2019). *Institutional theory in political science: The new institutionalism.* Edward Elgar Publishing, pp. 60-66.

unit of analysis. They assume that the individual or some analogues are rational, if goals are given, and they have freedom to choose among different alternative strategies, they will select the alternatives that maximize their possibility of achieving their goals.[49]

Rational choice institutionalism can be applied to all aspects of political life, not only the main political system of western developed countries (legislatures, courts, voting and bureaucracy), but also the study of the developing countries (corruption, democratic transition, revolution).[50] Rational choice institutionalism, as one of the new institutional theories, has universal applicability in the social sciences; and quite importantly, it can be applied to Chinese political science research.[51] For example, it can be applied to the theoretical research and policy design of China's political institutional reform and the transformation from planned economy to market economy. Rational choice institutionalism uses the rules of formal logic, mathematics language and economic concept to analyze political phenomenon, takes the institutional factors as effective intermediary link of economics and politics, and attaches great importance to the economic and political function of institution.[52] Using an economic framework to study new institutions provides novel ideas for institutional research; it has made great contributions to the rigor and accuracy of the political sciences. For a long time, China's political science has

[49]Geddes, B. (2003). *Paradigms and sand castles: Theory building and research design in comparative politics*. University of Michigan Press, pp. 199-200.
[50]Cao, F. (2010). "Applicability analysis of rational choice institutionalism in political science in China". *Journal of Yunnan Administration College* 1, p. 36. 曹芳：理性选择制度主义在中国政治学中的适用性分析
[51]Cao, F. (2010). "Applicability analysis of rational choice institutionalism in political science in China". *Journal of Yunnan Administration College* 1, p.36. 曹芳：理性选择制度主义在中国政治学中的适用性分析
[52]Yang, G. (2005) "The development of the new institutionalism in political science in China". *Teaching and research*, 1, pp. 45-46. 杨光斌：新制度主义政治学在中国的发展

focused on the "grand narrative" of political phenomena. Rational choice institutionalism uses systematic method to study on the "micro-foundation" of political phenomena[53]; it is an important clarificatory tool for Chinese political science methodology. In this sense, rational choice institutionalism has certain applicable space in China.

According to the standpoint of rational choice institutionalism, cooperation among states is a significant and growing area of research. States are considered the principle actors in international relations; their action are taken on the basis of a costs-benefit calculation. The international institutions are regarded as "incentives structures" and the state preferences are a fixed given.[54] The reason for the construction of a cooperative system among countries is that there are common interests among them, and participants within the international system can benefit from it. What is the interest of China in Sino-EU S&T cooperation? And what is the interest of the EU? Whether their benefits are symmetric or asymmetric? These questions will be answered within this dissertation. China and the EU have chosen to carry out cooperation in the field of science and technology, because both sides have broad common interests. For example, the EU has strong advantages in many areas of science and technology; it can provide many development experiences for China in these fields. China is the biggest developing country in the world. It enjoys rapid economic development and abundant human resources, and can provide the EU with huge market potential and development opportunities. On one hand, the scientific and technological cooperation between the two sides is conducive to the

[53]Cao, F. (2010). "Applicability analysis of rational choice institutionalism in political science in China". *Journal of Yunnan Administration College* 1, p. 37. 曹芳：理性选择制度主义在中国政治学中的适用性分析

[54]Telò, M. (2016). *International relations: a European perspective*. Routledge, p. 99.

improvement of the efficiency of market development and the expansion of the industrial space; on the other hand, the cooperation can also promote industrial restructuring and industrial transfer of the two sides, meets the mutual interests of both China and the EU. The focus of science and technology cooperation between EU and China is to give both sides a win-win situation, at the same time of keeping active contact and close cooperation, improving their own research, technology innovation and national competitiveness together.

Rational choice institutionalists believe that the relationship between the individual and the system is reciprocal. Their impact goes both ways. The existence of international institutions can make countries change their behavior according to the changing external conditions and the cost-benefit calculation. In the past, China only participated in the activities of EU science and technology research and development passively. With the development of science and technology in China, as well as the new cooperation institution, China began to integrate the European science and technology plan and its own strategy of science and technology together; study the science and technology strategic direction and policies of the EU and its member states; and taking the enhancement of independent innovation ability as a starting point, made a new cooperation strategy combined with the scientific and technological resources in EU.

The hindering factors of the EU-China S&T cooperation may also be analyzed from the perspective of rational choice institutionalism. For example: the issue of export restrictions on high-tech products. When we take cost-benefit calculation, if they set restrictions for China and protect their intellectual property rights effectively, the EU can get benefits such as maintain their technology advantages and their competitiveness in the international market.

Sometimes, conflicts between EU and China occurred when the costs outweigh the benefits. For example: "Galileo project" is the largest S&T cooperation project between the EU and China. In 2007, China was completely excluded from the decision-making process of this program. From China side, they hold the opinion that China put into a lot of money and human resources, but cannot get the equal return.[55] Whether this factor will influence the China-EU S&T cooperation, this dissertation will deal with it and test the relevant hypothesis.

2.2.3 Strand 2 - Historical Institutionalism

Historical institutionalism places more emphasis on the role of institutions than rational choice institutionalism. For historical institutionalism, institutions constitute "intervening variables". Institutions have the ability to shape goals and preferences of the actors, they define strategies for political actors, so as to shape the political situation and influence the political results.

Historical institutionalists criticize that the strictly rational assumption of rational choice institutionalism is too narrow. They tend to believe that political actors are not rational maximisers who know all the information. In a larger extent, they

[55]Liao Z. (2008). "Contemporary China's Participation in International High Science-technology Cooperation from the view point of China-EU "Galileo Project" Cooperation". Renmin University MA Thesis, 2008. 廖智聪：从中欧"伽利略计划"合作看当前中国对国际高科技合作的参与

follow the rules of "satisfaction". What is more important, relative to the rational choice institutionalism, historical institutionalists don't think that the preferences are exogenous; they tend to see preferences as endogenous thing.[56] How the individual defines their self-interest was also a problem for them. Take the objectives, strategies and preferences as the dependent variables to explain, historical institutionalism stressed the importance of clear understanding of the background and the need for analysis with historical basis, in order to figure out what are the goals that political actors really want to achieve and why they want to put some targets above other targets.[57]

Therefore, historical institutionalism pays close attention to the impact of the institution longitudinally. From the point of view of historical institutionalism, in the process of history, all powers will be strongly influenced by the past background, namely the concept of "path dependency". The path dependency phenomenon is that when a kind of institution is selected, it will produce a kind of self-defending and strengthening mechanism by itself, and makes the torsion and exit of such an institution become more and more difficult over time. Historical institutionalism also stressed the importance of major historic junctures and described the weight of historic change on institutional developments.[58]

Different from rational choice institutionalism, historical institutionalism is more popular in Chinese academia. Historical institutionalism emphasizes the attention

[56]Praça, S. (2009). "Preference formation and institutional change" *Brazilian Political Science Review* (Online) <http://socialsciences.scielo.org/scielo.php?script=sci_arttext&pid=S1981-38212009000100004> last visited on 1, 2021
[57]Bates, R. H., Comisso, E., Lange, P., Migdal, J., & Milner, H. (1992). *Structuring politics: historical institutionalism in comparative analysis*. Cambridge University Press, pp. 10-17.
[58]Telò, M. (2016). *International relations: a European perspective*. Routledge, pp. 101-102.

to history and analysis the formation and change of institutions in the long history.[59] Although Chinese society has experienced many revolutions and changes, much of China's political phenomenon can be only explained clearly by linking them with China's history and tradition. Only if Western theories and systems of understanding are consistent with China's social reality, history and tradition, can they play its proper value and effect and can be accepted by Chinese people.[60]

In 1979, the policy of reform and opening of Deng Xiaoping was approved and came into force. China started to open its door and cooperate with the world outside. In 1998, Chinese former Prime Minister Zhu Rongji put forward a proposal which aimed to enhance Asia-Europe Science and Technology cooperation in the second annual Asia-Europe meeting in London. In the same year, the China-EU scientific and technological cooperation agreement was signed in Brussels. In 1999, the Chinese government and the council of the EU approved the agreement, and it formally went into effect. From then on, the EU's most influential framework program and China's most important national science and technology program ("973" and "865" program[61], etc.) open to each other. It symbolized a comprehensive open exchange and breakthrough between EU-China science and technology cooperation, supporting the substantial cooperation in the field of basic science and high technology between two sides. Since then, the areas of EU-China science and technology cooperation have expanded continuously. On December 11, 2001, China formally joined the World Trade Organization (WTO),

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[59]Zhang, Y. (2013). "On the Reason of Changes of Chinese Possession Institution——from the Perspective of Historical Institutionalism". *Academics*, 12, p. 272.

[60]Zhang, S. (2014). "Historical institutionalism: from 'System of regression' to 'path dependence', and the applicability to the theory of political science research in China". *Theory Monthly,* 3, pp. 112-113. 张晒: "历史制度主义：从制度回归到路径依赖-兼论在中国政治学研究中的适用性

[61]863 program: State High-Tech Development Plan of China, 1986
973 Program: National Basic Research Program of China, 1997

becomingits143th member. Although the EU still does not fully recognize China's market economy status, the extent and depth of China-EU science and technology cooperation has made considerable progress. In 2003, China and EU started their Comprehensive Strategic Partnership relationship, their cooperation in a wide range of areas continues to deepen and expand.

Despite their differences, historical institutionalism and rational choice institutionalism have a lot in common as a result of their convergence on institutions than is ordinarily realized. Rational choice scholars often imputed preferences to individuals without worrying much about their larger sources, while historical institutional scientists treated preferences as caused mainly by macro-level dynamics without much concern about the micro-dynamics of their interaction.[62] If this dissertation uses them both, it can better explain the whole China-EU S&T cooperation.

Because this research mainly deals with the cost-benefit calculation of the interest of the EU and China, it is better for to utilize rational choice institutionalism. And according to rational choice institutionalism, the cooperation of states is only because of their interest, not because of the history, culture, discourse, perception, or any other factors. However, historical institutionalism can help me to know well about the background of the EU-China S&T cooperation, and it can also compensate part of the limits of rational choice institutionalism, I am also going to use this theory.

[62] Katznelson, I., & Weingast, B. R. (2005). "Intersections between historical and rational choice institutionalism" in Katznelson, I., & Weingast, B. R., *Preferences and Situations: Points of Intersection Between Historical and Rational Choice In*. Russell Sage Foundation, pp. 23-25

2.3 Research Hypotheses

According to Rational choice institutionalists, actors calculate their cost-benefit to make their choice of cooperation.

Hypothesis 1: The better structured the cooperation, the higher the level of effectiveness in cooperation. If the China-EU S&T cooperation is too loose, it may increase the difficulties for their cooperation. If both China and the EU are rational actors, they must pay attention to the structure of cooperation in order to create an effective communication link among the participants.

Hypothesis 2: The more comparable the efforts and risk sharing in the cooperation, the more effective cooperation will be. If China and EU work together with similar input — not necessarily the same, but they can share the financial, resource or other burdens equally —the two sides are shown to be equally committed, and it may influence the final result of the cooperation. When the two sides share the risk, their way of cost-benefit calculation will change.

Hypothesis 3: Sensitivity of the area of cooperation: the less sensitive the area of cooperation, the more likely and easier the cooperation, and the more intense cooperation will be. If the area of cooperation is not that sensitive, there will be fewer conflicts and more contacts between China-EU S&T cooperation. Things related to intellectual property rights and military use always come along with many problems, including those of the political nature. For example, when Chinese company Huawei did its cooperation with the Belgian firm Option, there were many property disputes.[63] If the cooperation does not fall within those sensitive areas, the possibility to lose competitiveness and key technology will be reduced.

Hypothesis 4: The more symmetric the respective benefits in the cooperation are, the more intense and effective cooperation will be. If one side is always the provider, then the good will from that side will eventually fade. If both sides are satisfied with symmetric cooperation, the level of intensity and the level of effectiveness will be higher. If both China and the EU really depend on each other equally in one project, then the cooperation will go more smoothly. In order to achieve mutual benefits, with a fair distribution of labor, China and the EU will choose to cooperate with each other.

For historical institutionalism, institutions constitute "intervening variables". Institutions have the ability to shape goals and preferences of the actors, they define strategies for political actors, so as to shape the political situation and influence the political results.

Hypothesis 5: Path dependency. After China and EU established their cooperation in the form of framework cooperation, it has continued.

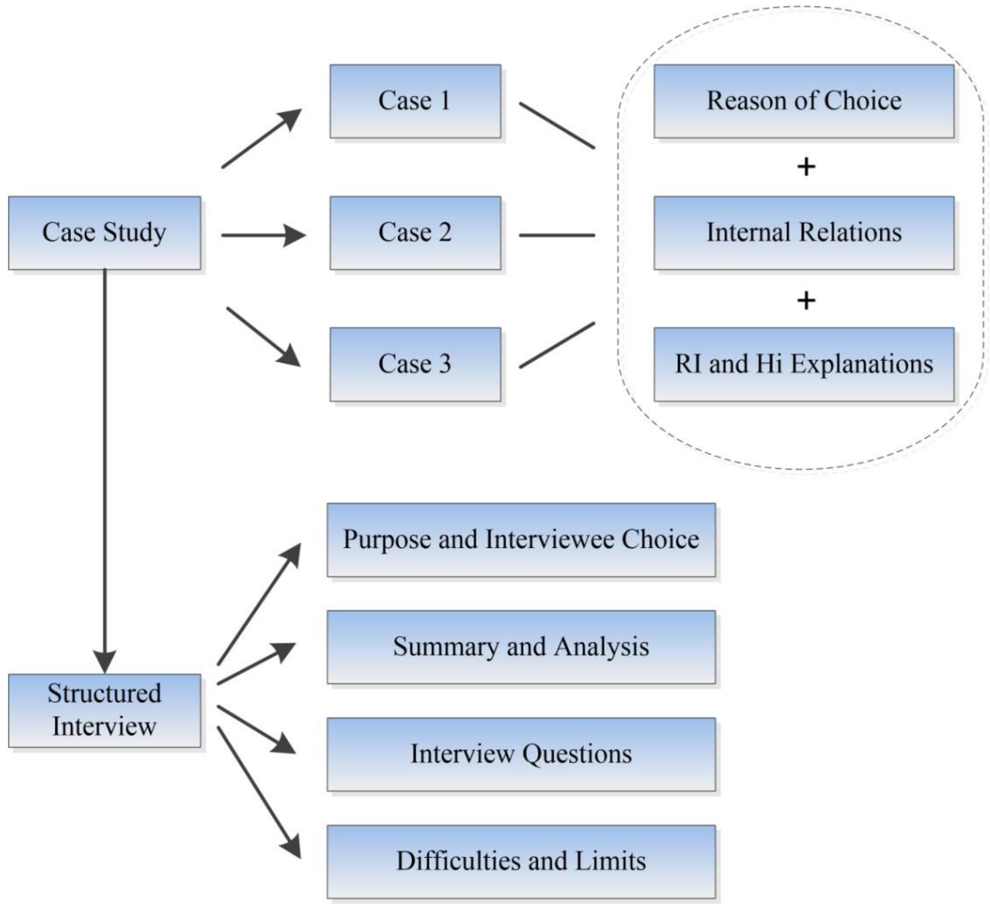
Hypothesis 6: Historical critical juncture. In 2015, the **"Made in China 2025"**

[63]Kathrin, H. (2010). "Huawei and Option forge telecoms technology alliance". *Financial Times*, <https://www.ft.com/content/b64ffb80-e1ec-11df-a064-00144feabdc0> last visited on 1, 2021

was issued for the transformation and upgrading of China's manufacturing industry. From the view of many Europeans, the "Made in China 2025" has already impacted on the S&T cooperation or non-cooperation between China and the EU. China rising to the top level in the field of S&T, and this will bring a fundamental change with new asymmetric relationship and will cause significant disruption.

This dissertation tries to explain the degree, intensity and effectiveness of the institutionalization of Sino-EU S&T cooperation on the basis of cost-benefit analysis and historical institutionalism. Those hypotheses were developed out of that, in order to test them, I will look at three cases by applying certain methodology: qualitative interviews, assessment of the literature, etc.

2.4 Research Method



2.4.1 Case Study

2.4.1.1 Case Study

This dissertation uses the case study method, and has selected three typical case studies of Sino-EU Cooperation: Galileo project; The Europe-China Clean Energy

Centre project (EC2); and the Dragon program. These three cases will explain related issues identified in the previous section from different angles, allowing for a more holistic view.

2.4.1.2 Case Selection

In the article *Case Selection Techniques in Case Study Research: A menu of Qualitative and Quantitative Options*, Jason Seawright and John Gerring mentioned that case selection in case study research needs a representative sample and useful variation on the dimensions of theoretical interest. They put forward seven case selection procedures: typical, diverse, extreme, deviant, influential, most similar and most different. Case selection in case study research needs a representative sample and useful variation on the dimensions of theoretical interest. Some case studies follow only one strategy of case selection, but many case studies mix and match among these case-selection strategies.

The case selection strategies of this thesis are influential, most similar and most different.

Influential cases are cases with influential configurations of the independent variables. Without this case, the whole relation between X (independent variable) and Y (dependent variable) may change. What is more, it is only apply for small to moderate sized samples. When it comes to the large sample, only one case of them is not that important.

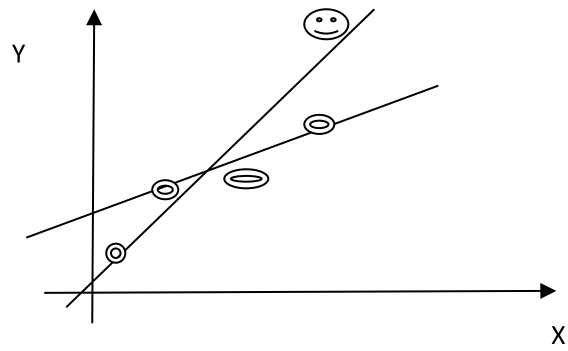


Figure 2.1 Influential Case and Its Impact on X-Y Relationship

From the figure above, we can see that without the Influential case (the smile face), the whole line will change.

Galileo Project is selected as the influential case, it is the largest S&T cooperation project between the EU and China. In 2003, EU and China signed their Comprehensive Strategic Partnership agreement, this agreement highlighted the importance of Galileo Project, and mentioned that new agreements covering cooperation on the EU's Galileo program should be concluded. In the very beginning of China-EU cooperation on this project, in the year 2003, the EU initially planned to put 3.2 billion Euros and China decided to invest 230 million Euros.[64] This project contained great political, economic and military meanings and has a high research value. In 2007, conflict between EU and China within the project led to the problem with China-EU relations, because of the project's important political strategic significance and economic effects. In order to avoid such conflicts, it is necessary to delve into the case. This dissertation analyses the

[64]People.CN. (2003) "China will join EU's Galileo project soon" <http://www.people.com.cn/GB/keji/1056/2791204.html> last visited on 3, 2018

main international political issues in the Galileo Project: the great values of the project towards China and the EU; the restrictive effect of China-EU divergence, and the different attitudes of the U.S. and Russia. In addition, it also analyses the international political influence of Galileo Project.

The Dragon program is China's largest international cooperation project in the field of earth observation. This program is funded by FP7, and aims to support the Chinese participation in Horizon 2020; the reciprocity originating from the signed EU-China Scientific Cooperation Agreement, the bilateral cooperation in scientific, technological and industrial research and innovation fields, and the ongoing EU-China Innovation Cooperation Dialogue.[65] Following recent high-level meetings between Chinese and ESA officials, it was decided to reinforce this cooperation.

EC2 project is with great important case in the field of clean energy, it is mentioned in the 2013 EU-China 2020 Strategic Agenda for Cooperation (the only mentioned project in the field of energy). The Europe-China Clean Energy Centre (EC2) is a five-year cooperation project between the EU and China. EC2 received 10 million Euros from the European side and 3.25 million Euros from the China side in 2009.[66] In the field of clean Energy, the EU and China have certain degree of complementarity, they can benefit from the cooperation with each other. Clean energy does not involve sensitive technology; environmental protection has always been advocated by the EU; and China's demand in this area is also large. Compare to the sensitive technology, cooperation in this field is easier. In the process of

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[65]<http://www.dragon-star.eu/> last visited on 4, 2018

[66]EU-China Clean Energy Centre <http://ec.europa.eu/europeaid/index_en.htm> last visited on 4, 2018

cooperation, both sides made the necessary policy coordination and reached many consensuses.

Most-similar and Most-different

Most similar cases and most different cases are cases with not only one independent variable. (They have X1, X2, X3…) Y=f(X1, X2, X3…)

Most similar cases are: between two cases, one of the independent variables (variable of interest) is different, all the other independent variables are exactly the same, but the outcome is different.

Most different cases are: between two cases, one of the independent variables (variable of interest) is the same, the other independent variables maybe the same, and maybe not, but the outcome is the same. (that is to say, the other independent variables are not important)

Galileo project and Dragon program are within the similar field (space cooperation), they have many similarities, but the outcome is different, the Dragon program is a successful project, but the Galileo project does not have the same outcome.

The outcome of EC2 project and Dragon program is the same, they are successful cases(according to the official report), we can find something in common, and the two cases are in two different field(space and energy), and have many differences.

2.3.1.3 The importance of the three cases

The three cases are very representative. First, the Galileo project was created by the EU and the ESA; it is the official cooperation of the EU with the world. The EC2 is funded by the European Union and founded by the European Commission, the National Energy Administration of China and the Ministry of Commerce of China, with the support of the Italian Ministry for the Environment, Land and Sea. The Centre is managed by a consortium of nine partners and led by Politecnico di Torino (Italy). The Dragon program is still in process, it is the cooperation between ESA and the National Remote Sensing Centre of China (NRSCC), an entity under the Ministry of Science and Technology of China. There are many different institutions among the three cases. It is valuable to study on them.

Table 2.1 Three cases

Galileo Project	EC2 Project	Dragon Project
Official cooperation of the EU with the world outside & Ministry of science and technology OF PRC	Managed by a consortium of nine partners Six European and three Chinese led by Politechnico di Torino(Italy)	ESA & NRSCC

Second, both the Galileo project and the Dragon program are regarding Earth observation, but on different scales; this parallel comparison can help me to find out whether the scale of China-EU S&T cooperation matters. Third, the Galileo project and the EC2 are about different areas. Whereas Galileo is more sensitive and EC2 is not that sensitive, and I will use these two cases to see whether the area of cooperation will influence the final result. Fourth, the Galileo project is the official cooperation platform between the EU with the world. The Dragon program is the China's official cooperation with the world outside, they put different amount of money in different projects, and we can see how the forms of cooperation influence the result. Fifth, both the Galileo project and Dragon project have several regular stages, and EC2 is the third stage of EU-China clean energy cooperation. We will therefore check the phased results and see its influence to the cooperation.

2.4.2 Empirical Data

2.4.2.1 The purpose and the interviewee choice

The purposes of this interview are: first, to know more about EU S&T Policy, competence sharing, characteristics, cooperation with other countries, development, and factors that may influence the cooperation between Sino-EU S&T cooperation. And also Chinese S&T Policy; second, to know more about the cost-benefit calculation from the EU side and the cost-benefit calculation from China's side, collect different voices from China side and EU side(; collect ideas about EU-China treaties and path dependency, etc.()

Target people: EU and Chinese officers, S&T Policy scholars, and scientists

Officers responsible for Case 1, 2 and 3.

EU side: The Directorate-General for Research and Innovation and Joint Research Centre

China: Ministry of Science and Technology, Ministry of Foreign Affairs , Ministry of Commerce, National Development and Reform Commission

Scientists who did concrete work under Case1, 2 and 3. (Natural sciences)

Scholars who did research about EU-China relations/S&T relations.(Social Sciences)

2.4.2.2 Summary and Analysis of the interview

Table 2.2 Interview Analysis Table: Interviewers, Quantities, and Difficulty

	Number of Interviewees	Accessibility
EU officers	10	Moderate
EU scientists	7	Moderate
EU scholars	6	Easy
Chinese officers	7	Difficult
Chinese scientists	4	Moderate - Difficult
Chinese scholars	5	Easy

Policymakers in the EU and China were interviewed, as well as many case project managers, the reliability and validity of this interview is high.

Interviews in English:

1, Record 1: RositsaPetrova; Policy Officer; Delegation of the European Union

2, Record 2: Pieter De Smet; Policy Officer; European Commission; Galileo

3, Record 3: Diego Sammaritano; Policy Officer; European commission DGs R&I

4, Record 4: FerdinardSchaff: BDI(skype business)

5, Record 5: Karl Bergquist: ESA; Gragon

6, Record 6: Hanna Muler; BDI chief representative Beijing

7, Record 7: Sara Medina; Enrich/Ericena

8, Record 8: Jean Marie Rousseau; retired EU commission officer

9, Record 9: Christian Egenhofer; CEPS

10; Record 10: Miroslav Bozic; Research Policy officer; European Commission DGs for Agriculture and Rural development

11, Record 11: Cristofilopoulos Epaminondas; Dragon Star Plus

12, Record 12: Michele Genorerse; Agency for the Promotion of European Research

13, Record 13: ReinhildeVeagelers; KU LEUVEN and BRUEGEL

14, Record 14: Elena Sachez; JRC

15, Record 15: Sandro D’Angelo; Policy Officer, DGs FOR internal Market; Galileo

16, Record 16: Manfred Horvat; University of Wien; Professor

17, Record 17: Schuller Margot; GIGA

18, Record 18: Silvestro Paolo Cosmo; scientist, Dragon

19, Record 19: David Doxaram; scientist, Dragon

20, Record 20: Casa Raffaele; scientist, Dragon

21, Record 21: Bernat Martinez Val; scientist, Dragon

22, Record 22: Reitebuch Oliver; scientist, Dragon

23, Record 23: Massimo Meneti; scientist, Dragon

Interviews in Chinese

1, Record 24 GaoZhihai, Coordinator of Dragon Program at China side, Chinese Academy of Forestry　高志海；龙计划中方协调员

2, Record 25 Zhao Junjie, Institute of European Studies of Chinese Academy of Social Sciences　赵俊杰；中国社会科学院欧洲研究所科技政策室

3, Record 26 Liu Yi, Institute of Atmospheric Physics of Chinese Academy of Sciences　刘毅；中国科学院大气物理所

4, Record 27 Zhang Min, Institute of European Studies of Chinese Academy of Social Sciences　张敏；中国社会科学院欧洲研究所科技政策室

5, Record 28 Wan Jinbo, Institute of Science and Development of Chinese Academy of Sciences　万劲波；中国科学院科技研究所

6, Record 29 Gao Feng，Linkoping university, scientist, 高峰；科学家

7, Record 30 Lei Jinliang MOST officer　雷瑾亮；科技部计划与监督部国际合作处

8, Record 31 Dong Keqin MOST officer　董克勤；科技部高技术中心欧洲处处长

9, Record 32 LiuLi, Tsinghua University(EC2)　刘莉；清华大学（EC2）

10, Record 33 Li Xiaozhe, China Energy Conservation and Environmental Protection Group(EC2 evaluator)　李小珍；中国节能环保有限公司（EC2 后评估）

11, Record 34 Liu Hua, Tsinghua University　刘欢；清华大学

12, Record 35 Fan Shaofeng, Peking University　范少锋；北京大学

13, Record 36 Zhoucheng, Peking University　周程；北京大学

14, Record 37 Shenlong, Chinese Science and Technology Counsellor in Belgium 沈龙；中国驻比利时科技参赞

15，Record 38 Shi Dan, director of the Institute of Industrial Economics of Chinese Academy of Social Sciences(EC2 officer)　史丹；中国社会科学院工业经济所所长，EC2 一期中方负责人

16, Zhang Chi, NRSCC, secret interview　张弛国家遥感中心内容不公开

2.4.2.3 Interview questions

Most of the interview questions are structured, they are predetermined for final analysis. The interviewees are asked by the same questions, their answer could be quantified, and these questions are: (some special questions are designed for different cases)

1, How long have you been working here?

2, Could you tell me about your S&T Policy decision-making process; when did the EU and China start to cooperate; on the EU side, who made the final decision? Who decided on the budget? And who will be actually responsible for the cooperation program?

3, In the process of science and technology policy decision-making, what are the differences between the EU level and the national level?

4, The EU also cooperates with other countries in the field of S&T, what are the main differences between the EU's S&T cooperation with China and the EU's S&T cooperation with other countries? (US, JAPAN, INDIA……)

(What is the interest of China in Sino-EU S&T cooperation? What is the interest of the EU?)

5, What has the EU so far gained from the EU-China S&T cooperation?

6, What has the EU so far lost from the EU-China S&T cooperation?

7, What will the EU gain from the EU-China S&T cooperation?

8, What will the EU lose from the EU-China S&T cooperation?

9, In your opinion, what has China so far gained from the EU-China S&T cooperation?

10, In your opinion, what has China so far lost from the EU-China S&T cooperation?

11, In your opinion, what will China gain from the EU-China S&T cooperation?

12, In your opinion, what will China lose from the EU-China S&T cooperation?

13, According to you, are China's and the EU's respective benefits symmetric or asymmetric?

14, Which factors have promoted the EU-China S&T cooperation?

15, Which factors have hindered the EU-China S&T cooperation?

16, Since the S &T cooperation started, what specific efforts has the EU made so far to promote EU-China S&T cooperation?

17, What should the EU ideally do I in addition for EU-China S&T cooperation? (But some of them may be hard to be done)

18, What additional actions is the EU planning to take to promote EU-China S&T cooperation further in the future?

19, So far, how satisfied is the EU with the way China has engaged in this cooperation?

20, What do you think China should do in the future for EU-China S&T cooperation?

21, What role does the scope of cooperation play in EU-China S&T cooperation? (sophisticated management system).

a) Does it make a difference to the cooperative process whether the number of partners involved is bigger or smaller?
b) Does it make a difference to the cooperative process if the partners involved are very diverse (academic, business, local/central government etc.) or less diverse?
c) Does it make a difference to the cooperative process whether the units in charge of the decisions and administrative procedures (signatures etc.) are located at a higher or lower hierarchical level of their organization (for example Ju vs Fu Ju level)

d) Do you see any other factors that facilitate or complicate the cooperation?

For case1 and Case3 officer:

e) Some cooperation project have failed (for example Galileo) whereas others have been running successfully (such as the Dragon program, EC2, etc.). How do you explain that?

f) If you now think of the Galileo and the Dragon programs: they are very different regarding these factors (number and diversity of actors and levels of decision-making). Did this make any difference to their success?

There are also some open questions related to cooperation agreement and path dependency which need the explanations from the interviewees:

22, Nowadays the EU replaced FP7 with Horizon 2020, with the aim to encourage other countries (especially China) to share a more equal burden in the cooperation with the EU. Why do you think the EU has made this change? To what extent will the new form of cooperation (Like China and EU work together with similar input, not necessarily the same, but they can share the financial, resource or other burdens equally, or EU ） influence their cooperation?

For case1 officer: For the Galileo project, the EU planned to put 3.2 billion Euros whereas China decided to invest 230 million Euros. Did this big difference in investment play a role in the unhappy ending of the project?

For case2 officer: EC2 received 10 million Euros from the EU side and 3.25 million Euros from the Chinese side in 2009.How crucial has the more equal sharing of the financial burden been for the success of the program?

23, Some areas of cooperation are more sensitive than others (for example intellectual property rights and military related technologies). According to you, do sensitive issues automatically lead to a more conflictual cooperation?

Case 1 officers: Galileo project). In the specific case of Galileo, the core channel technology was very disputed. According to you, would it be correct to say that this was the main reason for the breaking down of the China/EU cooperation?

24, From 1981 onwards, China-EU S&T cooperation has mainly focused on four areas: energy, biology, the environment and information. The output in these areas are relatively easier to transform into a marketable product than those of other areas where the outputs are less visible (for example Earth observation). According to you, would it be correct to say that if the output of the China-EU S&T cooperation project is easier to marketise, the two sides will show more willingness to continue the cooperation?

Case2: The output of the very successful EC2 project has significantly contributed to the Chinese government's efforts to build a more sustainable environmental protection and efficient energy systems. Do you think the degree of marketization of the project has mattered a lot for the success of the cooperation?

25, If the EU had alternative options in the field of S&T, i.e. if they could get similar or better benefits from cooperating with other countries, do you think that they would still chose China as their strategic cooperation partner? Or would the EU reduce some of the existing cooperation programs?

For Case1, Chinese officer: In the conflict over Galileo, China heldavery strong position. At that time, China already has its own Beidou project as the alternative plan. How important do you think that the Beidou project was for China's decision to quit the project?

26, Both the Galileo project and the Dragon project had several regular stages. Whereas for the Dragon program, the stage results after 4 years were clearly visible, they were not clearly visible for Galileo. How important do you think the achievement/non achievement of the stage results have been for the Sino-EU S&T cooperation?

27, In December 1998, the two sides signed the Science and technology agreement, their first official cooperative framework agreement. From then on, the EU's most influential framework program and China's most important national science and technology program ("973" and "865" program, etc.) opened up to each other. How did this agreement influence the Sino-EU S&T cooperation in these 20 years?

28, In November 2013, the two sides signed *the China-EU 2020 Strategic Agenda for Cooperation*. How will these agreement influence the China-EU S&T cooperation in the future?

29, For the EU side: After the Second World War, the Coordinating Committee for

Multilateral Export Controls was established by Western bloc powers to put an arms embargo on socialist countries. After the Tiananmen Square protests, the EU imposed an arms embargo and high technology export restrictions on China. In the current context of European economic and social crisis, easing these restrictions on technology exports to China could actually contribute to trade growth and job creation in the EU, and promote European economic recovery. However, this restriction has still not been cancelled. How do you explain that?

2.4.2.4 Difficulties and limits of the interview

In Europe, due to the limited budget, it is not possible to interview officers from every major member states of the EU, and collect their ideas. The field research in China is only lasted for three months. It is hard to reach the officers, and it is also not easy to reach scientists. The number of interviewees is not that much, the research result of this dissertation is only based on the interviews.

2.5 Thesis Framework

Based on the foundation of previous researches concerning the development of EU-China S&T cooperation and its status quo, this dissertation thoroughly unpacks the trends of the relationship between China and the EU, builds up basic framework of research, and makes thorough theoretical discussions and systematic expositions via scientific and appropriate research methods such as case study analysis, processing, sorting, refining with collected data, etc. The thesis consists of ten parts with a framework shown as follows:

Part one and two are introduction and methodological chapter, deals with the general development of Sino-EU cooperation and gives relative definitions, accompanied by a literature review and an overview of the two main theoretical approaches: rational choice institutionalism and historical institutionalism.

Part three focuses on EU S&T Policy by analyzing the EU's competence sharing, cooperation with other countries, development, and possible functioning factors influencing Sino-EU S&T cooperation. Part four shifts to Chinese S&T Policy, adopting a similar structure from part three. Part five is an in-depth analysis of the Sino-EU S&T cooperation.

Parts six to eight present the three cases studies: the Galileo project, the Europe-China Clean Energy Centre project (EC2), and the Dragon program, approaching related issues from different angles.

Part nine discuss “Made in China 2025”, which is the most obvious case for the historical institutionalism about the future Sino-EU relationship. It has already an impact on technology cooperation between China and the EU, and it alters the cost-benefit calculations of many Europeans, they feel a shift, it is a potential critical juncture.[67]

The last but not least, part ten strives to disclose cost-benefit calculation of Sino-EU S&T cooperation, and analyzes the degree, intensity and effectiveness of institutionalism of three cases in different stages. Besides, historical institutionalism and other influential variables are also being taken into account in the chapter.

Chapter 3 EU S&T Policy

3.1 European Scientific and Technological Cooperation: a History

Europe has written a glorious chapter in the history of science and civilization. Since modern times, Europe, especially Western Europe has been one of the world leaders in the field of science and technology.

However, after the Second World War, the global balance shifted: the United States gradually become the dominant power during the third and fourth science and technology revolutions, while Europe, which is the birthplace of the first and second science and technology revolution, has comparatively lagged behind.[68] In the late 1970s and early 1980s, with the further development of new technology revolution, international competition is more and more severe. The global science and technology center shifted from Europe to the United States; and the science and technology gap between the Europe and the United States, and similarly between Europe and Japan has also gradually expanded. This gap is not only reflected in many areas which Europe used to be the leading power, such as automobile and chemical, but also reflected in most of the new areas, like microelectronics and information technology.[69]

[68]Krige, J. (2008). *American hegemony and the postwar reconstruction of science in Europe*. MIT Press, p. 4.
[69]Amable, B., & Boyer, R. (1995). "Europe in the world technological competition". *Structural Change and Economic Dynamics*, 6(2), pp. 171-172.

From 1972 to 1982, the market share of the European Community in the world high technology market shrunk by 17%, at the same time, the share of the United States increased by 36%, and Japan saw an increase of 38%. According to the statistics of Organization for Economic Cooperation and Development (OECD), from 1973 to 1981, the European Community invested 500 million dollars on the research and development of the microprocessor, taking up 10% of the world market; and at the same time, the Japanese investment was 250 million dollars, but occupied 40% of the global market share. With regard to robot production, in 1982, Japan had 13,000 industrial robots, and within the United States there are 6,250 industrial robots; however, in comparison, the combined numbers of Britain, France and Western Germany, total only 5,602. In the same year, the United States had a two billion dollars surplus in the world market for electronic technology, Japan had a 25 billion dollar balance in their favor; however, the European Community had a sizeable deficit: 9 billion dollars.[70]

Outdated technology seriously affected the economic growth in the European Community, and relative to the United States and Japan, its share in international trade took on a downward trend. As a result, markets within the European Community were took on by American and Japanese companies. From 1973 to 1983, Western Europe had experienced two big recessions; and the industry growth rate of the European Community was far lower than the United States and Japan. In the aspect of sales profit, the European Community only got 1.4%, at the same time, Japan got 2.4%, and the sales profit of United States was as high as 4.8%.

[70]Yang, Q. (2008). "The international Science and Technology cooperation in the implement of the EU's major science and technology plan". Harbin Institute of Technology, p.18. 杨巧实：欧盟重大科技计划实施中的跨国科技合作研究

Between 1972 and 1985, the growth rate of Western European high technology products had never been more than 5%, while the ratio was 7.6% in the United States and 14% in Japan.[71]

There are various causes for the European science and technology lag; one of the most important reasons is the long-term lack of comprehensive and coherent policy in the area of science and technology. In the early 1950's, the west started its science and technology cooperation, but with significant limitations. In 1951, the European Community signed The European Coal and Steel Community Treaty. S&T research and cooperation were mentioned in Article 55: "The High Authority shall encourage technical and economic research concerning the production and the development of consumption of coal and steel……it shall establish all appropriate contacts among existing research organizations."[72] But cooperation was limited to only the coal and steel sector. The Treaty establishing the European Atomic Energy Community (Euratom Treaty) was signed in 1957, there was a chapter about research development, and it stipulated to set up a Joint Research Centre (JRC); however, it also limited to the only the area of nuclear research.[73] The Treaty of the European Economic Community which was signed in the same year also simply mentioned that the European Community should improve agricultural labor productivity through technological progress.[74]

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[71]Feng, J. (1990). *The Contemporary Scientific Communication and International Relations*. China Science and Technology Press, pp. 342-346. 冯江源:当代科学交流与国际关系

[72]Treaty constituting the European Coal and Steel Community. (1951) <http://www.consilium.europa.eu/uedocs/cmsUpload/Treaty%20constituting%20the%20European%20Coal%20and%20Steel%20Community.pdf> last visited on 1, 2021

[73]The Treaty establishing the European Atomic Energy Community. (1957) <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3Axy0024> last visited on 1, 2021

Treaty establishing the European Economic Community. (1957) <http://www.ab.gov.tr/files/ardb/evt/1_avrupa_birligi/1_3_antlasmalar/1_3_1_kurucu_antlasmalar/1957_treaty_establishing_eec.pdf> last visited on 1, 2021

Another reason for the European Community's lagging behind in high-tech area was that the research funding is relatively low. From 1987 to 1987, the total investment of the European Community member states in scientific and technology research was 440 billion Euro, in the meantime, the figure of United States was 1 trillion Euro, and Japan was 330 billion Euro. At the European Community level, the science and technology development funding was far less, only being allocated 3% of the European Community's budget.[75]

In addition, after the Second World War, Europe did not pay enough attention to the industrialization of science and technology; it laid particular stress on the basic theoretical studies, and to a large extent, ignored the application of high technology.[76]

Due to neglect of the joint science and technology approaches — especially cooperation in high technology fields — scattered forces and repeated labor, combined with the incompatible national scientific research policies, after the 1980s, the scientific and technological level gaps between Western Europe and the United States, Western Europe and Japan became wider and wider. As a result, the European Community was in an increasingly disadvantaged position in terms of international competition.

Therefore, the European Community member states realized the necessity to walk

[75]Zhou, Y. & Yang, Z. (1994). *The Blueprint of the Europe: the European Community after the Maastricht Treaty*. Economic Daily Press, p. 106. 周悦，杨祖功：欧洲联合的蓝图：马约之后的欧洲共同体

[76]Krige, J. (2008). *American hegemony and the postwar reconstruction of science in Europe*. MIT Press, p. 15.

on the joint road of science and technology, put forward to gradually achieve the goal of integration of science and technology, paying special emphasis on strengthening coordination and cooperation among member states, in order to enhance strength in the competition with the United States and Japan.

3.2 The Development of the European Science and Technology Policy

3.2.1 First Stage: the Single European Act and Its Follow Up

In 1987, the European Community member states signed the *Single European Act*, with the goal of building a unified market with free flow of goods, services, capital and persons. The European Community began to formulate its unified science and technology policy. Some provisions in the Single European Act outline that the European Community is committed to strengthening the European science and technology foundation and increasing the European industrial competitiveness.[77]

In 1984, the implementation of the First Framework Program (FP1) marked the milestone that European international S&T cooperation has entered into the phase of normalization. Since the Second Framework Program (FP2), the European Community set up several institutions to cooperation with other countries, has

[77]Wallace, H., Pollack, M. A., Roederer-Rynning, C., & Young, A. R. (2020). "An overview" in Wallace, H., Pollack, M. A., Roederer-Rynning, C., & Young, A. R. (2020), *Policy-making in the European Union*. Oxford University Press, USA, p. 5.

implemented STD (Science and Technology for development), ISC (International Scientific Cooperation), INCO (International Cooperation Program) and a series of international technology cooperation plan, provided a number of platforms for the European scientific and technology cooperation.[78]

During the ten-year period, there were two basic tasks of the European Community's S&T policy: to strengthen the science basis of European industry to enhance the competitiveness of enterprises and improve the living quality of European citizen. In this stage, the EC was in a weak position with regard to international competition, it encouraged science and technology cooperation among the enterprises, the research center, and universities within member states, but mainly focused on building the integrate European market among member countries.

3.2.2 Second Stage: the Maastricht Treaty and Its Follow Up

In the 1990's, the European Community accelerated its integration process. In 1992, the Maastricht treaty was signed and the European Community was transformed into the European Union (EU). The consistency of member state's science and technology policies created more favorable conditions for the acceleration of the international cooperation in the field of science and technology.[79] From the

[78]Feld, A., Casas, R., Sonsire Lopez, M., & Vessuri, H. (2014). "Policies to Promote International Scientific Cooperation in Latin America: Evolution and Current Situation" in Arvanitis, R., & Gaillard, J., *Research collaboration between Europe and Latin America: Mapping and Understanding partnership*. Paries: Archives Contemporaines p. 37.
[79]Grieco, J. M. (1996). "State interests and institutional rule trajectories: A neorealist interpretation of the Maastricht treaty and European economic and monetary union". *Security Studies* 5(3), pp. 261-262.

perspective of the international situation, after the Cold War, the international situation had a fundamental reversal: the economy became the leading element in international relations. Science and technology occupied a more significant role in economic development and increase of industrial competitiveness, thus, the development level of science and technology become an important part of national comprehensive strength. The European Union began to make explicit foreign science and technology cooperation policies, adjust international science and technology cooperation strategies, and establish new science and technology cooperation standards.

In 1995, the European Commission submitted a report to the European parliament on international cooperation in the field of research and technology. The following year, the final review report put forward several strategic implementation points for the European Union's international cooperation in the field of science and technology: 1) to make a distinction between different types of science and technology cooperation to effectively distinguish between S&T cooperation and technology development cooperation with business purposes, and understand its interactive relations; 2) differentiate methods of research development cooperation: cooperation, coordination, and assistance, and provide different methods with differentiated treatment; 3) adopt the differential policies for different third countries, strategically establish the cooperation areas and projects; 4) consolidate the protection of intellectual property rights, strengthen cooperation management, and set up bilateral technical steering committees; 5) synchronize the science and technology policy and foreign policy objectives, scientific and technological cooperation should help the EU to get more advantages in the international market, benefit the EU enterprises.[80]

After FP3 which is based on the single European act, FP4 which based on the Maastricht treaty mainly focus on the development of information, communications, remote sensing, energy and industrial technology. FP4 adjusted the corresponding policy of science and technology cooperation, strengthened the S&T cooperation with developing countries, and was designed to directly impact on developing countries, including solution ways of natural resources, public health and the agricultural production. In the fourth Framework Program, the EU increased the proportion of scientific and technological cooperation with Central and Eastern European countries and developing countries to more than 80% of the total budget. For the first time, the EU set up the special international S&T cooperation plan, and invested 570 million euros on it. [81]

FP5 aimed to resolve the economic and social problems of the European Union, and also show a positive response to global challenges. No longer confined to the European Union, FP5 modeled modern ways of cooperation for EU candidate states, Central and Eastern European countries, and developing countries, and formulated the corresponding special international technology cooperation plan.[82] Since FP5, the EU has steadily increased the budget of international cooperation projects with non-EU states year by year.

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[80]Lang, J. (1997). "International Competition for High-Technology Industry and the Multilateral Trading System" in Wessner, C. W., *International Friction and Cooperation in High Technology Development and Trade*. National Research Council, pp. 62-70.

[81]Gu Z. & Bai H. (1998). "International Science and Technology Cooperation Strategy of the European Union". *Global economic outlook* 1, pp. 53-54. 古征元,百华: 欧盟的国际科技合作战略

[82]Defazio, D., Lockett, A., & Wright, M. (2009). "Funding incentives, collaborative dynamics and scientific productivity: Evidence from the EU framework program". *Research policy*, *38*(2), p. 294.

In the following ten years, the EU formulated special laws with regard to international scientific and technological cooperation. In addition, the EU also started to strengthen cooperation with developing countries and implement the combination of S&T and economic and diplomatic, in order to better support the development of the industry.

3.2.3 Third Stage: the Lisbon Treaty and Its Follow Up

In March 2000, the Lisbon summit, European Union member states established the Lisbon Strategy, which aimed to place the EU as the most competitive and dynamic knowledge economy in the world by 2010, and achieve the sustainable economic growth, and at the same time, creates more job opportunities.[83] The president of the European commission Philippe Busquin suggested that the European Union needed to build the "European Research Area", centralize the European scientific research resources, strengthen the liquidity of scientific human resources, and deepen cooperation with the world outside.[84] At the same time, for the EU to learn from the lessons of the US and Japan, encourage a more tolerant working way, and enhance the competitiveness of the European research institutions through joint efforts. In order to build the EU as the most competitive and dynamic knowledge economy globally, the EU formulated its new strategic concept: to take science and technology as the guide to promote economic development.

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[83] Borrás, S., & Radaelli, C. M. (2011). "The politics of governance architectures: creation, change and effects of the EU Lisbon Strategy". *Journal of European Public Policy*, 18(4), p. 464.

[84] European Commission. (2000). "Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. Towards a European Research Area"
<http://www.aic.lv/ace/ace_disk/Bologna/contrib/EU/Toward_EResArea.pdf> last visited on 1, 2021

During this stage, the EU started its FP6 and FP7. There are four main principles of FP6: 1) to make the international S&T cooperation serve the EU, meet the general objective of economic and social development, optimize the employment environment of the EU, and to make the EU become the most competitive and most dynamic knowledge economy with sustainable growth; 2) to use international S&T cooperation to promote the EU foreign economic and trade cooperation and exchanges in other fields; 3) to utilize international S&T cooperation to increase the international status of the EU, expand the influence of the EU to other countries; and 4) to introduce cutting-edge scientific and technological talents and research achievement.[85]

During this period, the developing trend within EU international science and technology cooperation includes four aspects:

1) Gathering different countries' research institutions together to solve challenging problems. Along with the quickening pace of globalization in the world, the European Union realized the importance of collaborative science and technology systems, and advocated the scientists from all over the world cooperate together;

2) Networking development. The rapid development and mainstreaming of access to the Internet made the EU realize the great significance of the timely communication of scientific research information and the possibilities of sharing the achievements of scientific research, thus, the EU promoted strategic action of "electronic Europe", and promoted networking with other countries, such as the Asia Europe information network;

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[85]Defazio, D., Lockett, A., & Wright, M. (2009). "Funding incentives, collaborative dynamics and scientific productivity: Evidence from the EU framework program". *Research policy*, *38*(2), pp. 293-305.

3) Increasing attention to carry out the scientific research cooperation with great powers. In recent years the European Union intensified cooperation with the great powers, for example, within the Galileo project and ITER program, the EU attached great importance to the scientific research cooperation with great nations such as the United States, Russia, China;

4) Increasing the funding input of international S&T cooperation. If FP5 were compared with FP6, it is clear to see that the fund for international cooperation increased sharply.

In terms of the formulation of their science and technology policy, during this period, the EU transformed its framework from a single science and technology policy to a policy which combined technology, industry, and finance together. The European Union adopted a broader strategy of science and technology cooperation, gathered different countries' research institutions together to realize the development of networking, and paid more attention to the research cooperation with the world main S&T powers.

3.2.4 Fourth Stage: Horizon 2020

In this era of a multi-polarized world, the innovation ability in terms ofscience and technology of the US and Japan is still significantly ahead of that of the European Union. Emerging powers which represented by "the BRICS" are catching up quickly to European countries, and it is clear to the EU the dangers of such a crisis. Therefore, in 2012, Máire Geoghegan Quinn, the European Commissioner for

Research, Innovation and Science pointed out that the EU must work with other international partners to strengthen the research and development (R&D) and innovation cooperation in order to cope with global challenges together.[86]

In September 2012, the European Commission issued the communication "Enhancing and focusing EU international cooperation in research and innovation: A strategic approach". The EU began to formulate guidelines and basic ideas for international S&T cooperation under the new research and development framework "Horizon 2020". The new strategy set up three goals for the EU international cooperation in the field of science and technology: 1) raising the level of the EU R&D and innovation, thereby improving economic and industrial competitiveness; 2) responding to major global challenges; 3) providing support for the EU foreign policy.[87]

The new strategy pointed out that the EU Horizon 2020 plan will continue to open to the world and that there are mutually beneficial cooperation avenues between the EU and its key international partners. Notably, when the European Union is said to be helping developing countries, it could also benefit a lot from the development of the emerging market.

The EU would strengthen international technology cooperation in two ways: on the one hand, by encouraging international bottom-up cooperation, strengthening the

[86] European Commission. (2012). "Máire GEOGHEGAN-QUINN, European Commissioner for Research, Innovation and Science: Europe: Your Destination for Research and Innovation", Speech/12/22 <https://ec.europa.eu/commission/presscorner/detail/fr/SPEECH_12_22> last visited on 1, 2021

[87] European Commission. (2012). "Enhancing and focusing EU international cooperation in research and innovation: A strategic approach" <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012DC0497 > last visited on 1, 2021

openness of Horizon 2020, and encouraging non-EU countries to take part in the EU's development plans; on the other hand, by strengthening the strategic orientation of international cooperation and setting up "Science Diplomacy" for international cooperation with key countries and regions in order to achieve specific goals. Science diplomacy will use international cooperation in research and innovation as an instrument of soft power and a mechanism for improving relations with key countries and regions. Good international relations may, in turn, facilitate effective cooperation in research and innovation. This EU thus proposed to enhance and focus on "the Union's international cooperation activities in research and innovation by using the dual approach of openness complemented by targeted international cooperation activities, developed on the basis of common interest and mutual benefit, optimal scale and scope, partnership, and synergy".[88] In this way, the EU began to construct its S&T policy from the perspective of the overall macro-functional organization network, combining the innovative elements and efficient allocation of innovation resources in the construction of policies and systems in order to improve the efficiency of the whole EU innovation system.

As can clearly be seen in Figure below, in the past ten years the gross domestic expenditure on R&D in most EU countries has significantly increased.

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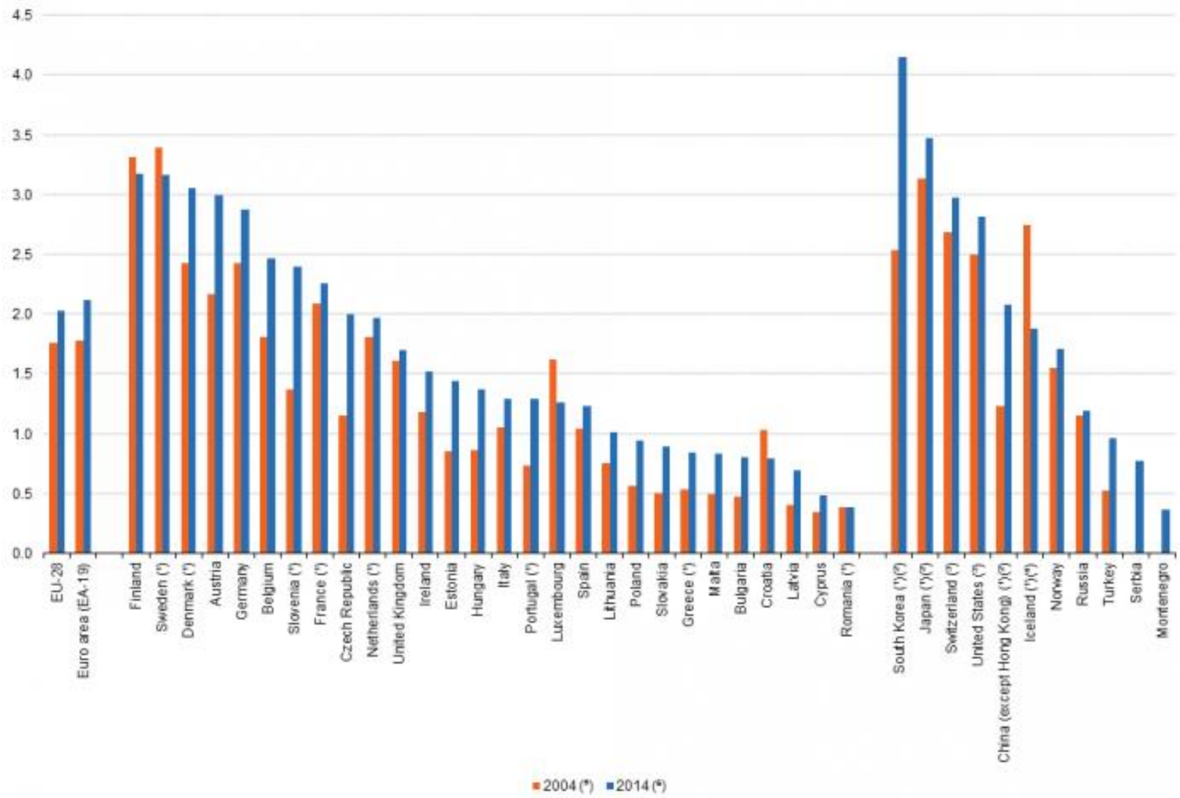
[88] Ibid.



(1) Break in series.
(2) 2013 instead of 2014.
(3) 2012 instead of 2014.
(4) 2003 instead of 2004.
(5) Portugal and Sweden: estimates. South Korea and the United States: definition differs.
(6) EU-28, EA-19, Belgium, the Czech Republic, Denmark, Germany, Ireland, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Austria, Portugal, Sweden, the United Kingdom and the United States: estimates or provisional. The United States: definition differs.
Note: when definitions differ, see http://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm.
Source: Eurostat (online data codes: t2020_20 and rd_e_gerdtot)

Figure 3.1 Gross Domestic Expenditure on R&D, from 2004 to 2014 (% of GDP)[89]

[89]Eurostat. (2015). "Gross domestic expenditure on R&D, 2004-2014" <http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Gross_domestic_expenditure_on_R_%26_D,_2004_and_2014_(%25_of_GDP)_YB16.png> last visited on 7, 2017

3.3 EU Competence in the Field of Science and Technology

3.3.1 Shared Competence Between the EU and EU Countries in the Field of Science and Technology

Sharing of knowledge between EU members states is governed by treaties, and the EU body itself retains the competence conferred on it by these treaties. For instance, the Treaty of Lisbon clarifies the division of competences between the EU and EU countries. These competences are divided into 3 main categories: exclusive competences, shared competences; and supporting competences.[90]

According to Article 4 of the *Treaty on the Functioning of the European Union*:

> […] the EU and EU countries are able to legislate and adopt legally binding acts. EU countries exercise their own competence where the EU does not exercise, or has decided not to exercise, its own competence. Shared competence between the EU and EU countries applies in the following areas: …… environment …… energy …… research technological development, space ……
>
> In the areas of research, technological development and space, the Union shall have competence to carryout activities, in particular to define and implement programs; however, the exercise of that competence shall not result in

[90]EUR-Lex. (2016). "Division of competences within the European Union" <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Aai0020> last visited on 1, 2021

Member States being prevented from exercising theirs.[91]

3.3.2 The EU's Expenditure on Research and Development

Economic globalization has led to increasingly fierce economic competition among countries around the world. Modern society is a knowledge-based economy, science and technology innovation has become a key factor in promoting national and regional economic growth and gaining advantages in international competition. The proportion of government investment in scientific research funds can reflect the degree of importance attaches to technological innovation. In recent years, with the increasing emphasis on scientific and technological innovation, the governments of various countries and regions have substantially increased their scientific research funding.

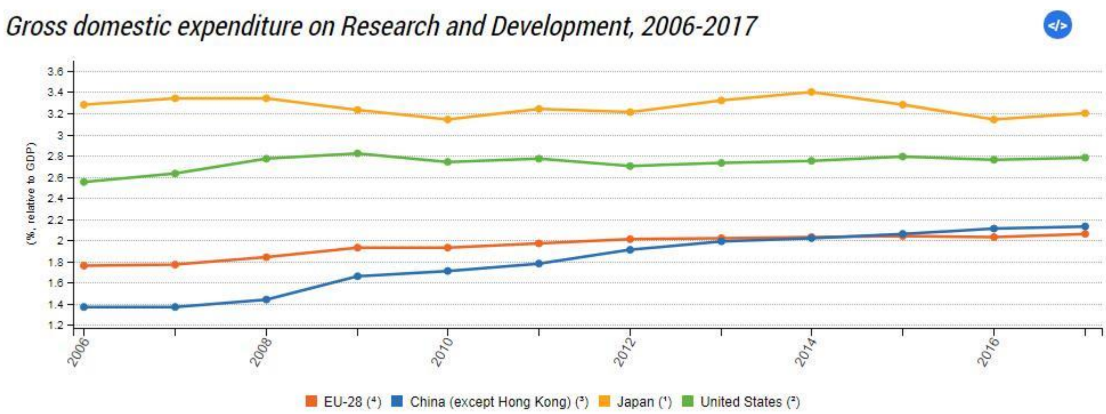


Figure 3.2 Research &Development Spending as % of GDP, 2006-2017[92]

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[91]European Union. (2012). "Consolidated version of the Treaty on the Functioning of the European Union" <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12012E/TXT&from=EN > last visited on 12, 2020

[92]Eurostat. (2019). "Eurostat R & D expenditure" <https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure> last visited on 12, 2019

Scientific and technological innovation is an inexhaustible driving force for the social and economic development of countries and regions, and it is also a key factor to determine the rise and fall of countries and regions. EU countries, especially Western Europe and Nordic countries, have invested heavily in scientific research funding, which amounts to 2% to 3% of GDP.[93]

Table 3.1 The R&D Spending by the EU Member States in 2018[94]

	R&D Spending [in Billion Euro]	R&D Spending as % of GDP	Number of researchers per million inhabitants
Austria	13.20	3.17%	5733
Belgium	13.75	2.82%	5023
Bulgaria	1.00	0.77%	2343
Croatia	0.93	0.97%	1921
Cyprus	0.16	0.56%	1256
Czech Republic	6.90	1.93%	3863
Denmark	8.30	3.06%	8066
Estonia	0.57	1.43%	3755
Finland	6.22	2.77%	6861
France	56.63	2.20%	4715
Germany	116.85	3.09%	5212
Greece	3.17	1.18%	3483

[93]Ibid.
[94]UNESCO. (2019). "How much does your country invest in R&D?" <http://uis.unesco.org/apps/visualisations/research-and-development-spending/> last visited on 12, 2019

Hungary	3.95	1.55%	3238
Ireland	3.92	1.15%	5243
Italy	29.83	1.40%	2307
Latvia	0.32	0.63%	1792
Lithuania	0.79	0.94%	3191
Luxembourg	0.71	1.24%	4942
Malta	0.10	0.57%	1947
Netherlands	17.80	2.16%	5605
Poland	12.23	1.21%	3106
Portugal	3.93	1.37%	4538
Romania	2.35	0.51%	882
Slovakia	1.30	0.83%	2996
Slovenia	1.30	1.94%	4855
Spain	19.55	1.24%	3001
Sweden	15.19	3.34%	7536
United Kingdom	44.19	1.72%	4603
Total	385.13		

3.3.3 The EU's Research Spending on Framework Programs

The smooth progress of scientific research projects is dependent on the consistent input of scientific research funds. Over the past few decades, the European Commission's spending on framework programs has increased. The EU's continuously growing research budget shows that research and innovation drive the future of the European economy.

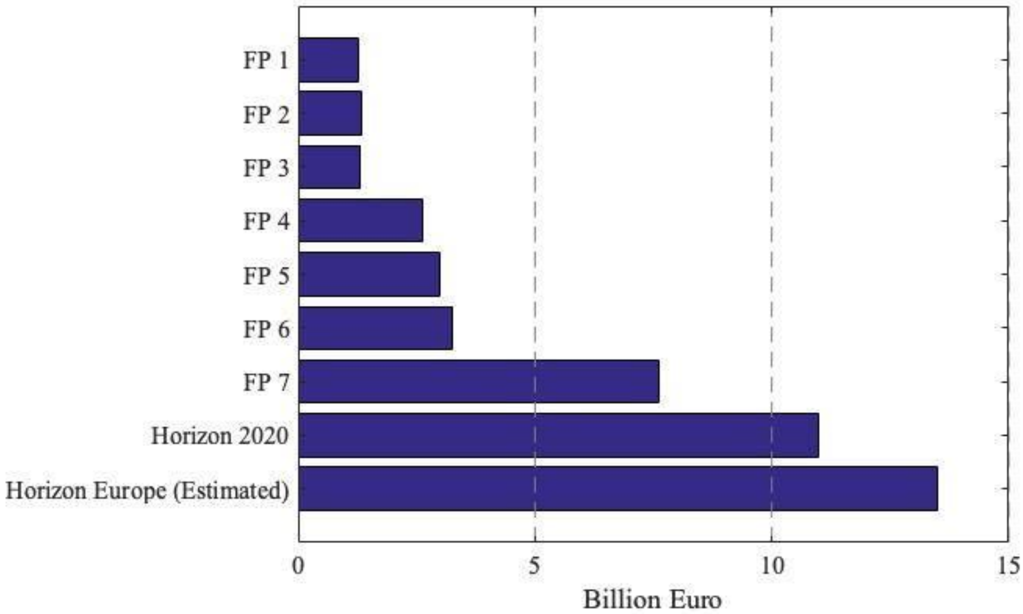

Figure 3.3 The EU's Average Annual Research Spending on Framework Programs

The Framework Program is the main instrument of the EU common research policy. Horizon 2020, the current Framework Program of the EU, was allocated a budget of 77 billion euro over 7 years, from 2014 to 2020.[95]

In 2018, the total amount of the R&D spending by the EU member states was about 385.13 billion euro.[96] In the same year, EU expenditure on Horizon 2020 was nearly 10 billion euro, accounting for almost 6% of the total expenditure of the EU in 2018.[97]

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[95]European Commission. (2019). "Commission to invest €11 billion in new solutions for societal challenges and drive innovation-led sustainable growth"
<https://ec.europa.eu/info/news/commission-invest-eu11-billion-new-solutions-societal-challenges-and-drive-innovation-led-sustainable-growth-2019-jul-02_en> last visited on 1, 2021
[96]See Table: The R&D spending by the EU member states in 2018
[97]European Commission. (2021). "EU expenditure and revenue 2014-2020"

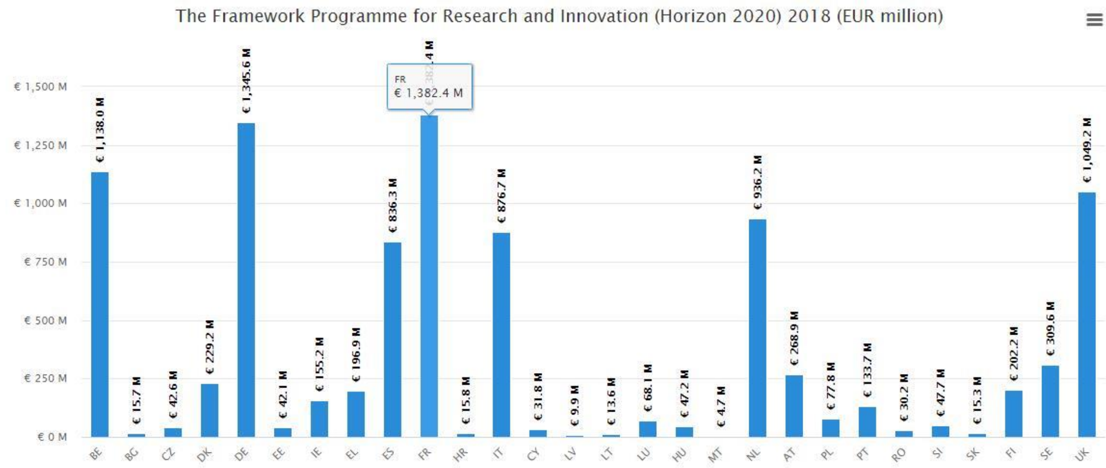

Figure 3.4 EU Expenditure on Horizon 2020 in 2018[98]

3.4 The Main Institutions of EU S&T International Cooperation

There are two main international science and technology cooperation institutions under European Commission: The Directorate-General for Research and Innovation and the Joint Research Centre.

3.4.1 The Directorate-General for Research and Innovation

The Directorate-General for Research and Innovation is responsible for the

<https://ec.europa.eu/budget/graphs/revenue_expediture.html> last visited on 1, 2021

[98]European Commission. (2021). "EU expenditure and revenue 2014-2020" <https://ec.europa.eu/budget/graphs/revenue_expediture.html> last visited on 1, 2021

formulation of research and development policies, the implementation of research and technological innovation, and the coordination of member states' research activities; with the aim to enhance the overall research ability of the EU, provide technological support for the environment, health, energy policy, and promote public understanding of science. In addition, this institution also responsible for the implementation of the EU research and development framework program.[99]

As a science and technology institution which operates directly under the European Commission, The Directorate-General for Research and Innovation or DG Research employs many specialists responsible for the international cooperation in the field of science and technology, the cooperative mission are: 1) support for the EU science and technology policy, helping its development, pursuing and reviewing scientific and technological cooperation activities, especially the cooperation with Asian countries; 2) monitoring the S&T cooperation agreement and corresponding bilateral policy dialogue which were signed with selected Asian countries, as well as evaluation of the cooperation mechanism and methods; 3) implementing the Innovation Union and other science and technology plan of the European Commission which aim to achieve the Europe's 2020 strategy; and, 4) enhancing the international science and technology cooperation level of the EU.[100]

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[99]European Commission. "Directorate-General for Research and Innovation" <http://ec.europa.eu/research/index.cfm?pg=dg> last visited on 6, 2018

[100]Larédo, P., & Mustar, P., *Research and innovation policies in the new global economy: An international comparative analysis*. Edward Elgar Publishing, p. 157.

3.4.2 Joint Research Centre

Europe's Joint Research Centre (JRC) was founded in 1960, directly under the European Commission. The JRC supports and executes the scientific and research policy of the European Union, and aims to build a competitive and innovative Europe. It provides technology support for the European Parliament, the European Council and research committee.

At present, the Joint Research Centre has cooperative relations with more than 1,000 public and private organizations, local agencies, professional associations, enterprises and research institutions in the world, and is connected to more than 140 large technology networks. There are seven European Joint Research Centres, they are respectively established in Belgium, Germany, Italy, the Netherlands, and Spain. The running mode of JRC has three categories: undertaking the EU special research projects, giving assistance to formulate the EU S&T policy, signing foreign contract of scientific experiment.[101]

The international S&T cooperation policy of JRC mainly aims to:

1) Provide corresponding support for the priority areas of cooperation. The priority areas defined by the JRC are: climate change, food security, crisis and disease

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[101]European Commission. (2014). *A-Z guide to the Joint Research Centre, the European Commission's in-house science service*. Publications Office of the European Union, p. 7. <https://ec.europa.eu/jrc/sites/default/files/jrc-a-z-guide-2014_en.pdf> last visited on 1, 2021

surveillance, world trade standardization research, energy and transport, key equipment protection, nuclear security and other global problems;

2) Strengthen the cooperation with DG Research and other science and technology service institutions in order to achieve policy consistency, to perfect the EU S&T agreement together with DG Research in specific fields, and to appoint the European technology counselor and technology experts to promote the communication with other countries;

3) Streamline the international scientific and technological cooperation in order to strengthen coordination ability of JRC headquarters, ensure the policy consistency among the JRC branches, DG Research and other related institutions, streamline the bilateral treaty with the third country, put more emphasis on key partners and priority areas.[102]

In order to jointly against natural disasters, the Joint Research Centre cooperates with worldwide partners: United Nations agencies, such as International Atomic Energy Agency, United Nations Environment Organization, European Economic Association of the United Nations; national level research institutions, like the National Technology and Standards Institute; standardization organizations, for example, the European Committee for Standardization(CEN), International Organization for Standardization(ISO), and the Organization for Economic Cooperation(OECD).[103] They worked together to develop the method evaluation, study on the world technical standard and unified measurement technology.

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[102]European Commission. (2017). *JRC services.* Publications Office of the European Union, pp. 2-8.

[103]European Commission. (2014). *A-Z guide to the Joint Research Centre, the European Commission's in-house science service*. Publications Office of the European Union, pp. 54-56. <https://ec.europa.eu/jrc/sites/default/files/jrc-a-z-guide-2014_en.pdf> last visited on 1, 2021

3.5 The Implementation of the Major EU International S&T Cooperation Programs

3.5.1 International Cooperation Within FP7

As the most important EU platform for international science and technology cooperation, the Seventh Framework Programme has many differences from the earlier Framework Programmes. The FP7 incorporated international S&T cooperation throughout all aspects, combined with the European Atomic Energy Community program, carried out strategic international cooperation action.[104]

3.5.1.1 Cooperation plan

In terms of research funding, FP7 was mainly opened to European Union member states, the associated states, and International Cooperation Partnership Countries (ICPC). ICPC countries are diverse, and include low-income, middle-income and high-income countries. The FP7 carried out a general open plan, and implemented a series of actions to promote targeted international science and technology

[104]Expert Group on the Interim Evaluation of the Seventh Framework Programme. (2010). "Interim Evaluation of the Seventh Framework Programme"

cooperation. The main tools within FP7 framework are: 1) the joint bid, jointly launched, selected, evaluated and funded by the EU and the third country; 2) the collaborative bid, launched and evaluated by the European Union and the third country; 3) the special action of international cooperation, the cooperative research projects needed the participate of a third country or region[105]; 4) an entity network, where other countries could participate in the jointly funded projects (by the European Union and the third country), to promote communication among scientists globally and support exchange visits or further joint projects.[106]

3.5.1.2 Ability plan

The Ability Plan is committed to supporting the construction of European research and innovation ability, it promoted the international science and technology cooperation of the EU mainly through a series of actions, and these main actions are:

1) Supporting bilateral regional dialogue. The INCO-NET action is aimed at strengthening and monitoring the policy dialogue between research and innovation actors. The target areas are the Association of Southeast Asian Nations (ASEAN), the Caribbean, Central America, Central Asia, South Caucasus, Eastern Europe, the Gulf, Latin America, the Mediterranean, the

[105]In addition, some coordination and supporting action also required the participation of a third country. Usually, after evaluation, the EU adopted corresponding cooperation projects and implemented supporting action for the third country or region

[106]Muldur, U., Corvers, F., Delanghe, H., Dratwa, J., Heimberger, D., Sloan, B., & Vanslembrouck, S. (2007). *A new deal for an effective European research policy: The design and impacts of the 7th Framework Programme*. Springer Science & Business Media, pp. 250-251.

Pacific, the sub-Saharan Africa and the Western Balkans.

2) Supporting bilateral coordinated actions. This action supported the network link between stakeholders in order to enhance the ability of science and technology cooperation with third countries, focused on providing information for the seventh Framework Program, and determined the common interest and benefits. Target countries: Algeria, Argentina, Australia, Brazil, Canada, Chile, China, Egypt, India, South Korea, Japan, Jordan, Mexico, Morocco, New Zealand, Russia, South Africa, Tunisia, Ukraine and the United States. Meanwhile, the action also improved the opportunity awareness of the researchers within the EU member states towards the project which is dominated by the third countries, strengthened mutual benefit. Target countries are Australia, Brazil, Canada, China, India, South Korea, Mexico, New Zealand, Russia, South Africa and the United States.

3) Supporting the coordination policies and actions of the EU member states and associated countries. a) ERA-net/ERA-NET+ aimed to strengthen the cooperation and coordination of research innovation among the EU member states and associated countries. The ultimate goal is joint operations, to achieve common goals, development and implementation. Target countries and regions are: the Black Sea, Africa, India, Japan, South Korea, Russia and southeast Europe. b) ERA – WIDE aimed to promote closer science and technology cooperation among European countries and strengthen the research quality of research centers in these countries. Target countries are: Eastern European countries and south Caucasus countries which not established cooperation

relations with FP7 yet, most of the partner countries of the Mediterranean (Morocco, Algeria, Tunisia, Libya, Egypt, Jordan, Palestine, Lebanon and Syria). c) INCO-LAB increased the S&T cooperation with third countries through the catalysis of joint research center, institutions, or laboratories. Target countries are Brazil, China, India, Japan, Russia and the United States. d) The IN-CO-HOUSE supported the jointly funded center (by one or more countries). The target country is India.[107]

Except for the actions which promoted scientific and technological cooperation, the European Union paid great attention to the construction of the electronic infrastructure, including high performance computing and communications resources, access to remote instrument and large databases. These global electronic infrastructures formed a seamless digital European Research Area, and it is now open to all research institutions around the world, made a crucial contribution to response of the global science challenges. In addition to technical measures, the European Union is committed to improving the common principles of global governance. For example, the EU cooperated with many internet sponsors of Japan, Canada, China and India to establish research and education network sets.

3.5.1.3 Talent plan

The implementation of Talent Plan mainly through Marie Curie Actions, aimed to strengthen international cooperation of FP7 by supporting the mobility and

[107]European Commission. (2015). “FP7 Research Overview” <https://ec.europa.eu/research/fp7> last visited on 12, 2016

professional development of researchers. Twenty five percent of its budget is dedicated to international cooperation projects. Marie Curie Actions mainly include five activities: 1) the construction of a start-up period training network of scientific research, the network aims to help early stage researchers by increasing their research abilities and complementary skills, and opening up their career development prospects; 2) life-long training and career development; 3) the establishment of cooperation partnerships among the industry and academia, funding joint research project to strengthen cooperation between the public and private research institutions (including universities, small and medium-sized enterprises, manufacturing, etc.) and the technology exchange; 4) international cooperation funds which aim to the promote the international talent flow; and, 5) other special actions and related policy support. In this way, a systemic framework is formed to ensure the cultivation and flow of talents. The indicative budget is shown in Table 3.2.

Table 3.2 Indicative Budget of Five Marie Curie Actions[108]

Activities	Indicative budget share 2007-2013
1. Initial Training of Researchers	around 40 %
2. Life-long Training and Career Development (including Co-funding)	between 25% and 30%
3. Industry-Academia Pathways and Partnerships	5 to 10%
4. International Dimension – World	25 to 30%

[108]European Commission. (2008). "The People Work Programme 2009". European Commission C(2008)4483 of 22 August 2008 <http://ec.europa.eu/research/participants/data/ref/fp7/88882/m_wp_200901_en.pdf> last visited on 1, 2021

Fellowships	
5. Specific Policy Actions	around 1%

3.5.2 International Cooperation of the Joint Research Center

As the internal science institution of the European Commission, the Joint Research Center aims to provide independent, evidence-based S&T support. The JRC deals with key social challenges, at the same time, it encourages innovation and the development of new methods, tools and standards, communicates with member states, scientific community, and international partners. In order to solve the global challenges, the Joint Research Center of the EU cooperates with many institutions in the world.

Table 3.3 The Cooperation Situation of JRC and Its Major Partners

Countries and Regions	Content of S&T cooperation
United States	The U.S. National Institute of Standards and Technology--energy, transportation and emerging technologies (nanotechnology) American Association for the Advancement of Science-- Clean energy and revolution of liquidity The U.S. National Oceanic and Atmospheric Administration-- Climate data tracking, space

	weather, tsunami model and fishery research National Nuclear Security Administration-- Nuclear safety
Japan	Japan Atomic Energy Agency-- Nuclear safety and security (stress tests), nonproliferation Japan's Central Research Institute of Electric Power Industry-- electric energy
Brazil	Environment and crops monitoring, soil mapping, life cycle analysis and measurement
China	Food, agricultural and biological technology innovation Chinese Academy of Inspection and Quarantine—nanotechnology Climate change and clean transport Chinese Ministry of Science and Technology-- the peaceful uses of nuclear energy
India	India's Department for Scientific & Industrial Research-- Coordination of activities with common interested activities
Africa	Long-term partnership, consultation on important issues
Russia	Nuclear safety, technology standardization

In total, the JRC signed 12 bilateral agreements with China. The areas covered by these agreements are crop forecast, life cycle analysis and peaceful use of nuclear energy, etc. In 2010, JRC signed three agreements with China: on global soil mapping, electronic communication technology, nanotechnology and animal testing alternatives.

The priorities and action of JRC are: 1) to participate in the EU-China dedicated research team, provide research support for food, agriculture, biotechnology innovation; 2) to implement follow-up action of nanotechnology memorandum, in 2011, JRC and Chinese Academy of Inspection and Quarantine jointly organized a series of nanotechnology safety evaluation activities; and, 3) in the field of climate change and clean transport, to cooperate with Directorate-General for Climate Action and send many modeling experts to China. After the first meeting between China and European Commission about the peaceful use of nuclear energy, Chinese Ministry of Science and Technology accepted proposals put forward by the JRC, they stated to exchange experience about safety assessment and information analysis method of nuclear accident. According to the cooperation agreement, all Chinese new nuclear power plants will use the best technology and abide by the highest nuclear safety standards.[109]

[109]European Commission. Joint Research Centre. <https://ec.europa.eu/jrc/> last visited on 3, 2017

3.6 Chapter Conclusion

In the 1980s, the world S&T center shifted from Europe to the US, Japan is also gradually expanding. The European Community realized the importance of S&T and the necessity of cooperation, and began to formulate its unified science and technology policy.

In 1984, during the implementation of the First Framework Program (FP1), European international S&T entered into the phase of normalization. Step by step, the following FPs promoted the development of European science and technology policy. Shared competence between the EU and EU countries applies in the field of S&T. Being the main instrument of the EU common research policy, the European Commission's spending on FPs has increased continually throughout the years.

The EU's international S&T cooperation work was undertaken by two main institutions: The Directorate-General for Research and Innovation and Joint Research Centre. Currently, EU countries, especially Western Europe and Nordic countries, have invested heavily in scientific research funding, which amounts to 2% to 3% of GDP.

Chapter 4 PRC S&T Policy

4.1 The Development of Chinese S&T Policy

According to the definition of the United Nations Educational, Scientific and Cultural Organization (UNESCO), science and technology policies are a series of important institutions and actions which are implemented by governments to promote effective development of science and technology, and to realize the goal of the overall construction. The development of China's science and technology policy over the past 67 years is closely linked with the core aim. In different periods, the Chinese science and technology policy was based on different system models, and the policy showed its different characteristics. The nearly seven-decade development of Chinese S&T policy could be divided into three periods, and are overviewed below.

4.1.1 Chinese S&T Policy under the System of the Socialist Planned Economy (1949-1978)

During this period, Chinese science and technology policy was based on the socialist planned economy system. The government controlled all the science and technology resources, and used its administrative power to promote the establishment of a science and technology system and its development. It arranged S&T activities and allocated technology resources through careful planning. On one side, reflects the characteristics of socialist planned economy; on the other side, the circumstances can be linked to the situation during the early days after the foundation of New China: very few scientists, lack of scientific research equipment, incomplete intelligence data, and the extreme backwardness of culture and education. “The national science and technology personnel is not more than 50 thousand people, the number of specialists is no more than 500. There are only about 30 specialized scientific research institutions in this country. Modern science and technology is almost a blank.”[110] Under this condition, the idea of putting S&T resources together to solve key problems under the government’s comprehensive planning received a consensus among the highest decision-making level of the Chinese Communist Party, and got the most support from science and technology experts.

The national Science and Technology Development Plan of 1956 and 1957 was formulated under this idea. In this plan, in accordance with possibility and need, China should introduce the world’s most advanced scientific achievements to its science department, the defense department, production department and education department as quickly as possible, with the aim of catching up to the Soviet Union and other world powers in some much-needed areas of science and technology. At the same time, this plan also cleared out the principle of “task driven discipline”, all national science and technology activities were guided under this principle.

This plan achieved great success, not only quickly establishing a relatively

[110]Song, J. (2004). *Basic knowledge of modern science and technology*. Science Press, pp. 448-451. 宋健:现代科学技术基础知识

complete system of science and technology, but also resulting in some breakthroughs in specific areas of science and technology. It made China greatly strengthen its science and technology capacities and met the needed to maintain national security and promote economic growth in a relatively short period of time. Even though comparatively, China's economic strength and S&T capacity was relatively weak, they were able to make "two bombs and one satellite" with less time and fewer resources than it took for capitalist countries.[111] China also made significant progress in semiconductor, computer, space science, molecular biology, and other cutting-edge areas. Among them, the successful of artificial synthesis of crystalline bovine insulin was a typical case of teamwork among a number of S&T research institutions.

From this success, it can be seen that this S&T system can help China to focus resources and accomplish large undertakings with less money. However, this S&T system also contained many internal defects. Planned and concentrated power lead to the high rigidity of the whole system structure. To a certain extent, it cut the link between science, economy, and society, reflected not only in the disconnect between science and economy, but also in the disconnect between science and technology, and science and education. This rigid plan system's lack of adaptability and self-renewal ability to respond to rapid changes in the external environment resulted in different government departments have to set up research intuitions to meet their needs. It therefore led to the repetition, dispersal, and lack of coordination, as well as a high concentration of research institutions. There was no

[111]Gong Y. (1991). "Marxism and science and technology". *Scientific Reseach 9(*3), pp. 4-5. 龚育之:马克思主义与科学技术

guarantee for the autonomy of the scientific community, and the government's power was extensive. Especially political mistakes had negative impact on science and technology outcomes. In addition, this policy model also dampened the enthusiasm and creativity of science and technology researchers and personnel.

4.1.2 Chinese S&T Policy under the System of Reform and Transition (1978-1992)

In 1978, the Chinese national science and technology conference was held for the first time. During this conference, it was clearly highlighted that science and technology is the first productivity, and modern science and technology is the key to the four modernizations. Since then, reform and opening become the prominent era theme, with the science and technology policy adapting along with the reform and transition. On the one hand, it reestablished the position of the role of S&T and S&T workers by bringing order out of chaos in the field of science, technology and education; on the other hand, it increased the enthusiasm and creativity of science and technology workers through system reform, andput emphasis on solving the problem of the disconnect between S&T and economy. It was clearly put forward that "economic construction must rely on science and technology, science and technology work must be geared to the needs of economic construction"[112].

On April 16th, 1981, when forwarding the report of the outline for the development

[112]CPC Central Committee. (1985). "Decision of the CPC Central Committee on the Reform of the Science and Technology System" 中共中央关于科学技术体制改革的决定
<http://www.reformdata.org> last visited on 2, 2019

of science and technology policy by the State Science and Technology Commission, the State Council expressed the following opinion:

> [...] in order to make science and technology really play a role in the national economy, the current system needed to be reformed step by step. At present, we should strengthen the collaboration among grass-roots units and gradually break the boundaries of regions and departments. The scientific research units should provide its achievements the production unit, carry out consulting services. Between scientific research units and production units, contract system can be used, scientific research and production association can also be formed.[113]

On May 15th, 1981, according to the joint proposal of 89 scientists in the fourth Academician General Assembly, the Chinese Academy of Sciences decided to set up a national tender natural science fund in 1982, and established the National Natural Science Foundation in 1986.

On March 13th, 1985, "the decision about the system reform of science and technology by the Central Committee of the Communist Party of China" was officially released, and the main contents of the science and technology system reform were: 1) in the aspect of operational mechanism, China should reform the funding system, develop the technological market, no longer rely only on the administrative means to manage work in science and technology, use economic lever and market regulation to give the capacity for self-development to the S&T institutions; 2) in the aspect of organizational structure, China should change the

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[113]Ministry of Science and Technology of China. (1992), "Guidelines of China Science and Technology policy", White paper on science and technology, 1992 科技部:中国科学技术政策指南

situation of the disconnect between research institutions and enterprises, the separation of research, design, education and production, and the division of departments and regions, strengthen the enterprises' technical absorption and development capabilities, promote the collaboration and cooperation among research institutions, design institutions, universities, and enterprises; 3) in the aspect of the personnel system, China should overcome the influence of "left"[114], release restriction on science and technology personnel, promote rational flow of talents, and respect intellectual activities.[115]

During this period, two Chinese National Medium- and Long-Term Science and Technology Development Plans were formulated: the *1978–1985 National Science and Technology Development Plan* and the *1986–2000 Science and Technology Development Plan*. The *1986–2000 Science and Technology Development Plan* not only further clarified the overview of science and technology development, but also systematically laid down relevant science and technology policies. This is the first time for China to formulate its S&T policy systematically. In November 1986, the State Council approved *the State High-Tech Development Plan*(863). In August 1988, the *Torch High Technology Industry Development* (Torch Plan) was also approved by the State Council. These two plans aimed to trace the world high technology frontier, promote high-tech achievements towards commercialization, industrialization and internationalization, and push forward the technical innovation and industrial structure adjustment of Chinese traditional industry.[116]

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[114]Left: Mistakes occurred during the Great Leap Forward and the Cultural Revolution from 1957 to 1976

[115]Ministry of Science and Technology of China. (1992), "Guidelines of China Science and Technology policy", White paper on science and technology, 1992 科技部:中国科学技术政策指南

[116]Fan, P., & Watanabe, C. (2006). "Promoting industrial development through technology policy: Lessons from Japan and China". *Technology in Society*, *28*(3), p. 312.

There are some notable characteristics of the S&T system reform and the S&T policy in this period: 1) it put emphasis on the combination of S&T and economy; 2) it began to pay more attention to the adaption of the characteristics of science and technology activities, promoted the free inquiry in the basic research through the establishment of National Natural Science Foundation of China; 3) it started to use non administrative means to manage the scientific and technological work, such as the introduction of competition mechanism and the expansion of market regulation, instead of relying on operating mechanism of administrative means; 4) it gradually expand the autonomy of research institutions and scientific research personnel, tried to build a more flexible mechanism of resource allocation in order to better adapt to the change of external environment; and, 5) it aroused the enthusiasm and creativity of science and technology personnel through science and technology award regulations and patent law.

However, it is notable that the S&T system reform within this period is still under the planned economy system. Although the science and technology system reform was carried out on multiple levels and the science and technology policy was adjusted, the problem of disconnect of S&T and economy was not solved fundamentally. The situation of the repetition, scatter, and lack of coordination which formed under the old system still existed.

4.1.3 Chinese S&T Policy on the basis of the Socialist Market Economic System (Since 1992)

In 1992, the 14th National Congress of Communist Party of China (CPC) approved the establishment of Chinese socialist market economy. The transformation from a planned economy to a market economy is a long-term and arduous task. The science and technology policy in this period still remains to fully implement the concept of "science and technology as the first productive force". In some aspects, such as system, mechanism and ideas, there were still many obstacles of the connection between technology and the economy.

In 1995, the State Council put forward the strategy of invigorating the country through Science, Technology and Education. The goal was preliminary establish a science and technology system adapt to the socialist market economic system in 2000; and improve the system, realizing the organic combination of technology and economy in 2010.[117] During this period, the focus of the science and technology policy was primarily promoting combinations between S&T and economy and S&T and society. After 1992, the S&T policy began to pay more attention to the coordination and matching problem among the reform of the economic system, political system, S&T system and education system. The number of S&T policies which jointly issued by the State Commission for restructuring the economy, the Ministry of Finance of the State, the State Commission for Economics and Trade, the State Science and Technology Commission, the State Education Commission,

[117]Xu, K. (2008). "Engineering education and technology in a fast-developing China". *Technology in Society,* 30(3), pp. 271-272.

and the State Administration of State Property increased significantly.

One prominent change of the science and technology policy in this period is the combination of science and technology policy and innovation policy according to the internal requirement of market economy and the reality needs of international competition. It integrated the work of science and technology and the improvement of national and enterprise innovation ability.

At the beginning of the 21st century, in 2001, China joined the World Trade Organization (WTO) and started to formulate its first medium- and long-term S&T development plan under a socialist market economy, with the aim of comprehensively construct a well-off society. In 2006, the State Council issued the *Chinese National Medium- and Long-Term S&T Development Plan 2006-2020*. Its aim was to enhance independent innovation ability and build an innovative country. This plan outlined comprehensive planning for the Chinese science and technology development in the following15 years. It is the programmatic document of the future development of science and technology in China.

The *Chinese National Medium and Long Term S&T Development Plan 2006-2020* also points out the problems existing in the current science and technology policy: 1) the enterprise has not really become the main body of technological innovation, its independent innovation ability is not strong enough to face the fierce global competition; 2) the science and technology strength from various aspects are self-sustaining, not only dispersed but also repeatable, the overall efficiency is not very high; 3) there are many problems in the macro science and technology management, the way of science and technology resource allocation and the evaluation system cannot adapt to the new development of science and technology and the transformation of government function; 4) the mechanism of encouraging talents and innovation is also imperfect.[118]

4.2 USSR's Assistance in Early China's S&T Development

From the 1940s to the early 1960s, the S&T assistance from the USSR facilitated the large-scale transfer of modern technology to China. China and the Soviet Union were both members of the Socialist Camp and had a Treaty of Alliance, China was in need of technology and specialists, and the USSR was eager to assist.[119] With the help of the USSR in S&T, China had established relatively complete scientific research institutions and S&T management systems. The signing and implementation of the S&T cooperation agreement between the two countries played an active role in promoting this process.

In the early 1950s, in order to better coordinate and manage various affairs of Sino-Soviet S&T cooperation, China and the USSR established the Joint Commission for Cooperation in Science and Technology to promote the cooperation between the two sides in research institutions, product R&D and discipline construction of technical science.

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118 Chinese National Medium and Long Term S&T Development Plan 2006-2020; see also: Serger, S. S., & Magnus, B. (2007). "China's fifteen-year plan for science and technology: an assessment". *Asia Policy* 4(1), pp.135-164.

119 Shen, Z., & Alitto, G. (2002). "A Historical Examination of the Issue of Soviet Experts in China: Basic Situation and Policy Changes". *Russian History*, *29*(2/4), p. 400.

China made a 12-year long-term plan for the development of S&T in 1956, with the guidance and assistance of USSR experts, which determined the direction, objectives, and core policies of S&T development in China. It had a significant impact on China's S&T development. In the early 1960s, with the rupture of relations between the two countries, Sino-Soviet S&T cooperation was utterly disrupted.

Prior to 1953, China and the Soviet Union had no special long-term S&T agreement. The two sides' S&T cooperation was mainly conducted through short-term foreign trade contracts. The main forms of cooperation were to invite Soviet experts to China to guide S&T research work; send Chinese S&T experts to the Soviet Union to study and participate in academic conferences; exchange S&T information, books and periodicals from time to time.[120]

The Chinese government dispatched a delegation from the Chinese Academy of Sciences, led by Qian Sanqiang, to visit the Soviet Union in February 1953. After returning to China, the delegation gave an extensive publicity report on Soviet S&T and its managerial experience.[121] In the summer of 1954, the Chinese Academy of Sciences convened a symposium on learning advanced scientific experiences from the Soviet Union. At that time, 93.2 % of researchers of the Chinese Academy of Sciences had learned Russian, and 73.5% of them could read Russian literature.[122] The USSR government delegation led by Nikita Khrushchev visited China in

[120]Zhang, B., Zhang, J., & Yao, F. (2005). "Technology Transfer in Sino-Soviet Scientific and Technological Cooperation". *Contemporary China History Studies,* 12(2), p. 76. 张柏纯，张久纯，姚芳：中苏科技合作中的技术转移

[121]Fan, H. (1999). *Annals of the Chinese Academy of Sciences (1949~1999).* Shanghai: Shanghai Science & Technology Education Press, pp. 32-34. 樊洪业：中国科学院编年史（1949~1999）

[122]Wu, H. (1991). "A delegation from the Chinese Academy of Sciences visited the Soviet Union for the first time". *Historical Data and Research of Chinese Academy of Sciences, 2*

September of the same year to encourage large-scale and planned S&T cooperation between China and the USSR. The Chinese received 698 technical documents from the Soviet side between the beginning of 1950 and July 1954.[123]

On October 12th, 1954, the Agreement on Science and Technology Cooperation between the Government of the People’s Republic of China and the Government of the Union of Soviet Socialist Republics was signed in Beijing, with a validity period of 5 years. This is the first S&T cooperation agreement between China and the USSR.[124] From the signing of the agreement to the end of the 1950s, China and the USSR had participated in the cooperation with more than 800 scientific research institutions, and the cooperation covered almost all essential fields of S&T. In order to ensure the implementation of the agreement, the Joint Commission for Cooperation in Science and Technology was established, which was composed of 7 people from each side and held regular meetings. Under the promotion of this committee, the USSR provided China with a vast number of drawings and technical materials.[125]

In December 1954, the Sino-Soviet S&T cooperation committee held its first S&T cooperation meeting in Moscow. The meeting decided that the USSR would provide China with free design and technical materials for metallurgical plants, machine tool plants, and power stations, working drawings and process materials

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[123]Rahmanin, O. B., & Koloskov, B. (Translated by Xiao, D., & Tan, S.) (1982), S*ino-Soviet relations (1945-1980)*, Sanlian Bookstore, pp. 56-57. 鲍里索夫、科洛斯科夫著，肖东川、谭实译: 《苏中关系(1945-1980)

[124]Ministry of Foreign Affairs of the People's Republic of China. (1991). *Treaties of the People's Republic of China (Volume 31).* World Affairs Press, p. 161. 中华人民共和国外交部：中华人民共和国条约集（第 31 集）

[125]Shen, Z. (2015). *Excerpts from declassified Russian archives: Sino-Soviet relations (Volume 8, 1958.4-1959.10).* China Publishing Group Oriental Publishing Center, p. 445. 沈志华：俄罗斯解密档案选编：中苏关系（第 8 卷 1958.4-1959.10）

for production machines and equipment, as well as the relevant scientific and technological documents. The Committee held 15 meetings in total, and the technical information provided by the Soviet Union far outweighed that offered by the Chinese side. These data can be divided into four categories: (1.) Design data, such as construction of coal mines, concentrators, power stations, locomotive factories, vehicle manufacturing plants and oil plants. Among them, the complete sets of design materials for coal power, non-ferrous metals, industrial and civil construction design were particularly valuable. (2.) Various kinds of mechanical manufacturing drawings and technological data. (3.) Process data of paints, pigments, enamels and other products. (4.) All kinds of internal technical documents, teaching plans, teaching syllabus and technical standards. At that time, the Soviet side committed to furnish 2868 items of national standards.[126]

In 1954, the State Development Planning Commission decided to formulate a 15-year plan for the national economy (1953-1967). V. A. Kovda, a Soviet scientist who served as a consultant to the president of the Chinese Academy of Sciences, drafted “Methods regarding the plan and organization of scientific research in the People’s Republic of China”. He recommended China to organize and plan scientific research work at the national level and formulate long-term plans for scientific development in order to solve the most important problems raised in the 15-year plans for the national economy.[127]

[126]Zhang, B., Zhang, J., & Yao, F. (2005). “Technology Transfer in Sino-Soviet Scientific and Technological Cooperation”. *Contemporary China History Studies,* 12(2), p. 78. 张柏纯，张久纯，姚芳：中苏科技合作中的技术转移

[127]Shen, Z., & Xia, Y. (2015). *Mao and the Sino-Soviet partnership, 1945-1959: a New History*. Lexington Books, p. 105.

In order to achieve his global strategy of restructuring and strengthening the communist camp and mending relations with the US, Nikita Khrushchev, the premier of the USSR modified the policy towards China by increasing aid.[128] In 1955, the Soviet Union started to provide enormous help to China and handed over all of its properties in northeast China to the Chinese government. Common political convictions and ideologies aided the two nations' comprehensive collaboration even further.[129] Moreover, despite of some reluctant voice from the Soviet military, Khrushchev chose to assist China to develop nuclear weapons in 1957[130] The USSR also aided China in the development of rocket weaponry. Under the assistance from the USSR, China built a high-power long-wave radio transmission station and a special-purpose long-distance radio communication center.[131]

On January 14th, 1956, the Premier of China Zhou Enlai outlined a speedy and effective manner to achieve the goals of the 15-year plan at the Central Committee of the Communist Party of China (CPC) Conference on Intellectuals, among which the first three were related to the assistance from the Soviet Union: First, dispatch groups of experts, outstanding scientific personnel, and excellent college graduates to the USSR and other nations for one to two years internships, or MA/PhD students, depending on the most pressing demand. Second, for specific disciplines, several groups of experts shall be invited from the USSR and other countries to assist China in establishing scientific research institutions and training cadres in CAS and other

[128]Shen, Z. (2019). *A Short History of Sino-Soviet Relations, 1917-1991*. Springer Nature, p. 148.
[129]Zhang, J., & Feklova, T. Y. (2018). "Soviet scientists in chinese institutes: A historical study of cooperation between the two academies of sciences in 1950s". *Endeavour*, *42*(1), p. 18.
[130]Liu, Y., & Li, J. (2009). "Analysis of Soviet Technology Transfer in the Development of China's Nuclear Weapons". *Comparative Technology Transfer and Society*, 7(1), pp. 67-68.
[131] Shen, Z., & Alitto, G. (2002). "A Historical Examination of the Issue of Soviet Experts in China: Basic Situation and Policy Changes". *Russian History*, *29*(2/4), pp. 398.

relevant departments as quickly as possible. Third, organize a large number of scientific staff and technicians in a planned way to learn from Soviet experts in China. During the construction and production process of the 156 enterprises assisted by the USSR, a large number of technicians should be systematically organized to study and grasp the new technical concepts and impart them promptly to other people.[132][133]

These Soviet experts worked actively in China; they introduced the experience of the Soviet Union and the development of S&T in the world, and contributed their ideas to the establishment and development of modern S&T in China. In July 1956, the Scientific Planning Committee translated their academic reports, lectures or briefings for Chinese scientists into Chinese and compiled them into a volume.[134]

In November 1957, a delegation of CAS led by its president Guo Moruo visited the Soviet Union. In the following month, CAS and SAS signed the "Scientific and Technological Cooperation Agreement between the Chinese Academy of Sciences and the Academy of Sciences of the Union of Soviet Socialist Republics"; this agreement formalized the direct link between the two academics of sciences specifying the scope of contacts between counterpart institutions. The number of scientists sent from the Soviet Union to the CAS rose dramatically after the agreement.[135]

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[132]Literature Research Office of the CPC Central Committee. (1994). *Selection of important documents since the founding of China (Volume 8)*. Central Academic Publishing House, p. 40. 中共中央文献研究室:建国以来重要文献选编(第 8 册)

[133]Document Editing Committee of the CPC Central Committee. (1984). *Selected Works of Zhou Enlai (Volume 2)*. People's Publishing House, p. 183. 中共中央文献编辑委员会：周恩来选集下卷

[134]National Science Planning Commission. (1956). *Compilation of reports of Soviet scientists*. National Science Planning Commission, p. 276. 科学规划委员会:苏联科学家报告汇编

[135]Zhang, J., & Feklova, T. Y. (2018). "Soviet scientists in chinese institutes: A historical study of cooperation between the two academies of sciences in 1950s". *Endeavour*, *42*(1), p. 19.

Most of the Soviet scholars in China were occupied with the natural sciences. Inviting Soviet scientists became a viable solution to China's scientific labor problem. SAS professionals filled vacant positions and assisted China in developing fresh talent. Approximately 90% of Chinese scientists trained by Soviet scientists in cutting-edge technical domains were deployed into areas of weakness within Chinese science.[136]

On January 18th, 1958, the "Agreement between the Government of the People's Republic of China and the Government of the Union of Soviet Socialist Republics on Jointly Conducting and the Soviet Union's Assistance to China in Major Scientific and Technological Research" (the 122 agreement) was signed in Moscow.[137] The 122 agreement is a significant S&T cooperation agreement between China and the USSR.

It represents the transition of the Soviet Union's S&T assistance to China from a focus on production technology to a balanced approach that includes both production technology and scientific research. The agreement 122, which was carried out in compiling and implementing annual cooperation plans, widened the channels of S&T exchanges between China and the USSR. As the executive entity, the Joint Commission on Science and Technology Cooperation had played a vital

[136]Zhang, J., & Feklova, T. Y. (2018). "Soviet scientists in chinese institutes: A historical study of cooperation between the two academies of sciences in 1950s". *Endeavour*, *42*(1), p. 21.

[137]Chinese Academy of Sciences. "Protocol and exchange of documents between the Government of the People's Republic of China and the Government of the Union of Soviet Socialist Republics on jointly carrying out major Scientific and technological Research", Archives of Chinese Academy of Sciences, 1958-2-27-1 中国科学院：中华人民共和国政府和苏维埃社会主义共和国联盟政府关于共同进行和苏联帮助中国进行重大科学技术研究的议定书和换文

role.[138]

The agreement stipulated that: (1.) China and the USSR should engage in comprehensive S&T cooperation to assist China in achieving its S&T development goals and bringing China's S&T level up to par with that of the rest of the world. (2.) Consolidate and strengthen the direct links between the scientific research institutes of the two countries, and broaden the content and scope of direct contact. (3.) The exchanges between scientists of the two countries will no longer take the form of long-term and large-scale recruitment, but would mainly take the form of short-term academic business trips. This form was conducive to training China's S&T talents. (4.) Establish specialized institutions to solve the supply problems of non-commercial scientific research equipment, instruments, samples, materials, reagents, and small quantities of sporadic equipment. (5.) Establish a supervisory agency.[139]

By July 1960, all of the joint research projects had been implemented to varying degrees, with some completed or nearing completion. For example, Soviet institutions and Soviet experts helped China with establishing research institutions for emerging or important technologies such as nuclear energy, electronic technology, automation, semiconductors, radio, electric power, electrical engineering, precision machinery, and optics, and had made certain achievements. It laid a foundation for the future S&T development of China.

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[138]Chinese Academy of Sciences. "Methods and procedures of settlement for the expenses related to the major scientific and technological research projects jointly carried out by China and the Soviet Union", Archives of Chinese Academy of Sciences, 1957-4-2-22 中国科学院：实现中苏双方共同进行和苏联方面帮助中国方面进行的重大科学技术研究项目有关的费用的结算办法和手续

[139]Chinese Academy of Sciences. "Several requirements for the preparation of 122 in 1959", Archives of Chinese Academy of Sciences, 1958-4-66-8 中国科学院：有关122项1959年计划编制工作的几点要求

Differences and contradictions in ideology, national interests, and foreign policy between the USSR and China gradually escalated at the end of the 1950s, eventually leading to an open debate between the two parties and the rupture of relations between the two countries.[140] On July 16, 1960, the Soviet authorities notified China that the Soviet Union had decided to withdraw its experts and consultants from China. This was a watershed moment in Sino-Soviet relations.[141] 1230 Soviet experts in China returned to the USSR in the following month.[142]

4.3 The Institutions of China S&T International Cooperation

In China, main actors in the S&T policy decision making and the S&T international cooperation are the Ministry of Science and Technology, Ministry of Foreign Affairs, Ministry of Commerce, National Development and Reform Commission, Companies, Universities, and Public Institutions.

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[140]Lüthi, L. M. (2010). "Sino-Soviet Relations during the Mao Years, 1949-1969)", in Li, H., *China Learns from the Soviet Union, 1949-Present.* Rowman & Littlefield, p. 40.
[141]Lüthi, L. M. (2010). *The Sino-Soviet Split: Cold War in the Communist World.* Princeton University Press, p. 43.
[142] Li, Y. (2001). *A personal experience of Sino-Soviet diplomacy.* World Knowledge Press, p. 53. 李越然：中苏外交亲历记

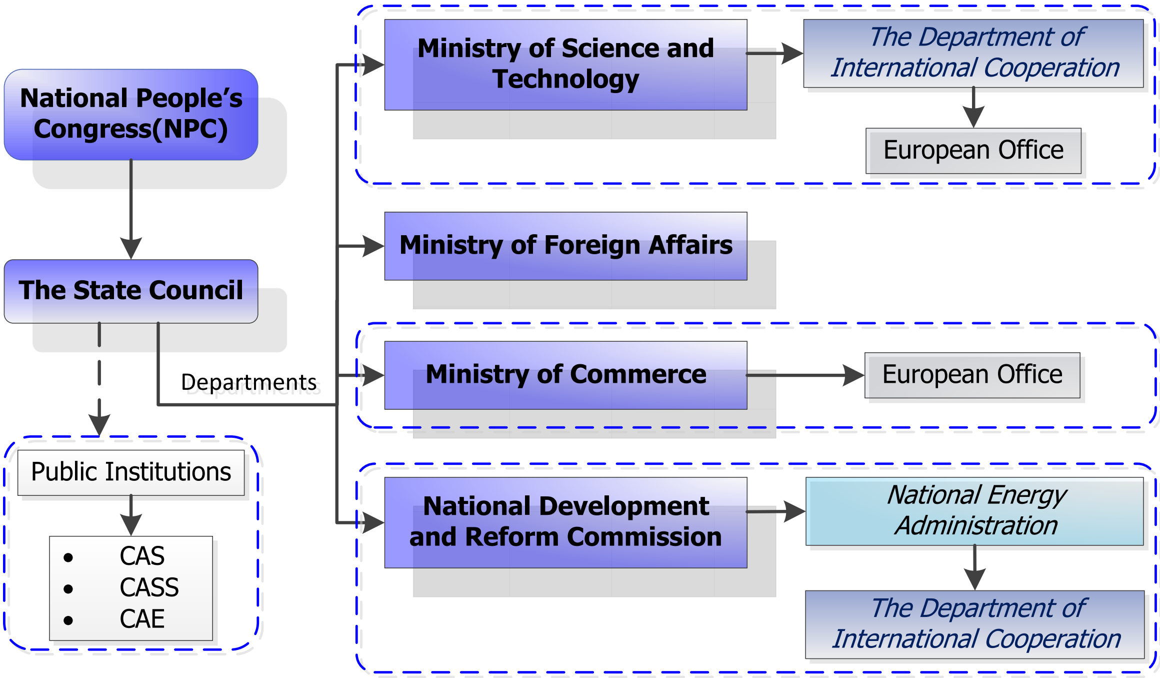

Figure 4.1 Chinese S&T International Cooperation Related Institutions

4.4 Chapter Conclusion

The overall evolution of Chinese S&T policy can be divided into three periods: under the system of the socialist planned economy (1949-1978), under the system of reform and transition (1978-1992), and on the basis of the socialist market economic system (Since 1992). At present, the most important institution in the

S&T policy decision making and with regard to S&T international cooperation is the Chinese Ministry of Science and Technology.

In 1978, the Chinese national S&T conference was held for the first time, since then, reform and enlargement become the prominent era theme, and China opened its door to the world outside. In 1992, when the 14^{th}National Congress of CPC approved the establishment of Chinese socialist market economy, within S&T policy more attention was paid to the coordination and matching problem among the reform of the economic system, political system, S&T system and education system.

Chapter5 Analysis of the China-EU S&T Cooperation

5.1 Science and Technology

In this thesis, “science” mainly refers to fundamental research, the aim of which is to generate knowledge about the world. “Technology” can be understood as the application of science to resolve the concrete problems in the process of knowing the world. They are closely interrelated. Technology develops new tools to investigate nature. And new science findings lead to new applications and solutions.

The revolution of modern science and technology is the confluence of the scientific revolution and technological revolution. From the perspective of scientific theory, the revolution is based on relativity, quantum mechanics, system theory, information theory and cybernetics; from the perspective of technique and technology, it is the revolution of microelectronics technology, biological engineering, marine engineering, space technology, etc. The modern science and technology revolution led to the emergence of new industry groups that tremendously influenced the various fields of modern production and life. The modern science and technology revolution is changing the world, and it is one of the symbols of the progress of society. Advantages in science and technology largely decide a country’s international competitiveness.

Figure5.1 shows the relationship between science, technology, education and international competitiveness, the three factors influencing Science and Technology

Competiveness. According to the International Science and Technology Competitiveness report from Chinese Academy of Science, when one of the three sub factors enhances, a country's global ranking and general international competitiveness would accordingly increase. At the same time, only when all three sub factors' index fall, will a country's general international competitiveness fall. When only one of them goes down, it may not greatly influence the General International Competitiveness. For general international competitiveness to decrease, all three sub factors must be involved.[143]

[143]Pan J. (2010). *Research on International Science and Technology Competitiveness*. Science press, pp. 29-35. 潘教峰：国际科技竞争力研究报告

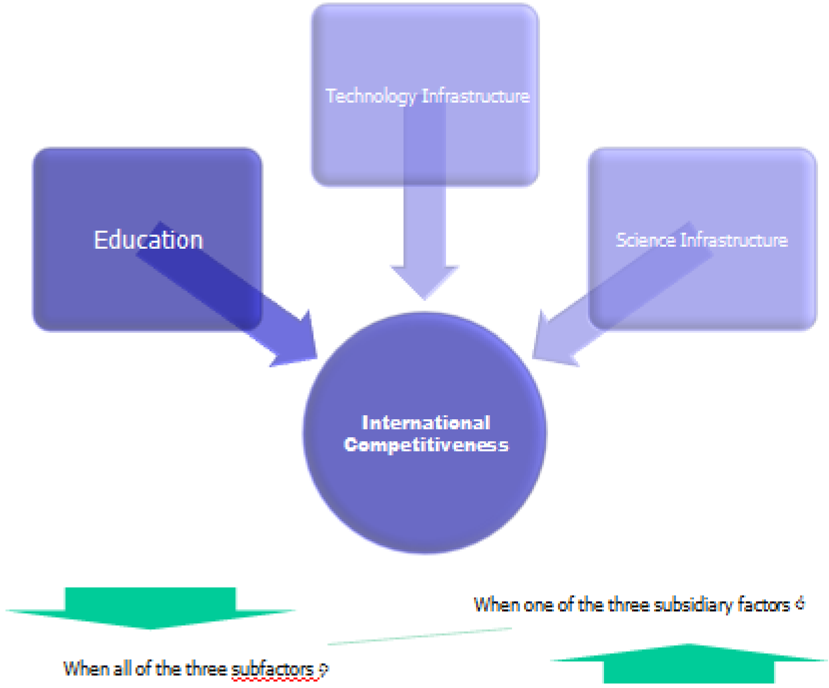

Figure 5.1 The Relationship Between Science, Technology, Education and International Competitiveness

Both China and the EU realize that S&T is of critical importance in promoting or maintaining their respective international competitiveness. Nowadays, China has its Chinese National Medium and Long-Term S&T Development Plan 2006–2020, which aims to enhance the domestic innovation capability and S&T level to promote economic and social development and to maintain national security, in an effort to provide strong support to build a well-to-do society, to have a strong impact on S&T achievements worldwide and to join the ranks of innovative countries, thus paving the way to become a world S&T power by mid twenty-first century. The EU Horizon 2020 programme, a framework programme for research and innovation, aims to establish the EU as a leading knowledge-based economy, producing world-class science and innovation to ensure Europe's global competitiveness.

To achieve their national goals, China and the EU cooperated in many high-tech areas. The main areas of China-EU S&T cooperation are information technology, energy and sustainable development of the environment, nanotechnology, food and aerospace. In relation to China-EU cooperative S&T projects, the proportion of cooperation related to high science and technology is about 78%.[144] For example, the Galileo satellite system project is the largest joint EU-China S&T project. When the cooperation on this project commenced in 2003, the EU planned to invest 3.2 billion euro and China to invest 230 million euro. This project has great political, economic and military importance and high potential value in promoting China's Science and Technology status. The Dragon Programme is China's largest international cooperation project in relation to earth observation. This program was funded by the EU's research and innovation program for 2007–2013(FP7), which has been replaced by the Horizon 2020 programme, and which aimed to encourage Chinese participation in Horizon 2020. After high-level meetings in 2014 between Chinese and European Space Agency (ESA) officials, it was decided to reinforce the cooperation of Dragon Program.

5.2 The Purpose of Countries Participate in International S&T Cooperation

The development of science and high technology programmes usually needs

[144] Wen, X. (2000). *High-tech Knowledge Chrestomathy*. University of Defense Technology Press, p. 28. 温熙森：高科技知识读本

significant financial support and a rich brain pool that goes beyond one single country's capability. This creates the need for cooperation among countries in order to maximize the input-profit ratio. One example is the International Thermonuclear Experimental Reactor, one of the most ambitious international energy projects in which China, the US, the EU, Korea, Japan, Russia, India and other countries are collaborating to build the world's largest manmade magnetic fusion device to provide sustainable, large-scale and carbon-free energy. From 2006 to 2016, its budget is over 20 billion euro.

Each country has its own goals when it cooperates in international S&T programmes. Through international cooperation in S&T, the developed countries can obtain an advantage from other countries' resources and thereby save research time and money, while developing countries can shorten the technology gap with advanced countries and attain the benefit of internationalization of talents, training and maximize its knowledge spill over.

Although countries cooperating in international S&T have diversified goals, both developed countries and developing countries can generally obtain mutual benefit and positive results from cooperation. Countries aims can be summarized as: 1)the US, Britain, Japan and other advanced scientific research powers: strive for global leadership; 2) France and Russia: enhance scientific research strength, catch up with the world top-level countries; 3) Finland and Singapore: promote domestic economic and social development that has been aided by international S&T cooperation; 4) the US, Japan, Germany: solve common global problems such as global warming; 5) the US: use S&T and diplomacy together to realize diplomatic and political purposes.

We can identify four levels of purpose in international S&T cooperation. The lowest level is that of countries with an absolute technical disadvantage. When they participate in international S&T cooperation, their first aim is to obtain technical assistance and absorb advanced technology from other countries. They always cooperate with scientifically advanced countries. Before joining in the WTO, China was in this situation, which sought to enhance its science and technology research level at all prices.

The next level is that of countries that need certain scientific research resources (finance, favourable policies and equipment) and international cooperation in S&T to develop domestic economies, improve scientific research quality, and look forward to obtaining more advanced technology, and seeking to gain more discourse rights in international affairs. China in the current time is considered to be in this level. It has already made quite developments and progress in S&T, and from these progresses it seeks to play a more active role in the international affairs. This is especially illustrated by China's importance in the ongoing Korean Peninsula crisis.

The third level is that of some developed countries, for example France and Russia, who strive to catch up with countries advanced in S&T and need to show their current scientific research strength for political purposes, and do so by S&T cooperation with other countries.

The fourth level, the top level, is countries with the perfect combination of science, technology and diplomacy that could form a positive cycle, for example, the US can achieve its political purposes through international S&T cooperation and accelerate its international S&T supremacy through political impulsion (an example is the US had developed "Star Wars" strategy during the Cold War).

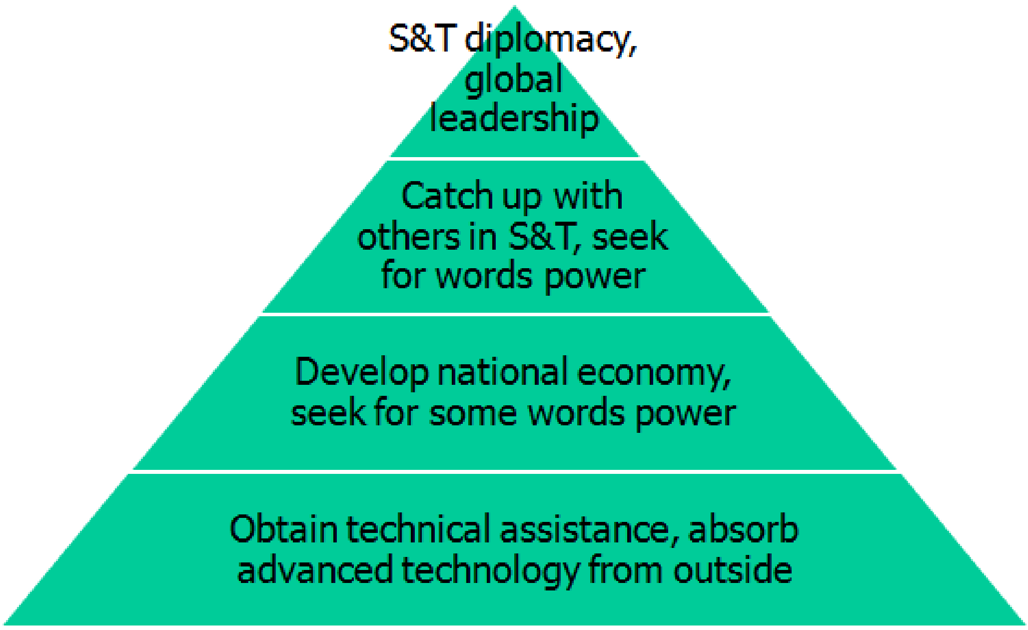

Figure 5.2 "Maslow's hierarchy of needs"

5.3 Institutionalized Bilateral Cooperation Between the EU and China

EU-China S&T cooperation started in the early 1980s. In December 1998, the two sides signed the EU-China Science and Technology Agreement, their first cooperative framework arrangement. Who are the main actors in the S&T policy decision-making in both China and the EU? In the EU, there are the European Council, the European Commission (DG for Energy, the JRC, DG for Research and Innovation, DG for Trade), the Council of the European Union, the European Parliament, the European External Action Service, companies, universities and think tanks. In China, the Ministry of Science and Technology, the Ministry of Foreign Affairs, the Ministry of Commerce, the National Development and Reform Commission, companies, universities and public institutions are the main actors (see Figure5.3)

Figure 5.3 Actors Influencing S&T Decision-making China and the EU

EU-China S&T cooperation has three main channels: the S&T cooperation under the European Commission's Framework Program, the intergovernmental S&T cooperation between China and the EU member states and Sino-EU technology trade. This dissertation mainly deals with the first one: the China-EU S&T cooperation at the government level. The EU is an important strategic partner of China in the field of science and technology, the Chinese government attaches great importance to the international scientific and technological cooperation with Europe. The Chinese government and the government of the EU signed a lot of scientific and technological cooperation agreements, they are listed in Table5.1.[145]

[145] Qi Y. (2015). "Output Characteristics and Performance Evaluation of International S&T Cooperation Projects Supported by the Government". Beijing University of Science and Technology, PhD Thesis. 漆艳如: 政府资助国际科技合作项目产出特征及绩效评价

Table 5.1 The S&T Cooperation Agreements Between China and EU Governments

Year	Important event for EU-China S&T cooperation	Significance	Concrete measures
1998	The first EU-China cooperative framework agreement was signed	It symbolized the comprehensive S&T cooperation between China and the EU, promoted the substantial cooperation of EU and China in the field of basic science and high technology.	A number of cooperation projects in the fields of biotechnology, information society, environment, energy and food security.
2004	Dragon Program was launched	The big S&T cooperative program between China and the EU in the field of earth observation	Various cooperation forms, including scientific research, data sharing, technical training, academic communication,

			etc
2005	Joint Declaration on S&T cooperation between China and Europe was issued	It is a guiding document for future China-EU S&T cooperation	Illustrated the guiding principles common goals and specific measures for China-EU science and technology cooperation
2006	China-EU S&T year	China-EU S&T cooperation entered a new period	1) organized various forms of activities such as the exhibition, BBS , academic seminar, etc 2) held a series of follow-up seminars, such as follow-up energy seminars, China-EU conference of Chinese medicine, robot seminar, etc
2008	Continued China-EU S&T		

	agreement		
2009	China EU technology partnership plan was started	Set up new equal cooperation mechanism	The two sides will jointly collect, review, and determine the partner cooperation projects in the common decided strategic priority areas, and put not less than 30 million Euro per year respectively
2012	The EU-China Joint Declaration on Innovation Cooperation Dialogue		

The attention of the governments and the signing of science and technology cooperation agreements promoted the China-EU S&T cooperation in multi-channel and many fields, and also laid a solid foundation for the further improvement of China-EU cooperation.

In 1998, at the second Asia-Europe Meeting in London, the Chinese Prime Minister Zhu Rongji put forward a proposal aimed at enhancing Asia-Europe S&T cooperation. In the same year, the China-EU Scientific and Technological Cooperation Agreement was signed in Brussels, and in 1999, was approved by the Chinese government and the Council of the EU. After that, the EU's most influential Framework programme for research and China's most important national science and technology programmes ('973' and '865' programmes, etc.) were open to each other. This agreement symbolized a comprehensive openness and breakthrough in EU-China S&T cooperation, which promoted substantial cooperation between the countries in basic science and high technology. Since 1999, EU-China S&T cooperation has expanded continuously. On 11 December 2001, China formally joined the WTO, becoming its 143th member. Although the EU does not fully recognize China's Market Economy Status, the extent and depth of China-EU S&T cooperation have increased. In 2003, China and the EU began their Comprehensive Strategic Partnership; accordingly, their cooperation in a wide range of areas continues to deepen and expand.

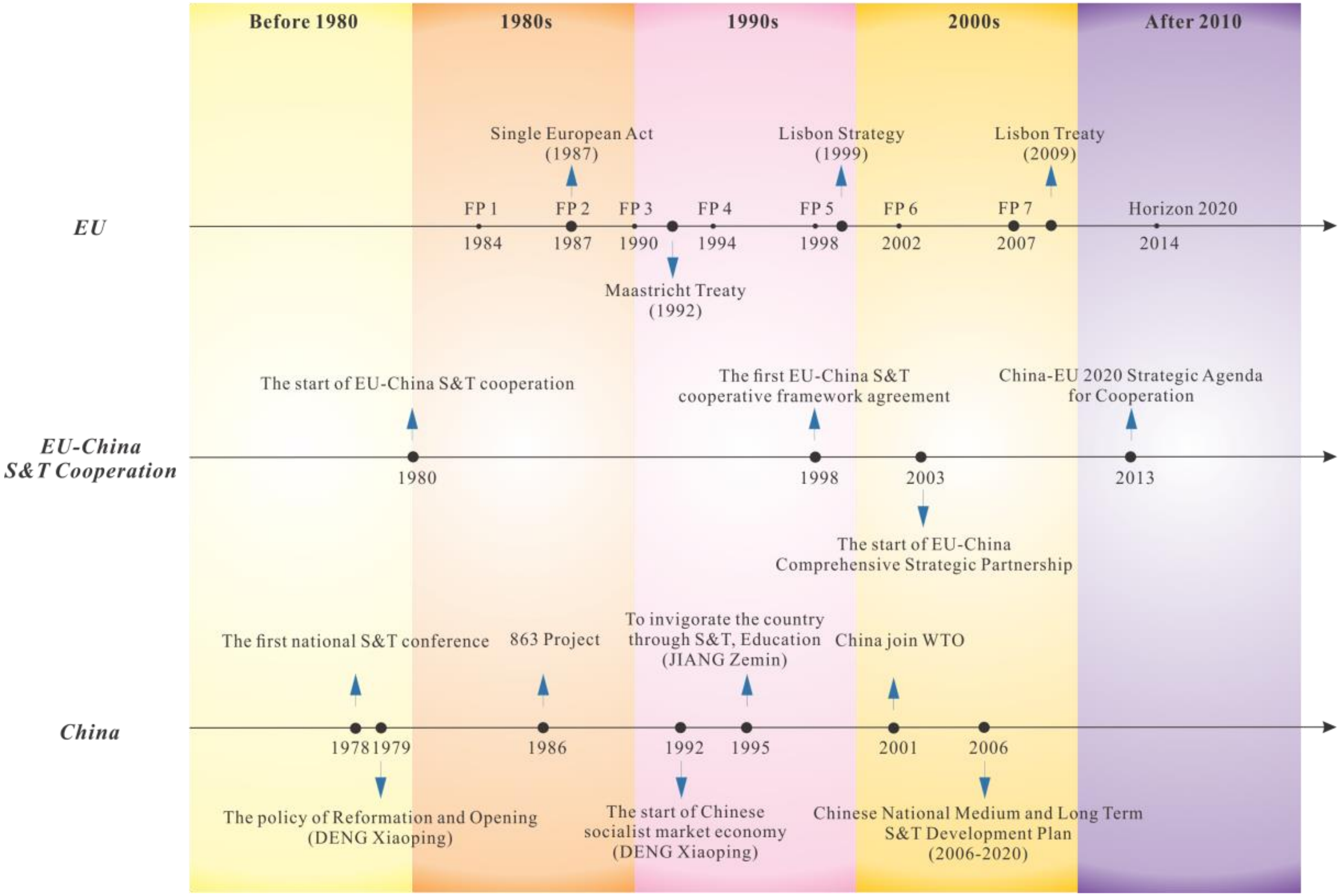

Figure 5.4 Important Historical Events of EU S&T Policy, China S&T Policy, and China-EU S&T Cooperation

5.4 The Problems within the China-EU S&T Cooperation

Though the S&T cooperation developed greatly after 1998, there have been problems, obstacles and even failures. Three types of problems have been identified in China-EU S&T cooperation.

5.4.1 Different Understandings of Costs and Benefits

The different opinions concerning costs and benefits, more specifically, the different understanding as to what can be gained from a joint S&T project, can lead to unpleasant results. The most distinct example of this divergence is Galileo project. It started with the idea of breaking the US's technology and market monopoly in S&T by developing an alternative satellite navigation system. In 2003, China and the EU agreed to collaborate in this project, despite the US's strong opposition. The president of the European Commission, Romano Prodi, said that the Galileo project was closely linked to the future of Europe, and it was 'a struggle between monopoly and anti-monopoly' (Scott 2007). From 2003 to 2006, China invested 230 million euros (Long & Sun 2004)) (while the budget of the EU was 3.2 billion euros) and Chinese technical personnel undertook a series of technical projects. However, due to the worries of damages to technology security and concerns about intellectual property, from 2006, China was excluded from the most important decisions about the Galileo project. China began to focus on its own BeiDou Navigation Satellite System. The Chinese opinion is that, in relation to the

Galileo project, China invested considerable money and human resources but did not receive its due return (Liao 2008). The EU side, however, was very concerned about China's satellite development, which it feared might put the EU in a more disadvantageous situation in the S&T cooperation. The report by Bernard Deflesselles makes clear the EU's opinion about the collaboration of Galileo project: the Chinese took advantage of European technology, and the regulated utility, which was an important part of the Galileo programme, could be jammed by the Chinese satellite system (Cazennave 2010).

5.4.2 Intellectual Property Rights

Intellectual property rights (IPR) have been a sensitive issue in the S&T cooperation between China and the EU. Because of the differences in the EUIPR protection system and that of China, conflicts in the field of high-tech trade occur frequently. In 2004, the EU listed China in the list of countries with most serious IPR problems. In 2009, China remained the only country in this category (Holslag& Jonathan 2015). According to European Commission's Report on the Protection and Enforcement of intellectual property rights in third countries published in 2015, China remains the priority 1 country concerning the issues of IPR, though EC has acknowledged its "various improvements in Chinese IP legislation". (European Commission 2015). This is certainly related tothe IPR-violating goods, as shown in Figure5.5.

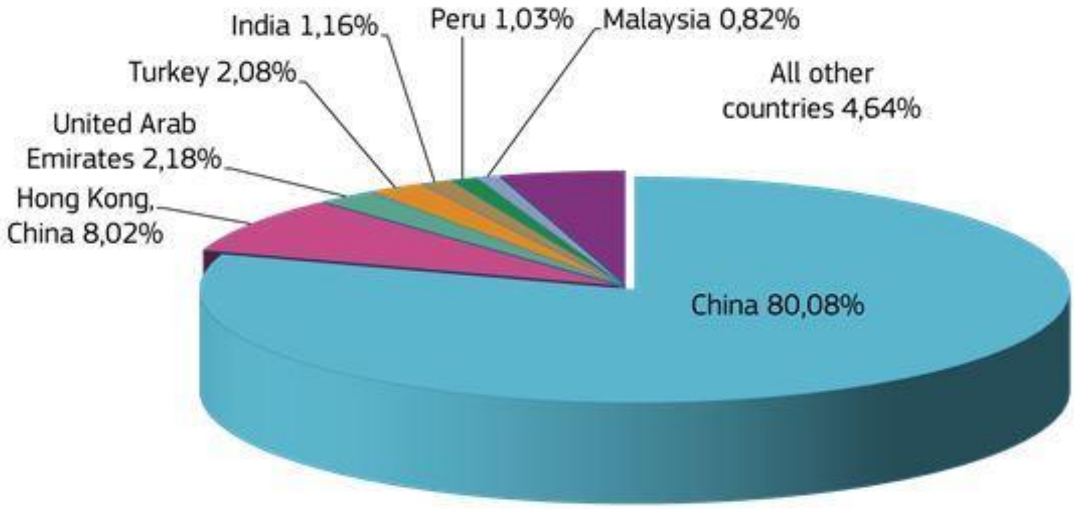

Figure 5.5 Countries of Origin of IPR-violating Goods Entering the EU

This highly controversial issue is also related to IPR protection in S&T.

For example, in 2015, the UK's Supreme Courtruled that Huawei infringed on patent technology of the intellectual property company Unwired Planet. In the judgment of the Supreme Court, Unwired Planet's patent is essential for 2G technology standards and it can improve the switch between mobile communication systems. Huawei was ruled to have infringed Unwired Planet's patent. In March, the Dusseldorf Local Court came to the same decision. However, Huawei did not accept the decision and appealed the judgment. Because of IPR problems, many

Chinese manufacturers could not sell their mobile phonesin the European market. In responding to this issue, at the occasion of IFA 2014 (Internationale Funkausstellung Berlin), Huawei's consumer business chairman, Yu Chengdong said to the organizer of IFA that entering the European market was very difficult for Chinese companies because of patent issues. Thus, from the Chinese perspective, EU's IPR protection is a technical barrier to exclude competitors.

5.4.3 Political Mistrust

Some problems in EU-China S&T cooperation have deep historical roots, such as the EU's high-tech products restrictions on China. After the Second World War, the Coordinating Committee for Multilateral Export Controls was established by Western bloc powers to place an arms embargo on socialist countries. After the Tiananmen Square protests in 1989, the EU started an arms embargo and placed export restrictions on high technology on China. Now, in 2017, in the situation of the current European economic downturn, easing restrictions on technology exports to China would be conducive to trade growth and job creation in the EU, which would promote European economic recovery. However, these restrictions have not been lifted. Chinese electronic information technology, new materials, sensing technology and lasers, shipbuilding and maritime equipment and many other technologies are still blacklisted. In April 2009, the European Parliament decided to maintain the sensitive technologies and arms embargo on China.

Another example for the political mistrust between China and the EU is the FP7.

China is the most active non-EU actor in the EU's FP7. The statistical results of China's 1,099 projects and 1,747 applying units show that China's average successful rate is 23.53%. Table 4.2 shows China's success rate in each subject area. However, the success rate of security, fusion energy and frontier explorations is still zero. This proves that EU political considerations still make the application and decision procedure of EU-funded research projects unclear and discriminatory. This greatly harms the cooperation interests, which are necessary for a successful cooperation, and generates mistrust.

Table 5.2 China's Success Rate in Applying FP7

(Specific Programmes)	Priority area	Unit Application			Project application		
		Number of applications	Number selected	Success rate	Number of applications	Number selected	Success rate
CAPACITIES	International cooperation activities	44	10	22.73%	27	5	18.52%
	Research for the benefit of SMEs	6	2	33.33%	6	2	33.33%
	Research infrastructures	52	7	13.46%	21	6	28.57%

	Science in society	15	5	33.33 %	15	5	33.33 %
	Subtotal	117	24	20.51 %	69	18	26.09 %
COOPERATION	Energy	77	16	20.78 %	48	8	16.67 %
	Environment (including climate change)	280	40	14.29 %	140	25	17.86 %
	Food, agriculture and fisheries, and biotechnology	141	33	23.40 %	107	32	29.91 %
	Health	153	29	18.95 %	83	15	18.07 %
	Information and communication technologies	269	52	19.33 %	199	37	18.59 %
	Joint	1	1	100.0	1	1	100.0

	technology initiative			0%			0%
	Nanosciences, nanotechnologies, Materials and new Production technologies (NMP)	41	7	17.07 %	32	7	21.88 %
	Security	12	0	0.00 %	9	0	0.00 %
	Socio-economic sciences and humanities	197	16	8.12 %	112	9	8.04 %
	Space	10	2	20.00 %	7	2	28.57 %
	Transport (including aeronautics)	133	53	39.85 %	61	16	26.23 %
	Subtotal	1314	249	18.95 %	799	152	19.02 %
Euratom	Fusion	1	0	0.00	1	0	0.00

	energy			%			%
	Nuclear fission and radiation protection	4	1	25.00 %	4	1	25.00 %
	Subtotal	5	1	20.00 %	5	1	20.00 %
Frontier exploration	(ERC)European Research Council	11	0	0.00 %	11	0	0.00 %
	Subtotal	11	0	0.00 %	11	0	0.00 %
PEOPLE	MarieCurie actions	300	137	45.67 %	215	78	36.28 %
	Subtotal	300	137	45.67 %	215	78	36.28 %
	Total	1,747	411	23.53 %	1,099	249	22.66 %

Source: European Commission: Seventh FP7 Monitoring Report

Unlike the S&T cooperation between China and the US, the main bodies engaged in China-EU S&T cooperation are universities and research institutions. Chinese enterprises are not that active in the China-EU Framework Cooperation. For example, in FP5, there were only seven enterprises, which is less than 5% of the total number. In FP6, the number increased to 51 and accounted for 15% of the total project. In FP7, the rate was still not very high, only 12%.

5.5 Chapter Conclusion

Since the 1980s, China and the EU have worked together to enhance their S&T cooperation, based on their common interests. After China and the EU started to use the S&T framework cooperation agreement, they built a successful institutional cooperation framework. At present, their cooperation is in a new stage and China and the EU are trying to adapt to their new equal cooperation mechanism.

However, the problems summarized in this chapter are serious obstacles that hamper the deepening of this cooperation. They are mainly that:

a) transaction costs remain high as both parties still engage in cost-benefit calculations;
b) misunderstandings and dilemmas frequently occur because of divergences in ideologies very often;
c) the establishment of a partially shared normative framework is difficult to achieve; and
d) enlarging the large number of decision-making actors is difficult in the short term, as well as decentralizing societal actors.

Thus, in the era of globalization and the new S&T revolution, the EU and China need to create a better way to build mutual trust and communication. There is still a long way to go, but it is the only way to go.

Chapter 6 Case study: Galileo Project

6.1 International Cooperation in Outer Space

With the continuous progress of human science and technology and the enhancement of capabilities of outer space development, all countries have been strengthening their input and attention in the field of outer space. During the Cold War, two superpowers, the United States and the Soviet Union, monopolized almost all outer space activities, and other countries could only participate in space activities in a limited scope.[146] After the end of the Cold War, especially in the 21st century, outer space, with its unique military, economic and social benefits, has become a new strategic high ground for major space powers. The European Union, China, Brazil, India and other space technology powers have chosen international cooperation to break the monopoly of the United States. Outer space has become a new diplomatic front after the military battlefield in the Cold War period. Meanwhile, it has also become an important issue in the relations between major powers in international politics and a new geopolitical space for competition and cooperation between space countries.

Due to the difficulties in outer space exploration, countries have decided to engage in strategic cooperation while competing. For example, even during the Cold War, when the US Apollo 13 was malfunctioning and about to re-enter the earth's

[146]Kuhn, B. (2007). *The race for space: the United States and the Soviet Union compete for the new frontier*. Twenty-First Century Books, p. 44.

atmosphere, the Soviet government immediately shut down all radio communications at the same frequency as the Apollo program to prevent any possible interference.[147] What is more, the Soviet Union sent ships to the Pacific and Atlantic to prepare for emergency rescue operations if necessary. In 1987, the confrontation between the US and the Soviet Union remained unchanged, but the two sides signed the "Agreement between the United States of America and the Union of Soviet Socialist Republics Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes", which launched bilateral space cooperation.[148] Although the level of cooperation between the two countries was relatively low at that time and was limited to the exchanges of basic science and the formulation of space laws, it is undeniable that both sides had the sense of cooperation.[149]

With the change of international strategic environment and the pursuit of national economic development, the space exploration objectives of the world's major countries has shifted from militarized use to commercial and technological use, and therefore they are more willing to cooperate in different forms when organizing large-scale space research and application projects. In addition, the rapid development of globalization also made international cooperation more mainstream. Globalization enables countries to engage in international cooperation on a series of global issues, such as space debris and space pollution, which transcend national and regional boundaries and concern the well-being of all mankind, because no

[147]Goldberg, J. (2003). *James Lovell: The Rescue of Apollo 13*. The Rosen Publishing Group, pp. 75-96.
[148]United States of America and the Union of Soviet Socialist Republics. (1987). "Agreement between the United States of America and the Union of Soviet Socialist Republics Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes". with attatched "Agreed List of Cooperative Projects". *NASA Historial Reference Collection*, Washington, D.C.
[149]Watanabe, H. (2009). "The Kennedy Administration and Project Apollo: International Competition and Cooperation through Space Policy". *Osaka University law review* 56 , p. 31.

country in the world can be immune from such issues. In addition, the space industry is a high-investment and high-risk business, and the formation of a large space market also requires the full cooperation of all countries.[150] Therefore, international cooperation in the field of space has gradually become an important part in international relations.

The necessity for space cooperation has become the consensus of all countries in the world. In 1959, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) was established in accordance with UN General Assembly Resolution 1472.[151] On December 20th, 1961, the United Nations General Assembly (UNGA) adopted "Resolutions 1721 A and B (XVI): International Cooperation in the Peaceful Uses of Outer Space", which was the first document to mention the importance of international cooperation in outer space activities.[152] On December 19th, 1966, the UNGA adopted "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies".[153] Since then, various agreements on international cooperation in outer space have been adopted. By the joint efforts of all the states, especially after the end of the cold war, substantive steps have been taken in international space cooperation. At present, international space cooperation has the following modes:

[150]Sadeh, E. (2006). *Space Politics and Policy: An Evolutionary Perspective*. Springer, Dordrecht, p. 152.
[151]Hosenball, S. N. (1979). "The United Nations Committee on the peaceful uses of outer space: Past accomplishments and future challenges". *Journal of Space Law. 7*, p. 95.
[152]United Nations. Office for Outer Space Affairs. (2008). "United Nations Treaties and Principles on Outer Space: Text of Treaties and Principles Governing the Activities of States in the Exploration and Use of Outer Space and Related Resolutions". Adopted by the General Assembly. United Nations Publications
[153]United Nations. (2008). "Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies". *United Nations Audiovisual Library of International Law*

First, cooperation through the United Nations and other international platforms. This type of cooperation is mainly aimed at jointly dealing with global issues related to outer space matters such as dealing with space debris. For example, the United States and Europe established a council to deal with space debris in 1987,[154] and the United Nations held a coordination meeting on the same topic in 1994.[155]

Second, the establishment of regional space organizations to coordinate regional space activities. For example, on May 30th 1975, 18 European countries including France, Germany and Britain established the European Space Agency (ESA) to carry out space activities together. By the end of the Cold War, ESA's aerospace and space technology capabilities ranked third in the world, only behind of the United States and the Soviet Union.[156] In 2005, China, Iran, Mongolia, Pakistan, Peru, Bangladesh, Thailand and Turkey, established the Asia-pacific Space Cooperation Organization (APSCO) to promote space science and technology development in the Asia-pacific region through regional cooperation.[157]

Third, carrying out space cooperation on specific projects through bilateral and multilateral cooperation. In addition to the international space cooperation between the United States and Japan; the United States and Europe; and Europe and Japan, there are now more new space partners. There is cooperation between developed and developing countries, such as the Galileo project between Europe and China,

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[154]Crowther, R. (2002). "Space junk--protecting space for future generations". *Science*, 296(5571), pp. 1241-1242.

[155]Hollingsworth, G. (2013). *Space Junk: Why the United Nations Must Step in to Save Access to Space*. Santa Clara L, p. 239.

[156]Hoerber, T. C. (2009). "The European Space Agency and the European Union: The next step on the road to the stars". *Journal of Contemporary European Research*, *5*(3), pp. 405-414.

[157]Zhao, Y. (2016). "The role of bilateral and multilateral agreements in international space cooperation". *Space Policy*, *36*, p. 14.

and the launch of climate science and technology satellites by France and India.[158] There is also South-South Cooperation among developing countries, such as the "The China-Brazil Earth Resources Satellite program" (CBERS), which has become a classic example of south-south cooperation, and the cooperation between India and Israel.[159] Moreover, after the 1990s, multilateral space cooperation worldwide, such as multilateral cooperation in the Asia-pacific region and the Pacific Rim, has become increasingly active.

Although the scope of international cooperation in outer space is expanding, the areas of cooperation are still mainly focus on civilian and commercial aspects. Since military affairs refer to the national security of a country, military cooperation in the field of outer space is confined to limited information and technology sharing within groups with common interests. For example, Israel and Japan seek help from the United States to develop their military satellites.[160] Although countries have strong willingness for cooperation, there is inevitably conflict in international cooperation out of self-interest. For example, in the cooperation between the United States and Europe, the European Galileo project was resisted and suppressed by the United States.[161] Although the cooperation among EU countries in ESA is very united, there remain many problems in reality.[162]

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[158]Guo, H., Fu, W., & Liu, G. (2019). *Scientific Satellite and Moon-Based Earth Observation for Global Change*. Singapore: Springer, pp. 31-49.

[159]Lino, C. D. O., Lima, M. G. R., & Hubscher, G. L. (2000). "CBERS-An international space cooperation program". *Acta Astronautica*, *47*(2-9), p. 559.

[160]Steer, C. (2017). "Global commons, cosmic commons: Implications of military and security uses of outer space". *Georgetown Journal of International Affairs,* 18(1), pp. 9-10.

[161] 黄爱民. "伽利略 (GALILEO) 系统对美国 GPS 的冲击." 测绘与空间地理信息 30.3 (2007). pp. 41-44.

[162]Interview 5, with Karl Bergquist, ESA

6.2 Sino-EU Cooperation in the Field of Outer Space

Since 1975, space cooperation between China and the EU has had three stages, outlined in the following sections:

6.2.1 Embryonic Stage of Cooperation: Before 1990's

Before the 1990's, the world was embroiled in the Cold War between the two camps of the United States and the Soviet Union. China and the European Community belonged to different camps. At that time, *EU-China relations* were largely restricted and influenced by the relationship between the US and Europe, and the relationship between China and US. The space cooperation between China and Europe in this period took 1975 as the boundary and was divided into two phases: the period of no exchange and the period of contact and exchange.

Before 1975, although China established diplomatic relations with some major European countries, the hostility between them resulted in little contact in outer space. When Sino-Soviet relations broke down in the 1960s, the Soviet Union withdrew all the experts, leaving China to develop its space industry on its own.

On May 6th 1975, China established diplomatic relations with the European Community. However, restricted by the international environment at that time, there was no substantial progress in bilateral relations.[163] In 1977, the Chinese

[163] Marking 45 years of EU-China diplomatic relations in a time of global crisis, Delegation of the European

Aerospace Technology Delegation took the lead in going abroad to investigate France's space technology. After that point, China's long isolation from the outside world was broken. After China's reform and opening up and the establishment of diplomatic relations between China and the United States, European countries such as France, Germany and Italy have also started exchanges with China in the field of outer space. However, at that time, the forms of exchange were mainly low-level exchanges such as space personnel training, exchange of experts and scholars, and organization of scientific seminars. The two sides did not achieve space cooperation.

In 1980, the European Space Agency and the China Science and Technology Commission (the predecessor of the Chinese Ministry of Science and Technology) signed a document of acilitate the exchange of information; and China and the EC started their scientific collaboration in the field of outer space.[164] Since then, China and Europe have ushered in high-tech dialogue and exchanges. In 1981, invited by the Chinese government, the commissioner of Directorate General for Energy of the European Community, Michel Carpentier led a delegation to China to discuss the scientific and technological cooperation between China and Europe. In October 1985, the China Science and Technology Commission and the Directorate General for Research and Innovation of the European Community jointly organized a symposium on "The new technology revolution" in Beijing to discuss the future development of the high-tech cooperation between China and the Europe.[165]

Union to China, 2020

[164]ESA. (2001). "A HISTORY OF COLLABORATION" <https://www.cosmos.esa.int/web/double-star/history-of-collaboration> last visited on 1, 2021

[165]European Commission. (1987). "EEC-CHINA JOINT COMMITTEE" <https://ec.europa.eu/commission/presscorner/detail/en/MEMO_87_3> last visited on 1, 2021

Regarding space cooperation between China and Europe from 1975 to 1990, due to the huge gap in technical capacity between the two sides, the EC with its significant technological advantage did not show its willingness to cooperate with China, despite the frequent interaction between the both sides during this period. The ESA still focused on internal affairs such as the development of the Ariane launch vehicle and the construction of the International Space Station, without allowing China to participate in its own practical space cooperation projects.

6.2.2 Initial Period of Cooperation: from 1990s to the Beginning of the 21st Century

Relations between China and the EC were at an impasse between the late 1980s and the collapse of the Soviet Union in 1990, primarily due to the Tiananmen Square incident in 1989. This event led the EC to follow the US in imposing economic sanctions on China, significantly straining Sino-EU and Sino-US relations during that period. In the second half of 1990, the EC adjusted its policy towards China. In 1991, the Sino-European Scientific and Technological Cooperation Working Group was established to regularly discuss space cooperation policies and action measures.[166] In 1992, the relation between China and Europe began to rebound, the same year, the European Space Agency and the Chinese Academy of Sciences, China Science and Technology Commission signed a cooperation agreement regarding "multipoint exploration satellites". This is the first space cooperation project between China and Europe. For the first time, China was a full member of

[166]Zhang, L. (2002). "Strategic cooperation between China and the EU and its challenges". *Practice in Foreign Economic Relations and Trade*, 4, pp. 7-8. 张良卫：中国—欧盟的战略合作及其面临的挑战

one of the highest-level and largest international space cooperation programs. In 1993, Liu Jiyuan, director of the China National Space Administration (CNSA), signed a joint statement with the German minister of aerospace technology, confirming that the 1984 “Agreement on Civil Space Science and Technology Cooperation” was still valid, and indicated that he would actively support the cooperation between German aerospace companies and the Chinese space industry. In 1994, China and Germany established a joint venture, Huade Aerospace Technology Co., Ltd., LTD., the space cooperation between China and the EU has made a substantial start. The aerospace companies of China, Germany, and France signed the “SINOSAT-1” satellite development and production contract in June 1995, and the launch was successful three years later. This is the first satellite cooperation between China and Europe.[167]

In 1994, the EU formulated “Toward a New Asia Strategy”, and advocated broader dialogue with China and other Asian countries.[168] In 1995, the EU issued its first policy paper on China: “A long term policy for China-Europe Relations”.[169] On the 22nd of December 1998, China and the EU signed the “Agreement for scientific and technological cooperation between the European Community and the Government of the People’s Republic of China”, the Framework Program (FP) of the EU officially opened to China—the first major international research project open to China — at the same time, the National Advanced Technology Research and

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[167]Wu, H., & Xiao, Z. (1994). “China has expanded satellite cooperation with other countries”. *Aerospace knowledge* 12, pp. 25-26. 吴海, 晓祝: 中国扩大对外卫星合作

[168]European Commission. (1994). “Communication from the Commission to the Council. Towards a New Asia Strategy”
<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:51994DC0314> last visited on 1, 2021

[169]European Commission. (1995). “Communication of the Commission. A long term policy for China-Europe Relations”
<https://eeas.europa.eu/archives/docs/china/docs/com95_279_en.pdf> last visited on 1, 2021

Development Program and *National Basic Research Program*(“863” and “973” program) of China were open to the EU.[170] The agreement provides more opportunities and new channels for both sides in future high-tech cooperation. In order to implement this agreement and support China’s participation in the FP of the EU, the Ministry of Science and Technology of China set up the “*China–EU Science and Technology Cooperation Promotion Office”* in 2001, with the strong support from the Directorate-General for Research and Innovation and the EU Mission to China.[171] After this agreement, the EU began to promote China’s participation in applied space projects. Therefore, this agreement is also regarded as the formal beginning of strategic cooperation between China and the EU in the field of outer space.

6.2.3 Comprehensive Cooperation Period: Since the Beginning of 21st Century

Since the beginning of the 21st century, space cooperation between China and the EU has gone beyond the scope of bilateral cooperation. Space cooperation between China and the EU now involves EU member states as well as supranational institutions such as the European Commission.

[170]European Community & Government of the People’s Republic of China. (2000). “Agreement for scientific and technological cooperation between the European Community and the Government of the People’s Republic of China”. *Official Journal of the European Communities*, L 006, pp. 40-45. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22000A0111%2802%29> last visited on 1, 2021

[171]Hannas, W. C., Mulvenon, J., & Puglisi, A. B. (2013). *Chinese industrial espionage: Technology acquisition and military modernization.* Routledge, p. 236.

6.2.3.1 Cooperation between China and the ESA

In 2001, the China National Space Administration (CNSA) proposed the "China's Geospace *Double Star* Exploration *Program*" (DSP) on space exploration, which was adopted by the European Space Agency.[172] This cooperation has taken a substantial step forward in China-EU space cooperation. In March 2000, invited by ESA, Sun Laiyan, deputy director of CNSA, went to Europe to investigate the Galileo navigation system and explore the possibility of China's participation in the project. China became the first country outside the EU to join the program in 2003.[173]

In 2004, the ESA and the National Remote Sensing Center of China(NRSCC) jointly initiated the "Dragon program" for Earth observation satellites. In 2006, the "China-EU Science and Technology Year" was launched in Brussels, with the theme of collaborative innovation for mutual benefit. Various conferences, seminars, forums, and exhibitions were held to promote cooperation in all fields of science and technology. In 2007, when the Chinese lunar-orbiting spacecraftChang'e-1 carried out mission in outer space, China was allowed to use three observation and control stations of the ESA and the Chilean CEE station. The ground receiving station of ESA received the telemetry and forwarded the control commands to China. This is the first time that China and ESA have achieved international cooperation in the field of deep space measurement and control. In

[172]Liu, Z. X., Escoubet, C. P., Pu, Z., Laakso, H., Shi, J. K., Shen, C., & Hapgood, M. (2005). "The Double Star mission". *Annales Geophysicae*., 23(8), p. 2707. Copernicus GmbH

[173]Sun, L. (2007). "China's Aerospace Development Strategy and Key Fields", *Aerospace China* 1, p. 4. 孙来燕:中国航天的发展战略和重点领域

return, China shared its relevant data with the ESA. The two sides established a mechanism for mutual visits.[174]

In 2012, the NRSCC organized the first meeting of the working group on the reflection signals of navigation satellites. Relevant persons in charge of the ESA International Affairs Department and the Galileo Project Navigation-related Activities Department were invited to attend the meeting. At the meeting, China and the ESA reached a consensus on the working mechanism of the working group and agreed to promote substantive cooperation in the first half of 2012.[175] In November 2013, CNSA, ESA and the Russian Federal Space Agency (RFSA) held the first meeting of the tripartite working group in Beijing. During the meeting, the three parties discussed the trilateral cooperation plan on Mars exploration and other space fields and agreed on the follow-up cooperation plan.[176] In the same year, China and the EU jointly issued the "China-EU 2020 Strategic Agenda for Cooperation", including space cooperation.

6.2.3.2 Cooperation between China and Germany

Germany is the first country to conduct space cooperation with China. China and Germany have the longest history of space cooperation; the two sides not only

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[174]ESA. (2007). "Chang'e-1-New Mission to moon lift off" <https://www.esa.int/Science_Exploration/Space_Science/SMART-1/Chang_e-1_-_new_mission_to_Moon_lifts_off> last visited on 1, 2021

[175]China National Space Agency. (2012). "China and the EU will conduct substantive cooperation on navigation satellite research" 中国国家宇航局：中欧导航卫星研究将开展实质性合作 <http://www.cnsa.gov.cn/n1081/n7529/n308608/430960.htm> last visited on 4,2018

[176]China National Space Agency. (2013). "The first meeting of the EU, China and Russia tripartite working group was held in Beijing" 中国国家宇航局：中欧俄三方工作组首次会议在京召开 <http://www.cnsa.gov.cn/n1081/n7529/n308608/594609.html> last visited on 4, 2018

maintained a good cooperative relationship, but also conducted fruitful cooperation. In 1994, China and Germany established a joint venture, Huade Aerospace Technology Co., Ltd., LTD; in 1995, they cooperated in SinoSat Satellite project, and in 1997, for the Dongfanghong-3 satellite. China and Germany maintained frequent high-level visits between space agencies and achieved fruitful results in space cooperation.[177] In 2008, China and Germany set up the joint space robot laboratory, which works under the guidance of the two national space agencies. Based on the technical cooperation between Harbin Institute of Technology and the German Aerospace Center (DLR), the laboratory has gradually expanded to other space fields.[178] In 2011, the two sides carried out a number of cooperation projects on the Shenzhou-8 spacecraft, which also carried German weightlessness research equipment.[179] No foreign experimental equipment has ever been launched with the Chinese spacecraft before. In September 2013, China and Germany held the first round table meeting in Beijing to promote the exchanges between the Chinese and German aerospace industries,[180] which greatly promoted the cooperation between the two countries in the aerospace field. In 2019, China and Germany jointly completed the Lunar Neutron and Radiation Dose Detector (LND) project. The two sides shared scientific data, they cooperated in an open manner and shared many technical details.[181] Pascale Ehrenfreund, who heads the DLR, said that now China

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[177]Cheng, Q. & Hao, L. (2014). “Analysis of Sino-European Space Cooperation”. *Germany Research,* 2, p. 9. 程群,郝丽芳:中欧太空合作分析

[178]State key laboratory of robotics technology and systems (Harbin Institute of Technology). (2008) 机器人技术与系统国家重点实验室（哈尔滨工业大学）
<http://robot.hit.edu.cn/gjhzqk/list.htm> last visited on 8, 2018

[179]Yang, S. (2011). “Space Rendezvous: A new chapter in China’s ‘Wen Tian Journey’”. *Science & Technology Review,* 29(31), p. 7. 杨书卷:太空交会:中国 “问天之旅”新篇章

[180]China National Space Administration. (2013). “The Sino-German aerospace industry held the first roundtable meeting” 中国国家航天局：中德航天工业界召开首届圆桌会议
<http://gfplatform.cnsa.gov.cn/n152/n15148/n15319/c36815/content.html> last visited on 1, 2021

[181]Xinhua Net. (2019). “Keele University team: great cooperation with China” 新华网：德国基尔大学团队:“和中国的合作棒极了”
<http://www.xinhuanet.com/world/2019-01/12/c_1210036656.htm> last visited on 1, 2021

is the country Germany most wanted to cooperate with among all the space faring nations. "China has its own space program, and it moves at its own pace, but it's also open to collaboration".[182]

6.2.3.3 Cooperation between China and France

In March 2000, the National Center for Space Studies of France (*Centre National d'études spatiales* / CNES)and the CNSA held the first meeting of the French-Chinese space committee in Paris. By 2019, China and France had held 12 joint committee meetings. At each meeting, the chairmen of the two sides listened to the work reports of all working groups and discussed the next stage of cooperation in outer space. At the most recent joint space committee meeting which was held in Shanghai in June, 2019, both China and France pledged to continue to expand and deepen cooperation in the space field.[183]

The China-France space cooperation group, established during the former French President Jacques Chirac's visit to China in October 2004, has greatly promoted the development of space cooperation between China and France. In November 2004, the China and France aerospace forum was held, which was the first high-level dialogue between China and France in the aerospace industry.[184] From 2005 to

[182]Deutsche Welle. (2018), "Towards the Moon: Why Europe wants to work with China" <https://www.dw.com/en/towards-the-moon-why-europe-wants-to-work-with-china/a-45644847> last visited on 1, 2021
[183]Spacewatch Global. (2019). "China And France Hold Twelfth Space Cooperation Meeting In Shanghai" <https://spacewatch.global/2019/06/china-and-france-hold-twelfth-space-cooperation-meeting-in-shanghai/> last visited on 1, 2021
[184]Hu, Q. (2004). "China-France High-level Aerospace Forum draws up a blueprint for future cooperation between the two countries". *Aerospace China* 12, p. 18. 胡群芳:中法航空航天高层论坛共绘两国未来合作蓝图

2012, China successively put several satellites made by French companies into orbit. In 2012, China and France jointly launched the APSTAR-7 communication satellite.[185] In January 2015, China and France signed the *Memorandum of Understanding on the Promotion of China-France Cooperation in the Development of Maritime Satellites*, which clarified follow-up arrangements for the satellite project, speeded up the development of the China-France maritime satellite project, and promotes bilateral cooperation on follow-up projects.[186] Three years after that, the first China-France joint satellite was launched to study ocean surface winds and waves around the clock.[187]In March 2019, Xi Jinping, the president of China and Emmanuel Macron, the president of France signed an agreement on future space cooperation; it further boosted the space cooperation between China and France.[188]

6.2.3.4 Cooperation between China and the UK

In January 2005, the director CNSA, Sun Laiyan and the UK Science and Technology Minister, Lord Sainsbury of Turville signed the “China-UK Space Science and Technology Cooperation Agreement framework”. In order to further strengthen the exchanges and cooperation between China and the UK in space science and technology, the first “China-UK Workshop on Space Science and

[185]Global Security. (2012). “APStar: Chinese Communication Satellite Systems” < https://www.globalsecurity.org/space/world/china/apstar.htm> last visited on 1, 2021
[186]China National Space Administration. (2015). “China and France sign a memorandum of understanding on advancing Sino-French marine satellites” 中国国家航天局：中法两国签署推进中法海洋卫星谅解备忘录 <http://www.cnsa.gov.cn/n1081/n7529/n308608/667894.html> last visited on 7, 2018
[187]France24. (2018). “France, China launch first jointly built satellite to study climate change” <https://www.france24.com/en/20181029-france-china-satellite-climate-change> last visited on 1, 2021
[188]Spacewatch Global. (2019). “China And France Hold Twelfth Space Cooperation Meeting In Shanghai” <https://spacewatch.global/2019/06/china-and-france-hold-twelfth-space-cooperation-meeting-in-shanghai/> last visited on 1, 2021

Technology" was held at Beijing University of Aeronautics and Astronautics in March 2006.[189] Since then, the succeeding seminars were supported by the Beijing University of Aeronautics and Astronautics and the Rutherford-Appleton National Laboratory (RAL) of UK. The second seminar was held in the UK in October 2006, and it was where China and the UK signed a memorandum of understanding. The third seminar was held in Shanghai in March 2007, and was the venue where China and the UK expressed their intention to establish a joint research laboratory for space science and technology.[190] In November 2007, China and the UK signed the "Agreement on Establishing Sino-UK Joint Space Science and Technology Laboratory" at the Beijing University of Aeronautics and Astronautics.[191] In December 2013, China and the UK signed a memorandum of understanding on the exploration and use of outer space, the two sides agreed to explore possibilities for cooperation in more space areas.[192] By 2019, China and UK had held 14 space workshops; it is the most important event for promoting capabilities, skills and technology partnerships in the space field of UK and China. At the most recent event which was held in Oxford University in September, 2019, both China and the UK continued collaboration and dialogue in space areas of mutual interest.[193]

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[189]Sun, Q. (2006). "China-UK Space Science and Technology Seminar held in Beijing". *Aerospace China* 4, p. 8. 孙青:中英空间科学与技术研讨会在京举行

[190]Ralspace. "UK-China Workshops" <https://www.ralspace.stfc.ac.uk/Pages/UK-China-Workshops.aspx> last visited on 1, 2021

[191]Ralspace. "UK-China Joint Laboratory for Space Science and Technology" <https://www.ralspace.stfc.ac.uk/Pages/UK-China-Joint-Laboratory-for-Space-Science-and-Technology.aspx> last visited on 1, 2021

[192]British Consulate General Shanghai. (2014). "UK and China's biggest yet Joint Workshop on Space Science and Technology" <https://www.gov.uk/government/news/uk-and-chinas-biggest-yet-joint-workshop-on-space-science-and-technology> last visited on 1, 2021

[193]Ralspace. "14th UK China Space Conference" <https://www.ralspace.stfc.ac.uk/Pages/14th-UK-China-Conference.aspx> last visited on 1, 2021

6.2.3.5 Cooperation between China and the other EU member states

In addition to space cooperation with ESA, France, Germany and the UK, China also maintains good space cooperation relations with Italy, the Netherlands and other EU member states.

In 2013, China provided the first launch service for a Dutch company, marking an important milestone in Sino-Dutch space cooperation. In September of the same year, a bilateral seminar was held to promote exchanges and cooperation between the Chinese and Dutch aerospace industries.[194] In 2014, China and the Netherlands signed the agreement on joint laboratory on optical instruments for space science, which was the milestone for the cooperation between China and the Netherlands in space science and technology.[195][196]

In 2011, the CNSA and Italian Space Agency (ASI) signed the "CNSA-ASI Agreement on Cooperation in the Field of Space Activities for Peaceful Purposes".[197] In 2013, China and Italy signed a memorandum of understanding on cooperation in the electromagnetic testing satellite project.[198] In July 2014, CNSA

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194 China National Space Agency. (2013). "China-Dutch space seminar is holding in Beijing" 中国国家宇航局：中荷航天双边研讨会在北京召开 <http://www.cnsa.gov.cn/n1081/n7529/n308608/587731.html> last visited on 4, 2018

195 China National Space Agency. (2014). "China and the Netherlands signed an agreement on a joint laboratory for space optical instruments" 中国国家宇航局：中荷两国签署空间光学仪器联合实验室协议 <http://www.cnsa.gov.cn/n1081/n7529/n308608/620691.html> last visited on 4, 2018

196 Netherlands innovation. "TNO establishes joint lab for space instruments" <https://netherlandsinnovation.nl/uncategorized/tno-establishes-joint-lab-for-space-instruments/> last visited on 6, 2020

197 China National Space Agency. (2011). "The Chinese and Italian space agencies signed CNSA-ASI Agreement on Cooperation in the Field of Space Activities for Peaceful Purposes" 中国国家宇航局：中意两国航天局签署关于在和平空间活动领域开展合作的框架协议 <http://www.cnsa.gov.cn/n6758823/n6758838/c6771359/content.html> last visited on 4, 2018

198 The Central People's Government of the People's Republic of China. (2013). "China and Italy signed a memorandum of understanding on cooperation in electromagnetic monitoring test satellites" 中国中央政府

and ASI signed a letter of intent on strengthening space cooperation in Rome. According to the letter of intent, the two sides would set up a joint committee for Sino-Italy space cooperation, hold regular meetings to expand and standardize cooperation, and establish a joint space science and technology laboratory relying on universities and scientific research institutions.[199]In October, 2019, China and Italy jointly held a seminar on China-Italy space cooperation. The two sides expressed their willingness to further strengthen exchanges and cooperation at the government, enterprises, universities and other levels to push China-Italy space cooperation to a higher level.[200]

6.3 The Introduction of the Galileo Project

6.3.1 Galileo Project: the Motivation Factors

The Galileo project, which is based on space technology, entailed a costly development and deployment process. Europe's determination to participate in space competition requires strong political determination and precise estimates regarding cost-benefit. The launch of Galileo project had several motivation factors:

门户网站：中国意大利签署电磁监测试验卫星合作谅解备忘录
<http://www.gov.cn/gzdt/2013-10/06/content_2501270.htm> last visited on 1, 2021

[199]Embassy of the PRC China in the Republic of Italy. (2014). "China and Italy sign letter of intent on space cooperation" 中国驻意大利使馆：中意签署航天合作意向书
<http://it.chineseembassy.org/chn/kjhz/t1176842.htm> last visited on 1, 2021

[200]Embassy of the PRC China in the Republic of Italy. (2019). "The Chinese Embassy in Italy held a seminar on China-Italy space cooperation, Embassy of the PRC China in the Republic of Italy" 中国驻意大利使馆：驻意大利使馆举办中意航天合作研讨会
<http://it.chineseembassy.org/chn/sbyw/t1709046.htm> last visited on 1, 2021

political independence and potential military needs, technological independence and huge economic benefits.

6.3.1.1 The political motivation for the Galileo project

When the Europeans named the planned European Global Navigation Satellite System Galileo, the name represented the significance of the project. In 1633, the Roman Catholic Church declared Galileo Galilei a heresy simply because he propagated the heliocentric theory and challenged the traditional view of the cosmic world under Catholic rule at that time. The European Galileo project is a challenge to global navigation, which is dominated by the US GPS system.

Although Europe has been an ally of the United States since the end of the Second World War, its quest for political and military independence has never stopped. The end of the Cold War in the 1990s gave the EU new opportunities for development, and a more politically independent tendency was formed in Europe. This independence is reflected in its adjustment of relations with the US. The GPS system is supported by the US government, directly controlled and operated by the US Air Force, and is partially used by Europeans. The Galileo project would help Europe gain greater independence from the US. Former French President Jacques Chirac told his European allies that if Europe fails to move ahead with the Galileo project, Europe is bound to be America's retainer.[201] In fact, during the Kosovo War and the Afghan War, European armies were restricted in their use of GPS

[201] Braunschvig, D., Garwin, R. L., & Marwell, J. C. (2003). "Space diplomacy". *Foreign Affairs,* 82(4), p. 156.

systems.

In addition to seeking political independence, the Galileo project will help Europe implement military operations independently from the framework of NATO. If it relies entirely on the US, it is inevitable that the US will one day restrict the movement of European troops by reducing and denying GPS services. Although the Galileo system is designed for civilian use, it is technically possible to combine military applications at any time. There is no doubt that if Galileo is put into use as scheduled, it will definitely contribute to the economic, political and security interests of Europe.

6.3.1.2 The technical and economic motivation for the Galileo project

It is one of Europe's goals to support the local space technology industry through the Galileo project, in order that the European industry can compete with the US at the same technological level. If Galileo outperforms GPS for civilian use, it could help Europe gain a bigger share of the market. A 2005 study by the EU estimated that by 2020, 65% of European residents will use global navigation satellite systems as the improvement of their business and lives. The economic benefits of the Galileo project will reach 740 billion euro by 2020.[202] As a core part of the future traffic management and measurement system, the Galileo navigation satellite system will become the key to reduce the cost and generate macroeconomic benefits. If estimates are made for the period from 2011 to 2020, the application of Galileo

[202] Air & Space Magazine. (2012). "Why Europe Wants its Own Satellite Navigation Program?" < https://www.airspacemag.com/space/the-galileo-project-4098287/> last visited on 1, 2021

will alleviate the problems of traffic jams, air pollution and traffic accidents, and the travel time of passengers will be greatly shortened. The use of the Galileo system on road traffic will help European countries save 200 billion euro, and the estimated benefits of civil aviation are about 500 million euro.[203] In a word, the Galileo project is well worth the investment, not only as a competition with the US, but also to help Europe out of the economic downturn.

6.3.1.3 The defect of the GPS monopoly gives Galileo project a chance

The civilian part of the United States' GPS system is a byproduct of military applications and GPS performance deficiencies, including lack of accuracy, reliability, and vulnerability, have not been adequately improved due to lack of competition. This leaves room for the development of Galileo. The GPS system was created for military purposes and deliberately reduced the accuracy of civilian subsystems to about 100 meters for security reasons, while subsystems for military purposes can be accurate to about 10 meters. The military characteristics of GPS mean that civil and commercial users may be interrupted at any time during a military crisis.[204] The accuracy of the GPS system in high latitude areas and urban areas is also problematic. Some countries in Europe are located at high latitudes, and cannot effectively enjoy the services of the GPS system. Another shortcoming of GPS is its reliability, which cannot guarantee normal operation at all times around the world. In 2000, GPS satellites malfunctioned, causing navigation signals

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[203] SINA TECH. (2005). "Galileo flying to challenge GPS" 新浪科技：伽利略飞天挑战 GPS <http://tech.sina.com.cn/d/2005-12-29/0752805563.shtml> last visited on 1, 2021

[204] European Space Agency. (2002). "Galileo: the European Programme for Global Navigation Services". *ESA Publications Division*, p. 32.

to disappear for as long as 18 minutes in places like Oklahoma and Kansas.[205]

Long-term existence without real competition makes the controllers of GPS lack the motivation for technological innovation, and as a result it has not solved the problems exposed in use or consider the problem of system upgrade. Compared with GPS, Galileo is more advanced, more reliable, and more accurate. According to the initial plan of the Galileo Project, the positioning accuracy of the system will reach the centimeter level. There is a vivid metaphor from an expert of Galileo: "if GPS can find the street, Galileo can accurately find the door of a house."[206] Therefore, through the Galileo system, accurate positioning is no longer an empty promise. The Galileo system uses many new technologies higher than GPS and GLONASS, which makes the system more flexible, comprehensive, reliable, and able to provide complete, accurate and real-time data signals. The Galileo system's satellite transmission signal power is greater than that of GPS, so in some areas where GPS systems cannot achieve positioning, the Galileo system can easily overcome interference and receive signals, such as high latitudes, Central Asia, and the Black Sea.[207]

"It's one of the most important initiative that Europe generated, it is a flagship initiative. This is a very important for European citizens, and will bring a lot of benefits, will bring also security and independence to EU. Because we are not to

[205]European Commission. (2002). "The European Dependence on US-GPS and the Galileo Initiative". Brussels, Belgium: Directorate-General for Energy and Transport

[206]Zhang, L. & Chen, Y. (2008). "The Galileo Project has been restarted and China-EU cooperation has a bright future--interview with Yin Jun, Director of the European Division of the International Cooperation Department of the Ministry of Science and Technology". *China Science and Technology Awards,* 1, p. 46. 张澜,陈永杰:伽俐略计划重新启动中欧合作前景广阔--专访科技部对外合作司欧洲处处长尹军

[207]Zhao, D. & Zong, G. (2011). "Galileo satellite navigation system overview". *GNSS World of China*, 36(1), p. 63. 赵大海,宗刚:伽利略卫星导航系统概述

rely on other programs, for example GPS. So it's very important for the EU. It's really important," said by Sandro D' Angelo, an officer of the EU Commission who responsible for the Galileo space policy and research.[208]

6.3.2 Galileo Project: the Response of the United States

Facing the challenge of Galileo project, the United States adopted different strategies at different stages. In the plan making phase of Galileo project, the US policy was to let Europe abandon the Galileo project and maintain GPS dominance. In the following phase, the US policy was to accelerate the expansion of the user base network, reduce the willingness of users to switch by improving performance and consolidate its first mover advantage. The final strategy was to be compatible with the Galileo system, acknowledge some of Galileo's advantages in the market, and share the market through compatibility and interoperability.

The creation of the Galileo system was costly, and it would affect the military alliance between the United States and Europe, which became the main excuse for the US to prevent the Galileo project. In 2000, the International Telecommunication Union (ITU) granted Galileo the right to transmit public signals in the GPS military M-code frequency band. This makes Galileo's signal likely to interfere with the GPS frequency band. In December 2001, Paul Dundes Wolfowitz, the deputy US Secretary of Defense, wrote to NATO defense ministers, emphasized that the addition of Galileo to the same frequency band would seriously affect the critical

[208]Interview 15, with Sandro D' Angelo; Policy Officer; European Commission; Galileo

role and capabilities of GPS systems in the event of conflict. He believed that the Galileo system was costly and unnecessary, and asked European military leaders to stop the implementation of the project.[209] At the same time, the US organized experts to decipher the experimental satellite code of Galileo Project, trying to contain it at technical level.

Upon realizing that Europe was determined to implement the plan, the United States switched strategies to consolidate its first mover advantage by accelerating the expansion of its user base network. The US changed its original discrimination policy on the accuracy of civilian equipment through administrative means, stimulating the growth of global GPS users. In 2000, the US government announced that they would cancel the policy of selectively providing service when ensuring that national security is not threatened. President Clinton said that this decision reflected the responsibility of GPS to civil and commercial users around the world. The US would provide a wide range of functions and services for civil and commercial users worldwide for free.[210] In order to attract users, the US even discloses the technical details of GPS system signals for users to decode, and made a commitment to continually improve the performance of the GPS system.

Although the US made such a commitment, design flaws cannot be overcome in a short time. To this end, BlockIIR-M and BlockIIF, the next generation GPS satellites of the United States were conceptualized to increase civil signal channels

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[209]Space Daily. (2001)". US Warns EU about Galileo's Possible Military Conflicts". Brussels. <https://www.spacedaily.com/news/gps-euro-01g.html> last visited on 6, 2019

[210]Clinton, W. J. (2000). "Statement on the Decision to Stop Degrading Global Positioning System Signals". Public Papers of the Presidents of the United States: William J. Clinton, P803 <https://www.govinfo.gov/content/pkg/PPP-2000-book1/pdf/PPP-2000-book1-doc-pg803.pdf> last visited on 1, 2021

and greatly improve the accuracy of civilian systems. According to the design, the accuracy of the next generation GPS satellite signal can reach the centimeter level, and the transmission power of the signal will be increased by 100 to 300 times than the current transmission power.[211]

The last strategy is the compatibility of the US GPS system with Galileo. In theory, for manufacturers with a large market share, deciding to be incompatible with other manufacturers can be a competitive strategy. By this means, other producers cannot share the product market with the dominant producer. However, after an extensive evaluation, the US believed that it was impossible to block the Galileo project through market means. It is better to work together than to simply suppress it. Although the monopoly position was shaken in this way, it also partially eased the huge challenge posed by the Galileo, which can sacrifice relative benefits to guarantee absolute benefits. In March 2002, the US State Department issued a statement on the competition between Galileo and GPS: "The United States will strive to make the GPS system become the global standard for accurate global positioning time information, the US is negotiating with Europe and the Galileo system should be compatible with the GPS system."[212] The statement emphasizes the advantages of GPS, which included civilian functions, technical reliability, and free use. Jeffrey Bialos, head of the US delegation responsible for negotiating the future of GPS and Galileo, pointed out that it was meaningless to have two unrelated and mutually exclusive global navigations in the global market, just as it was meaningless to have two unrelated internets around the world.[213] The US also

[211]Sirak, M. (2002). "USA Sets Sights on GPS Security Enhancements". *Jane's Defence Weekly* 16
[212]Zogg, J. M. (2009). "GPS: Essentials of Satellite Navigation" <https://zogg-jm.ch/Dateien/GPS_Compendium(GPS-X-02007).pdf> last visited on 6, 2019
[213]Bialos, J. P. (2002). "Togetherness on Galileo?". *Space News International*, 6

asked to join the development of the Galileo project to ensure that the system is compatible with the US ground positioning system, with the hope that they could get benefit from Galileo's expansion in the market.

6.3.3 Galileo Project: the Initial Design

The EU's navigation satellite program started in 1994, when the European Commission recommended the EU to participate in satellite navigation services.[214] Based on this, the Council of the EU requested the European Commission to start relevant research in November of the same year. In July 1996, the European Parliament and the EU Transport Ministers' Meeting formulated the Community Guidelines for the Development of the "Trans-European Transport Network" (TEN-T),[215] which for the first time proposed the establishment of independent European positioning and navigation system. In February 1999, the European Commission first proposed the Galileo project in its report "Galileo: Involving Europe in a New Generation of Satellite Navigation Services".[216] In November 2000, a report on the technical definition of Galileo was submitted.[217] The EU summit in March 2002 reached a consensus on the implementation of the Galileo project and decided to continually provide funding.[218] After that, the EU Council

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[214]European Commission. (1994). "Commission of the European Communities. Satellite Navigation Services: A European Approach" <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:51994DC0248&from=EN > last visited on 1, 2021

[215]European Union. (1996). "Decision 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network" GU L228.9 (1996): 11

[216]European Commission. (1999). "Communication from the Commission. Galileo: Involving Europe in a New Generation of Satellite Navigation Services", COM (99) 54 final, Brussels

[217]European Commission. (2000). "Commission Communication to the European Parliament and the Council on Galileo" COM (2000)750, Brussels

[218]European Commission. (2002). "C/02/930, Presidency Conclusions, Barcelona European Council, pp. 15-

of Ministers of Transport adopted a resolution to start the research and development phase of the Galileo project, which marked the full launch of the Galileo project.

The initial plan of the European Commission consists of two phases: the first phase (GNSS-1) was to develop a complementary system to the GPS and GLONASS, to improve their accuracy and to test the reliability of their signals. This system is known as the European Geostationary Navigation Overlay Service (EGNOS). This phase was initiated in 1994. The second phase (GNSS-2) was the implementation of the Galileo project. Complete Galileo system has three parts: Space segment, ground segment and user segment, the space segment includes 30 satellites (27 operational satellites and three spare satellites).

Although the information provided is still about location, speed and time, Galileo offers a much wider range of services than GPS.GPS only has Standard Positioning Service (SPS) and Precise Positioning Service (PPS), Galileo provides 6 services: first, **Open Service**. Similar to GPS SPS, the service is provided free of charge to users around the world; second, **Commercial Service**. Commercial Service is a value-added service to Open Service to obtain business returns. For example, adding encrypted data to Open Service, and realizing aerial communications through the combination of Galileo navigation and positioning systems and wireless communication networks; third, **Safety of Life Service** (SoL). It can be compared with the "vertical guidance method" in the International Civil Aviation Organization (ICAO) Standards and Recommendations (SARs), and provides integrity information. This service is generally only used for transportation, vessel

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16. March 2002"
<https://ec.europa.eu/commission/presscorner/detail/en/PRES_02_930> last visited on 1, 2021

entry, railway transportation control and air traffic control; fourth, **Public Regulated Service**. This service is only available to member states of the EU. It provides military, industrial and economic services closely related to Europe, such as: national security, emergency rescue, security, police, vigilance, and emergency energy, transportation and communications. Its satellite signals are more reliable and durable, and are controlled by EU member states, fifth, **Navigation Services to be Provided by Local Components**. This enhanced navigation and positioning service is provided to users through regionally-enhanced systems according to their specific requirements. This service can provide more accurate positioning and timing services; sixth, **Search and Rescue**. The Galileo search and rescue system has the same principle as the international common satellite search and rescue system, and it has greatly improved in performance.[219]

In the original design, the implementation of the Galileo project was divided into four stages, with different tasks and funding plans at different stages.

[219]Zhao, D. & Zong, G. (2011). "Galileo satellite navigation system overview". *GNSS World of China*, 36(1), p. 63. 赵大海,宗刚:伽利略卫星导航系统概述

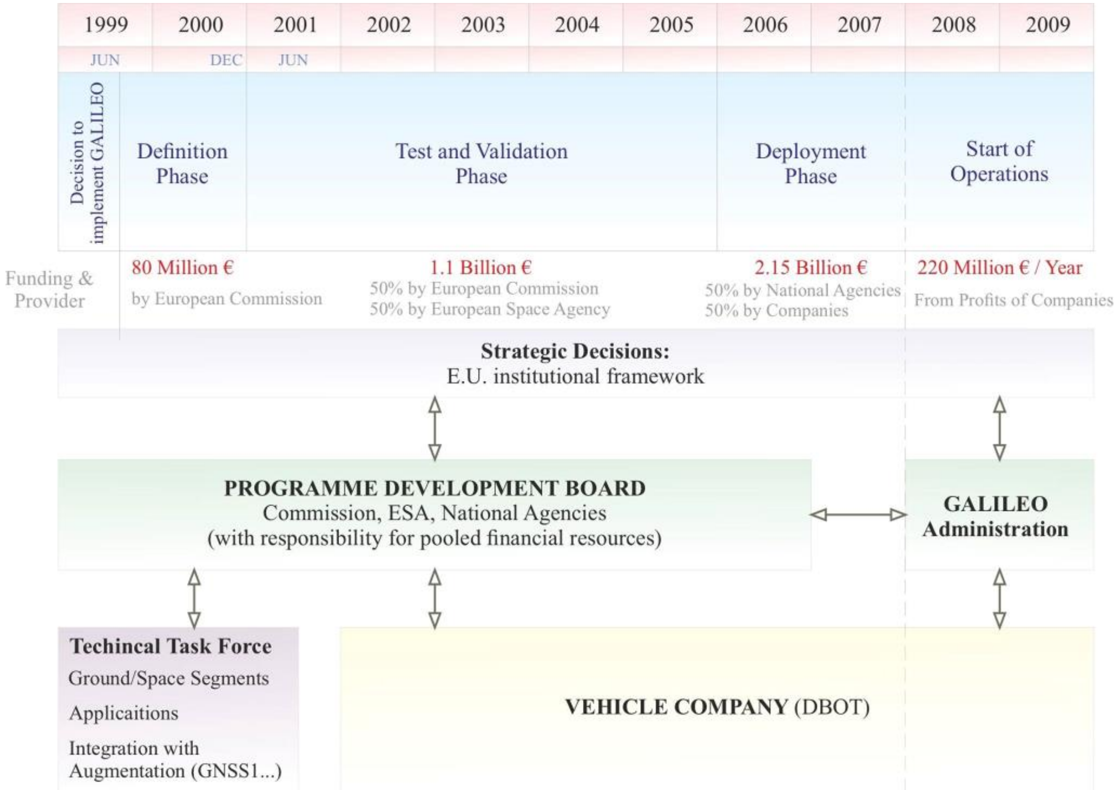

Figure 6.1 The Initial Design of Galileo Project[220]

6.3.4 Galileo Project: the Administrative Institutions

The implementation of the Galileo project is largely dependent on the cooperation between the European Commission and the European Space Agency. The *Framework Agreement between the European Community and the European Space Agency* established in August 2004 laid the legal foundation for the formal

[220]European Commission. (1999). "Communication from the Commission. Galileo: Involving Europe in a New Generation of Satellite Navigation Services", COM (99) 54 final, Brussels

cooperation between the two institutions.[221] The European Commission represents the overall interests of the EU and takes charge of the political and high-level mission requirements. For the Galileo project, the European Commission is mainly responsible for managing the Galileo project and its funding, planning license agreements, controlling risks, and defining the key stages of its implementation, especially initiating research on Galileo's overall structure, economic benefits, and user needs.

The ESA is responsible for the definition, development, and in-orbit validation of the Galileo's space and related ground components. The research and development of new technologies required by the Galileo system has also been carried out at this institution. The ESA is an intergovernmental cooperation institution and is not affiliated with the EU. Its leading body is the Council, which is composed of ministers responsible for scientific and technological affairs of each member state. Each member state has the right to vote independently in the Council. The ESA is headquartered in Paris, France, and currently has 22 member states.[222]

The Galileo project is huge and comes with high risk. Therefore, in the initial design, a "Public-Private Partnership" (PPP) approach was planned. After the completing of the definition phase cooperated by the European Commission and the ESA, the Galileo Joint Undertaking (GJU) established by the two institutions was responsible for research and development phase. In this process, the GJU needed to find franchise operators to continue the deployment and operation of the Galileo project.

[221]European Community & European Space Agency. (2004). "Framework Agreement between the European Space Agency and the European Community: A Significant Step Forward", *pp.* 53-56.
[222]ESA. Galileo.
< https://www.esa.int/Applications/Navigation/Galileo> last visited on 6, 2020

On June 17th, 2003, the GJU was formally established, it was headquartered in Brussels, Belgium, and planned to operate for four years. Its main management body was the Administration Board, and its members include founding members (EU and ESA), European Investment Bank. Private companies and third countries can also join in the later stage. The EU and ESA each have 40% of the voting rights at the Administration Board, and the share of other members' voting rights is proportional to the funds they provide.

However, the negotiation of the franchise contract between the GJU and the private enterprise consortium progressed slowly and reached an impasse in early 2007. In May 2007, the European Commission stated in a communication to the European Parliament and the Council of the European Union that the Galileo project had fallen into a substantial delay and seriously exceeded the budget.[223] Therefore, the Council of the European Union decided to readjust the Galileo project, and announced that the Galileo system deployment phase will be fully funded by the public sector. It would be delegated to the franchise operator only at the system operation phase, and grant the European Space Agency the role of "delegated procurement agent".[224] At the end of 2006, the GJU declared that it had successfully completed its main task and was subsequently disbanded, although it did not elect a franchise operator or sign an agreement with the last merged bidder.[225] European Court of Auditors evaluated the role of the GJU in the

[223]European Commission. (2007). "Communication from the Commission to the European Parliament and the Council. Galileo at a Cross-road: The Implementation of the European GNSS Programmes" <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52007DC0261> last visited on 1, 2021>

[224]European Union. (2008). "Regulation (EC) No 683/2008 of the European Parliament and of the Council of 9 July 2008 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo)"

[225]European Court of Auditors. (2009). "The Management of the Galileo Programme's Development and Validation Phrase". Special Report 7, Belgium

development and verification phase of the Galileo project and concluded that most of its tasks had not been completed.[226]

The European GNSS Supervisory Authority (GSA) took over the follow-up negotiations in January 2007. The GSA was founded on July 12, 2004. It mainly managed the public interest part of the European Global Navigation Satellite System project. It is also the regulatory agency in the deployment and operation phase of the Galileo project.[227] Its role changed after taking over the task of GJU, in September 2010, it was reorganized as an EU institution and was renamed the European GNSS Agency (GSA).[228]

The European GNSS Agency is mainly preparing for the commercialization of Galileo. In October 2014, the European Commission and the GSA signed a new authorization agreement, which stipulated that the main responsibility of the GSA is: service delivery and marketization, management, maintenance and continuous upgrading of space and ground facilities, research and improvement of user platforms in different application fields, research on new generation systems, and cooperation with other navigation satellite systems.[229] The administrative board, the executive director, and the Security Accreditation Board for European GNSS Systems (the Security Accreditation board) are the main bodies of the GSA. The administrative board is composed of representatives appointed by each member

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[226]European Court of Auditors. (2009). "The Management of the Galileo Programme's Development and Validation Phrase". Special Report 7, Belgium

[227]<https://www.gsa.europa.eu/> last visited on 3, 2017

[228]European Union. (2010). "Regulation (EU) No 912/2010 of the European Parliament and of the Council of 22 September 2010" <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010R0912> last visited on 12, 2020

[229]Sylvain, D., Pont, G., Da Costa, R., & Clivio, R. (2018). "European GNSS Agency Service Provision Plan for Galileo services". 2018 SpaceOps Conferenc

state, four representatives of the European Commission, and a non-voting representative appointed by the Council of the European Union. The chairman or deputy chairman of the Security Accreditation Board, a representative of the High Representative of the Union for Foreign Affairs and Security Policy(HR/VP), and a representative of ESA can be invited to attend meetings of administrative board as observers, the decision are passed by a two-thirds majority vote. The executive director manages the GSA under the supervision of the administrative board. The Security Accreditation Board is mainly responsible for the safety certification of the European satellite navigation program, including the approval of satellite launches and the safety certification required for the operation of various parts of the system.[230]

[230] Ibid.

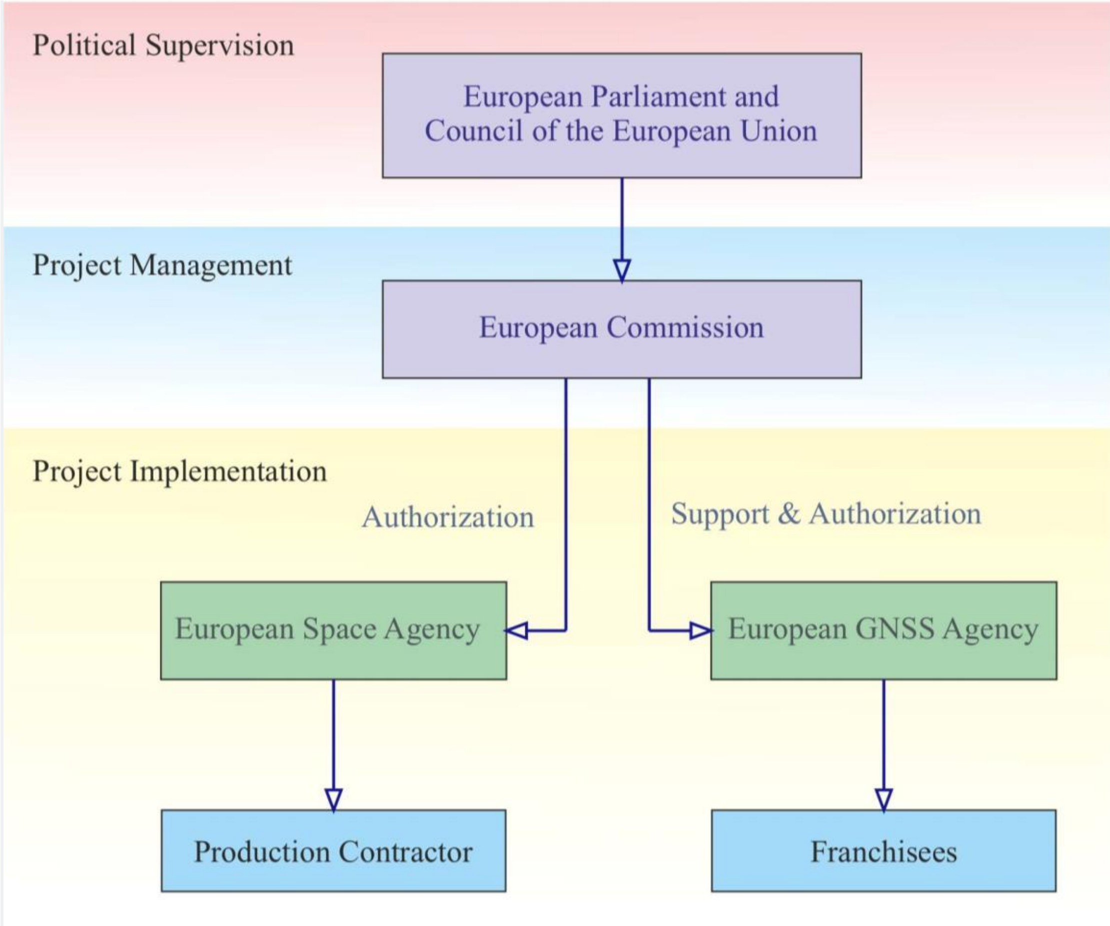

Figure 6.2 The Administrative Institutions of Galileo Project

6.3.5 Galileo Project: the Actual Operation

The defining phase of the Galileo project was completed as planned in 2001, and then entered the period of in-orbit validation. The two experimental satellites required for this phase were successfully launched in December 2005 and April 2006 respectively. However, the four operational satellites were not successfully launched until October 2012.Similar tests have been carried out across Europe since Galileo's space and ground facilities jointly located the ground for the first time in March 2013.In October 2013, the in-orbit validation phase announced to be completed,[231] eight years later than the original plan in 2005.

In 2014, Galileo entered the Full Operational Capability (FOC) phase to deploy the remaining space and corresponding ground facilities. On November 17, 2016, the Ariane5 rocket successfully launched four Galileo satellites.[232] On July 25, 2018, the Ariane5 rocket carried four Galileo satellites lifted off from Kourou, French Guiana, and successfully entered the orbit.[233] This phase is scheduled to end in 2020, at least 13 years later than the original plan to complete the full deployment of Galileo in 2007.

According to the design in the European Commission's report to the European Parliament and the Council of the EU in January 2011, the *Mid-term Review of the European Satellite Radio Navigation Programmes*: after the 18 Galileo satellites are in orbit, the Galileo system will reach the Initial Operating Capacity (IOC) stage and can provide Initial Services, including Open Service, Public Regulated Service and Search and Rescue Service.[234] On December 15th, 2016, the European Commission announced that the Galileo system began to provide services.[235] The GSA also launched a bid for the "Galileo Service Operator" (GSOp),[236] in December, 2016, and the GSA announced the award of the 1.5 billion euro Galileo

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[231]GPSWorld. (2014). "Galileo Achieves In-Orbit Validation" <https://www.gpsworld.com/galileo-achieves-in-orbit-validation/> last visited on 1, 2021

[232]European Space Agency. (2016). "Launch of new Galileo navigation quartet" <https://www.esa.int/Newsroom/Press_Releases/Launch_of_new_Galileo_navigation_quartet> last visited on 1, 2021

[233]Spacenews. (2018). "Ariane 5 rocket sends next 4 Galileo satellites into orbit" <https://spacenews.com/ariane-5-rocket-sends-next-4-galileo-satellites-into-orbit/> last visited on 1, 2021

[234]European Commission. (2011). "Report from the Commission to the European Parliament and the Council, Mid-term review of the European satellite radio navigation programmes". COM (2011) 5 final, Brussels

[235]European Space Agency. (2016). "Galileo begins serving the globe" <https://www.esa.int/Applications/Navigation/Galileo_begins_serving_the_globe> last visited on 1, 2021

[236]EUSPA. (2015). "Galileo Service Operator (GSOp)" <https://www.gsa.europa.eu/galileo-service-operator-gsop> last visited on 1, 2021

service operator contract to Spaceopal[237] (a joint venture established by the German Aerospace Center (DLR) and the Italian Telespazio company).

On the other hand, the actual progress of the Galileo project greatly exceeded the initial budget. After having to undertake the full cost of the Galileo system deployment in 2007, the European Union decided to allocate 3.4 billion euro from its agricultural budget and administrative budget during 2007 and 2013 to invest in the rest of the Galileo development stage, the deployment stage and the operation of EGNO. Out of the total funds, 600 million euro was used to complete the remaining development phase of Galileo, and 2.4 billion euro was allocated for Galileo's deployment phase.[238] From 2014 to 2020, the EU's budget for the global navigation satellite system was seven billion euro, of which two billion euro will be used to complete the remaining part of the Galileo deployment phase and three billion euro will be used for the Galileo application phase.[239] As a result, the EU's budget to complete the Galileo project will total more than nine billion euro, nearly three times the original budget.

6.4 The Analysis of EU-China Cooperation on the Galileo Project

[237]European Union Agency for the Space Programme. (2016). "GSA Signs Galileo Service Operator Contract" <https://www.gsa.europa.eu/gsa-signs-galileo-service-operator-contract> last visited on 10, 2018

[238]European Union. (2008). "Regulation (EC) No 683/2008 of the European Parliament and of the Council of 9 July 2008 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo)"

[239]European Commission. (2016). "Communication on the mid-term review of the Multiannual Financial Framework 2014-2020", COM(2016)603

6.4.1 EU-China Cooperation on the Galileo Project: a Good Start

In 2002, the European Commission and the European Space Agency formally launched the Galileo project, aimed at establishing an independent and autonomous civil global satellite navigation system in Europe. The Galileo project, with a total budget of 3.6 billion euro, was planned to operationalize 30 navigation satellites and two ground control centers, which were expected to be completed by the end of 2007 and put into commercial operation after 2008, though later postponed to 2014.[240] The system was planned to have greater coverage, accuracy and reliability than the GPS of the United States and the Global Navigation Satellite System (GLONASS) of Russia, and was targeted tobe mainly used in the civilian market. At that time, the EU was willing to involve non-member countries in the Galileo's research, development and industrial commissioning activities. (see Table6.1)

Table 6.1 EU's International Cooperation on the Galileo Project

	Signed	**Draft**	**Nego.**	**Talks**
U.S.A.	✓*			
China	✓			
Israel	✓			
India	✓			
Ukraine	✓			
Morocco	✓			
Norway			✓	

[240]Yue, X., & Yuan, J. (2004). "Analysis of Galileo satellite navigation system". *GNSS World of China*, 29(2), p. 20. 岳晓奎，袁建平：Galileo 系统的特点分析

Argentina			✓	
Russia			✓	
S. Korea	✓			
Canada				✓
Brazil				✓
Chile				✓
Mexico				✓
Malaysia				✓

In the past, the EU focused on building satellites and launching rockets to avoid competition with US and Russian satellite positioning systems. However, with the progress of European integration, the economic benefits and social benefits brought by the development of satellite positioning system have pushed Europe to fully promote the Galileo satellite positioning system as a breakthrough to reduce the dependence on the US military and technology. Cooperation with other space powers is an important part of achieving this goal. In 2000, shortly after the proposal of the Galileo project, during the meeting with Premier of the State Council of China Zhu Rongji, the vice President of the European Commission Loyola de Palacio expressed hope that China would participate in the Galileo project and received a positive response from China.[241]

[241]Casarini, N. (2006). "The evolution of the EU-China relationship: from constructive engagement to strategic partnership". European Union Institute for Security Studies, occasional paper n64, p. 27. <https://www.iss.europa.eu/sites/default/files/EUISSFiles/occ64.pdf> last visited on 1, 2021

The September 11 attacks changed the United States, and the Iraq War changed Europe. In 2003, Europe was filled with anti-American and anti-war sentiments, and felt the potential danger of a unipolar world. At that time, French President Jacques Chirac advocated the establishment of a multipolar world, and his call was firmly supported by the German Chancellor Gerhard Schroder. The Iraq war became a watershed in US-EU relations. The EU has always advocated the establishment of a multi-polar world, and valued and maintained the ability of the United Nations to play an important role on major issues, through applying multilateralism for emerging international disputes and contradictions, and resolving them through peaceful means of dialogue and consultation. This is completely contrary to the way of the United States sought to establish a unipolar world and maintain its global hegemony, arbitrarily bypassing the United Nations, and using force to solve problems unilaterally. In contrast, China has always advocated adherence to an independent and peaceful foreign policy, non-interference in the sovereignty of other countries, promotion of multi-polarization and democratization of international relations, and the establishment of the core role of the United Nations in resolving international issues. China and the EU have many similar approaches. Therefore, the two sides have the need to further develop bilateral relations.

On September 10, 2003, the European Commission issued a strategic document "A Maturing Partnership: Shared Interests and Challenges in EU-China Relations", called for the establishment of strategic partnership with China:

> Faced with these developments, it is in the clear interest of the EU and China to work as strategic partners on the international scene. EU and Chinese

> interests converge on many issues of global governance, in particular as regards the key role of multilateral organizations and systems. Through a further reinforcement of their co-operation, the EU and China will be better able to promote these shared visions and interests, and thus to shore up their joint security and other interests in Asia and elsewhere.[242]

In this document, the EU not only emphasized the importance of bilateral interests, but also considered the common interests of the two sides, which reflects the EU's willingness to further develop relations with China. In response, China issued the "China's EU Policy Paper" in October of the same year, acknowledging the EU's achievements that "the integration process has become irreversible, the EU is an important force in the world……China is committed to building a long-term and stable comprehensive partnership with the EU," appreciated the EU's "commitment to dialogue and non-confrontation" on human rights, and looked forward to "develop a strategic security consultation mechanism" in the military field.[243] Since then, the China-EU strategic partnership has been formally established.

In this context, the EU decided to include China in the EU's Galileo project, and China became the first non-EU participant. China and the EU formally signed the cooperation agreement during the sixth China-EU summit in 2003. On October 9th, the two sides signed the "Cooperation Agreement on a Civil Global Navigation Satellite System (GNSS)-GALILEO between the European Community and its

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[242]European Commission. (2003). "A Maturing Partnership: Shared Interests and Challenges in EU-China Relations"
<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52003DC0533> last visited on 1, 2021
[243]Ministry of Foreign Affairs of the People's Republic of China. (2003), "China's EU Policy Paper"
<https://www.fmprc.gov.cn/mfa_eng/topics_665678/ceupp_665916/t27708.shtml> last visited on 1, 2021

Member States and the People's Republic of China", which formally defined China's specific rights and obligations in participating in the Galileo project.[244] According to the agreement, China would invest 230 million euro to this project, has 20% ownership and 100% usage rights of the Galileo project, and can send teams to participate in the management and operation of the whole project.[245]

China set up China-EU satellite navigation technology training and cooperation center in Beijing to strengthen domestic technical personnel training and bilateral exchanges. In order to fulfill China's responsibilities and obligations, China established Galileo Satellite Navigation co., LTD., which is jointly owned by a number of relevant companies. As the domestic general contractor, the company is responsible for coordinating the relevant domestic institutions and companies to fulfill the tasks undertaken by China in the Galileo project.

For a long time, the GPS of the United States has taken the lead in the field of civil navigation. Although there was a Russian equivalent, GLONASS, which had the similar technological level with GPS, it was in a state of disrepair, the navigation satellite was incomplete, and has already faded out of the international market. GLONASS did not have the ability to compete with GPS. At that time, the Galileo Project launched by the EU is se considered to be the most powerful challenge to end the US dominance.[246] Galileo is designed to have a total of 30 "medium orbit" and "static orbit" navigation satellites covering the globe, with positioning accuracy

[244]Zhao, J. (2005). "China officially joined the Galileo project". *Space Exploration*, 1, pp. 6-7. 赵静:中国正式加入伽利略计划

[245]Zhao, D. & Zong, G. (2011). "Galileo satellite navigation system overview". *GNSS World of China*, 36(1), p. 65. 赵大海,宗刚:伽利略卫星导航系统概述

[246]Hein, G. W. (2000). "From GPS and GLONASS via EGNOS to Galileo–Positioning and Navigation in the Third Millennium". *GPS solutions* 3(4), p. 39.

exceeding GPS and better compatibility and accuracy than GPS. In an attempt to break the GPS monopoly, the Public Management Service system of Galileo deliberately chose frequencies close to those of the US GPS. Such an arrangement may dilute the effect of GPS channels and make Americans restless.[247] As a result, the United States strongly opposed the cooperation between China and Europe in the Galileo project and warned that the US would destroy Galileo's satellite constellation if the EU allow China to use the Galileo system militarily during the war between the United States and China.[248]

As early as a few years ago, China has made great progress in the development of regional satellite navigation and positioning system. In 2000, China successively launched two experimental navigation satellites in static orbit. In April 2003, China launched its third static orbit satellite, basically formed a regional navigation and positioning system covering all of China, this system is called the Beidou-1. At that time, the Beidou-1 system was still in the experimental development stage, and its technical parameters lagged behind GPS and Galileo. What is more, Beidou-1 was only regional and its commercial value was not high.[249] Out of consideration for capital and technology, China chose to cooperate with Europe at that time and temporarily shelved its independent satellite R&D plan.

Europe's inclusion of China in the Galileo project not only made political capital

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247Hein, G. W. (2000). "From GPS and GLONASS via EGNOS to Galileo–Positioning and Navigation in the Third Millennium". *GPS solutions* 3(4), pp. 42-44.

248SINA News. (2005). "China-European Galileo launched its first satellite today" 新浪新闻：中欧伽利略计划首颗卫星今日发射 <http://news.sina.com.cn/w/2005-12-28/09347838521s.shtml> last visited on 1, 2021

249 National Academy of Engineering. (2012). "Global navigation satellite systems: Report of the Joint Workshop of the National Academy of Engineering and the Chinese Academy of Engineering". Washington, DC: National Academy of Engineering

for European leaders, but also greatly eased the financial situation of the Galileo project. China promised to invest a huge sum of 230 million euro, and the first 70 million euro was soon transferred to the EU's account (including a 5 million euro participation fee).[250] More importantly, the Galileo satellite system based on civilian use will open up a huge market and perhaps unimaginable profits in China. European Commission President Loyola de Palacio said the EU-China agreement on the Galileo project would guarantee a good future for Galileo project itself and the commercial interests of Europe.[251]

This period was the honeymoon period of EU-China cooperation in the Galileo project. The two sides support each other in the international political arena and jointly opposed US unilateralism. Europe was able to ignore the pressure from the United States and is determined to establish a cooperative relationship with China. China has also promised to invest heavily.

6.4.2 EU-China Cooperation on the Galileo Project Entered into a Dormant Period

Since 2005, pro-American politicians in the EU member states have come to power, and Europe has quickly allied itself closer to the United States. In order to improve relations with the United States, the European Union spent a significant portion of

[250] Johnson-Freese, J., & Erickson, A. S. (2006). "The emerging China–EU space partnership: a geotechnological balancer". *Space policy*, *22*(1), p. 18.
[251]Casarini, N. (2006). "The evolution of the EU-China relationship: from constructive engagement to strategic partnership". European Union Institute for Security Studies, occasional paper n64, p. 27. <https://www.iss.europa.eu/sites/default/files/EUISSFiles/occ64.pdf> last visited on 1, 2021

its budget to revise its proposed launch frequencies which were similar to the GPS. As a result, the Galileo project faced financial difficulties and the EU was wrangling over its finances and the distribution of benefits.

It was also at this time that the EU began to exclude China from the Galileo project. Under pressure from the US, the EU refused to list China as a Galileo core country for violating the International Arms Trade Rules (ITAR).[252] In terms of technology development cooperation, the EU turned the cooperation with China on Galileo Project into another form: China would be able to spend money to buy the technologies from the EU after the success of the EU's research and development, but not the core technology.

Not only that, China was completely excluded from the decision-making process. In the initial design, China had the right to vote on the Administration Board of the Galileo Joint Undertaking (GJU) based on its capital contribution. However, in 2007, the European Union announced that announced that the Galileo project would be fully funded by the public sector and the GJU was dissolved. Its successor, the European GNSS Agency (GSA) is an institution belongs to the EU and it advocated for maintaining the interest of the European Union. Peter De Smet, the EU commission officer of the Galileo project, said that: "Unfortunately due to the governance change in 2008, we had to concentrate Galileo on member states of the EU only……the council decided to build Galileo as a complete European Union program, with the budget for the program 100% at EU level."[253]

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[252]Zhao, Y. (2011). "How to carry out public-private cooperation in major science and technology projects-the reasons and enlightenment of the Galileo public-private partnership project being stranded". *Tech CN*, 11, p. 64. 赵煜:如何在重大科技专项中开展公私合作——伽利略公私合营计划搁浅的原因及启示

[253]Interview 2, with Pieter De Smet; Policy Officer; European Commission; Galileo

Due to strategic needs, China did not completely withdraw from the Galileo project, but began to develop its own global navigation system – Beidou, and it made a breakthrough in a very short period of time. After being kicked out of Galileo in 2007, China launched three Beidou satellites and took over low earth orbit. This makes Beidou became the most perfect satellite navigation system after GPS, while Galileo system is still stalled in the endless debates of countries in the EU. China's Beidou system has surpassed Galileo, and Galileo became the bottom of the four navigation systems.[254] According to the principle of "first come, first served" in international law, Galileo will have to obtain China's consent to use the same frequency after China's Beidou-2i satellite occupied a favorable frequency.

The EU did not launch Galileo's second satellite until 2008, five years later than expected. In 2009, a dispute between China and Europe was triggered due to the overlap of the frequency band of China's Beidou satellite and the frequency band of the European Galileo satellite. Frequency is a scarce resource. The United States and Russia, which have taken the lead, occupied the best frequency bands. China's preferred frequency is considered to be the second best one, which is also coveted by the EU. China and the EU became competitors for this frequency band. The internationally accepted ownership principle of satellite launch frequency is "first come, first served". China launched 3 Beidou-2 satellites in 2009 and put them into operation. By the end of 2010, a total of 10 Beidou-2 satellites had been launched. At the same time, the EU had not even completed the launch of the 3 experimental

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[254] National Academy of Engineering. (2012). "Global navigation satellite systems: Report of the Joint Workshop of the National Academy of Engineering and the Chinese Academy of Engineering". Washington, DC: National Academy of Engineering, p. 20.

satellites.[255] The Galileo project was delayed again and again since 2007 due to the economic crisis and the long negotiations among EU member states. In 2012, the Galileo Project was restarted. However, China's Beidou navigation system has been ahead of Europe for 2-3 years in terms of system progress.[256]

[255]Liao, C. & Gao, F. (2011). "The construction of European Galileo satellite navigation system is progressing slowly". *Satellite Application*, 2, pp. 66-67. 廖春发,高菲: 欧洲伽利略卫星导航系统建设进展缓慢
[256]Li, H., Zhao, R. & Zhao, L. (2012). "The Management and financing lessons of the Galileo project for the EU's future space systems". *Satellite Application*, 6, pp. 44-45. 李璜, 赵睿涛,赵利平:伽利略计划为欧盟未来航天系统提供的管理和融资教训

Figure 6.3 Frequency and Four Main Satellites Systems

The Constellations

Name	Country	Began	#now	FOC	Type
GPS	USA	1978	31	30	MEO
GLONASS	Russia	1982	24	24	MEO
Galileo	European Union	2005	22	30	MEO
BeiDou	China	2007	25	35	MEO (27),GEO (5), IGSO (8)
QZSS	Japan	2010	4	4	IGSO
NavIC	India	2013	7	7	3 GEO,4 GSO
TOTAL			113	130	

Figure 6.4 The Constellations of the Major Satellite Systems

This period was a dormant period of EU-China cooperation in the Galileo project. Europe allied itself closer to the US, refused to list China as a Galileo core country and excluded China from decision-making institutions. China began to develop its own Beidou system and made good progress. China and the EU competed for the frequency bands of satellite launches and as it was ahead of the EU in terms of technological development, China finally won the competition according to the principle of "first come, first served" in international law. In the field of space, the two sides changed from partners to competitors.

6.4.3 The New Stage of the EU-China Cooperation on the Galileo Project

At present, the international satellite navigation technology and applied space industry are developing rapidly. The European Galileo system, the US GPS system, the Russian GLONASS system, and the Chinese Beidou System are recognized by the United Nations as the four core providers of the Global Navigation Satellite System (GNSS). These four global navigation satellite systems are in the process of system construction and modernization, and they provide continuous global services. Compatibility and interoperability have become the mainstream trend of multiple GNSS systems to coexist peacefully and provide joint quality services.

Multi-constellation is the new concept and is already widely used in many applications. According to Pieter De Smet, Policy Officer of the European Commission:

> […] the cooperation with China is important in the context of multi-constellation use……multi-constellation means to use different satellite

navigation systems together. We can use nowadays Galileo and Beidou and GPS and GLONASS in one system……it is important that in the future, we could use all satellite navigation systems at any time all over the world…… the global navigation systems should be used in the future at any time at any place in a joint way.[257]

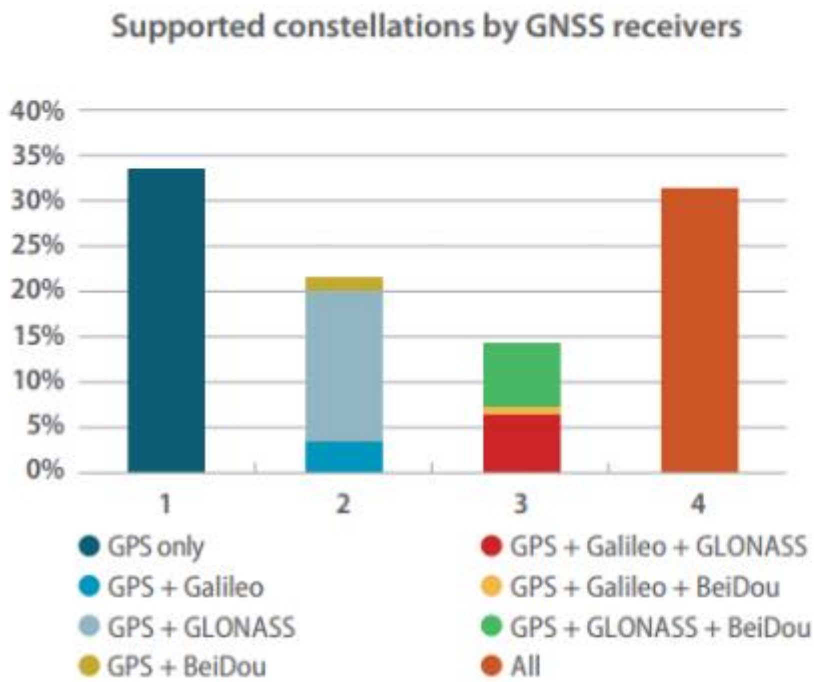

Figure 6.5 Multi-constellation, Supported Constellations by GNSS Receivers[258]

China still attaches great importance to bilateral cooperation with the EU. Deputy

[257]Interview 2, with Pieter De Smet; Policy Officer; European Commission; Galileo

[258]AIOTI and the European GNSS Agency. (2018). Webinar: "Where (exactly) are my things? Learn how Galileo can empower your IoT solution" <https://aioti.eu/webinar-where-exactly-are-my-things-learn-how-galileo-can-empower-your-iot-solution-presentation-available/> last visited on 1, 2021

director of the Chinese Satellite Navigation and Positioning Applications Management Center, Zhao Kangning believes that although the Beidou is still in its growth period, its design idea and service mode has brought new vitality and opportunities for the global satellite navigation. China's original data collection method, which has functions of positioning, reporting, and timing, opened up a new way for satellite navigation integrated applications. At the same time, the operators of Beidou have been conducting consultations on satellite frequency sharing with GPS, GLONASS, and Galileo to explore effective ways to achieve compatibility and interoperability, and have made progress.[259] Pieter De Smet said that "we're discussing with China as we do with other providers on the use of radio frequencies for satellite navigation……what is very important is to continue our discussions on radio frequencies. It's not easy to find solutions or agreements to use these scarce radio frequencies in an optimum way."[260]

In 2015, China and the EU held the fourth frequency consultation conferences on the Beidou and Galileo satellite navigation system in Prague, the Czech Republic. The EU delegation accepted the idea of frequency sharing proposed by China and agreed to complete the frequency coordination of satellite navigation under the framework of the International Telecommunication Union (ITU). This marks the end of eight years of frequency coordination between China and Europe.[261] In October 2016, the Ministry of Science and Technology of China, the European Commission and the ESA held the fourth meeting of the China-EU space science

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[259]CCTV. (2009). "The positioning accuracy of the Beidou second generation satellite has been significantly improved" 中国央视网：北斗二代卫星定位精度等有重大改进和提高 <http://news.cctv.com/china/20090416/112298.shtml> last visited on 1, 2021

[260]Interview 2, with Pieter De Smet; Policy Officer; European Commission; Galileo

[261]Ministry of Science and Technology of the People's Republic of China. (2015) "China and the EU held the fourth frequency consultation conferences on the Beidou and Galileo satellite navigation system" <http://most.gov.cn/kjbgz/201503/t20150313_118600.htm> last visited on 7, 2019

and technology cooperation dialogue in Beijing, which was a great success. At the meeting, representatives of the Beidou and the Galileo projects expressed their willingness to cooperate actively and drew up a timetable for the follow-up talks. Both sides agreed to continue to cooperate on a number of issues including sharing of the radio frequency. In addition, China and the EU have made smooth progress in the development of Galileo Mass Market Receiver (GMR) project, which is conducive to the application of Galileo in the Chinese market.[262]Pieter De Smet said: "open mutually our markets so that we can exchange equipment……it's very important to do that……to continue to open the markets for access to the different markets."[263]

Zhang Chi, the officer who responsible for the concrete work of EU-China cooperation on the Galileo project, mentioned in an interview that:

> […] nowadays, in the field of space, China and the EU are both competitors and collaborators……the current world is in an era of competition and cooperation. Continue to compete, also continue to cooperate, only a strong opponent, can become a competitor. Just like GO players of similar level, they play Go together, improve together, and make progress together.[264]

Pieter De Smet also shared his opinion:

> […] the competencies and the capabilities of the research organizations mattes. The more there are interested partners from both sides that find each other to cooperate, the better it is. So, if in certain areas, China has

[262]GOV.CN. (2016). "The fourth meeting of China-Eu Space Science and Technology Cooperation Dialogue was successfully held in Beijing" 中国政府网：中欧空间科技合作对话第四次会议在北京成功召开 <http://www.gov.cn/xinwen/2016-11/09/content_5130501.htm> last visited on 1, 2021
[263]Interview 2, with Pieter De Smet; Policy Officer; European Commission; Galileo
[264]Interview 36, with Chang Chi, officer, The National Remote Sensing Center of China(NRSCC), China

> competence and EU is lacking the competence, it will be difficult. And the other way around, if the EU is in certain research areas, developing things which are not yet in China, that makes cooperation difficult. Now, competencies and knowledge on both sides are increasing, in China and in the EU. So we will expand the cooperation in Galileo and other projects.[265]

With the development of space technology, EU-China cooperation on the Galileo project entered into a new stage. The Multi-constellation approach is the new concept and brings new opportunities for China and EU in Galileo-Beidou cooperation. The two sides continue to cooperate and discuss about the share of radio frequency, and continue to develop applications in a multi-constellation way. What is more, they also made progress on market opening. In the new period, China and the EU are both competitors and collaborators; improve together for better future cooperation.

6.5 Chapter Conclusion

Since the 1970's, the modern technological revolution has greatly advanced the development of human society and changed production methods, lifestyles and ways of thinking. Scientific and technological progress has become the main driving force for the growth of comprehensive strength of all countries and regions. As a regional organization, the EU is committed to promoting scientific and

[265]Interview 2, with Pieter De Smet; Policy Officer; European Commission; Galileo

technological cooperation among member states in order to enhance the union's overall technological competitiveness. Among them, the space industry, as a high-tech industry, is receiving more and more attention because of its huge strategic value.

In the 1990's, the Global Position System (GPS) of the United States came into the limelight. With the positioning provided by the GPS, missiles or fighters can accurately strike ground targets and this capacity marked a deep impression on European countries. As a result, the EU decided to develop their own Global Navigation Satellite System (GNSS) in order to reduce their dependence on the US GPS system and to take a share in the future satellite navigation and positioning market. The launch of the Galileo project marks the point that the EU began to develop its own satellite navigation system and participate in international cooperation and competition in the space industry.

In the initial stage of the Galileo project, the EU actively encouraged the participation of third countries, and China was the first non-European country to join. In October 2003, China and the EU signed a cooperation agreement, which formally established the cooperation framework between the two parties in the Galileo Project. China promised to invest heavily and enjoy the corresponding rights.

However, the Galileo project was delayed again and again since 2007, and obstacles have since arisen with regard to cooperation with China. Due to international political reasons, China was excluded from decision-making process of Galileo project. After that, China began to develop its own Beidou system and became a competitor with the EU, competing for the frequency band of satellite launches and eventually won this competition through quick deployment of its own satellites.

With the advancement of technology, the development requirements of international satellite navigation from the era of single GPS to the era of multiple systems, the nature of compatible sharing has emerged with the goal of achieving compatibility and interoperability. Compatibility and interoperability have become the mainstream trend for GNSS systems: for Galileo, Beidou, GPS and GLONASS to coexist peacefully and provide joint quality services. China and the EU made progress on negotiations on the sharing of radio frequency and the opening of markets in the Galileo project. The two sides are now both competitors and collaborators, and will go further on future cooperation.

Chapter7 Case Study: EC2 Project

7.1 The Introduction of Sino-EU Clean Energy Cooperation

In 1981, the EU sent the first official delegation from the Directorate-General for Energy to China. It was the beginning of EU-China energy cooperation.[266] From then on, with the continuous advancement of clean energy technology and the active promotion from both sides, China and the EU have established a hierarchic bilateral cooperation mechanism system. Additional platforms for Sino-EU clean energy cooperation include some multilateral cooperation mechanisms involving energy issues, such as the cooperation mechanism established by the international community for climate and environmental problems.

7.1.1 Sino-EU Clean Energy Cooperation Mechanism under the Multilateral Framework

Sino-EU clean energy cooperation mechanism under the multilateral framework mainly includes the Clean Development Mechanism (CDM), the Global Environment Facility (GEF), ASEM Environment Ministers' Meeting and Major Economies Forum on Energy and Climate Change.

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[266]Zhao, D. & Lai, S.(2015). "China-EU Energy Governance: What lessons to be Drawn?" in Piefer, N., Müller, F. & Knodt, M. *Challenges of European External Energy Governance with Emerging Powers*. Ashgate Publishing, Ltd., p. 135.

According to Article 12 of the Kyoto Protocol, one of the flexible mechanisms, Clean Development Mechanism (CDM) was established to promote clean energy cooperation between the industrialized countries (Annex 1 parties) and the developing countries (Non-Annex 1 parties) to reduce greenhouse gas emissions. It allows the investors from industrialized countries to carry out emission reduction projects in developing countries which are conducive to the sustainable development of developing countries, thus to reduce overall greenhouse gas emissions. The resulting emissions reductions can therefore partly offset the emissions reduction obligations which industrialized countries promised in the Kyoto Protocol.[267] The CDM provides a flexible implementation mechanism for industrialized countries; in the meanwhile, developing countries could obtain some financial aid and advanced technology through CDM projects.[268] In addition, countries or regions involved in CDM projects must be parties to the Kyoto Protocol and must have ratified the protocol. Both China and the EU have ratified the Kyoto Protocol: China fails under Non-Annex 1 countries, while European Union countries are classified as Annex 1 countries; therefore, the EU could provide financial and technical support for China's emission reduction projects. According to the rules of the CDM, projects involving improving the efficiency of terminal energy use, improving supply-side energy efficiency, renewable energy and alternative fuels are potential projects of the CDM.[269] Therefore, China and the EU can cooperate extensively in the field of clean energy under the framework of CDM.

[267]Ellis, J., Corfee-Morlot, J., & Winkler, H. (2004). "Taking stock of progress under the Clean Development Mechanism". *Organisation for Economic Cooperation and Development*, information paper
[268]Olsen, K. H., & Fenhann, J. (2008). "Sustainable development benefits of clean development mechanism projects: A new methodology for sustainability assessment based on text analysis of the project design documents submitted for validation". *Energy policy*, *36*(8), p. 2820.
[269]Zhang, Z. (2006). "Toward an effective implementation of clean development mechanism projects in China". *Energy policy*, 34(18), p. 3692.

The Global Environment Facility (GEF) is an international environmental financial institution established by the United Nations in 1990, it is the funding mechanism of the United Nations Framework Convention on Climate Change. The purpose of the fund is to provide financial assistance and transfer relevant technology to help developing countries implement projects which aim to prevent climate change and protect biological species and protect water resources, in order to obtain the global environmental benefits and promote the sustainable development of the recipient countries. The fund mainly has two sources, one is the central fund, the contribution of the fund takes the way of voluntary donation; the other one is the co-financing agreement, supporting the central fund through co-financing activities through bilateral concessional loans or grants.[270] Climate change is the second major category of GEF funding. GEF's plan in the field of climate change includes removing barriers to energy conservation and energy efficiency, cutting the long-term costs of energy technologies that reduce greenhouse gas emissions, promoting the use of renewable energy by eliminating barriers and reducing implementation costs, and promoting sustainable transportation systems. France, Germany, Italy and other EU countries have participated in this funding mechanism by donating a large sum to the GEF central fund, and signing co-financing agreements; China is a recipient country of GEF.[271] Therefore, China and the EU can continue to expand and deepen their cooperation in the field of climate change and clean energy through GEF.

The Asia Europe Meeting (ASEM) was started in 1996, and is an important

[270]Tietje, C., & Brouder, A. (2009). *Handbook of Transnational Economic Governance Regimes*. Leiden: Brill, pp. 899-914.
[271]Streck, C. (2001). "The Global Environment Facility - a Role Model for International Governance?". *Global Environmental Politics* 1(2), p. 71.

intergovernmental and interregional forum which aims to enhance understanding, strengthen mutual trust and promote the establishment of the new Asia-Europe comprehensive partnership through political dialogue, economic cooperation and social cultural exchanges. The activities of ASEM include summit meetings, foreign ministers' meetings and other ministerial meetings. The daily work of ASEM is communicated and coordinated through senior officials.[272] ASEM Environment Ministers' Meetings are organized under this mechanism, the fourth ASEM Environment Ministers' Meeting was held in Mongolia in 2012. The theme of this meeting was sustainable water and forestry management.[273] ASEM conference on climate change response toward sustainability was held in the Mekong Delta province of Can Tho on June 18. The conference was jointly organized by the Ministry of Foreign Affairs (MoFA), the Ministry of Natural Resources and Environment and the city's People's Committee. The conference is one of the most important inter-regional events on climate change and the only one of ASEM 2018 hosted by Vietnam. It is also the first ASEM initiative in its third decade of cooperation on climate change response toward sustainability.[274]

In April 2009, the United States invited 16 major economies, Australia, Brazil, Britain, China, France, Germany, Canada, the European Union, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia and South Africa, and the representative of the United Nations to attend the Major Economies Forum on Energy and Climate Change in Washington. After the meeting, leaders of the major economies and

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[272] Gilson, J. (2002). *Asia meets Europe: inter-regionalism and the Asia-Europe Meeting*. Edward Elgar Publishing, p. 13.
[273] European Commission. "Environment-international issues" < http://ec.europa.eu/environment/international_issues/relations_asem_en.htm> last visited on 1, 2021
[274] Nhan Dan. (2018). "ASEM conference highlights climate change response" <http://en.nhandan.org.vn/scitech/environment/item/6290202-asem-conference-highlights-climate-change-response.html> last visited on 1, 2021

representative of the United Nations and Denmark held a summit in Ramadana, Italy. This Forum aimed to promote a candid dialogue among major developed and developing economies in the field of energy and climate change.[275]

7.1.2 Sino-EU Clean Energy Cooperation Mechanism under the Bilateral Framework

The bilateral mechanism is the most important mechanism for China-EU cooperation in the field of clean energy and can be divided into an official channel, a semi-official channel and a non-governmental organization channel.

7.1.2.1 The Official Channel

The official mechanisms for bilateral clean energy cooperation between China and the EU include the EU–China High-Level Energy Meeting, the EU-China Energy Dialogue and the EU-China High-Level Energy Working Group.

The European Commission and Ministry of Science and Technology of China sponsored the EU–China High-Level Energy Meeting in Brussels in 1994, which was by far the largest and highest-level meeting in the field of Sino-EU energy cooperation. It was then held alternately every two years in China and the European

[275]High-Level Meeting on International Aviation and Climate Change. (2009). "Declaration of the Leaders of the Major Economies Forum on Energy and Climate Change" <https://obamawhitehouse.archives.gov/the-press-office/declaration-leaders-major-economies-forum-energy-and-climate> last visited on 6, 2019

Union.[276] Each energy conference hosts a significant number of senior representatives of the industry and government from EU and China. They discuss many topics of mutual interest, such as how to deal with the energy challenges. The EU–China Energy Conference is not only an official channel for exchanges between China and the EU on energy issues, but also provides a platform for energy companies in China and Europe to communicate regularly.

In 1996, the second EU–China Energy Conference proposed the idea of the EU–China energy working group. In 1997, the EU-China high-level energy working group was formally established and held its first meeting in Brussels.[277] Since then, the working group has held a meeting every two to three years, and has become an important work form in the field of energy cooperation between China and the EU; it is the guiding, coordinating, and monitoring mechanism of China-EU energy cooperation.

With the deepening of EU-China energy cooperation, in order to better coordinate the two governments' standpoint for energy problem and the cooperation, in 2005, China and the EU signed the memorandum of understanding on energy dialogue between China and the EU.[278] China and the EU held the first China-EU energy dialogue in the following year. The dialogue is normally co-chaired by the director of the National Energy Bureau of China and the EU energy commissioner. Through the dialogue, China and the EU exchanged views on energy issues, reached a lot of

[276]Zhou, Y., & Song, W. (2017). "Sino-European Cooperation on Renewable Energy Development". *The International Spectator*, *52*(4), p. 151.
[277]Mission of the People's Republic of China to the European Union. (2004). "China-EU Scientific and Technological Cooperation and Exchange"
< http://www.chinamission.be/eng/kj/t72211.htm> last visited on 1, 2021
[278]European Commission. (Energy-International cooperation"
< https://ec.europa.eu/energy/en/topics/international-cooperation> last visited on 1, 2021

consensus and took new steps in practical cooperation.

7.1.2.2 The Semi-Official Channel

The Semi- official channel of China-EU clean energy cooperation mainly refers to the seminars and forums which were launched by the National Energy Bureau of China and the European Commission Directorate General for Energy, and attended by energy industry representatives and academic institutions in the field. The first China-EU seminar on clean coal was organized by the energy affairs department of China and the EU in 2008.[279] At the seminar, government representatives from both sides, representatives of the energy industry and representatives of academic and think tanks in this field actively communicated relevant practical cases, policies and technologies. The seminar provided a good opportunity for the two sides to explore concrete issues of common interest to deepen cooperation between China and the EU in the area of clean coal.

One of the most important cases handled was the Europe China Clean Energy Centre (EC2 Project). On April 30, 2010, EC2 Project was launched in Beijing.[280] The project was set up by the European Commission, the National Energy Bureau of China and the Ministry of Commerce of China, and was supported by the Ministry of Environment, Territory and Oceans of Italy.[281] The period of this project was five years. The Europe China Clean Energy Centre is a landmark

[279]European Commission. (2010). "Concrete cooperation projects under the EC-China Energy Dialogue" <https://ec.europa.eu/energy/sites/ener/files/documents/concrete_cooperation_projects_ec_china_energy_dialogue.pdf> last visited on 1, 2021

[280]Lee, B. (2012). "The EU and China: Time for a strategic renewal?". Chatham House ESPO Report p. 30.

[281]Chang, M., Du, W., & Li, S. (2012). "A Study of Potential and Constraints of the Biomass Sector in China from the Europe-China Clean Energy Centre (EC2)". 20th European Biomass Conference and Exhibition. Milan, p. 18.

cooperation project which aimed to strengthen research and development in the field of clean energy for China and the EU and a short-term mechanism which aimed to promote clean energy cooperation between China and the EU. The Politecnico di Torino and Tsinghua University were responsible for daily management of the center, whose main function was to promote technology transfer and technology exchange in the field of clean coal, renewable energy, low energy consumption building and smart grids between China and the EU.

7.1.2.3 The Non-Governmental Organization Channel

Civil organizations expanded the communication channels between China and the EU in the field of clean energy; acted as an important bridge between the governments and enterprises of the two sides; and played an irreplaceable role in China-EU clean energy cooperation. In the field of clean energy, non-governmental organization channels are mainly in the form of chambers of commerce and trade associations, such as the China renewable energy institute and the European wind power association.[282] These organizations promote cooperation between the two sides by opening international exhibitions, international seminars, or fora.

The European Union Chamber of Commerce in China is an important non-governmental channel in EU-China energy cooperation. Since its establishment in 2000, it has developed into a very active organization. It is the representative of the EU enterprises' opinions in China, and it also provides a channel for the

[282]Ydersbond, I. M., & Korsnes, M. (2014). "Wind power in China and in the EU: Comparative analysis of key political drivers". *Energy Procedia*, *58*, p. 101.

communication between the political and business circles in China and the EU.[283] The chamber of commerce has established an energy working group, which currently has more than 40 members, including Europe's largest energy companies and energy equipment producers. In addition, the working group cooperated with Chinese and European officials on energy policy. In recent years, with the increasing importance of clean energy in China-EU energy cooperation, the European Union Chamber of Commerce in China set up the renewable energy working group in 2009 and intelligent electric networking group in 2010.[284] The two groups promoted the rational development of European clean energy enterprises in China through case studies, consultation service for enterprises and regularly or irregularly meetings or forums, thus promoting the deepening and development of China-EU cooperation in the field of clean energy.

7.2 The Foundation of Sino-EU Clean Energy Cooperation

7.2.1 China and the EU Have Good Conditions for Clean Energy Cooperation

Both China and the EU have paid great attention to the necessity of clean energy and both have issued a series of supporting policies, vigorously promoting the development of clean energy. This forms the foundation for the cooperation

[283]European Chamber. "About the Chamber" <https://www.europeanchamber.com.cn/en/european-chamber-background> last visited on 1, 2021
[284]Ibid.

between the two sides. In the process of promoting the development of clean energy, governments played a huge role. Both the Chinese government and the EU government adopted a series of supportive policies and measures to guide the vigorous development of the clean energy market to promote the industrialization of clean energy. In recent years, the two sides' governments have vigorously promoted the development of clean energy.

China introduced the People's Republic of China Renewable Energy Law in February 2005, which established the basic legal system and policy framework system for renewable energy development.[285] In order to effectively implement the renewable energy law, relevant departments of the state council come out with administrative laws and regulations, technical specifications and standards. In October 2007, the Standing Committee of the People's Congress approved the amendment of the Energy Conservation Law in the People's Republic of China, to further improve the basic system of energy saving, improve the energy conservation standard system and supervision system and intensify policy incentives. In order to better promote the development of domestic clean energy, and deal with global warming problems with more active attitude, in August 2009, the Standing Committee of the People's Congress passed the Amendments to the Renewable Energy Law. The amendment was implemented in April 2010. The amendment stipulates the full guaranteed purchase system of China's renewable energy generation, network electricity price management system, and the renewable

[285] People's Republic of China. (2005). "Renewable Energy Law of the People's Republic of China" (President Order No. 33) <https://rise.esmap.org/data/files/library/china/Renewable%20Energy/China_Renewable%20Energy%20Law%20of%20the%20People_s%20Republic%20of%20China%202005.pdf> last visited on 1, 2021

energy development fund which was supported by the national finance.[286] The amendment also stipulates that the government should formulate relevant plans and set up medium and long-term goals to promote the development and use of the national renewable energy. In December 2011, China announced the 12th Five-Year Plan for national renewable energy development. The development of China's clean energy will focus more on the quality rather than on the scale.[287] According to this plan, China established a competitive system of renewable energy industry, and started to conduct international cooperation in the field of clean energy to break through the difficulties and bottlenecks in the development of clean energy.

The guidance and support from the EU government started earlier on promoting the development of clean energy. The EU has introduced a series of policy documents and has established a relatively thorough support plan and evaluation mechanism for policy implementation. The EU's policy papers on renewable energy development mainly include the White Paper on Renewable Energy and its plan of action, as well as EU directives on the development of renewable energy. Among them, the EU directive is a legally binding document guiding the legislation of member states, which has specific provisions on the development of renewable energy. In 2001, the EU issued the Directive on Electricity Production from Renewable Energy Sources (Directive 2001/77 / EC of the European Parliament and of the Council of 27 September 2001), the directive ruled that in 2010, 22% of the total electricity consumption of the EU must come from renewable energy

[286]Wang, Q. (2010). "Effective policies for renewable energy—the example of China's wind power—lessons for China's photovoltaic power". *Renewable and Sustainable Energy Reviews*, 14(2), p. 706.
[287]People's Republic of China. (2011). "12th Five-Year Plan for Energy Development" <https://policy.asiapacificenergy.org/sites/default/files/12th%20Five-Year%20Plan%20for%20Energy%20Development%20%28CH%29.pdf> last visited on 1, 2021

sources.[288] In 2009, the European Union has issued a new directive to promote renewable energy, it set the development goal in the form of law that renewable energy should account for 20% in energy consumption structure of the EU, and the bio fuels should account for 10% by 2020. In addition, the EU released its "2050 energy roadmap" in December 2011. Renewable energy plays an extremely important role in the roadmap. The European Union estimates that its share of total energy demand will rise from 10% to more than 55% by 2050.[289]

Second, thanks to the active promotion of their respective governments, the technology in the field of clean energy developed fast in both China and the EU, and it provides certain industrial and technological conditions for the cooperation between the two sides. The EU has an earlier start in the development of clean energy. At present, it is the world leader in clean energy utilization and the development of related technologies and industries. This is reflected in the European Union' data on the use of clean energy in recent years.

According to the European Commission's report "Snapshot of renewable energy development in the EU-28", the EU countries have committed to bring the EU's 2020 Climate and Energy Package into effect. It was enacted in 2009 with the Renewable Energy Directive:

> Between 2005 and 2012 relevant changes took place at the EU as a whole and in each Member State are energy markets (electricity, heating/cooling and

[288]European Union. (2001). "Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market", Official Journal of the European Communities L 283

[289]European Commission. (2012). "Energy Roadmap 2050" <https://ec.europa.eu/energy/sites/ener/files/documents/2012_energy_roadmap_2050_en_0.pdf> last visited on 1, 2021

transport) in which renewables are competing with fossil fuels and other non-renewables. The Renewable energy share in the EU increased from 8.2% in 2005 to 14.15% in 2012 and furthermore to 14.95% in 2013.[290]

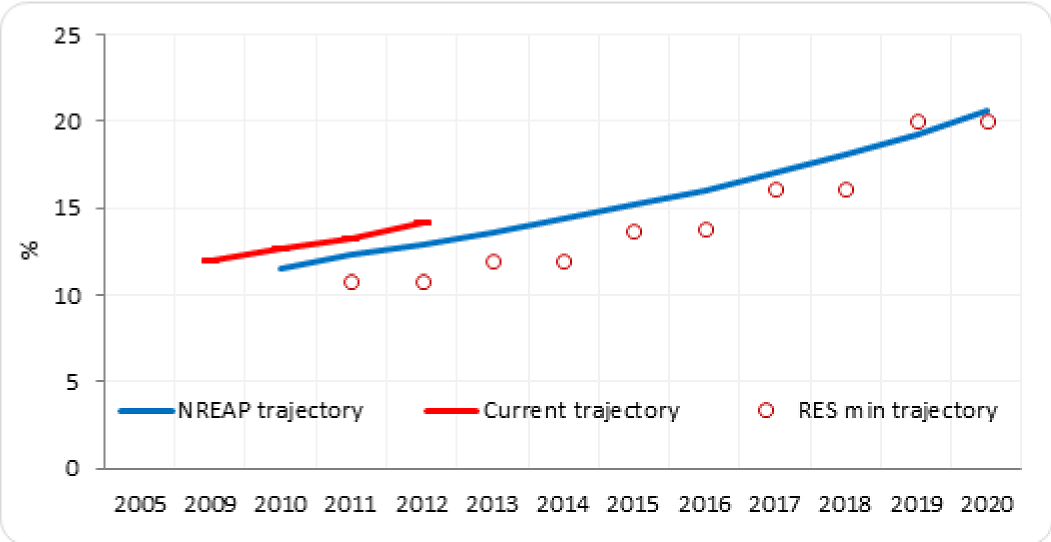

Figure 7.1 Overall Renewable Energy Share(RES) in EU-28

Biomass provided the highest additional renewable heat/cool that was consumed between 2005 and 2011 with +15.7 Mtoe reaching 68.8 Mtoe (2882 PJ). This consumption increased further by 5.7% (+3.9 Mtoe) in 2012." "In 2012 biomass dominated the overall renewable energy mix followed by hydropower (17.9%) wind (10.8%), biofuels (7.5%), solar (5.1%), heat pumps (4.3%) and geothermal (0.7%)[291].

290European Commission. (2015). "Snapshot of renewable energy development in the EU-28" , DG JRC, Directorate C-Energy, Transport and Climate <https://e3p.jrc.ec.europa.eu/articles/snapshot-renewable-energy-development-eu-28-volume-2> last visited on 1, 2021

[291]Ibid.

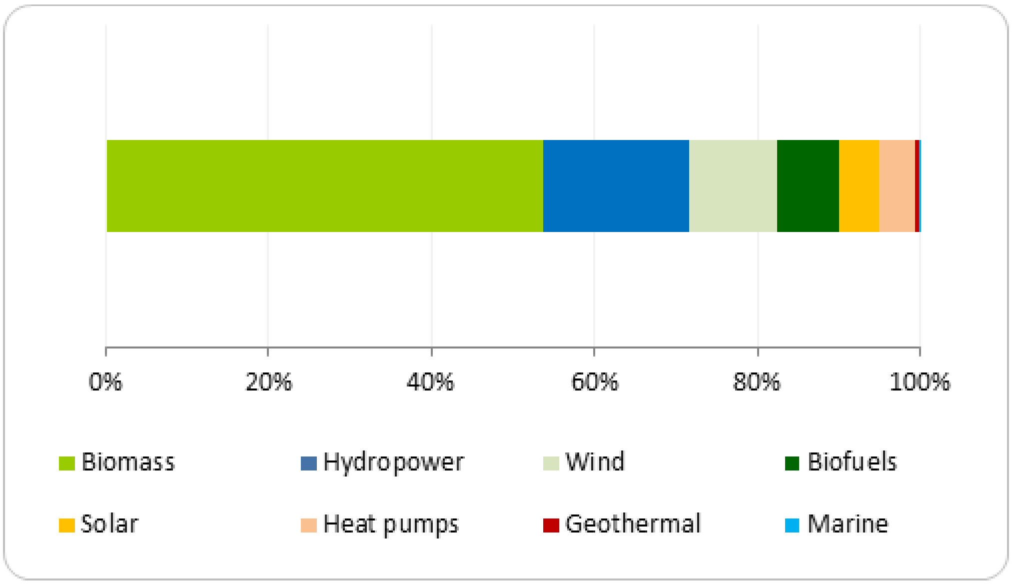

Figure 7.2 Overall Renewable Energy Share

The report mentioned that the renewable heat of the EU countries experienced the fast expansion of heat pumps in 2012, and the biomass sources share increased to 53.7% in terms of renewable energy mix. The contribution of renewable electricity in final consumption of renewables jumped to 40.2%, and wind power almost tripled its absolute contribution compared with the figure in the baseline year.

China has abundant renewable energy resources, which provide a very favorable precondition for promoting the development of China's clean energy strategy. At present, China has made significant achievements in the use of solar energy and biogas. Under the impetus of the government, wind power, solar power and biological liquid fuel have also achieved rapid development in recent years.

In 2015, China's commercialized renewable energy consumption was 436 million tons of standard coal, accounting for 10.1% of the total primary energy consumption. If took the utilization of non-commercial renewable energy sources such as solar thermal into account, the annual energy consumption of all renewable energy sources was 500 million tons of standard coal. If add the contribution of nuclear power, all non-fossil energy use accounts for 12% of the total primary energy consumption, compared the figure of 2010, it increased by 2.6%.[292]

By the end of 2015, the national hydropower was 320 million KW, wind power was 129 million KW, and the photovoltaic grid installed as 43.18 million KW. The area of solar energy heat utilization were more than 400 million square meters, it was the world's largest scale. The total renewable energy output was 1.38 trillion KWH, accounting for about 25 percent of the electricity consumption of the whole society, of which 5 percent was non-water renewable energy. Biomass energy continued to develop into diversification, and the annual consumption of various biomass energy were about 35 million tons of standard coal.[293]

Table 7.1 Major Renewable Energy Development Indicators at the End of the 12th Five-year Plan Period[294]

Major renewable energy development indicators at the end of the 12th five-year plan period				
Content	2010	The target of the	2015	The average

[292]National Energy Administration of China. (2011). "National Energy Science and Technology 12th Five-Year Plan" 中国国家能源局：国家能源科技"十二五"规划 <http://www.nea.gov.cn/131398352_11n.pdf> last visited on 1, 2021

[293]National Energy Administration of China. (2011). "National Energy Science and Technology 12th Five-Year Plan" 中国国家能源局：国家能源科技"十二五"规划 <http://www.nea.gov.cn/131398352_11n.pdf> last visited on 1, 2021

[294]National Energy Administration of China. (2011). "National Energy Science and Technology 12th Five-Year Plan" 中国国家能源局：国家能源科技"十二五"规划 <http://www.nea.gov.cn/131398352_11n.pdf> last visited on 1, 2021

		12th five-year plan		annual growth (%)
1) Power generation				
(1) Hydropower (ten thousand KW)	21,606	29,000	31,954	8.1%
(2) Grid-connected wind power (ten thousand KW)	3,100	10,000	12,900	33.0%
(3) Photovoltaic power generation (ten thousand KW)	80	2100	4318	122.0%
(4) All kinds of biomass generate electricity (ten thousand KW)	550	1300	1030	13.4%
2) Gas supply				
Methane gas (ten million cubic meters)	140	220	190	6.3%
3) Heating supply				
(1) Solar water heater (10,000 square meters)	16,800	40,000	44,000	21.2%
(2) Geothermal energy (ten thousand tons of standard coal per year)	460	1500	460	0.0%

4) Fuel (1) Bio-formed fuel (ten thousand tons) (2) Fuel ethanol (ten thousand tons) (3) Biodiesel (ten thousand tons)	0 180 50	1000 400 100	800 210 80	 3.1% 9.9%
Total consumption (ten thousand tons of standard coal per year)	28,600	47,800	51,248	12.4%

7.2.2 China and the EU Have Strong Incentives for Clean Energy Cooperation

China and the EU not only have good conditions for cooperation in the field of clean energy, but both also have strong motivation for cooperation.

First of all, in a practical sense, at the present stage, the development of clean energy in China is complementary to the development of clean energy in the EU. Therefore both of them can benefit from mutual cooperation. In recent years, large developing countries such as China advanced rapidly in the field of clean energy, especially in terms of scale; however, generally speaking, at present the European Union still has advantages in the field of clean energy, especially on the core technology of clean energy. Because of the huge investment in technology research and development, if their leading position in the core technology field is not jeopardized and the EU is happy to benefit from the export of clean energy technologies and related international cooperation. On the Chinese side, nowadays China is vigorously promoting the use and development of clean energy. Considering present trajectories, the demand of China for clean energy is bound to jump even further. However, most clean energy companies in China lack the support of independent intellectual property rights, and they cannot master the core technology in a single night, China needs to import from other regions or countries which have the core clean energy technology. This also means that China has large clean energy market. "Made in China 2025" is a technology initiative to comprehensively upgrade Chinese industry. One of its ten priority sectors is new-energy vehicles and equipment.[295]

From the perspective of the current development status of clean energy in China and Europe, if China and the EU cooperate in the field of clean energy, China can provide its huge market to the EU, and the EU could provide China with the core technology in the field of clean energy.

Second, from a strategic perspective, the two sides also have enough motivation to cooperate. In recent years, both aim to fight for the initiative on the world energy and environmental issues, and seize the commanding point of future technological and economic development. After the information revolution, the new energy revolution is likely to transform the global economy and the international landscape once again. Countries that can stand out in this revolution will be able to occupy a favorable position in the future international economic and political landscape. In the 1990's, Internet technology had been heavily promoted by the Clinton's

[295]CSIS. (2015). "Made in China 2025"
< https://www.csis.org/analysis/made-china-2025> last visited on 1, 2021

administration, resulting in the longest boom of the United States economy in the post-war period.[296]Their actions caused a huge worldwide information revolution, and the United States was the biggest winner of the revolution. President Barack Obama's administration launched new energy strategy with clean energy development as its core and with energy saving and improving energy efficiency as an integral part, spare no effort to promote the development of the American clean energy industry. [297] The action of Obama administration has far-reaching implications. The Obama administration tried to emulate his predecessor; they promoted a new economic revolution based on green economy to make sure that the United States would continue to maintain its global leadership in this century. The Trump administration introduced a new plan to replace Obama's Clean Power Plan with weaker greenhouse gas rules for power plants. They add the Affordable Clean Energy rule, which aroused great controversy.[298]

World powers such as China and the European Union will not give up this opportunity to seize the commanding heights of future economic development. Due to the large initial investment in the development of clean energy technology, and the climate problems caused by traditional energy sources such as fossil fuels are also global problems, countries need to cooperate with each other. In the meantime, due to the dominance of future energy issues, the competition in this field among countries would be more and more intense.

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[296]Zhang, L., Amos, C., & McDowell, W. C. (2008). "A comparative study of Internet addiction between the United States and China". *Cyber Psychology & Behavior*, 11(6), p. 728.
[297]Obama, B. (2007). "Renewing American Leadership". *Foreign Affairs*, July/August, p. 13.
[298]Jotzo, F., Depledge, J., & Winkler, H. (2018). "US and international climate policy under President Trump". *Climate Policy*, 18(7), p. 815.

Under the situation of both competition and cooperation, on the one hand, China-EU cooperation in clean energy field is conducive to both sides to play their respective advantages. It could promote the common development of the clean energy industry and provide powerful support for the two sides to fight for a favorable position in the clean energy revolution. On the other hand, the cooperation between China and Europe in the field of clean energy can form a balance against other powerful competitors.

7.3 The Main Forms of Sino-EU Clean Energy Cooperation

The main forms of Sino-EU clean energy cooperation include policy coordination; personnel exchanges and training; and technology transfer and joint research and development. Among them, technology transfer and joint research and development is the most important form at present. EU-China Clean Energy Centre (EC2) is an example.

7.3.1 Policy Coordination

In the early 1980's, China and Europe began to cooperate on energy policy. In 1985, the two sides signed the "China and the European Union trade and economic cooperation agreement involves the energy problem". Since the 1990's, especially after the establishment of the regular Leaders' Meeting between China and Europe, the policy coordination between the two sides in the field of clean energy has become more frequent and the content richer.[299]

The Leaders' Meeting between China and the EU began in 1998; it is the highest-level political consultation mechanism between the two sides and played a huge role in promoting and deepening the Sino-EU relations. During the meeting, China and the EU exchanged views and held consultations on issues of common concern, including political problems, and economic problems and other problems. The energy issue has always been a topic of great concern to both sides. In recent years, the energy problem, especially the clean energy problem has become the key discussion issue between the two sides during the meeting. The Leaders' Meeting between China and the EU reached many consensuses on energy issues at the macroscopical level; the EU–China Energy Conference, the EU-China Energy Dialogue and the EU-China High-Level Energy Working Group provide the specialized platform for both sides to further exchange information, coordinate their clean energy policy and implement their consensus.

Generally speaking, China and the EU have held consultations on the future development of clean energy, clean energy and global warming, clean energy and environmental problems through the Leaders' Meeting and energy dialogue. On the premise of mutual benefit, they have made necessary policy coordination and reached many consensuses, not only laid the policy foundation for the two sides' cooperation in the field of clean energy, but also effectively promoting pragmatic cooperation in this field.

[299]Zhang, C. (2017). "The EU-China Energy Cooperation: An Institutional Analysis". EIAS conference paper

7.3.2 Personnel Exchanges and Training

Personnel exchanges and training is one of the long-term forms of Sino-EU clean energy cooperation. In the field of clean energy, personnel exchanges between China and the EU can be roughly divided into three levels: high-level exchanges between governments, exchanges between energy managers and exchanges between technical personnel.

The EU is ahead of China in many aspects such as energy management, energy-saving technology and environmental protection technology, and as a result the EU trained many Chinese energy practitioners, including energy managers and clean energy technology personnel, this is the main form of exchanges among managers and technology personnel between China and the EU. One of the most representative projects is the China-EU energy management training course; this training course is one of the earliest projects in the energy field between China and the EU, and it lasted a long time. In 1982, the first China-EU energy management training center was established in Nanjing, this training program was officially launched. Since then, Zhejiang Energy Research Institute, Tianjin energy conservation technology center, Shanghai Institute of energy research and Chongqing energy conservation technology service center have successively established the China-EU energy training center. From then on, the five training centers have regularly held one to two energy training courses each year where EU professors and experts gave courses about the EU's energy management and energy-saving technologies. Through attending energy training courses, companies, government departments and the energy research institute managers from China could not only grasp the newest trend of the European energy technology research and development, but also obtain a more clear and rational understanding of energy conservation. Therefore, after nearly 30 years of development, the project has achieved fruitful results and has trained a large number of energy management personnel for China. It is helpful to improve energy efficiency, protect environment and promote the sustainable development of the economy. In the process of training Chinese energy managers, the EU not only spread its ideas to China, but also promoted the sale of their clean technology and relevant products, thereby increasing their export and revenue.

In recent years, with the development of China's energy conservation and environmental protection policies, and the growth of the Chinese clean energy industry, the exchanges of clean energy technology talents and management personnel between China and the EU increased. In the process of mutual visits, the two sides often have the opportunity to discuss the common challenges of industry developing and the relevant problems, exchange successful experience with each other. In this sense, the reciprocal nature of people-to-people exchanges between China and the EU has been enhanced.

In a word, personnel exchanges and training have deepened the understanding between China and the EU; it is beneficial to the promotion, utilization and marketization of clean energy technology. It is a fruitful and mutually beneficial form of cooperation.

7.3.3 Technology Transfer and Joint Research and Development (R&D)

In the early days of cooperation between China and Europe, simple technology transfer played a major role. China's access to EU technology was mainly through import of clean energy technology products from the EU. In addition, sometimes, in cooperation with Chinese companies, the EU energy companies transferred some of their technology to China in order to be able to enter the Chinese market.

The EU has also provided some of the non-core clean energy technology to China through its aid framework, such as setting up technology demonstration projects in China. In the early stage of Sino-EU clean energy cooperation, China was the transferee of clean energy technology due to its backward technology and insufficient funds.

In recent years, in various areas of clean energy technology, such as wind turbines, solar cells and pulverized coal gasification and car lithium-ion batteries, China is already at the forefront of the world. At the same time, China has also increased R&D investment in the core technology of clean energy. With the enhancement of China's technological capability and financial strength, the cooperation model between China and the EU in the field of energy and technology has also begun to change.

The Ministry of Science and Technology of China issued the "Implementation

Outlines for International Scientific and Technological Cooperation in the Eleventh Five-year Plan" in 2006,and according to the outline, China's international scientific and technological cooperation will give priority to the development of energy, water resources and environmental protection technologies.[300] In the field of clean energy, China will strengthen the international cooperation in the field of clean coal, implement international cooperation plans on renewable energy sources such as wind, solar and biomass energy, and support international cooperation projects under the Clean Development Mechanism (CDM). According to the specialized plan for Thirteenth Five-year Plan on Science, Technology and Innovation in 2017, China should take responsibility, tackle global challenges such as climate change, population health, energy security, food security, and environmental problems hand in hand with other countries of the world. China should participate in the global governance of scientific and technological innovation cooperation through bilateral, multilateral and regional cooperation mechanisms in order to enhance China's influence in the formulation of cooperation procedures.

At this stage, many technical problems remain to be solved in the clean energy industry, and the EU hopes that China can share some of the financial risks of R&D technology. At present, China and the EU have strengthened information sharing and experience sharing on the latest progress in clean energy technology area, and carry out cooperation in the field of technical standards in order to create conditions for the pragmatic cooperation between the enterprises such as joint research and

[300]Mai, K. (2006). "The 11th Five-Year Plan: Targets, Paths and Policy Orientation". A speech by the Minister of National Development and Reform Commission
<https://en.ndrc.gov.cn/newsrelease_8232/200603/t20060323_1193874.html> last visited on 1, 2019

development. For example, the EU-China Clean Energy Centre, which was launched in Beijing in April 2010, is a landmark project of R&D cooperation on clean energy between China and the EU.

7.4 The Introduction of the EU–China Clean Energy Centre (EC2) Project

7.4.1 EC2: Background

In 2007, at the 10thEU-China Annual Summit, the EU and China released a joint statement: the two sides maintained that the energy issue is a global issue which is closely related to the economic and social development of all nations.[301] Both China and the EU recognized the importance of enhancing bilateral communication and cooperation on this issue, and agreed to take effective measures and continue to promote their mutually beneficial and practical cooperation in the energy field. During that summit, the European and Chinese leaders decided to establish the EU–China Clean Energy Centre (EC2).

In 2009, the EU and China agreed to support the setup of EC2 and signed a Financing Agreement to this effect. This project started on 30thApril 2010.Five years later, China and EU exchanged ideas on issues such as energy development

[301]Zeng, L. (2009). "A Preliminary Perspective of Negotiations of EU–China PCA: A New Bottle Carrying Old Wine or New Wine or Both?". European law journal 15(1), p. 137.

strategy and energy security, and achieved a series of important consensus at the China-EU High-Level Meeting on Energy which was held in Brussels. It was there that the two sides signed the China-EU Joint Declaration on Energy Security established the EU–China Urbanization Partnership and the EU–China Strategic Energy Consumer Partnership. They plan to draw a Roadmap on China-EU energy cooperation.[302]

7.4.2 EC2: Budget, Goals, Phases and Advantages

The Europe-China Clean Energy Centre (EC2) was a five-year cooperation project funded by the European Union and founded in April 2010 by the European Commission, the National Energy Administration of China and the Ministry of Commerce of China, with the support of the Italian Ministry for the Environment, Land and Sea. The Centre is managed by a consortium of European and Chinese partners led by Politecnico di Torino (POLITO).[303]

The budget of the EC2 project was 8 million Euros, with 75% of that was supported by the European Commission, 15% was paid by the Italian government, the remaining 10% was a task for EC2. It is envisaged that EC2 would become an autonomous entity and will continue to operate further in the future; they hope that they will be able to raise that 10% on their own.

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[302] EC2 Administrative Board. (2015). "China-EU Energy Cooperation Roadmap 2020-Concept Note", pp. 4-6.

[303] <www.*ec2*.org> last visited on 7, 2017

The main tasks of EC2 were to promote an increased use of clean energy in China and to support the Chinese Government's efforts to shape a better energy sector. They were very ambitious at that time; they planned to foster EU-China clean energy technology cooperation and provide advice on policy-making, deliver institutional capacity building, and raise awareness on clean energy and its benefit to the environment.[304]

EC2 has nine partners: Politecnico di Torino (Italy) (POLITO), Institute of Industrial Economics of Chinese Academy of Social Sciences (China) (IIE/CASS), Commissariat à l'énergieAtomique et aux énergies Alternatives (France) (CEA), Chalmers University of Technology (Sweden) (CHALMERS), Centro Euro-Mediterraneo per iCambiamentiClimatici (Italy) (CMCC), Energy Research Institute of National Development and Reform Commission (China) (ERI/NDRC), Regional Environmental Center for Central and Eastern Europe (Hungary), Tsinghua University (China), Universitàdella Calabria (Italy) (UNICAL).[305] Its office is located in Sino-Italian Ecological and Energy-efficient Building of Tsinghua University, the building is funded by Italy and designed by an Italian Architect.

It has five focus areas: clean coal (e.g. carbon capture & storage, energy efficiency in power production), sustainable bio fuels, renewable energy sources, energy efficiency in energy consumption (buildings, products, industry), and sustainable and efficient distribution systems.

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[304]<www.*ec2*.org> last visited on 7, 2017
[305] Ibid.

This five-year project can be divided into 2 phases, the first phase is from 2010 to the end of 2012, this is an academic period, they mainly focus on policy research, the European director is Prof. Francesco Profumo from POLITO and the Chinese director is Prof. Shi Dan from Institute of Industrial Economics of Chinese Academy of Social Sciences.

In 2012, after the High-Level Meeting on Energy, China and the EU planned to draw a Roadmap on future bilateral energy cooperation. The Ministry of Commerce of China suggested that the EC2 project could adjust its tasks according to the needs of China. From 2013 to 2015, the second phase shifted to the practical level, the European director was Prof. Roberto Pagani from POLITO and the Chinese director was Ms. Liu Xiaoli from Energy Research Institute of National Development and Reform Commission.

The EC2 project presented many advantages. It was signed by the leaders of China and the EU in 2009; and one year after, Zhang Guobao, deputy director of the National Development and Reform Commission and director of the National Energy Administration, and Jose Manuel Barroso, President of the European Commission jointly chaired the opening ceremony.[306] Both sides attached great importance to this project. What is more, POLITO and Tsinghua have very good relations, Ecological and Energy-efficient Building of Tsinghua was a gift from Italy in 2006. The EC2 project has very good cooperation foundation.

[306]<http://www.tsinghua.edu.cn/publish/thunews/9650/2011/20110225232444937650243/2011022523244493 7650243_.html> last visited on 7, 2017

7.5 The Analysis of the EC2 Project

7.5.1 EC2: Achievements

During the second phase of the EC2 project, there were three key results:

First, the new energy city. The EC2 set Urumqi clean energy Demo Zone, drew up a development strategy for Urumqi, the capital of Xinjiang Autonomous Region in Western China.[307] The city has embarked on an ambitious plan to reshape the structure of its industry, transform energy development, combat air pollution and reduce greenhouse gas (GHG) emissions. The EC2 brought the toolkit and provided many experts to provide guidance to the city of Urumqi on innovative and low carbon urban planning, with the aim of achieving a circular economy, energy saving and emission reduction.

[307] Pagani, R., Alessandra M., & Nannan L. (2015). "The Clean Energy Demo Zone as a Case of Cooperation between the European Union and China". EC2 paper

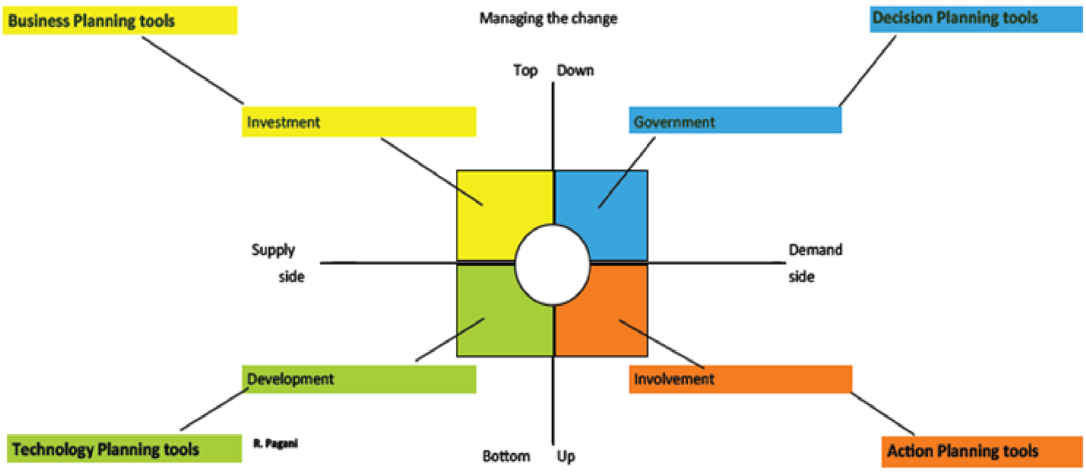

Figure 7.3 Toolkit for Urumqi Clean Energy Demo Zone[308]

Second, APEC Low-Carbon Model Town. The low-carbon town project of Xuwei new area and Shenzhen international low-carbon city project were jointly completed by Chinese project units and EC2 experts. EC2 experts such as Professor Brian O'Brien added European experience to the overall project planning of low-carbon cities and towns, and optimized the initial low-carbon urban indicators whereas Chiel Boonstra put forward at the meeting that, in the process of the establishment of indicators, we should take the actual situation of the city into consideration.[309] The outcome will contribute to the future development of low-carbon cities and towns in the Asia-Pacific region. EC2 also tried to build Sister City relationships, through pairing Barcelona and Fuyang, Genoa and Lianyungang.

Third, the China-EU Energy Cooperation Roadmap 2020. This Roadmap 2020 has been elaborated by the Europe-China Clean Energy Centre (EC2) and it provides

308 Ibid.

309<http://www.apsec.org.cn/index.php/?m=News&a=read&id=58> last visited on 7, 2017 suggestions on cooperation goals and recommendations for a Roadmap to 2020[310]. The roadmap is the highlight of the EC2 project.

7.5.2 EC2: Was It a Success Story?

From the official report and official website data of the EC2 project, it appears that the project was very successful; however the EC2 coordinator has shared that the success rate can be said to be 50%, and from the perspective of the EC2 evaluator, the rate is only 25%. What is more, there were many complaints from the scientists who undertook concrete work of the EC2 project.[311]

7.5.3 EC2: Problems

7.5.3.1. Leadership and Staff

The first Chinese director Shi Dan from CASS said that "person matters, the most important factor which influence the success of a cooperative project is all the participants". At the senior level, both the Chinese director and European director were extremely busy: Pagani came to China once a month, and Liu Xiaoli was unable to visit the Tsinghua office every day, so the most important implementation work was delegated to other people. At the junior level, the following text was taken

[310]EC2 Administrative Board. (2015). "China-EU Energy Cooperation Roadmap 2020-Concept Note"
[311]These results are drawn from my interviews.

from a job advertisement:

"The project is looking for the following four positions:

1. Administration and Human Resources Division Administration and Legal Affairs Officer

2. Advisory and Training Division PROJECT OFFICER

3. Information, Promotion and Communication Division OPERATIONAL OFFICER IN COMMUNICATION

4. Co-director's Secretary

Applications and updated CV should be submitted to eu.china@polito.it and to HR@ec2.org.cn by ***December 15, 2011****."*[312]

It can be seen from that posting, there four important positions withinEC2 were available, and one and a half year after launching the project, they still lacked qualified personnel for the project. And another difficulty was high turnover.

EC2 Scientist, Liu Huan said that," for me, if I cooperate with other institutions in the field of clean energy, the most important factor is whether I am interested in this topic"[313]. Many scientists have their field of focus and area of interest, so assigning the right work to right people is a key factor to success.

[312]<http://www.chinadevelopmentbrief.cn/jobs/europe-china-clean-energy-centre-is-seeking-several-positions-based-in-beijing-administration-and-legal-affairs-officer-project-officer-of-advisory-and-training-division-operational-officer-in-comm/> last visited on 7, 2017

[313]Record 34, Interview with Liu Huan, scientist, Tsinghua University

7.5.3.2 Management and Internal Coordination

According to many interviewees: "the EC2 is based on a grant contract, not TA, its accounting requirements are in conflict with those in China." Liu Huan said that she filled many complex forms for the EC2, but never received any salary she should have gotten, "it is a waste of time for scientist", she complained, "I undertake some work for the project, but there is no feedback, and what I could learn from the project is nothing".

In 2012, the funding from the Italian side was delayed, which also caused many problems for EC2. The 5-year project has two phases, and the two sides needed time to adapt to each other. It focused on too many areas, so the project spent a lot of money, but without corresponding returns.

7.5.3.3 Timeliness

For the EC2 project, the EU and China started the negotiation and achieved consensus during the China's 11^{th}five-year period. When it came to the implementation, time flew and it reached the 12^{th} five-year period. The energy policy changed a lot between these two periods: the first problem for the EC2 project was that it didn't start very well, they strictly followed the bid. As a result, their reports also lacked timeliness.

7.5.3.4 Continuity

Did Urumqi adopted the plan and use the toolkit well? What was the result for the New Energy City?

Was theEC2 is successful in raising the 10% co-funding by itself? Didit become an autonomous entity?

Regarding the sister cities, what happened after that? What wasthe result for the APEC Low Carbon Model Town?

EC2 organized many seminars on biomass, smart electricity, smart grid……after that, was there any evaluation, analysis, or feedback?

The answer for all the above questions is: who knows. The EC2 project is lack of continuity.

7.5.3.5 Competition

The degree of interdependence in the supply of energy products between China and EU is low, and as China's energy technology and products become more competitive in the European market, it cannot be ignored that there is increasing competition between China and Europe in the field of energy technology and equipment.

7.6 Chapter Conclusion

Following the end of the framework programme, the EU replaced FP7 with Horizon 2020, with the aim to encourage other countries (especially China) to carry a more equal burden with regard to cooperation with the EU. From China's side, having more say in the terms of cooperation is also preferable. If the cooperation contract could be changed from grant to TA, the capital regulation might be more direct and effective.

As Diego Sammaritano, Policy Officer, DGs for R&I, said, "We should do more on framework conditions and on reciprocity". The EC2 project had too many focus areas, if they chose one or two areas, they might have been able to do more concrete work. If a clear goal and a clear structure, harmonized institution, and the right personnel were all made available for the cooperation, the success rate of the project may have been higher.

For the Urumqi demo zone, the data acquisition and local coordination were problematic.EC2 experts wanted to provide their tools and experience to this demo zone; however, they didn't take the ideas from the audience into consideration. If higher-level decision is made without taking into account the underlying feedback, there would be many problems in the implementation level.

If China and the EU can work together to explore the third market for energy products, maybe they can transform the current competition into better cooperation, for example, through the One Belt One Road Market.

Chapter8 Case Study: Dragon Program

8.1 The Introduction of Dragon Program

China has been cooperating with Europe in the field of remote sensing for more than 20 years. In 1994, China formally began to receive European Remote Sensing (ERS) satellite data from Europe. From 1997 to 2002, in order to promote the application of ERS satellite data in China, scientists from China and the European Union conducted cooperative research on rice monitoring in southern China, land use mapping in Beijing, and flood disaster monitoring and forest mapping in China. On March 1st, 2002, the European Space Agency's environment satellite: Envisat, which carries 12 sensors for different applications, was launched successfully; it was one of the world's most advanced earth-observing satellites in orbit. Later in June, the former minister of Science and Technology of China, Xu Quanhua visited the European Space Agency. Both China and the EU expressed their willingness for in-depth cooperation in the field of remote sensing. For the implementation of the outcome of the high-level talks, the two sides decided to formally launch a large-scale cooperative research project: Dragon Program, the Program was officially launched in 2004. The main goal was to set up a joint research team for the applied research of the earth observation data, and to promote the development of satellite remote sensing application technology.[314]

[314]Desnos, Y. L., Bergquist, K., & Li, Z. (2004). "Cooperation between the European Space Agency (ESA) and China in the field of remote sensing and earth observation: Dragon Program". *Remote Sensing Information*, 4, pp. 78-79. 李增元:欧洲空间局(ESA)与中国在遥感对地观测领域的合作:龙计划

The Dragon Program is currently China's largest international cooperation program in the field of earth observation, which is jointly implemented by the National Remote Sensing Center of China, Chinese Academy of Forestry sciences, and the earth observation department of the European Space Agency. The first phase of cooperation was officially launched in 2004 and officially ended in 2008.The second phase of cooperation officially started in 2008 and ended in 2012.The third phase was officially launched in 2012 and ended in 2016.The fourth-phase of cooperation was officially launched in 2016 and is scheduled to end in 2020.

The Dragon Program has been on-going for 16 years. China and the EU successfully completed the first stage (2004-2008), the second stage (2008-2012), and the third stage (2012-2016) cooperation tasks, step by step to explore a new international science and technology cooperation mechanism. With a platform provided by the government; independent participation; voluntary cooperation; extensive cooperation studies carried out including technical training, academic exchange and data sharing; and the establishment of an EU-China joint research team in the field of earth observation, the Dragon Program has obtained a large number of advanced international research results, and has effectively promoted the development of earth observation technology in both China and the EU.

The Dragon Program involves various forms of cooperation, including: 1) joint research, 2) academic discussion, 3) exchange, 4) technical training and data sharing.

8.1.1 The Joint Research

One of the most important parts of the Dragon Program is to organize scientists from both China and the EU to carry out joint research on remote sensing applications. Through the collection and selection of specific research themes, they choose research topics. The joint research area was set in China, and they also hire the dual-responsibility experts (one each from China and Europe) to be responsible for the implementation of the subject.

The first phase of the Dragon Program focused mainly on the Europe Envisat satellite data application in China. There were 16 concrete joint research topics: agriculture monitoring in Fujian province, rice monitoring, China forestry mapping, forest fire monitoring, Polarimetric interference SAR data inversion of forest parameters (POLinSAR), topographic survey, Seismic deformation monitoring, landslide monitoring, rapid mapping and monitoring of flood disasters, water resources evaluation and management, drought monitoring, Climate coupled to the ocean system, atmospheric chemical analysis and climate change, air quality monitoring and forecasting, oceanic environment, earth observation and Olympic management. In China, 119 scientists from 32 research institutes in the field of remote sensing participated in the joint research. On the EU side, more than 50 young scientists and experts from Germany, France, Italy, Spain, Norway, England, Finland, Belgium, the Netherlands, Greece and other ten European Space Agency member states participated in the research work.[315]

In 2008, China and Europe officially signed the second term cooperation agreement of the Dragon Program at the first term summary and the second term launch meeting which was held in Beijing, which also marked the official launch of the second term of the Dragon Program. Compared with the first phase, the second phase of the Dragon Program is more extensive. The second phase cooperation set up 25 specific cooperation research projects: seismology, topographic survey, the three gorges, the role of crops in the carbon balance of payments, crop monitoring, marine environment and safety monitoring, China ocean monitoring, Polar imetric interference SAR technique, forest ecology, urbanization, earth observation technology and sports activities, drought monitoring, water resources, drought, SMOS data calibration and verification, the coastal zone, river delta, water quality, China' s air quality monitoring and forecast, chemical and climate change, detecting radar calibration and verification, coal fire, sea ice detect, forest fires, and wetlands. The research program covered many remote sensing application fields such as agriculture, water conservancy, forestry, ocean, atmosphere, surveying and mapping, and disaster forecasting. The number of participating research institutes was 165, and the number of participating scientists reached more than 400.[316] The number of research institutes and scientists involved in the Dragon Program and its impact are unprecedented.

[315]China Science and Technology Achievements. (2007). "'Dragon Project'-Research on the Comprehensive Application of ENVISAT Earth Observation Data". *China Science and Technology Achievements*, 3, p. 58. 田昕:"龙计划"——ENVISAT 对地观测数据综合应用研究

[316]Huang, F. (2014). "Summary of the 2013 Dragon Program Meeting in Italy". *Meteorological Science and Technology Cooperation Trends*, 1, pp. 7-8. 黄富祥:赴意大利参加 2013 年龙计划会议总结

In the third phase, the Dragon Program set up 51 cooperative research projects. Based on the previous cooperation mode, the project continued to carry out in-depth cooperation in the aspects of earth observation application, technical training, academic exchange and data sharing. It paid close attention to the latest and future launch of scientific exploration satellites in both China and the EU, carried out joint research on the remote sensing application, scaling and authenticity, further expanded the earth system science and global climate change research, increase many research content such as the earth gravity field and geoid, cryosphere, atmospheric dynamics, the earth's magnetic field and its evolution, Changes in atmospheric aerosols and earth system science and climate change.[317]

8.1.2 Academic Discussion and Exchange

In order to regularly summarize the achievements of the Dragon Program and promote the academic and technical exchanges between China and the EU, every year, they held an international academic symposium involving 150 to 300 people, which is held alternately by China and Europe. At present, 16 high-level academic seminars have been held in Xiamen(China), Santorini(Greece), Lianyungang(China), Provence(France), Beijing(China), Barcelona(Spain), Yangshuo(China), Prague (Czech republic), Beijing(China), Palermo(Italy), Chengdu(China), Interlaken(Switzerland), Wuhan(China), Copenhagen(Denmark), Xi'an(China), and Ljubljana, (Slovenia) successively. During the conferences, all

[317]Dragon Program Office, National Remote Sensing Center, Ministry of Science and Technology of China. (2014). "The development of Dragon Program-China's largest international cooperation project in the field of remote sensing technology". Space International, 10, p. 19. 中国科技部国家遥感中心"龙计划"项目办公室:"龙计划"来龙去脉-我国遥感科技领域的最大国际合作项目

research projects progress were jointly reported by the leadexperts of both sides, which fully reflects the cooperative research spirit of China and the Europe. They also convened group meetings, formulated annual work plans for each research topic, and exchanged research experiences. The events organized special reports of young scholars and promoted the academic level of young scholars involved in the project.

8.1.2.1 Symposiums under the Cooperation Framework of the First Phase of the Dragon Program

The Dragon program launch symposium in 2004:

From 27 to 30 April 2004, during the Dragon program launch meeting, the 2004 academic symposium was held in Xiamen, Fujian province in China. The meeting was attended by 50 European scientists involved in the Dragon Program and 70 representatives from more than 20 relevant remote sensing research institutes from China, as well as officers from the Ministry of Science and Technology, ESA, and Fujian province. The symposium marked the official launch of the Dragon program, and enabled China and Europe to have a deeper understanding of their work foundation and research level and laid a solid foundation for the future implementation of the Dragon program.[318]

The 2005 Dragon program symposium:

[318]Desnos, Y. L., Bergquist, K., & Li, Z. (2004). "Cooperation between the European Space Agency (ESA) and China in the field of remote sensing and earth observation: Dragon Program". *Remote Sensing Information*, 4, p. 79. 李增元:欧洲空间局(ESA)与中国在遥感对地观测领域的合作:龙计划

From June 27th to July 1st, 2005, the 2005 Dragon program symposium was held on the island of Santorini, Greece. On the Chinese side, officers of the Ministry of Science and Technology and 52 experts from 21 domestic remote sensing units attended the meeting; on the Europe side, 67 European scientists from ESA member states attended the meeting, with a total number of 119 participants. To support the organization and management of the 2008 Beijing Olympic Games, the meeting decided to add a new earth observation and Olympic management study to the research topics launched by the Dragon program.[319]

The 2006 Dragon program symposium:

From July 10th to July 14th, 2006, the 2006 Dragon program symposium was held in Lijiang, Yunnan province of China. The meeting was attended by 124 officers and experts from the Chinese side, and 46 European scientists and officials from ESA and its 10 member states. During the meeting, official talks between China and Europe were held to arrange the work of the Dragon program from 2007 to 2008, China and the Europe decided to launch the second phase of the Dragon program in 2008.[320]

The 2007 Dragon program symposium:

From June 18th to June 22nd, 2007, the 2007 Dragon program symposium was held in Aix en Provence, France. 57 representatives from the Ministry of Science and Technology and Chinese remote sensing related research institutes attended the meeting. 45 European representatives from the member states of the ESA

[319]MOST(China)-ESA Dragon Program office. (2005). “China MOST-ESA Dragon Program, Summary of the 2005 Seminar in Greece”
<https://earth.esa.int/dragon/dragon_abstracts_chinese.pdf> last visited on 1, 2021
[320]<http://www.nrscc.gov.cn/nrscc/lssj/200607/t20060720_1733.html> last visited on 7, 2017

participated in this event. An official meeting of the Ministry of Science and Technology and the European Space Agency was also held during the meeting to discuss the results of the first phase of the Dragon program and the specific arrangements for the launch of the second phase of the program.[321]

8.1.2.2 Symposiums under the Cooperation Framework of the Second Phase of The Dragon Program

The 2008 Dragon program symposium:

From April 21st to April 25th, 2008, the 2008 Dragon program symposium was held in Beijing, China. A total of 344 representatives, including 76 European representatives from the ESA and other European research institutes, and Chinese officers of relevant departments and experts from 63 relevant remote sensing research institutes attended this event. The symposium marked not only the successful conclusion of the first phase of the Dragon program, but also the official launch of the second phase of the Dragon program.[322]

The 2009 Dragon program symposium:

From June 22nd to June 26th, 2009, the 2009 Dragon program symposium was held in Barcelona, Spain. This symposium was the first academic symposium since the implementation of the second phase of the Dragon program. The meeting was attended by 74 Chinese representatives from the Ministry of Science and

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[321] GOV.CN. (2007). “Academic seminar of ‘Dragon project’, cooperated by MOST and ESA was held”中国政府网：科技部与欧洲空间局合作“龙计划”学术研讨会召开 <http://www.gov.cn/gzdt/2007-07/09/content_677949.htm> last visited on 1, 2021

[322] <http://earth.esa.int/dragon/symp2008/> last visited on 7, 2017

Technology and Chinese remote sensing research institutes participating in the Dragon program, and 89 European scientists from ESA member states, with a total of 163 participants. Experts from both sides comprehensively summarized the research results of cooperation in the year since the launch of the second phase of the dragon project, and enhanced the academic exchanges and friendship between China and Europe.[323]

The 2010 Dragon program symposium:

From May 17th to May 21st, 2010, the 2010 Dragon program Mid-term symposium was held in Guilin, Guangxi province in China. The vice Minister of Science and Technology of China, Cao Jianlin and Stephen Briggs, the director of the ESA's earth observation science and application department attended the opening ceremony. On the Chinese side, 196 representatives from the Ministry of Science and Technology, the national remote sensing center, the science and technology department of the Guangxi autonomous region and relevant Chinese remote sensing research institutes participating in the program attended the meeting. On the European side, 62 scientists from ESA member states also joined this event, bringing the total number of participants to 258.[324]

The 2011 Dragon program symposium:

From June 20th to June 24th, 2011, the 2011 Dragon program symposium was held in Prague, Czech Republic. The purpose of the meeting was to discuss and exchange the achievements of China-ESA cooperation research in the past three years since

[323]GOV.CN. (2009). "Academic seminar of 'Dragon project'(cooperated by MOST and ESA) was held"中国政府网：科技部-欧洲空间局"龙计划"合作项目研讨会举行
<http://www.gov.cn/gzdt/2009-07/08/content_1360182.htm> last visited on 1, 2021

[324]<http://www.nrscc.gov.cn/nrscc/lssj/201005/t20100520_2144.html> last visited on 7, 2017

the launch of the second phase of the Dragon program, and to deploy the next step of cooperation activities. 56 scientists representatives from Chinese remote sensing research institutes participating in the Dragon program attended the meeting, and 76 European scientists from ESA member states participating in the program attended the event, bringing the total number of participants to 132.[325]

8.1.2.3 Symposiums under the Cooperation Framework of the Third Phase of the Dragon Program

The 2012 Dragon program symposium:

From June 25th to June 29th, 2012, the 2012 Dragon program symposium was held in Beijing. The purpose of the meeting was to discuss the results of the second phase of the Dragon program (2008-2012) and officially launched the third phase (2012-2016) cooperation project. During the meeting, China and the ESA officially signed the cooperation agreement. Cao Jianlin, vice Minister of Science and Technology, attended the closing ceremony. 366 people attended the meeting, including the officers and experts of the relevant domestic remote sensing research institutes, as well as the officers and experts of the ESA and its member states.[326]

The 2013 Dragon program symposium:

From June 3rd to June 7th, 2013, the 2013 Dragon program symposium was held in Palermo, Italy. Representatives of 95 scientists from the Chinese side and 92

[325]GOV.CN. (2011). “2011 symposium of the second phase of the Dragon Project (cooperated by MOST and ESA) was held”中国政府网：中欧科技合作"龙计划"二期 2011 年学术研讨会召开 <http://www.gov.cn/gzdt/2011-07/06/content_1900243.htm> last visited on 1, 2021

[326]<https://cn.ambafrance.org> last visited on 7, 2017

European scientists from the Europe side attended the meeting. The total number of participants was 187. The two sides also held two small project progress meetings in Beijing every year, and the leading experts of the two sides organized Chinese experts to carry out technical discussions and solve problems existing in the implementation of each subject. Each project under the big program also held a small-scale academic seminar and lecture every year in China or Europe to further summarize and exchange the specific academic achievements of the cooperative research.[327]

The 2014 Dragon program symposium:

In the afternoon of 28th May 2014, the 2014 Mid-term symposium of the third phase of the Dragon program was held in Chengdu, China. Cao Jianlin, the vice Minister of Science and Technology, attended the closing meeting and delivered a speech. He affirmed the important role of the Dragon program in enhancing the cooperation between China and Europe in the field of earth observation, and praised the Dragon program as a model for China and developed countries to jointly carry out research on the application of high technology. Nearly 300 Chinese and European scientists attended the conference. The symposium comprehensively summarized the latest progress of the cooperation research in the third phase of the Dragon program. Chinese and European scientists made a total of 106 conference reports, and the young scholars of both sides presented a total of 116 wall posters. During the seminar, the two sides also held high-level bilateral meetings to deploy major work in the next two years, including the next year's academic seminar and

[327]<http://www.nrscc.gov.cn/nrscc/gjhz/zgljhhz/xwkx1/201306/t20130617_32070.html> last visited on 7, 2017

senior training course on remote sensing.[328]

The 2015 Dragon program symposium:

From June 22nd to June 26th, 2013, the Ministry of Science and Technology of China and the European Space Agency jointly held the 2015 Dragon program symposium in Switzerland. Dr. Zengyuan Li, China's chief scientist of the Dragon program and Dr. Yves-Louis, Desno, the ESA's chief scientist of the Dragon program jointly made the 2015 progress report of the Dragon program, Dr. Deren Li, the academician of Wuhan University reported the earth observation plan of China, and Dr. Maurice Borgeaud, the director of department of earth observation science application and new technology of the European Space Agency introduces the ESA's earth observation plan. The conference comprehensively summarized the latest progress of the cooperation study of the third phase of the Dragon program, deployed the work of the third phase of the Dragon program over the next year, and discussed the launch of the fourth phase of the program.[329]

8.1.2.4 Symposiums under the Cooperation Framework of the Fourth Phase of the Dragon Program

The 2016 Dragon program symposium:

From July 4th to July 8th, 2016, the 2016 Dragon program symposium was held in Wuhan, China. It was the third phase wrap-up meeting and the fourth phase kick-

[328]ScienceNet. (2014). "The Dragon Program" for China-EU scientific and technological cooperation has achieved remarkable results over the past ten years" 科学网：中欧科技合作"龙计划"实施十年成效显著 <http://news.sciencenet.cn/htmlnews/2014/5/295521.shtm> last visited on 1, 2021

[329]<http://www.most.gov.cn/kjbgz/201507/t20150726_120840.htm> last visited on 7, 2017

off meeting of the Program. In the fourth phase of the Dragon Program(2016-2020), based on the results of the previous three phases, the two sides will extend their content of cooperation to the application research of the global forest monitoring, CO2 monitoring, the atmospheric pollution monitoring, remote sensing calibration and disaster prevention and mitigation. They will carry out in-depth cooperation in applied research of earth observation data, technical training, academic exchange and data sharing.[330]

The 2017 Dragon program symposium:

From June 26th to June 30th, 2017, the 2017 Dragon program symposium was held in Copenhagen, Denmark. Wang Qian, the director of the National Remote Sensing Center of China, Maurice Borgeaud, the director of the department of earth observation science application and new technology of the European Space Agency, Peng Sizhen, the technological counselor of the Chinese embassy in Denmark attended the seminar and delivered their speeches. The symposium focused on the main work progress and research achievements of the fourth phase of the Dragon program since its inception, sorted out the key tasks and core tasks of this period, and further strengthened the cooperation and exchange of satellite data sharing and application technologies between China and the Europe.[331]

The 2018 Dragon program symposium:

From June 19th to June 22nd, 2018, the 2018 Dragon program symposium was held

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[330]CAS. (2016). “The third phase wrap-up meeting and the fourth phase kick-off meeting of the Dragon program was held in Wuhan” 中国科学院：“龙计划”三期总结研讨会暨四期启动会在武汉召开 <http://www.iap.cas.cn/xwzx/kyjz/201607/t20160711_4638760.html> last visited on 1, 2021

[331] CAS. (2017). “The Department of Earth Observation went to Denmark to participate in the 2017 International Symposium of the fourth ‘Dragon Program’ of China-Europe cooperation” 中国科学院：对地观测部赴丹麦参加中欧合作“龙计划”四期 2017 年国际学术研讨会 <http://www.aoe.cas.cn/gjjl/gjhy/201707/t20170714_4833245.html> last visited on 1, 2021

in Xi'an, China. The seminar was held over five sub-sessions: climate and carbon cycle, ocean and coastal zone, hydrology and cryosphere, solid earth and disaster reduction, ecosystem and smart city. More than 200 experts and scholars from both China and Europe participated in the symposium, and made 105 oral academic reports. This symposium focused on the main work progress and research achievements of the fourth phase of the Dragon program, which is of great significance for the smooth continuation of the Dragon program.[332]

The 2019 Dragon program symposium:

From June 25th to June 29th, 2018, the 2019 Dragon program symposium was held in Ljubljana, Slovenia. The Director of the China National Remote Sensing Center Wang Qi'an, Counsellor of the Chinese Embassy in Slovenia Yuan Kehua, Academician of Wuhan University Li Deren, Director of the European Space Agency's Earth Observation Department Maurice Borgeaud, Director of the European Space Agency's International Relations Department Karl Bergquist, State Secretary of the Ministry of Economic Development and Technology of Slovenia Ales Cantarutti, and nearly 200 representatives of Chinese and European scientists participated in this meeting. The progress Report on the fourth phase of the Dragon Program was jointly presented by China and the EU. Academician Li Deren made a report on China's typical achievements in the Dragon Program. The representative of ESA introduced the European Earth Observation Plan and the representative of Slovenia introduced the country's work on earth observation and its vision for the future. During the five days meeting, scientists from China and the EU presented 63 papers and posters, and made 116 reports at five sub-sessions, including climate

[332]<http://www.lmars.whu.edu.cn/index.php/xwzx/2170.html> last visited on 6, 2020

and carbon cycle, ocean and coastal zone, hydrology and cryosphere, solid earth and disaster reduction, land and ecological environment. The meeting also discussed the direction of the planned fifth phase of the Dragon Program and formulated a follow-up work plan. Both China and the EU are looking forward to launching the fifth phase of the Dragon Program, have full confidence in the future cooperation.[333]

8.1.3 The Technical Training

Under the cooperation framework of the Dragon program, every year the National Remote Sensing Center of China and the earth observation department of the European Space Agency jointly organize a special advanced training course on remote sensing in China. Through the inspection of facilities, a university or scientific research institute is selected to be the specific organizer of the training course in China, co-organized by the Netherlands international school of geographic information science and earth observation (ITC). The one-week training course is mainly aimed at the recruitment of young scientific researchers and postgraduates from relevant research and teaching research institutes in China. The teaching experts are composed of top European experts selected by the ESA and well-known experts in related fields in China. The teaching content is composed of theoretical teaching and operational practice.

[333]<http://www.nrscc.gov.cn/nrscc/zxdt/201907/t20190702_34117.html> last visited on 12, 2019

8.1.3.1 The Training Course under the Cooperation Framework of the First Phase of The Dragon Program

Advanced Training Course in Ocean Remote Sensing in 2004:

The first Advanced Training Course in Ocean Remote Sensing of the Dragon Program was held in the Ocean University of China from 25 to 30 October 2004. 78 students from major Marine research institutes and universities in China, Japan, South Korea and India attended the training. The European space agency sent five scientists to the training class for special lectures, which systematically introduced the earth observation satellite program of ESA, the observation principle and application potential of satellite data such as SAR, MERIS, AATSR and RA, the products and application examples of the above data in Marine remote sensing, and the use of data processing software such as BEAM and BEAM.[334]

Advanced Training Course in Land Remote Sensing in 2005:

The Advanced Training Course in Land Remote Sensing was held at the Capital Normal University from October 10 to 15 in 2005. The European Space Agency invited 13 experts in the field of land remote sensing to the training class to give lectures and guide the trainees' operation practice. 150 students from 35 relevant remote sensing research institutes and universities in China participated in the six-day training. The experts took the ENVISAT satellite MERIS, ASAR, AATSR sensor data and archive ERS data as an example, from the basis of the SAR and

[334]<http://www.nrscc.gov.cn/nrscc/gjhz/zgljhhz/zoljhhz1/pxbqk/> last visited on 6, 2020

visible light-thermal infrared image characteristic, explained systematically on the various principles and the application of remote sensing data, cover the topics of soil, agriculture, forest, flood, topographic change, vegetation cover, drought, fire monitoring, and guide students with the practice exercises.[335]

Advanced Training Course in Atmospheric Remote Sensing in 2006:

From October 16th to October 21st in 2006, the Advanced Training Course in Atmospheric Remote Sensing was held at Peking University. 13 Chinese and European atmospheric remote sensing experts gave lectures and practical guidance for this training course. 55 trainees from 27 Chinese remote sensing research institutes and universities attended this training. Lectures include satellite data (GOME, GOMOS, MIPAS, SCIAMACHY and "third-party mission" data, etc.), ground facilities (WMO, NDSC network), data processing and applications (data retrieval, data validation, application model and data assimilation, etc.)[336]

Advanced Training Course in Ocean Remote Sensing in 2007:

The second Advanced Training Course in Ocean Remote Sensing was held in Hangzhou, Zhejiang Province from October 15th to 20th, 2007. 51 students from 27 research institutes in China and Europe and six auditors participated in the six-day training. The main contents of this advanced training course include ocean color remote sensing and ocean microwave remote sensing principles, data processing and application. This training course promoted the improvement of marine remote sensing application technology in China and effectively strengthened the training

335 Ibid.

336 <http://www.most.gov.cn/kjbgz/200610/t20061025_36872.htm> last visited on 7, 2017

of young people in marine remote sensing technology.[337]

8.1.3.2 The Training Course under the Cooperation Framework of the Second Phase of the Dragon Program

Advanced Training Course in Land Remote Sensing in 2008:

The second Advanced Training Course in Land Remote Sensing was held at Wuhan University on October 13th in 2008. The purpose of the course was to promote the development of the research on the basic theory and applied technology of land remote sensing in China by using the data of the European environmental satellite (ERS and ENVISAT) and the technological advantages of the European side. 10 Chinese and European land remote sensing experts gave lectures and exercises for this training, and 3 European technical personnel participated in the practice internship guidance. A total of 60 participants from 27 research institutes, including research institutes and universities in China, Thailand and Bangladesh, and more than 30 auditors participated in the six days training. The main content of this advanced training course on land remote sensing included the optical remote sensing and radar remote sensing and related application software practice.[338]

Advanced Training Course in Atmospheric Remote Sensing in 2009:

From October 19th to October 24th in 2009, the second Advanced Training Course in Atmospheric Remote Sensing was held at Nanjing University. 60 Chinese students from 27 universities and research institutes took part in the training for one

[337]<http://www.most.gov.cn/kjrcgz/rcgzdt/200711/t20071102_56904.htm> last visited on 7, 2017
[338]<http://www.nrscc.gov.cn/nrscc/gjhz/zgljhhz/zoljhhz1/pxbqk/> last visited on 7, 2017

week. 5 European experts and 3 Chinese experts taught the training course. The subject of the training course was “application of remote sensing technology in the field of atmospheric science and monitoring”. The course included two parts: the theory of atmospheric remote sensing and the practice of atmospheric remote sensing. Many training materials and several remote sensing data processing software were provided by ESA. Students could not only have access to the latest progress of remote sensing technology in the world, but also mastered the new ideas and new technologies of atmospheric remote sensing research and improve the ability of remote sensing analysis application and operation.[339]

Advanced Training Course in Land Remote Sensing in 2010:

From September 6th to September 11th in 2010, the second Advanced Training Course in Land Remote Sensing was held at the institute of cold and arid environment and engineering of the Chinese Academy of Sciences (the institute of cold and drought). 14 experts from land remote sensing gave lectures and exercise guidance for this training, and 6 European technical personnel participated in exercise guidance. 70 formal students from 38 research institutes including China, France and Italy and nearly 30 auditors participated in the six days training. Among them, 47.14 % were from western colleges.[340]

Advanced Training Course in Ocean Remote Sensing in 2011:

The 2011 Advanced Training Course in Ocean Remote Sensing was held at the East China Normal University from October 24th to 29th, 2011. This training course was

[339]<http://www.nrscc.gov.cn/nrscc/gjhz/zgljhhz/xwkx1/201204/t20120427_30777.html> last visited on 7, 2017

[340]<http://www.nrscc.gov.cn/nrscc/lssj/201009/t20100915_2151.html> last visited on 7, 2017

the first advanced training course on ocean remote sensing in China since the second phase of the Dragon program was launched. 67 students from 34 universities and research institutes in China participated in the one-week training; most of them were postdoctoral, doctoral student and young technical backbones in various institutes.[341]

8.1.3.3 The Training Course under the Cooperation Framework of the Third Phase of the Dragon Program

Advanced Training Course in Land Remote Sensing in 2012:

The 2012 Advanced Training Course in Land Remote Sensing was held at Institute of Electronics of Chinese Academy of Sciences from October 15th to 20th, 2012. 70 postdoctoral, doctoral students and young technical backbones from 44 universities and research institutes in China and Europe attended the six-day course.[342]

Advanced Training Course in Ocean Remote Sensing in 2013:

From October 21th to October 26th in 2013, the Advanced Training Course in Ocean Remote Sensing was held at the Chinese University of Hong Kong. This course is the first of its kind to be held outside the mainland China. 50 doctoral students and young researchers from Mainland China, Hong Kong, India, Pakistan,

[341] SKLEC. (2011). "The 2011 Advanced Training course on Ocean Remote Sensing was successfully concluded" 华东师范大学河口海岸学国家重点实验室：2011 年海洋遥感高级培训班顺利结束 <http://www.sklec.ecnu.edu.cn/node/240> last visited on 1, 2021

[342] GOV.CN. (2012). "The third 'Dragon Program' advanced training course on land remote sensing was successfully held in Beijing" 中国政府网："龙计划"三期陆地遥感高级培训班在京顺利召开 <http://www.gov.cn/gzdt/2012-10/29/content_2253085.htm> last visited on 1, 2021

Vietnam, Niger and other countries participated in the six-day training course, and 16 well-known experts in the fields of optical, thermal infrared and microwave remote sensing served as seminars teachers of the course. This one-week advanced course is divided into six topics: extraction of sea surface salinity, geophysical parameters of radar altimeter, ocean water color extraction, geophysical parameters of SARS, sea surface temperature, assimilation of climate variables and model data. European scientists introduced the latest series of earth observation satellites and new algorithms and software for processing related satellite data.[343]

Advanced Training Course in Land and Water Resources Remote Sensing in 2014:
From October 13th to October 18th in 2014, the Advanced Training Course in Land and Water Resources Remote Sensing was held at Jiangxi Normal University. A total of 82 students participated in the six-day training course. 25 land and water remote sensing experts from Italy, France, the Netherlands, Germany and China explained the basic principles and application examples of topics such as radar remote sensing, optical remote sensing, thermal infrared remote sensing and water remote sensing, and guided the trainees to practice relevant application software. The topic of water resources was added to this training course and played an important role in promoting the development of water resources remote sensing in China.[344]

Advanced Training Course in Ocean Remote Sensing in 2015:
The 2015 Advanced Training Course in Land Remote Sensing was held at Tianjin Normal University from October 16th to 21th, 2015. More than 90 students from

[343]<http://www.nrscc.gov.cn/nrscc/zxdt/201311/t20131121_32420.html> last visited on 7, 2017
[344]<http://www.nrscc.gov.cn/nrscc/zxdt/201410/t20141022_33060.html> last visited on 7, 2017

more than 40 universities and research institutes at home and abroad attended the graduation ceremony. The training course was divided into two classes: optical class and microwave remote sensing class, which were held simultaneously. The remote sensing data used in the course are the most advanced remote sensing data of both China and Europe.[345]

8.1.3.4 The Training Course under the Cooperation Framework of the Fourth Phase of the Dragon Program

Advanced Training Course in Atmospheric Remote Sensing in 2016:

The 2016 Advanced Training Course in Atmospheric Remote Sensing was held in Shanghai from October 24th to 29th, 2016. This training course is mainly for young scientists and technicians from research institutions and universities in China. A total of 60 students participated in the six-day course. 19 famous experts in the field of atmospheric remote sensing from Germany, the United Kingdom, France, the Netherlands, Belgium, Italy, and China systematically gave lectures on the latest research progress of the European Space Agency and China's atmospheric satellite remote sensing applications, and introduced in detail the application of air quality and greenhouse gas monitoring, and guide the students in the actual operation of remote sensing data processing software.[346]

Advanced Training Course in Land Remote Sensing in 2017:

345<http://www.nrscc.gov.cn/nrscc/gjhz/zgljhhz/xwkx1/201511/t20151130_33879.html> last visited on 7, 2017

346<http://www.sari.ac.cn/xwzx/ttxw/201610/t20161031_4687925.html> last visited on 7, 2017

From November 20th to November 25th in 2017, the Advanced Training Course in Land Remote Sensing was held in Kunming, Yunnan province of China. Nearly 21 experts in the field of remote sensing, and 102 students from more than 80 universities and research institutes at home and abroad attended the training course. The main training contents of this training course are microwave remote sensing application, visible remote sensing and thermal infrared remote sensing application. The course takes land remote sensing as the theme and is mainly aimed at young researchers, doctoral students and post-doctoral students engaged in land remote sensing application research, which in order to train young land remote sensing personnel for China, and provide support for the country to carry out global earth observation research, especially for cultivate high-level talents for Yunnan to implement the “One Belt And One Road” construction towards south and southeast Asia.[347]

Advanced Training Course in Ocean Remote Sensing in 2018:

From November 12th to November 17th in 2018, the Advanced Training Course in Ocean Remote Sensing was held in Shenzhen. This training course takes ocean remote sensing as the theme, mainly aimed at for young researchers, doctoral students and postdoctoral fellows who are engaged in the research of marine and coastal zone remote sensing applications, with the purpose of promoting the development of China’s ocean remote sensing technology level and strengthening the academic exchanges between China and the EU. The training course fully embodies the training purpose of combining theory with practice. The students not

[347]MWRF. (2017). “The 2017 Advanced Training Course on Land Remote Sensing of the Dragon Program of China-EU Science and Technology Cooperation was held in Kunming” 中国射频网：中欧科技合作“龙计划”2017 年陆地遥感高级培训班在昆明举办
<www.mwrf.net/news/zhbd/2017/22595.html> last visited on 1, 2021

only learned the basic theoretical knowledge in ocean water color, sea surface temperature and climate change, and sea surface salinity; at the same time, combined with examples, they also learned the processing of earth observation data and the use of relevant software tools.[348]

Advanced Training Course in Land Remote Sensing in 2019:

From November 18th to November 23th in 2019, the latest Advanced Training Course in Land Remote Sensing was held in Chongqing. 110 trainees from nearly 90 universities and research institutes attended the course. The training course is the last course of the fourth phase of the Dragon Program. Taking land remote sensing as the main topic, it is mainly aimed at young scientific researchers who are engaged in the research of land remote sensing applications. The participants learned the theoretical knowledge of the application of remote sensing technology in the field of land science monitoring, and the processing of the earth observation data, laid a foundation for them to better develop remote sensing technology applications in the future.[349]

[348]CAS. (2018). "The 2018 Ocean Remote Sensing Advanced Training Course of the Dragon Program for China-EU Remote Sensing Cooperation was held in Shenzhen" 中国科学院：中欧遥感科技合作"龙计划"2018 年海洋遥感高级培训班在深圳举办
< http://www.castt.ac.cn/news/detail/6266.html > last visited on 1, 2021

[349]<http://www.nrscc.gov.cn/nrscc/zxdt/201911/t20191125_34343.html> last visited on 6, 2020

8.1.4 Remote Sensing Data Sharing

During the first phase of the Dragon Program, the European Space Agency provided free Envisat ASAR, MERIS, AATSR, SCIAMACHY, MIPAS, GOMOS and archived ERS1/2 satellite remote sensing data to all cooperative research projects, which were shared by researchers from both China and Europe to ensure the smooth implementation of all cooperative research work. Under the cooperation framework of the first phase of the Dragon Program, the Chinese side obtained data of SCIAMACHY, MIPAS and GOMOS atmospheric chemical sensors.[350] The amount of data acquired greatly exceeded the number of originally planned.

In the second phase of the program, in addition to the European side's continued provision of satellite remote sensing data such as Envisat and ERS, Chinese satellite remote sensing data such as beijing-1, CBERS, FY and HJ, as well as third-party data such as ALOS and Chris-Proba were also included in the second phase cooperation framework, which greatly met the data needs of the expansion of the second phase cooperation research area.[351] The sharing of these data greatly ensured the smooth development of research activities of 25 cooperative projects, especially the first use of Chinese remote sensing data by the Dragon program. The data source of the program was enriched by cooperative research, it itself improved the level of cooperative research, and expanded the impact of China's remote sensing data in Europe.

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[350]Dragon Program Office, National Remote Sensing Center, Ministry of Science and Technology of China. (2014) "The development of Dragon Program-China's largest international cooperation project in the field of remote sensing technology". *Space Internationa*l, 10, pp. 18-19. 中国科技部国家遥感中心"龙计划"项目办公室:"龙计划"来龙去脉-我国遥感科技领域的最大国际合作项目

[351]Ibid.

In the third phase of the Dragon program, the latest scientific satellite data launched by China and Europe were incorporated into the data sharing platform of the program, such as the "sentinel" launched by ESA and the HJ1C-SA data obtained by China. It provided abundant and timely first-hand information for scientists to conduct in-depth scientific research.

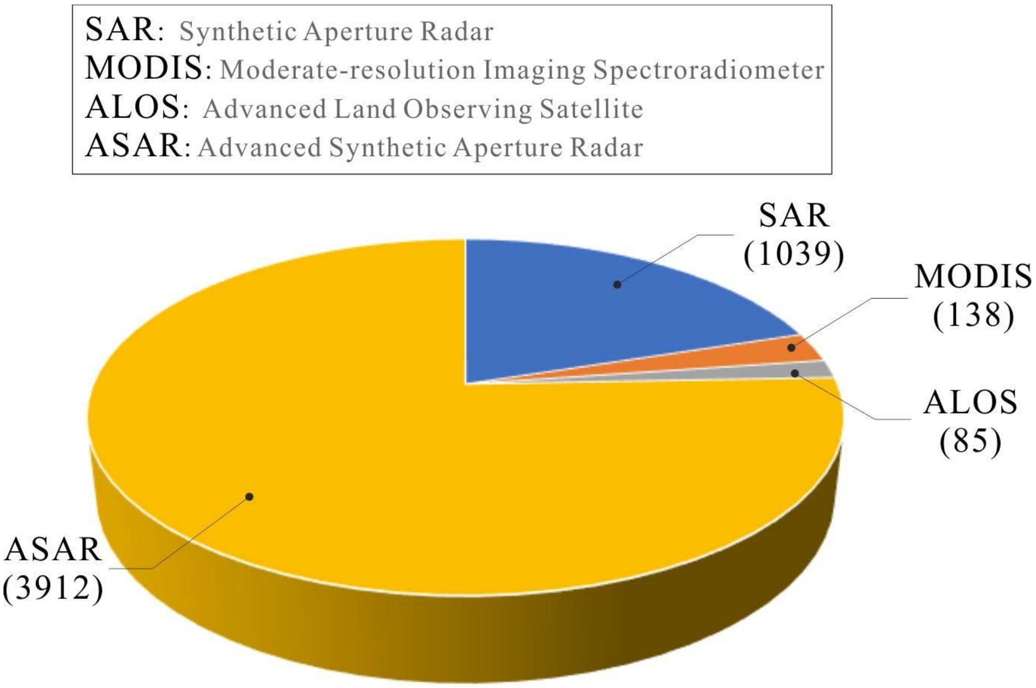

Figure 8.1 Data Provided by the ESA and the Third Party under the Dragon Program[352]

[352]Ibid.

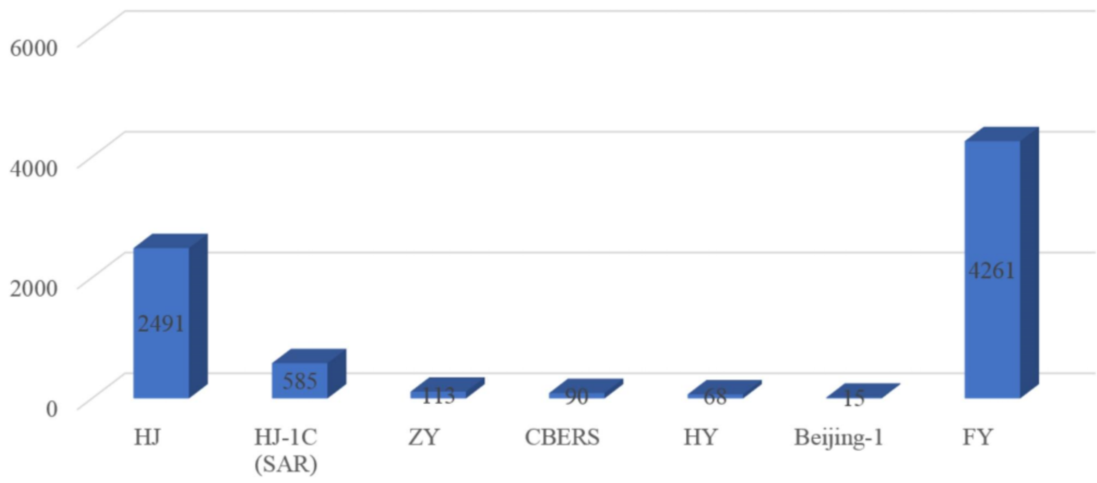

Figure 8.2 Data Provided by China under the Dragon Program[353]

8.2 The Analysis of Dragon Program

8.2.1 Dragon Program: Achievements

Over the past sixteen years, the Dragon Program has achieved fruitful results of cooperation, and has established a solid foundation for the follow-up implementation of the program cooperation.

First, it established an important platform for Sino-EU cooperation in the field of remote sensing technology. Through the joint efforts of the Ministry of Science and

[353] Ibid.

Technology of China, the European Space Agency, and the collaboration between scientists in China and Europe, the Dragon Program has become an important platform for the remote sensing science and technology cooperation. It not only improved the remote sensing application technology level and ability for both Europe and China, but also has had a broad international influence. The program has become the successful model of Sino-EU science and technology cooperation, and has a positive impact on Sino-EU comprehensive cooperation in the field of earth observation.

The Dragon program is first and foremost a platform for Sino-EU research on remote sensing technology. More than 400 scientists and young researchers from both sides were involved in 51 projects of the third phase of the Dragon program. At the same time, it is also served as a remote sensing science and technology exchange platform between China and Europe, relying on the platform of large series of academic seminars, greatly promote the Sino-EU comprehensive and deep communication, Remote sensing scientists achieved the purpose of mutual exchanges. It not only improved the level of remote sensing science and technology exchange, but also promoted the mutual understanding and friendship between the two sides, which laid a foundation for deeper cooperation. As a platform, the Dragon program has played a bridging role for the scientists from the two sides to be involved in other international projects.

Second, since the launch of the program, the cooperation between the two sides has achieved a large number of internationally advanced research results. For example, with the using of InSAR, they achieved the accurate monitoring of surface deformation due to the Wenchuan earthquake, and it provided an important basis for evaluating the possibility of major earthquakes occurring in the future.[354] With the using of GOME-2 remote sensing data, the accurate monitoring of change of the content of CO and NO2 and O3 in the atmosphere in China was realized, and the monitoring data of the atmospheric environment in Beijing during the Olympics obtained more accurate results.[355] Based on InSAR and permanent scatterer technology, accurate monitoring of Shanghai city ground subsidence is realized[356]; forest cover and biomass mapping in northeast China were achieved by using serial ERS SAR data[357]; and using the ASAR, RA, MERIS and AATSR sensor data of Envisat satellite, a wide range of surface biophysical parameters could be retrieved.[358] Other techniques include flood monitoring and accurate mapping in the Boyang lake area[359], rice mapping and methane release inversion based on optical, SAR and atmospheric sensor data[360], and remote sensing inversion of in-ocean wave parameters. These achievements basically represented the most cutting-edge level of international remote sensing research. Through cooperation, a lot of remote sensing application technology research in China has been synchronized

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[354]Qu, C., Shan, X., Song, X., Zhang, G., Zhang, G., Guo, L., Liu, Y., & Han, Y. (2010). "Spatial analysis of co seismic displacement field of the Wenchuan Ms 8.0 earthquake derived using D-InSAR". *Seismology and Geology*, 32 (2), p. 175. 屈春燕,单新建,宋小刚,张桂芳,张国宏,郭利民,刘云华,韩宇飞: D-InSAR 技术应用于汶川地震地表位移场的空间分析

[355]Zhang, Y., Gao, Y., Zhu, S., & Zhang, G. (2014). "Variation of Total Ozone over China for 30 Years Analyzed by Multi-source Satellite Remote Sensing Data". *Journal of Geo-information Science*, 16(6), pp. 971-972. 张莹,高玚,祝善友,张桂欣: 近 30 年中国上空臭氧总量时空变化遥感监测分析

[356]Lan, H., Liu, H., Sun, t., Jia, Y., Yang, Z., Li, L., Ding, S., & Huang, X. (2011). "Attribute Classification of High Resolution Permanent Scatterer for Monitoring Complex Urban Subsidence". *Journal of Engineering Geology*, 19(6), p. 894. 兰恒星,刘洪江,孙铁,贾有良,杨志华,李郎平,丁尚起,黄晓明:城市复杂地面沉降永久干涉雷达监测属性分类研究

[357]Ling, F., Li, Z., Chen, E., Huang, Y., Tian, X., Schmullius, C., Leiterer, R., Reiche, J. & Santoro, M. (2012). "Regional forest and non-forest mapping using Envisat ASAR data". *Journal of Remote Sensing*, 16(5), p. 1101.

[358]Desnos, Y. L., Bergquist, K., & Li, Z. (2004). "Cooperation between the European Space Agency (ESA) and China in the field of remote sensing and earth observation: Dragon Program". *Remote Sensing Information*, 4, p. 79. 李增元:欧洲空间局(ESA)与中国在遥感对地观测领域的合作:龙计划

[359]Hui, F., Xu, B., Huang, H., Yu, Q., & Gong, P. (2008). "Modelling spatial-temporal change of Poyang Lake using multitemporal Landsat imagery". *International Journal of Remote Sensing*, *29*(20), p. 5767.

[360]Zhang, G., Xiao, X., Dong, J., Kou, W., Jin, C., Qin, Y. & Biradar, C. (2015). "Mapping paddy rice planting areas through time series analysis of MODIS land surface temperature and vegetation index data". *ISPRS Journal of Photogrammetry and Remote Sensing*, *106*, p. 158.

with the world. Certain technologies filled the gap in China's domestic research and greatly promoted the development of the level of remote sensing technology in China.

Third, it trained a large number of young talents in the field of remote sensing technology for China. The favorable international cooperation environment of the Dragon program has created good conditions for the development of young scholars. Young scholars also became the most active force and the most direct technological beneficiary in the cooperation process. The Chinese young and middle-aged scholars (under 45 years old) accounted for nearly 80% of the total number of participants in the program. A large number of outstanding scientific and technological talents in the field of remote sensing have emerged after almost two decades of cooperative research. Many of them have grown into technical leaders in various fields of remote sensing application in China.

Fourth, China obtained a large amount of precious remote sensing data from Europe. Since the launch of the Dragon program, Chinese scientists have acquired a significant amount of Envisat and archived ERS1/2 satellite remote sensing data from the ESA, and more than 4,000 orbits of SCIAMACHY, MIPAS, GOMOS and other atmospheric chemical sensor data. The only radar data which China obtained previously was equivalent to about 3-4 years data from the launch of a satellite.[361] It greatly alleviated the radar remote sensing data shortage situation in China and laid the data foundation for the basic research for the application of radar remote

[361]Dragon Program Office, National Remote Sensing Center, Ministry of Science and Technology of China. (2014) "The development of Dragon Program-China's largest international cooperation project in the field of remote sensing technology". *Space International*, 10, pp. 14-21. 中国科技部国家遥感中心"龙计划"项目办公室:"龙计划"来龙去脉-我国遥感科技领域的最大国际合作项目

sensing and the application of radar remote sensing technology in social and economic development. By obtaining atmospheric chemical sensor data from Europe through this program, China's atmospheric chemical remote sensing research started smoothly and reached a high level.

Under the cooperation framework of the second and third phases of the Dragon program, China provided various satellite remote sensing data such as HJ1C-SAR、BEIJING-1、CBERS and HJ.[362] The remote sensing data from China has not only enriched the data source of cooperative research and improved the level of cooperative research, but has also promoted the wider application of remote sensing data in China and expanded the impact of China's remote sensing data in Europe.

8.2.2 Dragon Program: Problems

From the official report and official website data of the Dragon program, the program is reported to be very successful. According to the interview with scientists who participated in the Dragon Program, most of them are satisfied with the cooperation; however, there are issues that remain, and they are detailed below.

First, the form of cooperation is relatively loose, and it relies too much on personal relationships. There is no formal agreement on the Dragon Program, which is very unusual. Karl Bergquist, director of the ESA's International Relations Department, said that: "Usually when we have a project like this, we have an agreement. But as

[362] Ibid.

it started in a very small scale, there was never any use to have an agreement……The reason why we can do this without agreement is we have very good person to person relations which is fundamental when you run international cooperation……Without the very good personal chemistry between the organizers, I'm not so sure that it would have worked so well."[363]Liu Yi said that there are about fifty pairs of teams under the Dragon Program, so they also spend a lot of energy to manage it; this program still needs some support from the national level, otherwise this loose cooperation is still quite vague.[364]

Second, the budget is too small and untransparent, which limits the communication between the two sides to some extent. There is almost no research funding, and scientists therefore gave priority to other paid work. Gao Zhihai said that: "The European side is responsible for the funding of the activities of the European side, while the Chinese side is responsible for the funding of the activities of the Chinese side. Based on this voluntary principle, we could carry out some cooperation together. In fact, it is relatively loose. The program provides you a channel for international cooperation to improve your level after you got funding from other projects."[365] Liu Yi said that: "I haven't got a penny from the Dragon Program. I use the project funding from Chinese Academy of Sciences, nearly 70 million, to support my work on the CO2 satellite in the past five years. I mainly use the Dragon Program platform to cooperate with European scientists."[366] Reitebuch Oliver said that: "if there would be more funding, there would be more exchanges."[367] Casa

[363]Record 5, Interview with Karl Bergquist: ESA; Dragon
[364]Record 26 Interview with Liu Yi; Institute of Atmospheric Physics, Chinese Academy of Sciences, scientist, Dragon
[365]Record 24 Interview with Gao Zhihai; Chinese coordinator of the Dragon Program
[366]Record 26 Interview with Liu Yi; Institute of Atmospheric Physics, Chinese Academy of Sciences, scientist, Dragon
[367]Record 22, interview with Reitebuch Oliver; scientist, Dragon

Raffaele said that: "As Europeans, we receive a little funding from the European Space Agency, it's not very much but it is okay to partially fund a PhD student. Instead from what we learn from our Chinese colleagues, they don't receive any funding at all from the Dragon project……I think it hinders a little bit their willingness to collaborate because they concentrate on the projects for which they are funded."[368] In addition, Bernat Martinez Val mentioned that: "Because of this program just provide fund for us to meet every year, we didn't have weekly or regular communication with our colleagues, because it's not funded and our priorities are on other side.[369]

Third, the two sides still have some problems in communication and understanding. The definition of sensitivity is different. It is relatively difficult for the European side to obtain Chinese data. Massimo Meneti, the scientist who is involved in Dragon Program, said that: "In Dragon, there are still problems with access to the data acquired by the Chinese satellites. In theory it is all open, all available, but in practice it can be very complicated and frustrating".[370] David Doxaram mentioned that: "I was told sometimes here it is forbidden for you to do some measurements yourself. You're not authorized because you're not Chinese scientist, you're a European……it's time for China to open more, to share more……I think the EU has the same feeling. That EU is making a lot of effort to open knowledge, expertise, technologies, data access to China, while China is not making the same effort at the moment……it is not the choice of the scientist, but it is the choice of politicians or administrators purely."[371] Karl Bergquist said that: "There are so many

[368]Record 20, Interview with Casa Raffaele; scientist, Dragon
[369]Record 21, Interview with Bernat Martinez Val; scientist, Dragon
[370]Record 23, Interview with Massimo Meneti; scientist, Dragon
[371]Record 19, Interview with David Doxaram; scientist, Dragon

misunderstandings, and people see things on the internet, people see things on newspaper. So people have lots of prejudices. That is a big part of my job to explain that. Why you should behave this way. Why you should not behave this way. What is considered impolite in China……Please don't do this because Chinese people find this offensive. There are hundreds of them that you have to always be aware of when you set up cooperation projects."[372]Silvestro Paolo Cosmo said that: "when we started the relationship, it was difficult. Maybe because the different way to do things, it was hard to obtain data and information……about the sensitive, in my experience, the problem was that, we don't define the sensitivity of data in the same way, this was the biggest problem."[373]Bernat Martinez Val mentioned that: "Maybe in many cases we try to impose some methodologies and some processes and some ways of working that were based for Europe and were not suitable for China. So maybe you spent time and resources on that, try to emulate something that maybe was not good for China……China is providing a lot of satellite data, but on the other side our data has more quality, so we are providing more quality data but I would say that it's not symmetric……I can recall the air quality case, the air quality information in China was restricted and it's still restricted in many cases. This is really a political case, and you cannot tell anything or to publish anything in China about air quality in China, in our case is different."[374]

Fourth, European scientists are faced with more competition as a result of cooperation with China. Through cooperation, Chinese scientists became more capable. The research teams in China are large, with abundant human resources, the

[372]Record 5, Interview with Karl Bergquist: ESA; Dragon
[373]Record 18, Interview with Silvestro Paolo Cosmo; scientist, Dragon
[374]Record 21: Interview with Bernat Martinez Val; scientist, Dragon

immediate consequence of which is that the European scientists have fewer opportunities to publish on top journals. Silvestro Paolo Cosmo said that:“ They had this advantage that, in our work sometimes it is advantage to have more people working on the same project, so maybe sometimes we was slower than them but it's true that many ideas, started from our people, from our previous work.”[375] Casa Raffaele said that: “It happened in a few occasions, we shared some ideas and then they developed these ideas by themselves without collaborating. So they came up with the publication on exactly the same things that we were doing. So it's like, copying the ideas. So this is something I don't like very much……it is a sort of a competition.”[376]Bernat Martinez Val said that: “We are going to lose room in the number of publications that, because China they are having more and more researchers with more and more citations and you are accumulating more and more knowledge. So comparatively we are going to decrease our weight in the research. That's clear.”[377]

8.2.3 Dragon Program: Cooperation Experiences

First, the Dragon Program built a cooperation platform and expanded cooperation areas. The program set up a remote sensing technology cooperation platform, and established a new model of Sino-EU science and technology cooperation. Based on the platform, scientists from both sides were able to study topics of common interest, form a joint research team, carry out academic exchanges and joint research, and

[375]Record 18, Interview with Silvestro Paolo Cosmo; scientist, Dragon
[376]Record 20, Interview with Casa Raffaele; scientist, Dragon
[377]Record 21, Interview with Bernat Martinez Val; scientist, Dragon

greatly expand areas of cooperation and exchange. Compared with that in the past, the range of benefits is wider, more flexible and more conducive to comprehensively promote the improvement of application of remote sensing technology in China.

Second, it emphasized counterpart cooperation and sharing ofadvanced technology. The core of the Dragon program is technical cooperation; the participants could find cooperative partners through the platform by themselves. As a result, Chinese scientists could be directly involved in Europe's most advanced satellite data application development. For each research project, famous scientists from China and Europe lead the formation of cooperative research teams and carried out joint research and academic exchange. The Chinese scientists had the opportunity to communicate with European top scientists, to learn from the of Europe's most advanced remote sensing technology, thus fundamentally improving the remote sensing of high technology research and development ability of China.

Third, it paid close attention to talent cultivation and enhance the potential for cooperation. Talent is the fundamental power of scientific and technological development. Cultivating young talent is the fundamental goal and entry point of the Dragon program. The program organized advanced training courses, overseas short-term training, and a series of academic seminars to help young scholars with participating in collaborative research, and to make them have the opportunity to communicate with top scientists in China and Europe, fundamentally improve the scientific research ability of young scientist and technician.

Fourth, it promoted in-depth cooperation through scientific organization and management. Scientific organization, coordination and management are important guarantees for the further development of cooperation. The ESA has extensive experience in large-scale project management. Through cooperation, China was able to learn scientific management experiences from Europe and improve scientific and technological management level.

During the 16 years of the Dragon program implementation, the chief scientists and major managers from Europe visited China three or four times eachyear, held the project progress meetings, formulated the implementation plan of the program, visited the project related institutes, and followed the project progress. Each month, the chief scientists and key managers from both China and Europe held a teleconference to exchange project information and negotiate problem solution ways in the implementation of the project. For each topic, the progress report was needed every two months to judiciously grasp the progress and find the existing problems. European experts visited China through various channels to exchange research results and experience with Chinese experts. Now, the program management model which is suitable for Dragon program has been formed initially.

8.3 Chapter Conclusion

The Dragon Program is currently China's largest international scientific and technological cooperation program in the field of earth observation, which was jointly launched by the Ministry of Science and Technology of China and the European Space Agency. Since its launch in 2004, China and the EU have carried out in-depth cooperation in applied research on earth observation, technical training, academic exchanges and data sharing. More than 600 experts and young scholars from the two sides participated in cooperative research, which has resulted in a large number of advanced international research results, which effectively promoted the rise of the technical level of the earth observation of both sides.

The international academic symposium was held annually to provide a cooperation platform for the European Scientists and Chinese scientists in the field of earth observation. The Dragon program is not only a project between two sides, but also a point to connect many partners: by putting leading Chinese scientists and leading European scientists who are working on the same thing together, they can share ideas and relevant data, and publish their result together in top journals. Under the cooperation framework of the Dragon Program, China and the EU have jointly organized 16 advanced training courses on land, atmosphere, and ocean remote sensing, with nearly 1,000 trainees. In addition, every year, China sends two outstanding young scholars to the relevant ESA institutions for a period of 3 to 6 months of training. This program trained a large number of young talents in the field of earth observation for China.

Although most of the scientists involved in the program were satisfied with the cooperation, there are still some problems exists. The large-scale program has a relatively loose administrative system and very limited budget, which limits the cooperation. Sometimes, misunderstanding among the scientists from different backgrounds caused trouble in joint research. And there is an element on competition, which is complained by some scientists, but it could also push the research results a little bit further up.

Both China and the EU are looking forward to launching the fifth phase of the Dragon Program, and it will start in June 2020. They will continue to carry out the annual international academic symposium and training course to provide a better platform for the researchers and train more young remote sensing talents for the two sides.

Chapter9 Made in China 2025

9.1 Introduction

Since the beginning of the 21st century, the manufacturing industry has faced the opportunities and challenges brought by the adjustment of the global industrial structure. Especially after the international financial crisis in 2008, in order to find a new way to promote economic growth, governments of various countries began to re-emphasize the manufacturing industry. Meanwhile, as technologies such as industrial robots, 3D printing, virtual reality and artificial intelligence become more and more mature, the private sector also find huge commercial potential in these technologies.[378] A bud of a manufacturing revolution based on these technologies has emerged.

In 2010, Mr. Hiroshi Fujiwara, a leading figure in the field of Internet in Japan, published the book *Industrial Revolution of the Fourth* and became the first advocate of "industry 4.0" in Japan.[379] In February 2012, the National Science and Technology Council of the United States released the "National Strategic Plan for Advanced Manufacturing"[380]; in April 2013, the German government launched the

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378 Yu, N. (2017). *Made in China 2025: national strategy, international experience and Shanghai development*. Shanghai: Shanghai People's Publishing House, p. 56. 余南平：中国制造 2025：国家战略、国际经验与上海发展

379 Liao, Y., Loures, E. R., Deschamps, F., Brezinski, G., & Venâncio, A. (2018). "The impact of the fourth industrial revolution: a cross-country/region comparison". Production, 28., p. 7. <https://www.scielo.br/j/prod/a/hRmXgtCKq6qbwMkK4nVkj8g/?format=pdf&lang=en> last visited on 1, 2021

380 Executive Office of the President National Science and Technology Council, United States. (2012). "A National Strategic Plan for Advanced Manufacturing" <https://www.energy.gov/sites/prod/files/2013/11/f4/nstc_feb2012.pdf> last visited on 1, 2021

“German Industry 4.0 Strategy”[381]; in June of the same year, the Japanese government announced the “Japan Revitalization Strategy”[382]; in September, the French government launched the “The New Face of Industry in France”[383]; and in October, the British government released the “Future of Manufacturing: a New Era of Opportunity and Challenge for the UK”[384]. It is clear that a new round of industrial competition has begun.

On March 5th 2015, the Premier of the State Council of China, Li Keqiang first proposed the ambitious plan of “Made in China 2025” while delivering the government work report at National Committee of the National People’s Congress and the National Committee of the Chinese People’s Political Consultative Conference (NPC and CPPCC)[385]. The strategic goal of “Made in China 2025” was to realize the strategic transformation of China from a manufacturing country of quantity to one of quality through three steps. China’s manufacturing industry began to transform and upgrade.[386]

381Müller, J., Dotzauer, V., & Voigt, K. I. (2017). “Industry 4.0 and its impact on reshoring decisions of German manufacturing enterprises” in Bode, C., Bogaschewsky, R., Eßig, M., Lasch, R. & Stölzle, W., *Supply management research*, Springer Gabler. Wiesbaden, p. 165.

382Japan Government. (2014). “Japan Revitalization Strategy” <https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/en_saikou_jpn_hon.pdf> last visited on 1, 2021

383France Government Press. (2016). “The New Face of Industry in France: building the industry of the future” <https://www.gouvernement.fr/en/the-new-face-of-industry-in-france-building-the-industry-of-the-future> last visited on 1, 2021

384Walport, M., & Lapthorne, R. “Future of Manufacturing: A New Era of Opportunity and Challenge for the UK” <https://www.gov.uk/government/publications/future-of-manufacturing/future-of-manufacturing-a-new-era-of-opportunity-and-challenge-for-the-uk-summary-report (2014)> last visited on 1, 2021

385Tian, S. & Pan, Z. (2017). “ ‘Made in China 2025’ and ‘Industrie 4.0”-In Motion Together” in Sendler, U., *The internet of things: Industrie 4.0 unleashed*. Springer, p. 92.

386Xin, G. (2017). *The Diagram of Made in China 2025*. Beijing: the People’s Posts and Telecommunications Press, p. 19. 辛国斌: 图解中国制造 2025

9.2 Analysis of “Made in China 2025”

9.2.1 The Background of “Made in China 2025”

The development of China’s manufacturing industry can be roughly divided into the following stages: the first stage, the 1980’s, was characterized by active labor and other factors of production, the opening up and the reform of the economic system promoted the rapid development of China’s manufacturing industry in this stage; the second stage, the 1990’s, was characterized by modernization of equipment, in this stage, direct production efficiency was improved and economies of scale began to develop; the third stage, from 2000 to 2015, was characterized by product innovation and informatization, the innovation of design, technology and management mode started to promote the upgrading of manufacturing industry, and the integration of informatization and industrialization changed all aspects of manufacturing industry from control to management.[387]

In recent years, China’s GDP growth has slowed down; from the past high-speed growth to medium-high speed growth, and China’s manufacturing industry was affected by various internal and external factors. As a result, it entered into a new stage of manufacturing. The past development model of Chinese manufacturing was mainly driven by specific factors, especially demographic dividend and

[387]Wei, K. (2016). *National grand strategy: from ‘German industry 4.0’ to ‘Made in China 2025.* Beijing: Modern Publishing House, p. 231. 韦康博: 国家大战略:从德国工业 4.0 到中国制造 2025

investment. In recent years, the manufacturing in China has faced double pressure: the internal labor cost and operating cost continue to rise, and the external economic situation continues to be depressed. The trade figures are worsening: low-end manufacturing faces the low-cost competition from Southeast Asia and other developing economies, and high-end manufacturing needs to resist the impact of developed countries.[388]

Under pressure from both internal and external, in front of China's manufacturing industry, there are some new problems:

First, the cost advantage has been gradually shrinking. According to a report by Boston Consulting Group (BCG), the cost of manufacturing in China is almost the same as the United States. Among the top 25 economies in global export volume, if use the US manufacturing cost as the baseline 100, the cost index of China was 96 in 2016, and 93 in 2018.[389] The labor cost advantage of "made in China" is greatly reduced, and the competitiveness of traditional labor-intensive manufacturing industry is disappearing.

Second, the industrial structure is not reasonable, and the added value of products is low. Taking the iron and steel industry as an example, China has contributed most of the world's crude steel production, and in the case of special steel, a large amount of imports are needed to meet its domestic needs.[390] The mass production of basic

[388]Huang Q., & He J. (2015). "The Core Capability, Function and Strategy of Chinese Manufacturing Industry -- Comment on 'Chinese Manufacturing 2025'". *China Industrial Economics,* 6, pp. 6-7. 黄群慧，贺俊：中国制造业的核心能力，功能定位与发展战略——兼评《中国制造 2025》

[389]Boston Consulting Group report. (2018). "China's Next Leap in Manufacturing" <https://image-src.bcg.com/Images/BCG-Chinas-Next-Leap-in-Manufacturing-Dec-2018_tcm9-209521.pdf> last visited on 1, 2021

[390]Qiu, Z. (2016). "A study on the performance of industrial policy in the transformation and upgrading of

products makes China's manufacturing industry lack innovative vitality, and products are easy to be imitated or even replaced by other countries. Furthermore, the development of a large number of high-energy-consumption and high-pollution enterprises has also restricted the investment of capital in entrepreneurship and innovation, leading to dependence on key technologies and unsustainable economic development. Since the Reform and Opening up, China has made use of preferential and broad market policies to attract foreign enterprises to invest and build factories. However, for many of the foreign enterprises, what they bring is only the technology that has been prohibited by developed countries. China's core technology is still subject to other countries, and most Chinese manufacturers can only engage in simple assembly and basic processing industries. Due to the lack of brand and core technology, the profit is meager, and it is only a low processing fee. It cannot be extended to high value-added upstream and downstream industries, that is, the research and development stage and after-sales service stage, which makes it difficult to withstand the impact of the economic crisis and the anti-risk ability is weak.

Table 9.1 A List of the Key and Core Technologies Which China is Still Lagging Behind[391]

China's manufacturing industry". Shandong University, PhD Thesis 邱兆林:中国制造业转型升级中产业政策的绩效研究

[391] The reference websites of the table9.1 are:

Xinhua Net. (2018). "These 'details' make it difficult for China to expect top lithography machines" 新华网：这些"细节"让中国难望顶级光刻机项背
<http://www.xinhuanet.com/2018-04/19/c_1122704657.htm> last visited on 1, 2021;

Science Net. (2018). "What's stuck our necks-the pain of a big country that has lost the opportunity and has no self-developed operating system" 科学网：是什么卡了我们的脖子——丧失先机，没有自研操作系统的大国之痛
<http://news.sciencenet.cn/htmlnews/2018/4/410044.shtm> last visited on 1, 2021;

People.cn. (2018). "What is stuck in our necks-our protein 3D high-definition photos rely on imported transmission electron microscopes" 人民网：是什么卡了我们的脖子——我们的蛋白质 3D 高清照片仰赖舶来的透射式电镜
<http://scitech.people.com.cn/n1/2018/0606/c1057-30038658.html> last visited on 1, 2021;

Photolithography stepper	The photolithography stepper fabricated in P.R.China is able to reach to a precision of 90 nm so far, while the best in the world achieves the7 nm process using the EUV (Extreme ultraviolet) lithography developed at ASML, Netherlands.
Manufacturing of microchips	The mass production precision of the most advanced chip abroad is 10 nm, while that of P.R.China is only 28 nm; in the fields of computer systems, general electronic systems, communication equipment, memory equipment and display &video systems, the share of high-end microchips from the domestic manufacturers is almost zero.
Photoresists for LCD	At present, almost all photoresists for LCD rely on the imports, and the key technology has been monopolized by Japanese companies such as TOK, JSR, Sumitomo Chemical, and Shin-Etsu Chemical.
Operation system (of mobile phones and personal computers)	Three US companies monopolize the operating systems of mobile phones and personal computers. For the mobile phones, a survey shows that the Android market share reached 85.9% in 2017, while the Apple iOS market share was 14%; other systems only have 0.1%, which is basically Microsoft Windows and BlackBerry in the US.
Manufacturing of	The nacelle is the key equipment of the aircraft engine;

<http://tech.ce.cn/news/201806/14/t20180614_29430245.shtml> last visited on 4, 2020; <https://www.chinanews.com/gn/2018/04-24/8498534.shtml> last visited on 4, 2020

aircraft engine nacelle	Only three companies in the world can develop commercial use large-bypass engines for, General Electric (GE), Pratt & Whitney in the US, and Rolls-Roycein the UK. There are only two companies who can independently develop nacelles with high thrust and large bypass ratio turbofan engines: GoodRich, a top aerospace manufacturer, whose products are used in Boeing 878 and Airbus A350/A320neo; another is Nexcelle, which is a joint venture between GE and Safran in the US. In P.R.China, few research projects can be found in this field.
Radio frequency components of mobile phones	In 2018, the RF chip market was US$15 billion; the high-end market is mainly monopolized by Skyworks, Qorvo and Broadcom, and Qualcomm also holds market share partially. There is a great gap on the fabrication technology over Chinese manufacturers.
Heavy-duty gas turbines	Gas turbines are widely used in ships, trains and large power stations. Chinese manufacturers have the capability of fabrication of light-duty gas turbines, however, in the field of heavy-duty gas turbines, it still rely on the imports. The manufacturers for this are GE in the US, Mitsubishi in Japan, Siemens in Germany, and Ansal do in Italy. Harsh conditions are posed when they cooperate with China: the design and high-end component manufacturing technology cannot be

	transferred, and only non-core components manufacturing is permitted by license in China.
LiDAR	LiDAR is an essential component of autonomous vehicles, in this field, Chinese manufacturers have very little market share, while most of the autonomous vehicles involving the LiDAR use products of Velodyne in the US, which becomes the industry standard and holds more than 80% of the market share.
Industrial EDA software	The absence of industrial software has brought troubles to intelligent manufacturing. For example, chip design and production requires EDA industrial software. Compared with the mainstream EDA tools in the US, EDA products in China have a great gap in software performance. The main EDA companies, Cadence, Synopsys and Mentor, account for 70% of the total annual revenue of this industry worldwide.
High-quality bearing steel	The R&D, manufacturing and sales of high-end bearing steel are controlled by the world bearing giant companies such as Timken in the US, SKF in Sweden.
High-pressure plunger pumps	For high-pressure plunger pumps with a rated pressure above 35MPa, more than 90% rely on imports.
Transmission electron microscope	At present, there are only three manufacturers of transmission electron microscopes in the world, JEOL, Hitachi, and FEI in Japan. There is no companies in China that produces transmission electron microscopes.

Main bearing of the road header	The most critical main bearings of the road header are all relying on imports, RotheErde, IMO, and FAG in Germany, and SKF in Sweden occupy the global market.
Key components for fuel cells	There are almost no manufacturers in China for the key components in fuel cells used in the vehicle; those components (materials) determine the life and performance of fuel cells.

Third, transformation, upgrading and value chain rising. While labor-intensive industries are moving to lower-cost countries such as Southeast Asia and India, Chinese manufacturing is moving up the value chain.[392] "Made in China 2025" is the first 10-year program of action for China to implement the manufacturing power strategy. It lays out a plan for the transformation and upgrading of China's manufacturing sector and pushes forward the transformation from "Made in China" to "intelligent manufacturing in China".[393]

Fourth, the Internet and manufacturing are closely integrated. The deep integration of the Internet and traditional industries will become the commanding heights of the new round of "Made in China". The Internet of things, cloud computing, big data, industrial Internet, mobile Internet and e-commerce will all become key

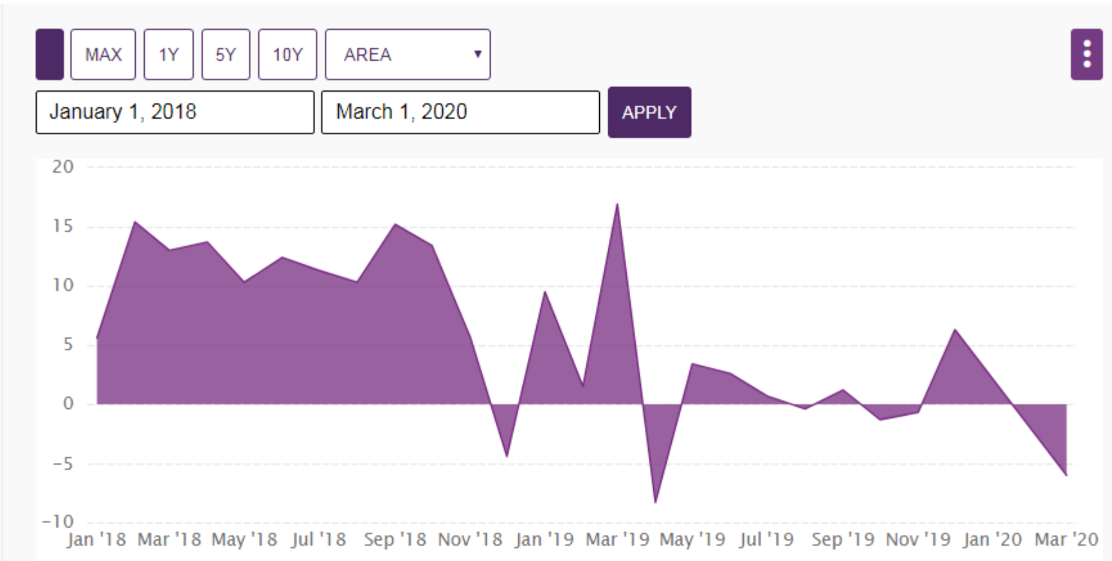
[392]Zhou, J. (2015). "Intelligent Manufacturing: Main direction of 'Made in China 2025'". *China Mechanical Engineering*, 26(17), p. 2274. 周济:智能制造:"中国制造 2025"的主攻方向

[393]Zhou, J., Li, P., Zhou, Y., Wang, B., Zang, J., & Meng, L. (2018). "Toward new-generation intelligent manufacturing". *Engineering*, *4*(1), p. 11.

technologies to promote the development of manufacturing.[394][395]

Fifth, consumer demand is changing. Consumers' demands are more and more diversified, with high requirements on product quality and innovation. There are more and more personalized demands, and the response time available is shorter and shorter. The demand for service quality is higher and higher. To a large extent, the success or failure of an enterprise depends on whether it can firmly grasp the needs of consumers and satisfy their experience.

Sixth, export growth has slowed. Trapped by the weak global economic, the growth rate of "Made in China" export data has slowed down. It used to be double-digit growth, but now it has dropped to single-digit growth, and even negative growth in certain months.



[394]Wang, X. (2018). *China Manufacturing 2025: Smart, Green, Integrated and Innovative*. Jinan: Shandong Science & Technology Press, pp. 47-48. 王喜文:中国制造 2025 曙光:智能、绿色、融合、创新

[395]Tian, S., & Pan, Z. (2017). " 'Made in China 2025' and 'Industrie 4.0'-In Motion Together" in Sendler, U., *The internet of things: Industrie 4.0 unleashed*. Springer, p. 99.

Figure 9.1 China's Total Exports Growth Rate (from January 2018 to March 2020)[396]

Seventh, more challenges from environment and resources. In the past decade, China's manufacturing industry has developed rapidly. While consuming a lot of energy, it has also caused a huge impact on the environment. The problem of high pollution and high energy consumption in the manufacturing industry has become increasingly prominent. The extensive development mode has led to excessive consumption of resources and energy in China, a large number of imported resources and energy is needed to maintain the development of the industry. At present, there is a serious problem of overcapacity in China, such as the construction industry that uses steel and cement. The heavy burning of coal has caused more and more serious smog, which has lowered the quality of people's life and put great pressure on the government. Therefore, it is urgent to promote the transformation and upgrading of the manufacturing industry.[397] In order to solve this problem, on the one hand, enterprises need to strengthen the green management of the product life cycle, and strive to build an efficient, clean, low-carbon, and recycling green manufacturing system; on the other hand, the government needs to pay more attention to the development of clean energy and increase the research and application of various energy-saving technologies and equipment.

[396] CEIC Data. (2020). "China Total Exports Growth" <https://www.ceicdata.com/en/indicator/china/total-exports-growth> last visited on 1, 2021

[397] Wang, X. (2018). *China Manufacturing 2025: Smart, Green, Integrated and Innovative*. Jinan: Shandong Science & Technology Press, pp. 97-100. 王喜文:中国制造 2025 曙光:智能、绿色、融合、创新

9.2.2 Analysis of the Specific Contents of "Made in China 2025"

The "Made in China 2025" plan is the first ten-year plan for the transformation and upgrading of the manufacturing industry in China. It aims to promote the transformation and upgrading of the manufacturing industry and the steady and healthy development of the economy, with intelligent manufacturing as the main focus according to the changes of the current domestic and international economic situation.

9.2.2.1 Guiding Principles and Basic Principles

According to the requirements of the State Council and relevant competent authorities, in order to promote the upgrading of the manufacturing sector, "Made in China 2025" proposes its general idea:

> […] in order to follow a new path of industrialization with Chinese characteristics. Manufacturing innovation will be the theme, improving quality and performance the core, integration of the next-generation IT into manufacturing the main thread, intelligent manufacturing the main priority, and meeting the demands of economic and social development and national defense the goal. We could reinforce the industrial base, improve integrated levels and training systems for multi-talented personnel to promote industrial transformation, cultivate a manufacturing culture with Chinese characteristics,

and realize the evolution of manufacturing from large to strong.[398]

According to this general idea, in order to realize the transformation and upgrading of the manufacturing industry in the right direction, five guiding principles are put forward: Innovation-driven Development, Quality First, Green Development, Structure Optimization, and Talent-oriented Development.[399]

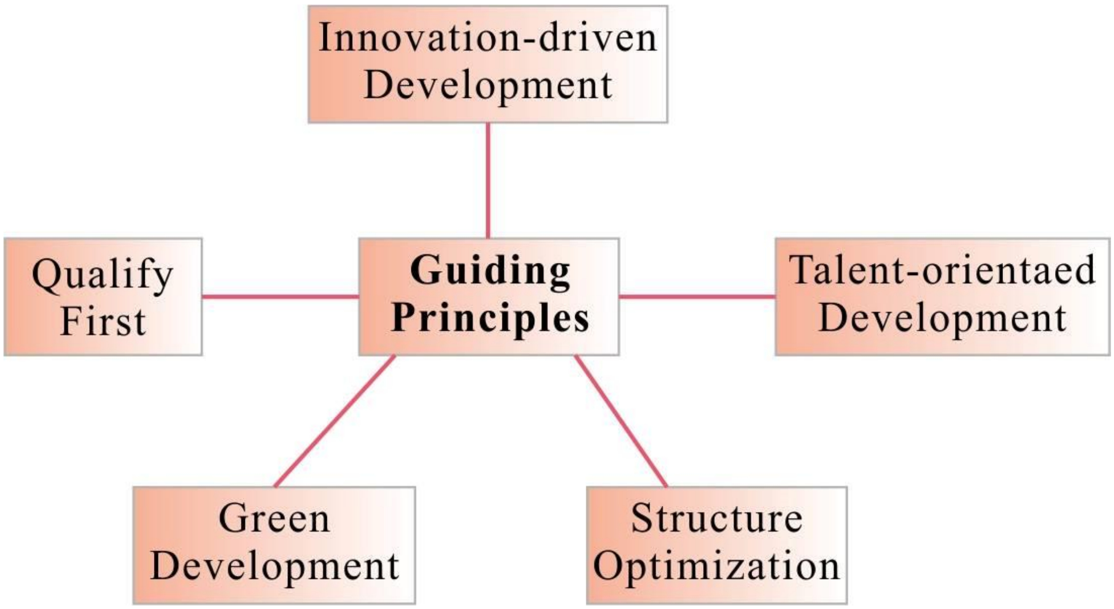


Figure 9.2 Guiding Principles of “Made in China 2025”

First, Innovation-driven Development. Innovation is the driving force for

[398]State Council of the People’s Republic of China. (2015). “Made in China 2025” <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf?fbclid=IwAR0vc5w-aTbS2p-eSvb4XZIuIus3oz95emeScb-zL_7k1nBwGTD-rTTMSXE> last visited on 1, 2021

[399]State Council of the People’s Republic of China. (2015). “Made in China 2025” <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf?fbclid=IwAR0vc5w-aTbS2p-eSvb4XZIuIus3oz95emeScb-zL_7k1nBwGTD-rTTMSXE> last visited on 1, 2021

technological progress and sustainable development. The state has always encouraged innovation, especially in major core technology areas. In the process of manufacturing transformation and upgrading, innovation is conducive to making full use of modern information and communication technology and achieving major technological breakthroughs. At present, compared with developed countries, China' manufacturing industry has less investment in innovation, and its production mode lacks innovative ideas. Therefore, it is necessary to pay more attention to innovation and provide enough guides to the development in this direction.

Second, Quality First. For the world' first-class brands, the high quality of enterprise products have always been a magic weapon to ensure the invincible position of enterprises. [400] However, China's manufactured products in the international market are generally considered both low price and poor quality. In some people's eyes, "made in China" has become a synonym for "copycat" or "inferior". In the process of manufacturing upgrading, China must put quality first, strengthen product quality construction and supervision system, build brand advantages and reverse the negative image.

Third, Green Development. With the increasing serious restrictions of resources and focus on the environment, the development of manufacturing industry urgently needs energy conservation and emission reduction. The transformation and upgrading of the manufacturing sector, focusing on improving quality and efficiency, means that the original extensive development model should be changed

[400]Wübbeke, J., Meissner, M., Zenglein, M. J., Ives, J., & Conrad, B. (2016). "Made in China 2025: The making of a high-tech superpower and consequences for industrial countries". Mercator Institute for China Studies. Papers on China

and green development should be pursued. The high pollution industry should actively promote energy-saving and environmental protection technology, upgrade and transform the original and old equipment, and improve the utilization efficiency of resources and energy.[401]

Fourth, Structure Optimization. At present, the development of China's manufacturing industry is mainly concentrated in labor-intensive and capital-intensive industries, with low requirements on technology, which directly limits the innovation capacity and sustainable development of the manufacturing industry. In the process of manufacturing transformation and upgrading, the government should provide more guides to the development of advanced manufacturing industry, and takes corresponding preferential measures.

Fifth, Talent-oriented Development. In the process of manufacturing transformation and upgrading, the construction of talent team is crucial. Enterprises need talents to support both product innovation and operating management. The key to realize the transformation and upgrading is to train the professional talents needed for the development of advanced manufacturing industry. The development of advanced manufacturing industry is different from the traditional manufacturing industry; it has higher requirements for talents, especially for compound talents. The government and enterprises should make great efforts to cultivate talents in this field.

In order to better implement the "Made in China 2025" strategy, the State Council

[401]Tian, S. & Pan, Z. (2017). "'Made in China 2025' and 'Industrie 4.0"-In Motion Together" in Sendler, U., *The internet of things: Industrie 4.0 unleashed*. Springer, p. 92.

has also formulated four basic principles to strengthen the guidance of the manufacturing industry[402]:

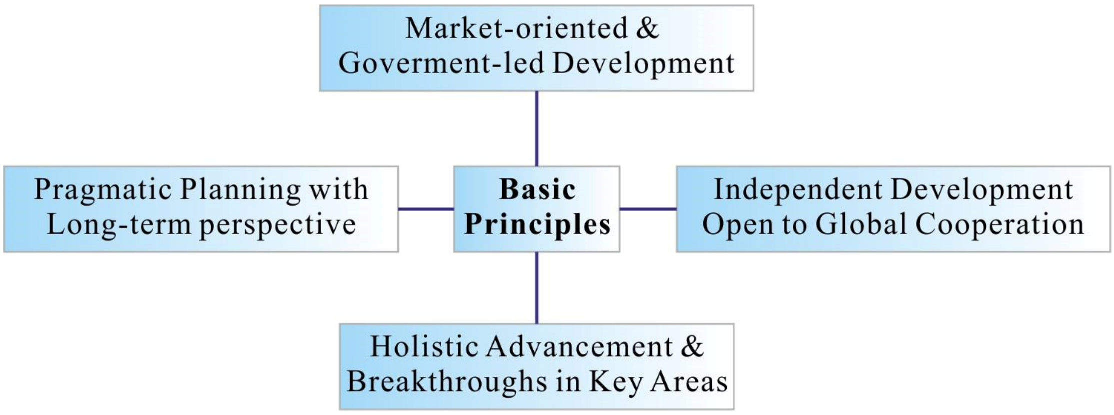


Figure 9.3 Basic Principles of "Made in China 2025"

First, Market-oriented and Government-led Development. The achievements since the reform and opening up have proved that the reform of the market economy is the right choice. The market can give full play to its advantages in terms of competition and innovation. The government could provide appropriate guidance, formulate relevant laws and regulations, and provide policy support to maintain the orderly and healthy development of the market economy. This will create an atmosphere of survival of the fittest for the transformation of the manufacturing industry, and enterprises will actively develop advanced manufacturing and eliminate backward production capacity.

Second, Pragmatic Planning with Long-term Perspective. Traditional

[402]State Council of the People's Republic of China. (2015). "Made in China 2025" <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf?fbclid=IwAR0vc5w-aTbS2p-eSvb4XZIuIus3oz95emeScb-zL_7k1nBwGTD-rTTMSXE> last visited on 1, 2021

manufacturing has created a large number of jobs; it is an important force for maintaining economic stability. The transformation and upgrading of traditional manufacturing industry and the development of advanced manufacturing industry cannot be accomplished overnight. They should be based on the basic domestic conditions. Labor-intensive industry in the coastal areas can be transferred to the inland areas and regain their vitality. Of course, the central government and local governments at all levels should also take a long-term view, break through obstacles in the transformation and upgrading of traditional industry, and actively utilize the existing advanced technology to develop higher-end technology.[403]

Third, Holistic Advancement and Breakthroughs in Key Areas. The upgrading of the manufacturing industry is neither the upgrading of some industries nor the non-upgrading of some industries. It is also not upgrading together regardless of key areas and regions. The upgrading will focus on both the whole and key areas. In all areas of the manufacturing industry, new technologies should be used to improve labor productivity and product quality, in key areas with serious pollution and major impacts on social and economic development, key technological breakthroughs should be accelerated to remove obstacles to the overall transformation and upgrading of the manufacturing sector.

Fourth, Independent Development Open to Global Cooperation. As a major power in the world, China's manufacturing industry, like its grain production, must keep its basic industry firmly in its own hands, master core technologies and take the

[403]Wübbeke, J., Meissner, M., Zenglein, M. J., Ives, J., & Conrad, B. (2016). "Made in China 2025: The making of a high-tech superpower and consequences for industrial countries". Mercator Institute for China Studies. Papers on China

initiative in international cooperation. At the same time, China should actively open wider to the outside world; make full use of the international market and foreign technologies to improve the efficiency and level of manufacturing transformation.

9.2.2.2 Strategic Goals and Tasks

"Made in China 2025" proposes a three-step strategy in order to achieve the strategic goal of becoming a manufacturing power[404]:

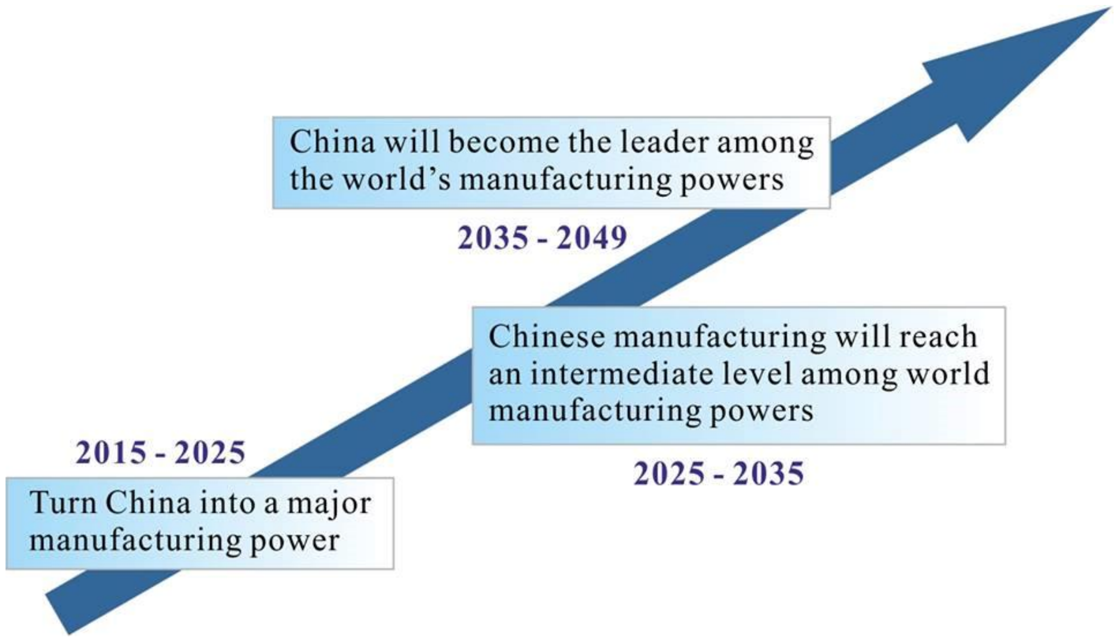


Figure 9.4 The Three-step Strategy of "Made in China 2025"

In the past, most of the national strategic plans were made for the next five years,

[404] State Council of the People's Republic of China. (2015). "Made in China 2025" <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf?fbclid=IwAR0vc5w-aTbS2p-eSvb4XZIuIus3oz95emeScb-zL_7k1nBwGTD-rTTMSXE> last visited on 1, 2021

this time, “Made in China 2025” takes a ten year time frame as a stage. On the one hand, it fully shows China’s emphasis on the transformation and upgrading of the manufacturing industry; on the other hand, it also reveals the country’s recognition of the difficulties that the manufacturing industry has to overcome.

In the strategic goals, each step has a clear positioning and development direction. For example, in the first step, the emphasis is on improving the informatization level of the manufacturing industry and reducing the energy consumption level, these are the key points that the manufacturing industry urgently needs to transform and upgrade. Therefore, the three-step strategic goal point out the way for the development of China’s manufacturing industry. The road will be bumpy and needs to be completed by one or even two or three generations.

To achieve the three-step strategy goals, we must overcome numerous difficulties and give priority to solving the major issues concerning the national economy and people’s livelihood. At the same time, the whole society should intensify publicity, reach consensus on the transformation and upgrading of the manufacturing industry, and break through the obstacles caused by the solidification of interests. Therefore, in order to achieve the three-step strategic goals at an early date, China has put forward nine tasks to promote the development of the manufacturing industry.

Figure 9.5 The Nine Strategic Tasks of "Made in China 2025"[405]

The nine tasks are aimed at the prominent problems of the manufacturing industry, and they are the direction for the transformation and upgrading of the manufacturing industry in the future. For example, for the current serious overcapacity and heavy pollution, the only way out is to actively develop green manufacturing. It emphasizes that the manufacturing industry should not excessively plunder natural resources, and at the same time, increases the proportion of clean energy utilization. These tasks call for technological innovation and optimization, strengthening cooperation and exchanges with developed countries, and the restructuring of the manufacturing sector. Therefore, these nine tasks are interlinked, and they will jointly promote the transformation and

[405]State Council of the People's Republic of China. (2015). "Made in China 2025" <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf?fbclid=IwAR0vc5w-aTbS2p-eSvb4XZIuIus3oz95emeScb-zL_7k1nBwGTD-rTTMSXE> last visited on 1, 2021

upgrading of China's manufacturing industry.

9.2.2.3 Policy Support and Guarantee

Throughout the transformation and upgrading of the manufacturing industry in the world's major developed countries, the active promotion of the government has played an important role. "Made in China 2025" has clearly defined the importance of policy support and guarantee. In particular, the key areas need more government policy support and guarantee to accelerate the progress. Taking the robotics industry as an example, it has a wide range of application fields. However, it has high technical requirements and a large amount of early-stage capital investment, which requires the government to provide support and guarantee in finance, taxation, talents, land and other aspects.[406]

For the reason above, "made in China 2025" proposes eight policies to provide support and guarantee for the manufacturing industry[407], as shown in Figure 9.6:

[406]Tian, S. & Pan, Z. (2017). " 'Made in China 2025' and 'Industrie 4.0"-In Motion Together" in Sendler, U., *The internet of things: Industrie 4.0 unleashed*. Springer, p. 107.
[407]State Council of the People's Republic of China. (2015). "Made in China 2025" <http://www.cittadellascienza.it/cina/wp-content/uploads/2017/02/IoT-ONE-Made-in-China-2025.pdf?fbclid=IwAR0vc5w-aTbS2p-eSvb4XZIuIus3oz95emeScb-zL_7k1nBwGTD-rTTMSXE> last visited on 1, 2021

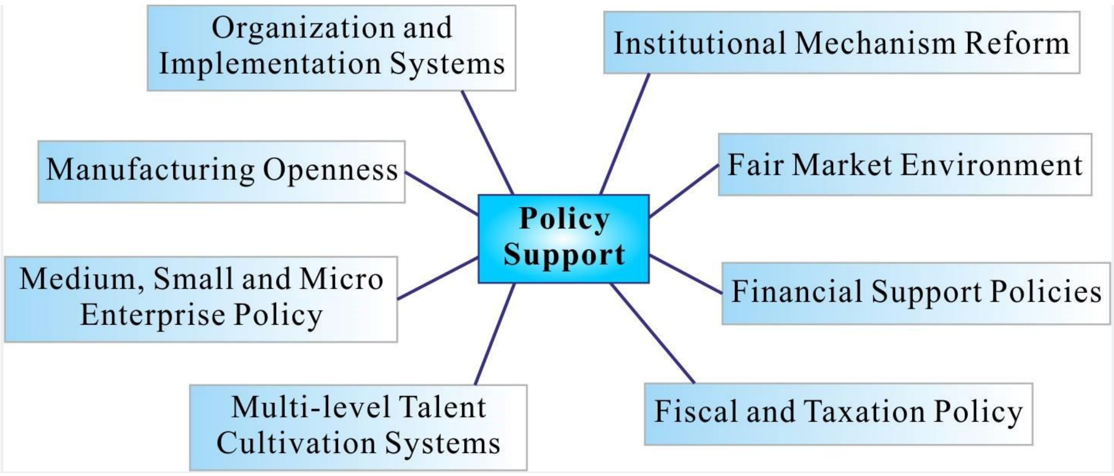


Figure 9.6 The Policy Support for "Made in China 2025"

These eight supporting policies are comprehensive in consideration and involve a wide range of sectors. It is necessary for all government departments to work together to provide a good ancillary facility and development environment for the implementation of the "Made in China 2025". At the same time, in the final part of the plan, the government has put forward specific requirements, namely, all regions and units across the country should have a clear understanding of the situation, seize the development opportunities, and jointly promote the transformation and upgrading of the manufacturing industry. In the specific implementation process, it is necessary to distinguish advantages and disadvantages according to local actual conditions, strengthen cooperation and achieve technological breakthroughs.

9.3 "Made in China 2025": the European Perspective and American Perspective

9.3.1 “Made in China 2025”: the European Perspective

Figure 9.7 China’s Rise: Panda Hugger or Dragon Slayer[408]

At present, the cooperation between the EU and China in science and technology industry has been extensive, covering all aspects from basic research to practical application. Active participants in this cooperation are not limited toEuropean enterprises, but also European universities and prestigious institutes such as Fraunhofer Institutes and Max Planck Institutes.

In an interview with Asia Society, Max J. Zenglein, a scholar of The Mercator Institute for China Studies (MERICS) think tank in Berlin, said that many people

[408]Verheul, J. (2015). “China’s Rise: Panda Hugger or Dragon Slayer?”. Utrecht University MA Thesis <https://dspace.library.uu.nl/bitstream/handle/1874/319296/Scriptie%20Liesje%20Pfaeltzer%2C%203472612.pdf?sequence=2&isAllowed=y.> last visited on 1, 2021

on the German side simply do not seem to realize that the core technology of German industry will be quietly transferred. He said there had been at least some change in European attitudes towards "Made in China 2025". For example, Europe has a tougher vetting system for foreign direct investment projects. Within the EU, there is a growing consensus that China is a strategic rival. The EU has indeed become more cautious and critical when dealings with China. But many industries feel they are benefiting from cooperation with China.[409]

Zenglein is one author of the report "Made in China 2025: The making of a high-tech superpower and consequences for industrial countries" which MERICS published in 2016. In this report, the authors outlined their concern about "Made in China 2025". They mentioned that for short-term interests, a large number of European companies and even governments have active participation in the "Made in China 2025", however, that would pose a long-term risk to the European economy.[410]

In 2019, he released another report about "Made in China 2025" with Anna Holzmann: "Evolving Made in China 2025: China's industrial policy in the quest for global tech leadership".[411] In this report, he pointed out that China's goal of gaining the leading position in the field of science and technology has not changed. He reiterated the threat "Made in China 2025" posed to Europe, and Germany is in the first place. Although the Chinese government has consciously dropped the

[409]Asia Society. (2019). "The European Perspective on 'Made in China 2025'"
< https://www.youtube.com/watch?v=TA8Pbqkgd7w> last visited on 1, 2021
[410]Wübbeke, J., Meissner, M., Zenglein, M. J., Ives, J., & Conrad, B. (2016). "Made in China 2025: The making of a high-tech superpower and consequences for industrial countries". Mercator Institute for China Studies. Papers on China
[411]Zenglein, M. J., & Holzmann, A. (2019). "Evolving Made in China 2025: China's Industrial Policy in the Quest for Global Tech Leadership". MERICS Paper on China, 8

phrase “Made in China 2025” in the face of external pressure such as the trade war over the past two years, its big goal of achieving technological upgrading has remained unchanged and is making steady progress.[412]

This report divided European enterprises which participate in “Made in China 2025” into three categories: the first are those industries that Beijing considers of little strategic value, such as restaurants and fast-moving consumer goods, which are opening up more rapidly to foreign investment. Even the traditional petrol-car industry has recently been included in this category, as evidenced by the lifting of restrictions on joint ventures by foreign carmakers in the Chinese market. The authors argue that these “low-value” companies are being used as bargaining chips by China; the second category is willing technology partners. According to the author, most German companies belong to the second category. The Chinese government is trying to persuade these companies with various preferential conditions to move the most technologically sophisticated parts of their industrial chain to China, and Beijing’s goal has always been to take the opportunity to upgrade its domestic industry and climb to a higher level in the global industrial chain. The report pointed out that China’s electronic product industry is a typical example: in the early years, it was subcontracted assembly point for international manufacturers, but now many Chinese local companies can produce important core components by themselves; the third category is foreign companies with still-unavailable technology. These companies often have a leading position in their respective industries, and the most valuable part of their industrial chain is still outside China. In order to gain access to these key technologies, the Chinese

412 Ibid.

government is adopting various methods, such as promising more preferential conditions for these companies, allowing Chinese companies to directly go overseas to acquire related companies, and poaching key employees from these companies to Chinese companies. This is because Beijing recognizes that dependence on foreign companies in certain core areas will become a fatal weakness in China's technological upgrading.[413]

"Made in China 2025" also aroused the concerns of the European business community, who feared that Chinese manufacturers would overwhelm the entire industry with excess capacity and trigger a protectionist rebound. Hanna Müller, the head of the Federation of German Industries (BDI) office in Beijing, said that the opportunities now outweigh the risks. However, after five years, maybe she would give a different answer. People will know more by then. There was a plan and clear quotas, but whether this can be implemented was still unclear.[414]

In 2017, the European Chamber of Commerce in China in Beijing released a report entitled "China Manufacturing 2025：Putting Industrial Policy Ahead of Market Forces", criticizing China's industrial policy and arguing that the proposed policies ran counter to market-oriented reforms. In this report, foreign carmakers with electric vehicles are under pressure to hand over their battery technology to Chinese partners in exchange for being able to produce and sell in China. A recently adopted policy in the field of new energy vehicles puts European companies under great pressure to exchange advanced technology for recent market access. The report also

[413]Zenglein, M. J., & Holzmann, A. (2019). "Evolving Made in China 2025: China's Industrial Policy in the Quest for Global Tech Leadership". MERICS Paper on China, 8
[414]Record 4, Interview with FerdinardSchaff, BDI

raises some questions about the development targets of "Made in China 2025", such as the market share of domestic brands.[415]

Jorg Wuttke, President of the European Chamber of Commerce in China, acknowledged that criticism of China's trade and investment policies might spark protectionist calls in the EU. However, he explained that this report was meant to prevent, not advocate trade barriers. This is not to encourage trade protection, but to remind populism is rising across Europe. Wuttke said the "Made in China 2025" was very unusual in setting precise targets for both domestic and foreign market share. That has prompted fears in Europe and other regions that Chinese state-owned enterprises would use Chinese manufacturing to occupy all those lucrative areas, which was similar to what has happened in other low-end manufacturing sectors over the past two decades. In many cases, such as high-speed rail, after western multinationals such as Siemens handed over technology under license agreements, they found that their Chinese partners turn to compete with them in foreign markets.[416] Attitudes towards China among overseas multinationals became hard in the past few years as growth has slowed and competition has increased. "Many companies that were tolerant of an unequal playing field during the era of double-digit growth in China are becoming less patient in this new, lower growth environment," said by Jude Blanchette of the Conference Board in Beijing.[417]

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[415]European Union Chamber of Commerce in China. (2017). "China Manufacturing 2025: Putting Industrial Policy Ahead of Market Forces"

[416]FTChinese. (2017). "'Made in China 2025' has been criticised by European business" FT 中文网：《中国制造 2025》遭欧洲商界批评
< https://www.ftchinese.com/story/001071670?archive> last visited on 1, 2021

[417]FTChinese. (2017). "'Made in China 2025' has been criticised by European business" FT 中文网：《中国制造 2025》遭欧洲商界批评
< https://www.ftchinese.com/story/001071670?archive> last visited on 1, 2021

9.3.2 "Made in China 2025": the American Perspective

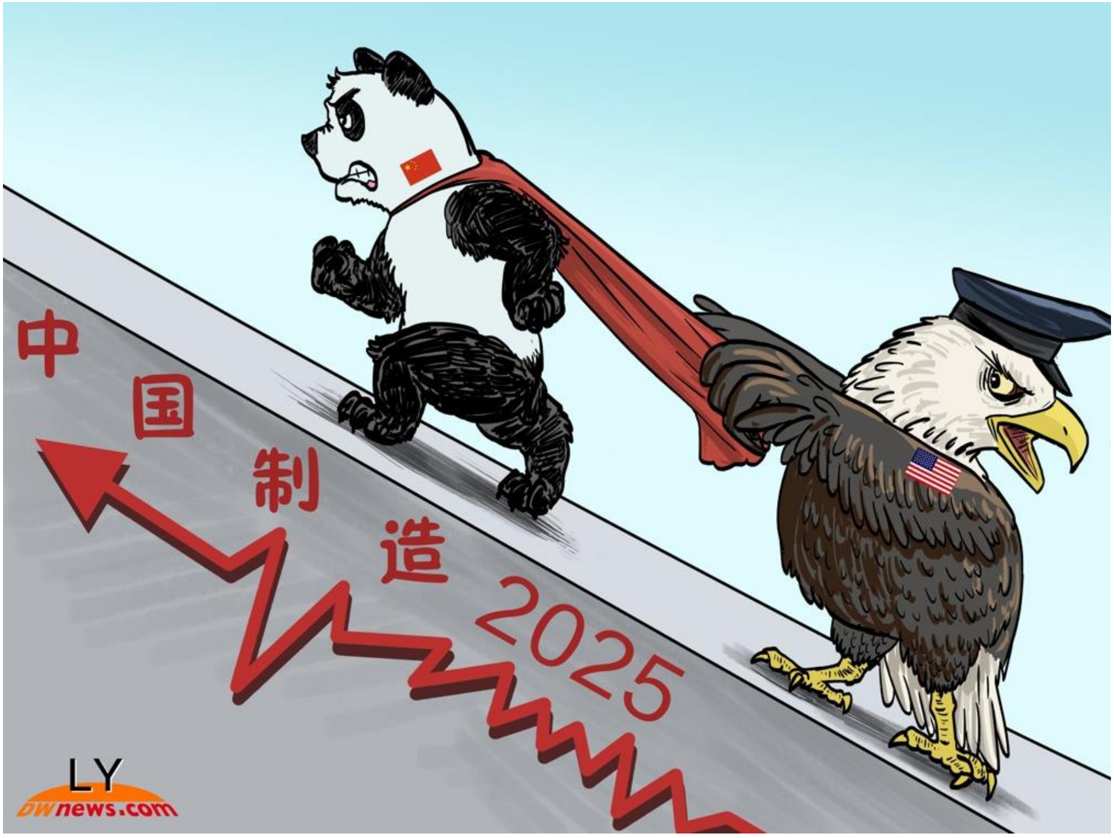

Figure 9.8 The United States is Wary of the "Made in China 2025"[418]

[418]DWNew. (2019). "Senior US officials criticize China on intellectual property: Made in China 2025 is a road map for theft" 多维新闻：美高官就知识产权批华：称中国制造 2025 是盗窃路线图 <https://www.dwnews.com/%E5%85%A8%E7%90%83/60130788/%E7%BE%8E%E9%AB%98%E5%AE%98%E5%B0%B1%E7%9F%A5%E8%AF%86%E4%BA%A7%E6%9D%83%E6%89%B9%E5%8D%8E%E7%A7%B0%E4%B8%AD%E5%9B%BD%E5%88%B6%E9%80%A02025%E6%98%AF%E7%9B%97%E7%AA%83%E8%B7%AF%E7%BA%BF%E5%9B%BE> last visited on 1, 2021

America's response to "Made in China 2025" was much more intense. After the economic crisis, in order to save the economy and achieve rapid growth, the Obama administration put forward the strategy of revitalizing the manufacturing industry with the future industry chain as the core, and launched a series of policies: "The American Recovery and Reinvestment Act of 2009", "The Manufacturing Enhancement Act of 2010", and "National Strategic Plan for Advanced Manufacturing", which took the combination of development of emerging technologies and manufacturing as a priority area for national breakthroughs. The United States has decided to revitalize manufacturing through the return of high-end manufacturing, and has placed this measure at the height of its national development strategy. China has also proposed "Made in China 2025" to promote the transformation and upgrading of the manufacturing industry and improve the structure and quality of export products. The US side believes that this will pose a threat to the supremacy of the US technology market and the global industrial chain.

Since the spring of 2018, US President Trump has threatened to impose high tariffs on steel, aluminum and other products of the world. In particular, he launched the "Section 301 investigation" against China and imposed a 25% tariff on Chinese exports to the United States which worth about 50 billion US dollars. This has brought China and the United States closer to a trade war and plunged the world economy into a tense atmosphere of confrontation between China and the US. The "Section 301 investigation" report mentioned "Made in China 2025" more than 100 times, said that the ambitious "Made in China 2025" plan made Americans feel that China would threaten the most fundamental US competitive advantage: technology and intellectual property. This investigation aims at emerging technology manufacturing industry supported by "Made in China 2025", which might threaten the future competitiveness of the US manufacturing industry. Sino-US trade has risen to the height of national development strategy.

In April 2018, China and the United States conducted trade negotiations in Beijing. The United States requested that China immediately stop providing subsidies and other assistance to the strategic industries under the "Made in China 2025" plan, and accept potential U.S. import restrictions on the "Made in China 2025" industries. The U.S. Trade Representative Robert Lighthizer said:

> We must take strong defensive actions to protect America's leadership in technology and innovation against the unprecedented threat posed by China……China's government is aggressively working to undermine America's high-tech industries and our economic leadership through unfair trade practices and industrial policies like 'Made in China 2025' Technology and innovation are America's greatest economic assets.[419]

Senior adviser and Trustee Chair in Chinese Business and Economics at the Center for Strategic and International Studies, Scott Kennedy believes that any country has the right to formulate its own industrial policies. However, the goals and means of realization of "Made in China 2025" are frightening and may threaten global technological innovation.[420] The goals of "Made in China 2025" is clear, two of them are particularly prominent. The first is import substitution. China is seeking

[419]USTR. (2018). "USTR Issues Tariffs on Chinese Products in Response to Unfair Trade Practices" <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/june/ustr-issues-tariffs-chinese-products> last visited on 1, 2021

[420]Kennedy, S. (2015). "Made in China 2025". Center for Strategic and international Studies < https://www.csis.org/analysis/made-china-2025> last visited on 1, 2021

for market shares and a dominant position at the technology supply chain. The second is national security. "Made in China 2025" is not just about promoting productivity but to make the Chinese People's Liberation Army stronger.[421]

According to "Made in China 2025", China will increase the domestic market share of basic core components and key basic materials suppliers to 70% by the end of 2025.[422] Scott Kennedy showed his concern about China's means of achieving these goals. The number of subsidies is usually trillions; restrictions on market access, requirements for local contracts, and unique standards. All these policies do not create a level playing field in China. This will eventually cause distortion and discrimination. Given the scale of the Chinese economy, the distortion of the Chinese market means the distortion of the global market. Therefore, China's domestic industrial policy affects not only China's domestic market, but also beyond its borders.[423]

[421]VOA Chinese. (2018). "Will 'made in China 2025' be an obstacle in future negotiations between the US and China?" "中国制造 2025"将是美中未来谈判的障碍？
< https://www.voachinese.com/a/4685039.html> last visited on 1, 2021
[422]Kennedy, S. (2015). "Made in China 2025". Center for Strategic and international Studies
< https://www.csis.org/analysis/made-china-2025> last visited on 1, 2021
[423]VOA Chinese. (2018). "Will 'made in China 2025' be an obstacle in future negotiations between the US and China?" "中国制造 2025"将是美中未来谈判的障碍？
< https://www.voachinese.com/a/4685039.html> last visited on 1, 2021

9.3.3 “Made in China 2025”: China’s Defense and Response

China believes that in order to promote economic development, the market needs to play a decisive role, while at the same time, the government also needs to play a guiding role. This is actually an internationally accepted practice. In order to develop the domestic manufacturing industry, some countries and regions have formulated documents similar to “Made in China 2025” in different periods. For example, the US has the “National Strategic Plan for Advanced Manufacturing”, Germany has the “German Industry 4.0 Strategy”, and Japan has the “Japan Revitalization Strategy”.

Miao Wei, Minister of Industry and Information Technology of China gave the corresponding reply. The report of the European Chamber of Commerce in China raised some doubts about the indicators related to the development of “Made in China 2025”, such as the market share of domestic brands. In this regard, Miao Wei explained that China did not deliberately pursue this indicator in the process of document formulation. After the release of the document, the Strategic Advisory Expert Committee issued a green paper, most of the references cited in the report of the European Chamber of Commerce in China are the indicators published in the green paper. However, when the Green Paper was released, they had stated that this indicator was predictive, not mandatory, had no binding effect, and was not a government action.

“Made in China 2025” and its related policies are applicable to all enterprises in China, including domestic and foreign enterprises; they are treated equally. For example, in the case of new energy vehicles, the entry condition is that enterprises must master a full set of development and manufacturing technologies for new energy vehicles. This requirement is not only for foreign enterprises, nor is it mandatory for foreign enterprises to transfer their technology to China. The original intention in formulating this policy was to prevent some enterprises from taking advantage of government subsidies to drill the loopholes of the policy, buying assembly parts to assemble a batch of cars, make a profit and then leave. In this case, it is not only damage to the interests of customers, but also harm to enterprises with intellectual property rights. Therefore, this policy was not formulated to restrict foreign enterprises. China treats domestic and foreign enterprises equally. And mastering this technology means: setting up a research and development center in China, or a research and development center established by an overseas parent company, it would be feasible as long as they own this technology. It is not necessary to set up a research and development center in China, and it is not mandatory to transfer this technology to China.

During the more than 30 years of Reform and Opening up in China, foreign enterprises have made positive contributions to China's economic development and shared in the fruits of China's economic development. In the process of promoting "Made in China 2025", China has always emphasized the need to strengthen international bilateral and multilateral exchanges and cooperation. For example, China and Germany have signed a cooperation agreement and established a cooperation mechanism on "Made in China 2025" and "German Industry 4.0 Strategy", and achieved positive results in the construction of intelligent manufacturing standard systems and some subdivided fields.

China believes that the United States is completely misrepresenting “Made in China 2025”. On April 5, 2018, Zhao Changwen, Minister of the Industrial Economic Research Department of the Development Research Center of the State Council, stated that the “Section 301 investigation” launched by the US is nominally to protect American companies involved in technology transfer, market access and investment protection from unfair treatment. But the essence is the US’s strategic containment and suppression of China’s high-tech industries and advanced manufacturing industries after the change of the economic strength and competition situation in the two countries. Zhao Changwen pointed out that the “Section 301 investigation” focused on “Made in China 2025”, revealed the essence of the US concerns. The ten key areas planned in “Made in China 2025” basically belong to the high-tech industry and advanced manufacturing field. The United States is worried that in the future China will develop mature technological capabilities and advanced manufacturing capabilities in these fields, which will form direct competition with the US in the field of high-tech which the US had a comparative advantage, and threatens the US’s leading edge.

He believes that the process of the investigation and the conclusion of the “Section 301 investigation” report reflected strong subjectivity and tendency. The survey is basically based on questionnaire survey and subjective assessment of some American enterprises, as well as the collection of planning and research opinions released by the Chinese government and some research institutions, lacking a large number of facts and data as a realistic basis. It is neither accurate nor rigorous. Many academic articles and public reports are cited, some reports are based on certain assumptions and cannot be regarded as objective and powerful evidence for investigation. Some of the policies mentioned in the report have already been adjusted by China, and can no longer be used as a basis for evaluation.

“Made in China 2025” is a strategic plan that adheres to market leadership and is open and inclusive. Its guiding principle is that the market plays a decisive role in the allocation of resources; the concept of development is innovation, intelligence, green and sustainable; the construction idea is open cooperation and mutual benefit. The Chinese government has always emphasized that “Made in China 2025” is an open system with universal applicability. Chinese leaders have repeatedly stressed that “Made in China 2025” treats Chinese and foreign companies equally and welcomes foreign companies to participate in the development of China’s manufacturing industry. At present, in the construction of intelligent manufacturing, green manufacturing and other projects of “Made in China 2025”, companies from many countries and regions such as the United States, Germany, and the United Kingdom are participating in cooperation.

Chinese Premier Li Keqiang mentioned at the 2017 Summer Davos Forum: “Made in China 2025” cannot be implemented without cooperation with other countries. First, the implementation of "Made in China 2025" will bring huge market opportunities for Chinese and foreign companies, because in order to improve the quality of their products, Chinese enterprises must improve their technological and equipment levels. In this process of improvement, China needs to cooperate with developed countries. For example, China has cooperation with “German Industry 4.0”. More foreign equipment manufacturing products and technologies will enter the Chinese market.

Second, there will be more cooperation between Chinese and foreign enterprises in the field of equipment and technology. Because when the foreign equipment enters China, if wants to occupy more markets, it needs to localize its products. For example, the General Electric of the United States now has a 17% market share in China, but it is a joint venture with Chinese enterprises. It has been modified according to the road conditions and climatic conditions in China, so its market share in China keeps expanding. This kind of cooperation is voluntary by enterprises and conducive to the expansion of the Chinese market and even the third-party markets. The Chinese government does not allow Chinese companies to force the transfer of technology or infringe intellectual property rights.

Third, in some relevant areas related to "Made in China 2025", such as green development, the Paris Agreement and the WTO encourage the governments to provide policy support. As long as foreign enterprises are registered in China, the Chinese government will provide the same policy support as domestic enterprises.

In view of the strong response from the United States, China has reduced its propaganda for "Made in China 2025". For example: From January to May in 2018, China's official Xinhua News Agency mentioned "made in China 2025" more than 140 times in its news reports, but since June, it has not used "Made in China 2025"in any report.[424]

[424]VOA Chinese. (2018). "Will China abandon 'made in China 2025'?" 中国会放弃"中国制造 2025"吗？ <https://www.voachinese.com/a/made-in-china-20181108/4651130.html> last visited on 1, 2021

When Chinese Premier Li Keqiang made his government report to the National People's Congress on March 5, 2019, he did not once mention "made in China 2025" in his 1.5 hour speech. However, for the past three consecutive years, "Made in China 2025" has been a focus of Li Keqiang's government work report. However, only the name "Made in China 2025" has disappeared. Although Li Keqiang did not mention "Made in China 2025" in the report, China's industrial policy is still there, Li Keqiang listed a series of emerging industries that the Chinese government plans to support.[425]

After nearly two years of trade war, the United States finally agreed to phase out tariffs on Chinese goods. But Scott Kennedy, a Chinese expert at the Center for Strategic and International Studies (CSIS) of the Washington Think Tank, pointed out that: "Pardon me if I don't pop champagne, but aside from a cessation of continued escalation, there is not much worth cheering. There is still significant ambiguity about what is in the deal but based on what we can surmise, it is unclear if the struggles of the past two and a half years have been worth it. The costs have been substantial and far reaching, the benefits narrow and ephemeral."[426]

Mary Lovely, a trade economist at the Peterson Institute for International Economics, said that: "US farmers lost billions of dollars in income, companies paid billions in tariffs and in many cases shifted their supply chains, and consumers saw some prices increase."[427] The agreement can only be regarded as a partial

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[425]Li, K. (2019). "Government work report (transcript)"
政府工作报告（文字实录）
<http://www.gov.cn/guowuyuan/2019-03/05/content_5370734.htm> last visited on 1, 2021
[426]CSIS. (2019). "A Fragile and Costly U.S.-China Trade Peace"
<https://www.csis.org/analysis/fragile-and-costly-us-china-trade-peace> last visited on 1, 2021
[427]Financial Review. (2019). "US-China agree to partial trade deal"
<https://www.afr.com/world/north-america/us-china-agree-to-partial-trade-deal-20191214-p53jxx> last

victory; the gains from the agreement weren't enough to make up for the losses of the US farmers and businesses. She even believes that Trump would like the US economy to return to where it was 18 months ago, before the trade war began.[428]

9.4 Sino-EU Cooperation after "Made in China 2025"

On October 11th, 2019, The European Union Chamber of Commerce (CCCEU) in China released its first flagship report in Brussels, which comprehensively summarized the major business activities of Chinese enterprises in Europe in recent years, and proposed a package of policy recommendations to EU institutions and member governments to further improve the business environment for Chinese companies in the EU. [429]

The report, titled "Report on the Development of Chinese Enterprises in the EU (2019)" was jointly released by the CCCEU and the world-renowned consultancy Berger Management Consultants. Zhou Lihong, the chairman of the CCCEU said in a speech at the press conference that the CCCEU represented more than 900 Chinese companies in the EU and received strong support from EU institutions and some European partners. Chinese entrepreneurs have confidence in the EU's 500 million population market, the professionalism of the EU's business partners and

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visited on 1, 2021

[428]Eunited. (2019). "Letizer: the first phase of the trade agreement is expected to be signed in Washington in the first week of January" 莱蒂泽：料明年 1 月首周在华盛顿签首阶段贸易协议
< https://eunited.com.my/323723/> last visited on 3, 2020

[429]China Chamber of Commerce to the EU, Roland Berger. (2019), "Report on the Development of Chinese Enterprises in the EU"

highly qualified employees.[430] As two major civilizations and two big markets, China and Europe have enormous potential and opportunities for further Cooperation.

Raymond Wang, Global Partner of Roland Berger expressed that the report was completed on the basis of in-depth research. The positioning of Chinese enterprises in the EU was not just at the market level, but the EU was regarded as the important strategic fulcrum of enterprise globalization development. More and more Chinese companies set up R&D centers and manufacturing plants in the EU, attached great importance to technological innovation and committed to long-term development. The EU provides a favorable policy environment for the development of Chinese enterprises, and Chinese enterprises will also bring huge benefits to the development of the EU.[431]

According to the report, the main challenges that Chinese companies encounter in Europe are: first, the increasing scrutiny of foreign investment by the EU has limited Chinese companies' access to key areas such as energy, artificial intelligence, communications and semiconductors; second, the EU has restricted the normal operation of Chinese enterprises, especially state-owned enterprises in certain fields such as energy due to misunderstandings caused by political and public opinion; Third, when Chinese enterprises do business in Europe, they take

[430]Eureporter. (2006). "CCCEU launches first flagship report, calling for better business environment in EU for Chinese businesses" <https://www.eureporter.co/frontpage/2019/10/12/ccceu-launches-first-flagship-report-calling-for-better-business-environment-in-eu-for-chinese-businesses/> last visited on 1, 2021

[431]Eureporter. (2006). "CCCEU launches first flagship report, calling for better business environment in EU for Chinese businesses" <https://www.eureporter.co/frontpage/2019/10/12/ccceu-launches-first-flagship-report-calling-for-better-business-environment-in-eu-for-chinese-businesses/> last visited on 1, 2021

many detours because they are not familiar with the local laws, regulations and rules; fourth, the lack of regular communication channels between Chinese enterprises and the local government leads to the problem that the government does not understand the demands of enterprises and the enterprises are often faced with no recourse; fifth, due to the lack of awareness of active voice, Chinese enterprises distance themselves from local industry associations and local people; sixth, there are certain differences in the governance modes between Chinese and European companies, resulting in labor and capital friction in the operation of enterprises.[432]

Although these challenges have not shaken the overall confidence and determination of Chinese enterprises to develop in Europe, they inevitably slow down the pace of enterprise development, and to some extent inhibit the development potential of enterprises. The report recommends: first, the EU should adhere to its free market policy, reject politicization of commercial issues, respect the ideology, political system, and cultural traditions of both sides, seek common ground while reserving differences, and expand practical cooperation; second, the EU should not use zero-sum thinking to measure China-EU economic and trade relations; third, the focus should not be limited to the present, but should focus on cutting-edge technology and incremental markets in emerging fields, with the goal of China and the EU working together for the development of global cutting-edge technologies; fourth, the EU member states governments should provide practical assistance to Chinese enterprises, such as information sharing, resource matching and process optimization, so as to enable Chinese enterprises to make greater

[432]China Chamber of Commerce to the EU, Roland Berger. (2019), "Report on the Development of Chinese Enterprises in the EU"

contributions to local economic development.[433]

In the same year, the European Union Chamber of Commerce in China and Roland Berger released the “Business Confidence Survey 2019”[434], which shows that European companies in China still have confidence in the Chinese market. Many companies expressed their hope that China’s measures to expand its opening-up to the outside world can be turned into real opportunities. Denis Depoux, the Asia head of Roland Berger, said that the European companies remain committed to the Chinese market despite the challenges shows the importance of China in the strategies of so many companies. This is not just about getting close to consumers, but also about access to the leading innovative technologies and products of Chinese companies. “Those who are not operating in China run the risk of falling behind.”[435]

According to the report, 62% of respondents regard China as the current and future top three investment destination, and 56% of respondents consider expanding their business in China in 2019.[436] This proves that even when the United States imposes tariffs on Chinese products, the enthusiasm of European investors to invest in China is still unabated.

A number of European companies have also found business opportunities in the

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[433]China Chamber of Commerce to the EU, Roland Berger. (2019), “Report on the Development of Chinese Enterprises in the EU”

[434] European Union Chamber of Commerce in China. (2019). “European Business in China: Business Confidence Survey 2019”

[435]China Daily. (2019). “European investors still favor China” <https://www.chinadaily.com.cn/a/201905/21/WS5ce33660a3104842260bcc08.html> last visited on 1, 2021

[436] European Union Chamber of Commerce in China. (2019). “European Business in China: Business Confidence Survey 2019”

"Made in China 2025". In industries covered by "Made in China 2025", the participation of European companies has increased significantly, with the proportion of companies able to participate in the initiative rising from 42% in 2018 to 53% in 2019.[437]

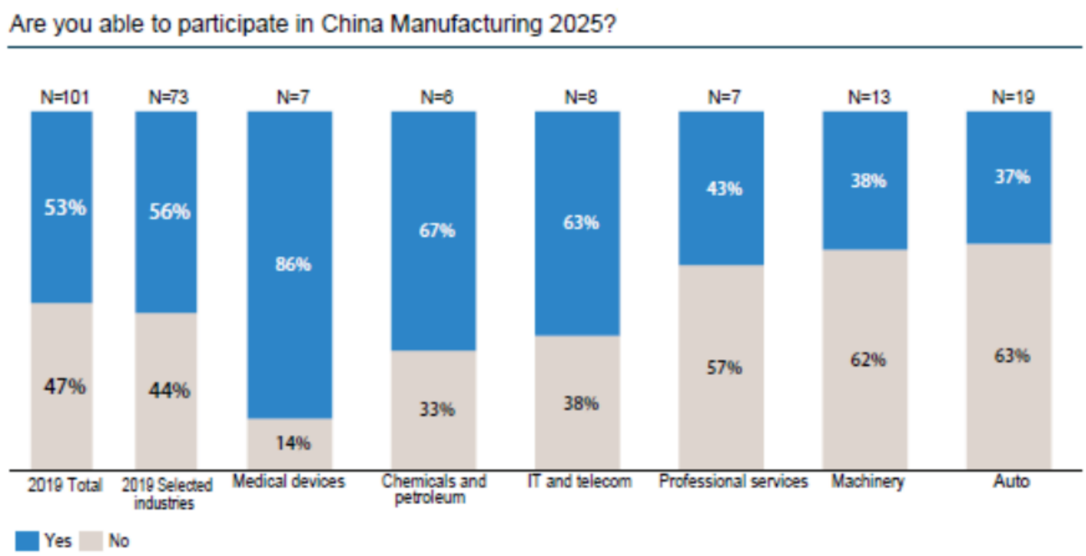

Figure 9.9 "Made in China 2025" Sees European Participation Rise in Industries Covered by the Initiative[438]

Denis Depoux also showed his opinion about the trade war between US and China. He believes that the Sino-US trade conflict is not good for European companies. "When I talked with some European companies, they thought that these trade conflicts would only accelerate the adoption of a more independent stance by the Chinese government and companies……The best solution is not retaliation, but a multilateral dialogue at the negotiating table."[439]

[437] European Union Chamber of Commerce in China. (2019). "European Business in China: Business Confidence Survey 2019"
[438] European Union Chamber of Commerce in China. (2019). "European Business in China: Business Confidence Survey 2019"
[439] Jiang, W. (2018). "The EU is committed to resolving economic and trade disputes through rational dialogue" *Beijing: Caijing Magazine* 江玮：欧盟坚持通过理性对话解决经贸纠纷

The European Union Chamber of Commerce in China hopes that market access and other issues they are concerned about can be resolved through negotiations on the EU-China Comprehensive Agreement on Investment (CAI). Negotiations on the CAI were launched in 2014, the main topics of the negotiations include pre-establishment national treatment, negative list management, neutrality of state-owned enterprises in competition, and opening of high-end service industries.[440]

Mats Harborn, the President of the European Union Chamber of Commerce in China said that they hope the negotiations of CAI can be finished this year. The negotiations were a complicated process, and the exchange of market access bids would be the key. Although the two sides have not yet exchanged negative lists, he hoped that the final negative list could be as short as possible, preferably in single digits. "57% of the companies surveyed said that if China has a more open market, they will increase their investment in China".[441]

Philippe Le Corre and Alain Sepulchre, the authors of "China's Offensive in Europe", mentioned in their book that China's overseas investment has expanded rapidly. Among them, the proportion of China's direct investment in Europe has increased significantly. The wave of Chinese overseas investment has brought some challenges to European companies and policy makers. In the face of deep-pocketed Chinese companies, multinational companies might accelerate the pace of

[440]European Community & Government of the People's Republic of China. (2021). "EU-China Comprehensive Agreement on Investment (CAI): list of sections, Agreement in principle" <https://trade.ec.europa.eu/doclib/press/index.cfm?id=2237> last visited on 1, 2021

[441]Jiang, W. (2018). "The EU is committed to resolving economic and trade disputes through rational dialogue" *Beijing: Caijing Magazine* 江玮：欧盟坚持通过理性对话解决经贸纠纷

acquisitions to ensure the dominant position of the market, and set off a corporate merger war. In terms of policy, it involves mutual benefit between China and the EU. Chinese companies have few restrictions and can freely acquire companies in various industries in Europe, while foreign companies, on the contrary, are not allowed to invest or hold shares in the Chinese traditional industry, such as banking, insurance, telecommunications, media, logistics, construction and medical insurance. The currently negotiated EU-China Comprehensive Agreement on Investment may be a possible solution.[442] On May, 2016, the European Parliament passed a non-legally binding but tough resolution requiring the European Commission to refuse to recognize China's market economy status in the World Trade Organization.[443] About China's market economy status, Philippe Le Corre and Alain Sepulchre argue that the EU needs to work out an intermediate route that can both recognize China's market economy status and protect Europe's major industries. Before that, the long and complex relationship between EU and China was about to begin.

In 2017, the leaders of China and the EU reached consensus during the 19th meeting, the ongoing EU-China Comprehensive Agreement on Investment was the primary task and should be given top priority, they would accelerate the negotiations in a spirit of cooperation and pragmatism, and strive to reach an ambitious and balanced outcome as soon as possible, in order to provide a friendly, predictable and business-friendly policy environment for investors on both sides. During the 20th meeting of leaders of the two sides in 2018, they officially exchanged their list bids,

[442]Le Corre, P., & Sepulchre, A. (2016). *China's offensive in Europe*. Brookings Institution Press
[443]European Parliament. (2016). "European Parliament resolution of 12 May 2016 on China's market economy status (2016/2667(RSP))"
<https://www.europarl.europa.eu/doceo/document/TA-8-2016-0223_EN.html> last visited on 1, 2021

marking a new stage in the negotiation of CAI.[444]

The 28th round of the CAI negotiations was finished on 24 April 2020 by videoconference. Detailed discussions continued on the revised offers, including on specific sectors of interest. Negotiations continued on the disciplines related to investment liberalization and level playing field, with a focus on state owned enterprises. Discussions advanced on sustainable development, notably on Corporate Social Responsibility and on the mechanism for addressing the differences. Decisive progress was made in the chapter on State-to-State Dispute Settlement.[445]

Both the China and the EU held a positive attitude towards the EU-China Comprehensive Agreement on Investment. Zhong Shan, the international trade negotiator and vice Chinese Minister of the Ministry of Commerce pointed out that the potential for bilateral investment between China and the EU is huge and has become a new highlight in China-EU economic and trade cooperation. The launch of negotiations on CAI is a major strategic decision made by leaders of both China and the EU and has become one of the most important issues in bilateral economic and trade relations.[446]

Nicolas Chapuis, the EU's ambassador to China, talked about CAI at a press

[444]Cao H. (2019). "Major challenges and responses in the negotiation of EU-China Agreement on Investment". *The Chinese Market*, p. 34. 曹鸿宇:""中欧双边投资协定谈判的主要挑战及应对"

[445]European Commission. (2020). "Report of the 28th round of negotiations on the EU-China Comprehensive Agreement on Investment". European Commission Directorate-General for Trade, Brussels

[446]Information Office of Ministry of Commerce of China. (2015). "International trade negotiator and vice foreign Minister of the Ministry of Commerce Zhong Shan attended and delivered a speech at the fifth China-EU high-level economic and trade dialogue" 商务部国际贸易谈判代表兼副部长钟山出席第五次中欧经贸高层对话并发言 <http://www.mofcom.gov.cn/article/ae/ai/201509/20150901124771.shtml> last visited on 1, 2021

conference in Beijing in January, 2020. He believed that the successful negotiation of CAI was on the top of the EU's wish list for this year. The current progress of agreement negotiation work has been accelerated and is at a critical stage. He said he was confident about the EU's prospects for concluding negotiations on CAI between China and the EU within this year for three reasons: first, in terms of a timetable, the two sides a on the right track in an orderly manner. The frequency of negotiations has accelerated, and the vast majority of important areas and elements have been fully covered. New progress can be seen every month; second, the leaders of both China and the EU have publicly expressed their willingness to complete the negotiations of CAI within this year; third, EU and Chinese companies showed their strong needs of this agreement; Last but not least, the Chinese government announced that they would take further market opening measures from 2013, last year it introduced a number of related policies, such as policies supporting the further opening of the financial services industry, investment protection, and protection of intellectual property rights, which were in line with the objectives of the CAI negotiations over the past seven years.[447]

[447]YICAI. (2020). "EU ambassador to China: we are confident that the EU-China investment agreement negotiations will be concluded within this year" 第一财经：欧盟驻华大使：对今年内完成中欧投资协定谈判有信心
<https://www.yicai.com/news/100473291.html> last visited on 1, 2021

9.5 Chapter Conclusion

Nowadays, China is the world's largest manufacturing country. The manufacturing industry has created many jobs and played an important role in promoting economic growth and raising people's income level. However, China realizes that its manufacturing industry faces many problems and needs to be transformed. "Made in China 2025" puts forward a detailed development strategy for the transformation and upgrading of China's manufacturing industry, which is also one of the national strategies vigorously promoted by the state. The implementation of "made in China 2025" is conducive to the development of the traditional manufacturing industry in the direction of intelligence and the transformation and upgrading of the economic structure. It will be a big booster to promote the development of China's economy in the future.

The response of the United States to "Made in China 2025" is very fierce. The United States is worried that in the field of high-tech industry and advanced manufacturing, China will form mature technological capabilities and advanced manufacturing capabilities, which will lead to direct competition with the US and threaten its leading advantage. Therefore, the US initiated a trade dispute with the China.

The European Union shares a similar concern with the United States. To some extent, the EU believes that "Made in China 2025" will pose a threat to Europe. But it does not agree with the US's choice of raising tariffs and the stick of the trade war. The attitude of the EU is that these fundamental structural problems could be resolved through the multilateral mechanism and dialogue of the WTO, which is the right way to move forward.

At present, as a whole, Chinese enterprises are doing well in Europe. More and more Chinese companies set up R&D centers and manufacturing plants in the EU. The investment from Chinese and the cooperation with China enterprises not only promoted employment growth and people's livelihood development in the EU, but also promoted the upgrading of the European industrial chain in all directions. However, factors such as stricter EU foreign investment review, increased restrictions on specific areas such as technology and energy and state-owned enterprises, and the lack of communication between companies and local governments have brought challenges and restrictions to the development of Chinese enterprises in Europe, and have caused concerns among Chinese enterprises.

European companies in China have great confidence in the Chinese market, and more and more European companies are participating in the industries covered by "Made in China 2025", but they believe that the discrimination against foreign companies still exists in China. They hope that market access, administrative examination and approval, and communication with the government and other issues they are concerned about can be resolved through negotiations on the EU-China Comprehensive Agreement on Investment (CAI).

Both China and the EU are sincere about future cooperation. The two sides have stepped up the frequency of meetings. The negotiation on CAI is at a critical stage, and it is hoped that a bilateral agreement can be reached this year.

The member states of the EU have always adhered to the principles of market economy, advocated trade and investment liberalization and facilitation, and supported multilateralism and free trade. Under the current circumstances, in the spirit of mutual respect and mutual benefit, China and the EU could maintain openness and continue to expand cooperation, which not only serves the interests of both sides, but also helps provide more positive energy and stability to the world.

Chapter10 Conclusion

In 2003, China and the EU sit together again, work on whether they can find common ground or not, they agree on a basic text: EU-China comprehensive strategic partnership, once they have done that, there is an institutionalization of cooperation. On the basis of that, there are various forms of S&T cooperation, individual projects. This dissertation analyzed three projects, one of the findings is: there is no casual relationship, the institutionalization is no prediction to the success of S&T cooperation that emerged on this particular platform, there are lots of intervening variables that also come into play.

10.1 Analysis of the Cost-benefit Calculation of Sino-EU S&T Cooperation

In order to understand the cost-benefit calculation of Sino-EU S&T cooperation, it is important to understand the different driving factors that push towards cooperation or against it. This data is presented in Tables 10.1 and 10.2, in the page 300 and page 305. These tables show the cost-benefit calculation of the interest of the EU and the interest of China based on in-depth qualitative interview with officers, scientist, scholars of EU and China conducted during the research phase of this dissertation.

In the table 10.1, opinions from EU Officers, German officers, EU Scientists (Natural Scientists who involved in the cooperation project with China) and EU scholars (Social scientists who studied on the field of Sino-EU S&T cooperation and Sino-EU relations) are included regarding the cost-benefit calculation of the interest of the EU in the Sino-EU S&T cooperation.

All those interviewed have a common view that China has no loss, or almost no loss when it cooperates with EU in the field of S&T. But in the other aspects of cost-benefit calculation, there are a lot of differences.

The EU officers held the most positive attitude towards China, they believe that the China's and the EU's respective are symmetric; and from the cooperation, the EU can gain access to the huge Chinese market, experience, technology and idea. At the same time, China can get knowledge, technology, experience, research resources and talent training from the EU. The EU officers interviewed were satisfied with the way China has engaged in this cooperation and show strong willing to cooperation with China in the future S&T cooperation. RositsaPetrova said that: "cooperate with China allows the EU to understand the Chinese market better……allows European countries to adapt their products to the market."[448]Diego Sammaritano mentioned that: "So, through the cooperation, The EU can improve the access to the Chinese market for European companies…… it's an objective which is one of the interest of the EU……very satisfied, I think we have reached a very excellent dialogue and understanding and cooperation with each other."[449]

The German officers interviewed presented the most negative attitude towards China, they believe that the China's and the EU's respective are asymmetric; and

[448]Record 1: Interview with RositsaPetrova; Policy Officer; Delegation of the European Union
[449]Record 3: Interview with Diego Sammaritano; Policy Officer; European commission DGs R&I

as a result of the cooperation, the EU can gain the access to the Chinese market, and China can gain technology and knowledge. However, they think the loss is greater: technologies are flowing from the EU to China, and as core technologies are losing in the joint venture with China, and there is a risk of losing IPR. They are dissatisfied with the way China has engaged in this cooperation and show skepticism in the future Sino-EU S&T cooperation. Ferdinard Schaff said that: "there is a flow of technology from EU's business to China's business……about the joint venture, in China, a company fear that there's some kind of implicit pressure to give up their core technologies, there's a problem and that is something many companies are afraid of when they're doing research and development in China." [450]Hanna Müler mentioned that: "when European companies go to China, the risk of losing IPR is quite high……we are very concerned about the Cyber Security law (which issued and implemented in China in 2016) at the moment, because this is something which could harm the cooperation, it could harm IPR from European companies, this is something we think we might lose."[451]Notably, this dissertation chose to interview German officers, because Germany is the largest economy in the EU, and Germany's attitude has a big impact on the EU's policy decision making. Due to the limited research funding and time, it was not possible to interview all the other member states' officers of the EU side.

Most of the scientists interviewed hold a positive attitude towards China; they believe that the China's and the EU's respective goals are symmetric and from the cooperation, EU can gain the access to the Chinese market, knowledge, idea, collaboration network and talents, while at the same time, China gain get

[450]Record 4: Interview with FerdinardSchaff: BDI(skype business)
[451]Record 6: Interview with Hanna Müler; BDI chief representative Beijing

knowledge, idea, technology, experience, collaboration network, and talent training from the EU. It is for mutual benefit and complementary cooperation. The scientists interviewed are satisfied with the way China has engaged in this cooperation and showed willing to cooperation with China in the future S&T cooperation. Massimo Meneti shared that:

> [...] if you have an idea for a measurement, and you can try it out and apply on a larger area for a longer period of time through cooperation with China......in China there are so many people now involved in the field of earth observation. That is much easier to do large projects......there are several example of systems of permanent observatories in China, that do not exist in Europe. I've seen one system in the Tibetan Plateau Himalayas, that is something unique, and many European colleagues attracted by that. So, to do a project in China, you have the opportunity to do field experiment that you will not be able to do in Europe.[452]

However, a few scientists hold the opposite attitude. They believe that the China's and the EU's respective are asymmetric, and the EU gains are less and losses are greater. They believe that they are losing their ground in the number of publications and the weight in research. They are not satisfied with the way China has engaged in the cooperation, and believe that the Chinese side should make more improvements in the S&T cooperation with the EU. Bernat Martinez Val said that: "We are going to lose room in the number of publications that, because China they are having more and more researchers with more and more citations and you are accumulating more and more knowledge. So comparatively we are going to

[452]Record 23: Interview with Massimo Meneti; scientist, Dragon

decrease our weight in the research. That's clear."[453]

The EU scholars interviewed fall into two camps, half of them believe that the China's and the EU's respective are symmetric, and they are satisfied with the way China has engaged in this cooperation. From the cooperation, EU can get experience, data, and information from China, at the same time, China can gain the access to European market, knowledge, technology, and research system. Elena Sachez said that: "we learn from each other, exchange experiences and information……after this earthquake in China, we started to share data to improve the situation with regard to natural disaster or risk management……we have make joint publications together."[454] The other camp believes that the China's and the EU's respective are asymmetric, or on the way to being symmetric. They believe that China has an unfair advantage to the EU; and that the EU is losing its competitiveness in the field of S&T and facing the risk of losing IPR. They dissatisfied with the way China has engaged in this cooperation. Reinhilde Veagelers mentioned that: "we didn't really benefit enough……we will lose a bit of competitiveness if we don't adjust."[455]

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[453]Record 21, Interview with Bernat Martinez Val; scientist, Dragon
[454]Record 14, Interview with Elena Sachez; JRC
[455]Record 13: Interview with ReinhildeVeagelers; KU LEUVEN and BRUEGEL

	EU's gain	EU's loss	China's gain	China's loss	Symmetric or Asymmetric	Satisfied or Dissatisfied	Other influential factors
EU Officers	Market, experience, technology, idea	Advantage in S&T,	Knowledge, technology, experience, research resources, talent training	No loss	Symmetric	Satisfied	Agreement, development of international S&T, the level of S&T development of both sides, mutual trust, policy dialogue, administration
German Officers	Market	Flow of technology, core technology in a joint venture in China, the risk of losing IPR	Technology, knowledge	No loss	Asymmetric	Dissatisfied	Chinese government, people, language
EU	Knowledge,	Room in the	Knowledge,	No loss	Majority of	Majority of	IPR issue,

Scientists	idea, collaboration network, market, talents	number of publications, the weight in research	idea, technology, experience, collaboration network, talent training		people interviewed symmetric; small majority asymmetric; small majority from asymmetric to the way of symmetric	people interviewed satisfied; small majority dissatisfied	government. administration, language, mutual understanding, funding
EU Scholars	Experience, china's data, information	Competitiveness in S&T, the risk of losing IPR	Knowledge, European market, technology, research system	No loss, expect for some unique Chinese data	Majority of people interviewed symmetric; small majority asymmetric; small majority from asymmetric to the	Half of people interviewed satisfied; another half dissatisfied	Mutual trust, mutual understanding, culture, history, influence from the member states of the EU, globalization of S&T, politics, administration

					way of symmetric		

Table 10.1 Cost-benefit Calculation of the Interest of the EU

In contrast to the first table, Table 10.2 presents the opinions from the Chinese Officers, Chinese Scientists (Natural Scientists who involved in the cooperation project with the EU) and Chinese scholars (Social scientists who studied on the field of Sino-EU S&T cooperation and Sino-EU relations) regarding the cost-benefit calculation of the interest of the China in the Sino-EU S&T cooperation.

The interviews from the Chinese side present more optimistic views about this cooperation: officers, scientists and scholars have a common view that the EU has no loss when cooperating with China in the field of S&T. But in the other aspects of cost-benefit calculation, there are some differences.

The Chinese officers hold the most positive attitude towards the EU, they believe that the China's and the EU's respective are symmetric, from the cooperation, China can acquire the experience, technology and idea from the EU; while at the same time, the EU can gain the access to Chinese market, the expansion of international S&T influence, and intellectual resources. To them, China has almost no loss except for some outflow of talent. They are satisfied with the way the EU has engaged in this cooperation and show strong willingness to cooperation with the EU in the future S&T cooperation. Dong Keqing said that:

> […] The prospects for China's cooperation with the EU in the field of S&T are very good. The Sino-EU S&T cooperation is relatively pragmatic, and almost all areas of the EU are open to China. In the cooperation, we have learned a lot from Europe, not only a lot of technology, but also their management experience, the operation mode of the institutions and so on. Now, in many areas, we can reach their height and cooperate on the same platform. The disadvantage is that when we collaborate we lose some of our intellectual

resources."[456]

In addition, Gao Zhihai mentioned that:

> […] Through cooperation with Europe, we have learned from some of the top European scientists, and the technical level has been greatly improved. For example, in the field of Synthetic Aperture Radar (SAR), before cooperation, very few people in China can do the quality and quantity research. The relevant scientists could not even write a better report. After the cooperation with the Europe in Dragon program, more people are engaged in radar research and the research level has been greatly improved. We could work with European scientists and publish the joint research result in the top journals……The EU sees the potential of the Chinese market and wants its data to gain a foothold in the Chinese market. In addition, Sino-EU S&T cooperation is also conducive to Europe to expand its international scientific and technological influence.[457]

The Chinese scientists interviewed also held a positive attitude towards the EU, most of them believe that the China's and the EU's respective are symmetric, from the cooperation, China can gain knowledge, technology, scientific management concept, S&T idea and communication skill, while at the same time, EU can get knowledge, data, complementary research opportunities from China, and gain the promotion of its soft power. They are satisfied with the way EU has engaged in this cooperation and showed willing to cooperation with the EU in the future S&T cooperation. Feng Gao said that: "We have an equal cooperative relationship with the European research team and learn from each other's knowledge and technology……Now there is a lot of domestic research funding…… The benefits gained by

[456]Record 31, Interview with Dong Keqing; Ministry of Science and Technology, High Technology Research and Development Center, Director of the Europe Office

[457]Record 24, Interview with Gao Zhihai, officer; Dragon program

both parties are symmetrical, and no one loses."[458] There are also some scientists who believe that the China's and the EU's respective cost-benefit analyses are asymmetric and that in the past, China learned more from the cooperation, but now it is more and more symmetric, because China is developing its technology and can work with the EU partner at the same level. Liu Yi said that: "For example, the Dragon Program, the first phase and the second phase, The Europeans provide us with satellite data, basically we were leaning from them. Things changed in the third phase and the fourth phase, we launch the Chinese CARBON dioxide satellite, which is not available in Europe, we provide them data, and we work together and learn from each other."[459] A few scientists hold the opposite attitude, they believe that the China's and the EU's respective are asymmetric, and that China made a lot of effort but has not received equal returns. Liu Huan complained that: "In the cooperation, we have less right to speak, and the systems of both sides are not coordinated……We always follow them, do research on topics they are interested in, but we are not, so as to make contributions to them."[460]

Most of the Chinese scholars interviewed hold a positive attitude towards the EU; they believe that the China's and the EU's respective are symmetric, or from asymmetric to symmetric (China used to gain more), and they are satisfied with the way EU has engaged in this cooperation. From the cooperation, in their view China can get technology, scientific management concept and funding from the EU, and improve its research ability, at the same time, the EU can gain the access to Chinese market, talents can flow from China to Europe, and the EU could expand its international influence. They are satisfied with the way EU has engaged in this cooperation. Wan Jingbo said that: "In the past, due to the lack of scientific research strength and insufficient funds, we traded the market for technology; now, with the

[458]Record 29: Interview with Gao Feng, Scientist, professor at Linköping University
[459]Record 26 Interview with Liu Yi, Scientist, Institute of Atmospheric Physics, Chinese Academy of Sciences
[460]Record 34 Interview with Liu Huan, Scientist, professor at Tsinghua University

growth of China's national strength and the growth of scientific and technological strength, we have undertaken more in cooperation…..Both sides are learning from each other, it is an equal, mutual benefit, and win-win cooperation." [461] Some scientists are worried about the talent flowing during cooperation and the loss of market; they are not satisfied with that. Liu Li said that: "The brain drain is a big problem, which will affect our future competition ability in international S&T……With advanced technology, the EU occupied our market, when our technology grows, the market has already been occupied."[462]

[461]Record 28 Interview with Wan Jingbo, Scholar, Institute of Science and Technology, Chinese Academy of Sciences
[462]Record 32 Interview with Liu Li, Scholar, Tsinghua University

	China's gain	China's loss	EU's gain	EU's loss	Symmetric or Asymmetric	Satisfied or Dissatisfied	Other influential factors
Chinese Officers	Experiences, technology, knowledge	Almost no loss, expect for some outflow of talent	Chinese market, expansion of international S&T influence, intellectual resources	No loss	Symmetric	Satisfied	Government, policy, American influence, political relations between china and the EU
Chinese Scientists	Knowledge, technology, scientific management concept, S&T idea, communication skill	No loss	Knowledge, the unique research data from China, complementary research opportunities, the promotion of the soft power	No loss	majority of people interviewed symmetric; small majority asymmetric; small majority from asymmetric to	majority of people interviewed satisfied; small majority % dissatisfied	Administrative procedure, the harmonization of the two regimes, personal relationship

					symmetric		
Chinese Scholars	Technology, experiences, scientific management concept, research ability, funding	Market, talent	Market, talent, expand international influence,	No loss	More than half of people interviewed symmetric; less than half from asymmetric to symmetric	majority of people interviewed satisfied; small majority % dissatisfied	Government, international S&T competition, culture, history, American influence, project rules and regulations

Table 10.2 Cost-benefit Calculation of the Interest of China

10.2 Analysis of the Degree, Intensity and Effectiveness of Institutionalization of Three Cases in Different Stages

Three cases were analyzed in this dissertation: the Galileo Project, the EC2 Project, and the Dragon Program. Table 10.4 shows the degree, intensity and effectiveness of institutionalization of three cases in different stages.

a) Case1 Galileo Project

In the honeymoon period of Galileo project:

The level of degree was high. China and the EU signed an official agreement in 2003 which clearly defined the two sides' specific rights and obligations. China had 20% ownership and 100% usage rights, and could send teams to participate in the management of this project. China established a company to coordinate the relevant domestic institutions and companies. The project attached great attention from the two sides and it is very well structured. The level of intensity was medium. This project involved some partners, including research institutes and companies, the two sides signed 11 contracts in the field of the application of GNSS. The level of effectiveness in this period was high. The satellite launched by Galileo in the first phase was equipped with a laser reflector made by the Chinese research team. And China's investment greatly eased the financial situation of the Galileo project. The formulated objectives in this period were fully achieved, and both sides were satisfied with the cooperation during the honeymoon period.

In this period, the institutionalization of the first S&T cooperation case was relatively successful on the level of degree and effectiveness, because they have mutual interest and strong willingness to cooperate. The EU wanted to develop its own GNSS system gain a share in the civilian use market, it needed to get funding from China. And in China, its own Beidou-1 system was still in the experimental stage; its commercial value was not high. China chose to cooperate with Europe at that time and temporarily shelved its Beidou plan. Comparing with the huge cost in Beidou system, to invest in Galileo and get the 100% usage rights is more attractive for China.

In the dormant period of Galileo project:

In 2008, the EU decided to build Galileo as a complete EU program, China was completely excluded from the decision-making process. The two sides almost stopped contact with each other. In the dormant period of Galileo project, the institutionalization of the first S&T cooperation case was a failure on the level of degree, intensity and effectiveness. In this period, the EU changed its national strategy, they want a 100% EU GNSS, and China stopped the following invest in Galileo, concentrated on its Beidou system, they competed for the frequency bands of satellite launches; there is almost no cooperation in this period.

In the new stage:

China and the EU still cooperate in Galileo project, but to a lower degree, intensity and effectiveness compared with their honeymoon period. The degree of cooperation is medium, the two sides held several conferences on the joint use of Beidou and Galileo, they started to cooperation in frequency sharing. The officers who responsible for the concrete work of Galileo in the EU and China, Pieter De Smet and Zhang Chi, they are expert in this field and have very good personal relations. The level of intensity is low, there are now very few participants works in the cooperation. The level of effectiveness is medium, because in this new stage, the objectives are the achieving the joint use of Beidou and Galileo and sharing the frequency. The two sides already have already reached a consensus on that, they are satisfied and looking forward to better future cooperation.

b) Case 2 EC2 project

In the first phase:

The degree of cooperation was medium. A formal agreement was signed by the leaders of China and the EU with both sides attaching great importance to this project. They set a regulatory office in Tsinghua University. A European director and a Chinese director were jointly responsible for the project. However, they still lacked qualified person for the realization of the project, and they could not create an effective link among the participants. The level of intensity was low, there are 9 universities and research institutes involved in the project, and they are less diverse, mainly focusing on policy research. The level of effectiveness was low; none of the initial objectives were achieved.

In the second phase:

The level of degree was high. The second phase shift to practical level, the two sides changed directors and recruited official managers, tried their best to create link for the participants. The level of intense is medium, Chinese local government was involved and provided help for the application of EU experience, they also increased cooperation projects. The degree of effectiveness was medium, there are three key results during the second phase, partly achieved the initial objectives. The officers are satisfied, but the scientists are not satisfied with the EC2 cooperation.

It is a learning process in the second case, compared with the first phase, the second phase improved on the level of degree, intensity and effectiveness, the institutionalization is relatively successful on the level of degree. Although it is still not on a perfect level, this is at least, partially getting better, and they seem to have learned how to better handle the cooperation.

c) Dragon Program

In the first phase

The degree of cooperation was low. The structure of the first phase cooperation was relatively loose. There was no formal agreement on the Dragon Program. It relied on the good personal relationship between director of ESA and the minister of MOST. The level of intensity was medium, it started at a relatively small scale, involved about 20 pairs of partners, and it was very narrow and specific on certain areas. The level of effectiveness was high, they fully achieved the initial objectives, and both sides are very satisfied. The EU sides provided satellite data and expect the return in the next phase. The China side learned technology and improved their research ability.

In the second, third, and fourth phases:

The degree of collaboration was medium. A European director and a Chinese director were jointly responsible for the project. They create a good connection network for the participants. The level of intensity was high, the scale is larger and larger, it involved about 50 pairs of partners, and it focus on various aspects in the field of earth observation. The level of effectiveness was high, they fully achieved the initial objectives, and both sides are very satisfied. Both sides provide data for cooperation, China is a more advanced partner, could cooperate with the European researchers at the same level, put equal effort and publish result on top journals together.

The Dragon program, as well as Galileo project, was also started in the new context of the 2003 China-EU post –strategic partnership signature. However, the degree of government's attention and the level of capital investment to this project was much less than Galileo project. It started with a low degree of collaboration, not well structured. From the second phase, more participants joined this program, it was better organized, the level of degree increased from low to medium. In each phase, the levels of effectiveness are high, most of the participants got their need in the program and had the willing to continue. Generally speaking, the institutionalization of case three was very successful on the level of intensity and effectiveness.

		Achievement of Objectives (Yes/No/Partly)	Respective Benefits Symmetric or Asymmetric	Satisfied or Dissatisfied	Willingness to Continue (Yes/No)
Case 1 Galileo project	The honeymoon period(2003 – 2007)				
	Officer	Yes	Symmetric	Satisfied	Yes
	Scientist	N/A[463]	N/A	N/A	N/A
	The dormant period(2007 – 2015)				
	Officer	Partly	Symmetric	Satisfied	Yes
	Scientist	N/A	N/A	N/A	N/A
	The new stage(2015 – present)				
	Officer	Partly	Symmetric	Satisfied	Yes
	Scientist	N/A	N/A	N/A	N/A
Case 2 EC2 project	The first phase(2010 – 2012)				
	Officer	No	Asymmetric	Dissatisfied	Yes
	Scientist	No	Asymmetric	Dissatisfied	No
	The second phase(2013 – 2015)				
	Officer	Yes	Symmetric	Satisfied	Yes
	Scientist	Partly	Asymmetric	Dissatisfied	No
Case 3 Dragon project	The first phase(2004 – 2008)				
	Officer	Yes	Asymmetric	Satisfied	Yes
	Scientist	Yes	Asymmetric	Satisfied	Yes

[463] I tried to contact a lot of Galileo scientists, None of them accepted the interview

The second phase(2008 – 2012)				
Officer	Yes	Asymmetric	Satisfied	Yes
Scientist	Yes	Asymmetric	Satisfied	Yes
The third phase(2012 – 2016)				
Officer	Yes	Symmetric	Satisfied	Yes
Scientist	Yes	Symmetric	Satisfied	Yes
The fourth phase(2016 – 2020)				
Officer	Yes	Symmetric	Satisfied	Yes
Scientist	Yes	Symmetric	Satisfied	Yes

Table 10.3 Analysis of the 3 Cases on the Achievement of Objectives, Respective Benefits, Satisfied Degree and Willingness to Continue

		Degree	Intensity	Effectiveness
Case 1 Galileo project	The honeymoon period (2003 – 2007)	High	Medium	High
	The dormant period (2007 – 2015)	Low	Low	Low
	The new stage (2015 – present)	Medium	Low	Medium
Case 2 EC2 project	The first phase (2010 – 2012)	Medium	Medium	Low
	The second phase (2013 – 2015)	High	High	Medium
Case 3 Dragon project	The first phase (2004 – 2008)	Low	Medium	High
	The second phase (2008 – 2012)	Medium	High	High
	The third phase (2012 – 2016)	Medium	High	High
	The fourth phase (2016 – 2020)	Medium	High	High

Table 10.4 The Degree, Intensity and Effectiveness of Institutionalism of 3 Cases in Different Stages

After analyzing the three cases, we can assess the initial hypothesis: whether they are verified, or falsified, or need to be reformulated in a particular sense.

Hypothesis 1: The better structured the cooperation, the higher the level of effectiveness in cooperation. If the China-EU S&T cooperation is too loose, it may increase the difficulties for their cooperation. If both China and the EU are rational actors, they must pay attention to the structure of cooperation in order to create an effective communication link among the participants.

It is falsified. From the Galileo project and Dragon program, we can observe that the collaborative framework of the Galileo project is quite robust. However, the subsequent lever of effectiveness fell short of expectations. In contrast, the Dragon program features a relatively loose collaborative structure, lacking even a formal official contract as support. However, its lever of effectiveness has consistently remained high.

Hypothesis 2: The more comparable the efforts and risk sharing in the cooperation, the more effective cooperation will be. If China and EU work together with similar input — not necessarily the same, but they can share the financial, resource or other burdens equally — the two sides are shown to be equally committed, and it may influence the final result of the cooperation. When the two sides share the risk, their way of cost-benefit calculation will change.

It needs to be reformulated. In the second phase of the EC2 project, both parties endeavored to collaborate closely, sharing risks and responsibilities; however, despite their concerted efforts, they were unable to achieve success. The level of effectiveness is disappointing; it has taken a step forward but has not altered the ultimate outcome.

In the Dragon program, each party bears its own budget without attempting to share risks jointly. Instead, they individually assume risks and corresponding responsibilities. This approach results in a high level of effectiveness for the program. From these two cases, we can reformulate the hypothesis as follows: Clearly defining each party's responsibilities and obligations is more important than sharing them jointly. This new hypothesis also requires further validation with more cases in the future.

Hypothesis 3: Sensitivity of the area of cooperation: the less sensitive the area of cooperation, the more likely and easier the cooperation, and the more intense cooperation will be. If the area of cooperation is not that sensitive, there will be fewer conflicts and more contacts between China-EU S&T cooperation. Things related to intellectual property rights and military use always come along with many problems, including those of a political nature. For example, when Chinese company Huawei did its cooperation with the Belgian firm Option, there were many property disputes.[464] If the cooperation does not fall within those sensitive areas, the possibility to lose competitiveness and key technology will be reduced.

It is falsified. The Galileo project and the Dragon program, both operating in

[464]Kathrin, H. (2010). "Huawei and Option forge telecoms technology alliance". *Financial Times*, <https://www.ft.com/content/b64ffb80-e1ec-11df-a064-00144feabdc0> last visited on 1, 2021

sensitive areas within the same field, yielded entirely different outcomes. However, the EC2 project, which operates in a non-sensitive domain, encountered similar challenges in cooperation, and its lever of intensity of collaboration did not deepen as a result.

Hypothesis 4: The more symmetric the respective benefits in the cooperation are, the more intense and effective cooperation will be. If one side is always the provider, then the good will from that side will eventually fade. If both sides are satisfied with symmetric cooperation, the level of intensity and the level of effectiveness will be higher. If both China and the EU really depend on each other equally in one project, then the cooperation will go more smoothly. In order to achieve mutual benefits, with a fair distribution of labor, China and the EU will choose to cooperate with each other.

It is verified. From the three stages of the Galileo project, we can see that in the first stage, after conducting their respective cost-benefit calculations, both parties believed that the benefits of cooperation matched their respective budgetary commitments. During this period, both the lever of intensity and the lever of effectiveness were relatively high. In the next stage, however, this calculation shifted. The EU considered that continuing the same level of deep cooperation as before did not align their interests with the effort expended. Consequently, both the lever of intensity and the lever of effectiveness decreased.

10.3 Historical Institutionalism and Other Influential Variables

Not only the respective cost-benefit calculations of the interest of China or the EU should be taken into consideration regarding influence on the degree, intensity and effectiveness of institutionalization of their S&T cooperation. The cost-benefit explanations are insufficient for the institutionalization of Sino-EU S&T cooperation, apart from rational choice arguments, other independent variables should also be taken into account:

10.3.1 Historical Institutionalism

There were many important historical events in the Sino-EU S&T cooperation saga. Deng Xiaoping's reform and opening-up policy in 1979 was the precondition for it all. Without that policy, there would be no Sino-EU S&T cooperation.

The framework agreement between China and the EU in 1998 allowed China to participate in the EU's framework programmes. From then on, China was entitled to participate in the succeeding framework programmes. EU replaced FP7 with Horizon 2020 in 2014; one of its aims was to encourage China to share a more equal burden in the S&T cooperation with the EU. It encouraged a double leadership of the program and allowed the level of symmetric; this change will influence the level of degree of institutionalism.

The “Made in China 2025” which issued by China in 2015, is a historical juncture from the point of view many scholars in Europe, because it alters the cost-benefit calculation of the Europeans. With China is surpassing Europe on the technological level, it will bring a new asymmetric aspect to the relationship. However, form the 3 cases; the impact from “Made in China 2025” could not be found.

After the Trump election in 2016, relations between China and the United States have taken a nosedive; their initial trade dispute has developed into a bilateral all-round confrontation. Karl Kaiser, a researcher at Harvard University, mentioned that: “The Trump Administration rejects the multilaterally implemented principle of free trade, instead of that, they ask for a return to bilateral deals, mercantilism, barter trade and protectionism. The US imposed tariffs on steel and aluminum imports and is further undermining the core of the trading order, the WTO, by bringing the dispute mechanism essential to its functioning to a halt.”[465] In the spring of 2018, The Trump administration of the United States imposed tariffs on 60 billion dollar of goods imported from China, and China also took corresponding countermeasures, it was the beginning of trade war between China and the US.

The new cold war between China and US and the Trump administration’s actions is creating an historical context which brings a deeper cooperation EU-China. First, China’s demand for imports from Europe has increased because of the trade conflict between China and the United States. Guntram Wolff, the Director of Bruegel mentioned that:“ European agriculture exports to China increase, as they replace

[465]Karl, K. (2018). “Present at the Destruction”. *The Economist*, June 7, 2018

products once sourced from the US."[466]

Second, EU's demand for experts to China has also increased, last year, the United States imposed punitive tariffs of up to 25% on EU goods which worth 7.5 billion US dollars, including German and French wine, Italian Parmesan cheese and Spanish olive oil. In August of this year, jam from Germany and France entered the restricted list.[467] The Chinese market is therefore very attractive for the EU, Phil Hogan, European Commissioner for Agriculture Phil Hogan revealed that, in the future, EU agricultural cooperation with China will focus on the export of high-quality products, e-commerce and investment cooperation.[468] Wang Yi, Chinese State Councilor and Minister of Foreign Affairs visited Italy, the Netherlands, Norway, France and Germany from this summer, deepening agricultural cooperation has been mentioned many times. China-EU cooperation in the field of agricultural technology has been further developed.[469] For example, Yili Group, a Chinese dairy giant, and Wageningen University in the Netherlands upgraded the R&D center to promote the company's product R&D for Chinese and European markets.[470]

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[466]Guntram B. W. (2018). "How could Europe benefit from the US-China trade war?"
< https://www.bruegel.org/2018/10/how-europe-can-benefit-from-the-trade-war/> last visited on 1, 2021

[467]France 24. (2019). "US imposes record $7.5 billion tariffs on EU goods, targeting wine and Airbus"
<https://www.france24.com/en/20191018-us-imposes-record-7-5-billion-tariffs-on-eu-goods-targeting-wine-and-airbus-1> last visited on 1, 2021

[468]Mission of the People's Republic of China to the European Union. (2019). "Mission of the People's Republic of China to the European Union: Ambassador Zhang Ming meets with the European Commissioner for Trade Phil Hogan" 中国驻欧盟使团：张明大使会见新任欧盟委员会贸易委员菲尔·霍根
< http://www.chinamission.be/chn/dshd/t1722840.htm> last visited on 1, 2021

[469] SINA Finance. (2020). "Increased opportunities for Sino-EU agricultural cooperation: agricultural technology cooperation and food processing are key investment areas" 新浪财经：中欧农业合作机遇加大：农业技术合作、食品加工等为重点投资领域
<https://finance.sina.com.cn/world/gjcj/2020-09-02/doc-iivhvpwy4394125.shtml> last visited on 1, 2021

[470]Invest in Holland. (2018). "Asian Dairy Giant Yili Opens New Innovation Center in the Netherlands"
<https://investinholland.com/news/asian-dairy-giant-yili-opens-new-innovation-center-in-the-netherlands/> last visited on 1, 2021

Third, the EU wants China to open up its markets to more sectors. To some extent, the new cold war between China and US has accelerated China's opening up, this has promoted Sino-EU S&T cooperation. Zhang Ming, head of the Chinese mission to the European Union, said that China will continue to follow the direction of opening up.[471]

Fourth, the United States withdrew from the "Paris Agreement" at the same time as China and the EU are strengthening cooperation on climate and environment. This puts this issue in an important position for economic development, especially economic recovery after the epidemic. The economic stimulus package recently launched by the EU and some of its member states, as well as China's "new infrastructure" plan, will promote the green transformation of the economy.[472]

Fifth, more Chinese investment will move to the EU. The EU and China have nearly finalized the Comprehensive Agreement on Investment. Guntram Wolff, the Director of Bruegel mentioned that: "As China has found it more difficult to invest in the US, it has moved its investment efforts to Europe, especially in cutting edge technology……Chinese investment is welcome and can increase corporate profits, especially when access to Chinese markets is improved."[473]Presently, China and the EU actively negotiate on the bilateral investment agreement. Robert Basedow, a

[471]China News. (2020). "Head of the Chinese Mission to the European Union: Opening up is China's most powerful response to the "New Cold War" and other conspiracies" 中国新闻网：中国驻欧盟使团团长：扩大开放是中方对"新冷战"等图谋最有力回应
<http://www.chinanews.com/gn/2020/09-10/9287234.shtml> last visited on 1, 2021
[472]China Daily. (2020). "Global Green Transformation: The United States is busy 'withdrawing from the group' without a position, China and Europe join hands to 'carry the banner'" 中国日报：全球绿色转型：美国缺位忙"退群"，中欧携手"扛大旗"
<https://cn.chinadaily.com.cn/a/202008/14/WS5f36665fa310a859d09ddf15.html> last visited on 1, 2021
[473]Guntram B. W. (2018). "How could Europe benefit from the US-China trade war?"
< https://www.bruegel.org/2018/10/how-europe-can-benefit-from-the-trade-war/> last visited on 1, 2021

researcher at LSE, said that: “China may need the EU even more as an export market and partner for its technological development. The EU may thus find it easier to negotiate an ambitious investment agreement with China to ensure access of European firms to still protected sectors such as financial services, infrastructure or utilities.”[474]

Figure 10.1 shows the historical path of Sino-EU S&T cooperation: including the 1978/1979 China’s Reform and Opening up policy, which was the precondition for Sino-EU S&T cooperation. From then on, China and EU started their cooperation, including the field of S&T.

The first EU-China S&T cooperative framework agreement provided a fundamental change in the degree, intensity, effectiveness of cooperation. From then on, China was entitled to participate in EU’s framework programmes. The S&T cooperative projects between China and EU were better organized and structured, more institutions in China and EU could have a formal channel to join this cooperation, and the results must be reported annually. All the three cases occurred after 1998, and under the EU’s framework program. Galileo project and Dragon Program are from FP6, FP7 to present framework program; EC2 is involved in FP7. After the agreement, almost all the important official S&T cooperation between China and the EU are included in EU’s framework program.

The 2003 EU-China Comprehensive Strategic Partnership has a huge impact on

[474]Robert, B. (2019). “The US-China trade war: Risks and opportunities for the EU and the United Kingdom” <https://blogs.lse.ac.uk/europpblog/2019/10/17/the-us-china-trade-war-risks-and-opportunities-for-the-eu-and-the-united-kingdom/> last visited on 1, 2021

degree and intensity of this cooperation. It institutionalized the existing cooperation. China and the EU put more emphasis on this cooperation, and provided more funding to S&T cooperation projects, especially large projects. For example, the Galileo project was started in this good historical context, and China was the first non-EU participant. The two sides signed official contract to formally define the two sides' specific rights and obligations, their cooperation on Galileo project entered into a honeymoon period. The Dragon program was launched one year after Galileo project, but what different from Galileo project is, there is no formal agreement between two sides. It started with small scale and a loose type of cooperation.

In 2013, the new president in China, Xi Jinping put forward "China Dream", with the aim of building China as a great power. In this context, the Belt and Road Initiative was announced in 2013, "Made in China 2025" was issued by China in 2015. From the perceptional point view of many Europeans, it alters the cost-benefit calculation and bring a new asymmetric. But from the China side, they just want to reach certain objectives as any other state does in the field of S&T.

The US Election in 2016 brought a new president, Donald Trump to US and the world. Unlike past American presidents, he was a total wild card. The Trump administration imposed a huge among of tariffs and launched a trade war against China. The deterioration of Sino-EU relations influenced Sino-EU relations and Sino-EU S&T cooperation. The previous paragraph mentioned some positive effects on this cooperation; however, it also has many negative impacts: for example, under the US pressure, the Netherlands company ASML planned to cancel China chip-equipment sale and ASML's export license would not be renewed; and Huawei 5G was refused by UK, Sweden, Belgium, and other European countries.

In December 2020, China and the EU reach agreement in principle on investment. The leaders of the two sides announced that the negotiation of EU-China Comprehensive Agreement on Investment (CAI) was completed. In the first month of 2021, a part of the text of CAI was published.

In the past eight years, since 2013, when China and the EU launched negotiations on the China-EU Comprehensive Investment Agreement, many changes have taken place in the world political and economic situation. In particular, the unilateralism and trade protectionism pursued by Trump since his election as US president have greatly increased the uncertainty of the whole world. Combined with the impact of COVID-19 in 2020, the global economy is facing the big challenge. The completion of the EU-China Investment Agreement negotiation is a useful attempt for China and the EU to seek for certainty in the uncertain international political and world economic environment.

In the following, the final two hypotheses will be examined：

Hypothesis 5: Path dependency. After China and EU established their cooperation in the form of framework cooperation, it has continued.   It is verified.

From Figure10.1, we can see that there is an institutionalization of Sino-EU S&T cooperation from 1998 EU-China S&T cooperative agreement, which is the beginning, 2003 EU-China comprehensive strategic partnership is the following on that path, and CAI, from the end of 2020, is in line with them, reconfirmed this path.

Hypothesis 6: Historical critical juncture. In 2015, the “Made in China 2025” was issued for the transformation and upgrading of China’s manufacturing industry. From the view of many Europeans, the “Made in China 2025” has already impacted on the S&T cooperation or non-cooperation between China and the EU. China rising to the top level in the field of S&T, and this will bring a fundamental change with new asymmetric relationship and will cause significant disruption. It is falsified.

“Made in China 2025” is a potential challenge to the existing pattern of good cooperation, this is one element lead to rethink cooperation with China in Europe and elsewhere in the world. But the CAI is the proof of the institutionalization that it is still on the same path. What is more, none of the three cases are affected by “Made in China 2025”.

Currently, there is no critical juncture yet. The historical path of Sino-EU S&T cooperation has been challenged by various factors, for example, the rise of competitiveness in China, the crisis in Europe, the internal problems of the EU, etc. These factors might have altered the European attention, but essentially it is not leading to a deviation from this initial path.

From many European’s perspective, especially from the US perspective, “Made in China 2025” was observed as a possible critical juncture, but it does not turned out to be the case, otherwise the EU and China would not have reach the CAI agreement, it is not really challenging the existing institutionalization of Sino-EU S&T cooperation. The strategic partnership is really in line, it is still the same path that leads to the CAI, a form of institutionalization of cooperation between the two sides. The CAI is a reconfirmation of the existing historical path, it shows that there is an institution that still going on, and it is now reaching a new stage.

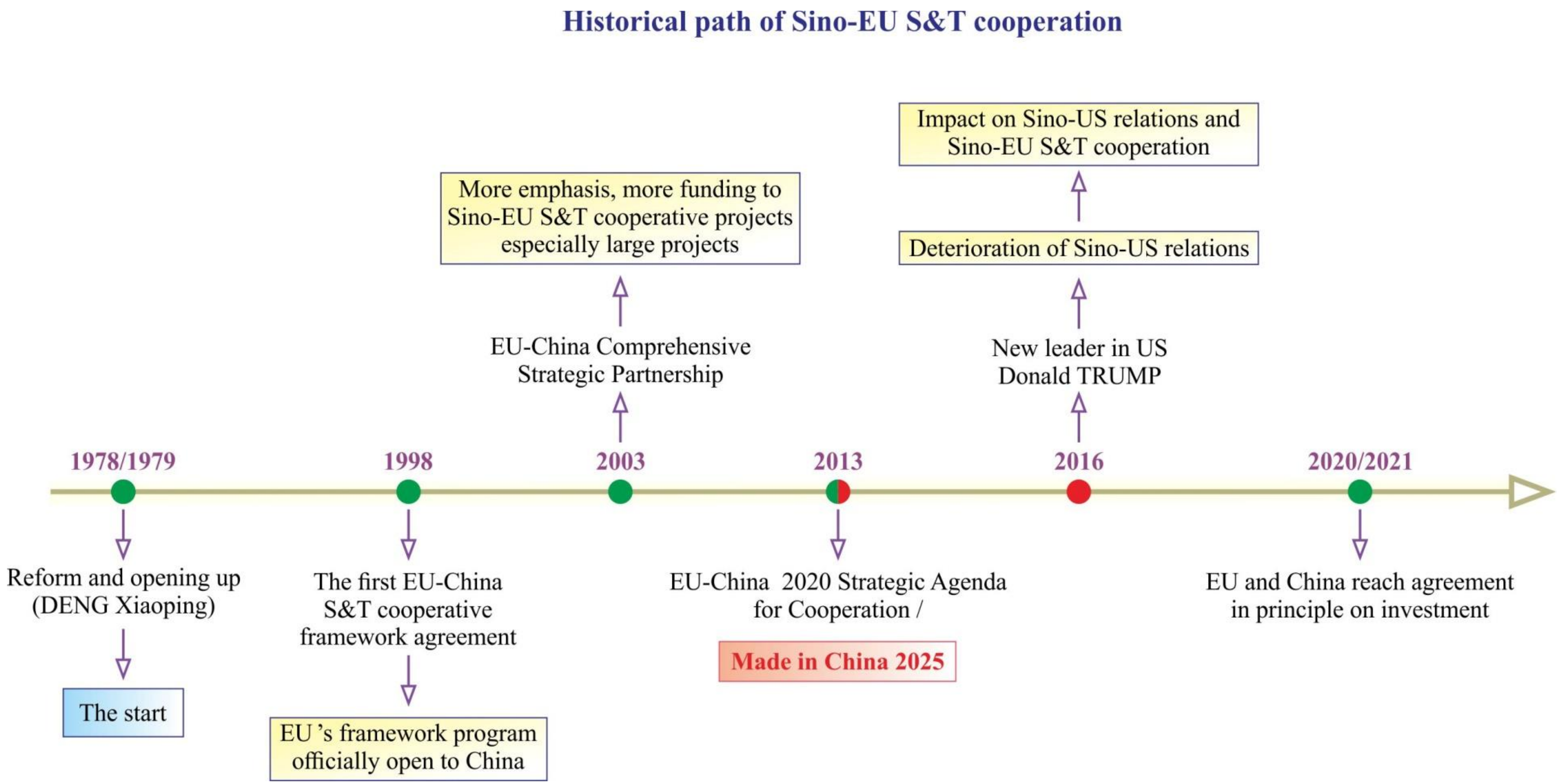

Figure 10.1 Historical Path of Sino-EU S&T Cooperation

10.3.2 Other Influential Variables

10.3.2.1 Political Influence

Case 1, Galileo project, in the honeymoon period, the level of degree of and the level of effectiveness of institutionalism of its S&T cooperation are high, and the level of intense in medium, it performs well. However, the project suddenly moved into a dormant period, their ways of cost-benefit calculation are changed due to the political influences. The pro-American politicians in the EU member states have come to power, and Europe has quickly moved closer to the United States, they began to exclude China from the Galileo project.

10.3.2.2 The Development of S&T

Case 1, during the dormant period Galileo project, the cost-benefit calculations of both China and the EU shifted, and the two sides almost stopped cooperation. The influential factor for their new stage cooperation is the development of S&T, which brought the new cost-benefit calculation to the two sides. Multi-constellation was the new concept and is already widely used in many applications. The development of S&T influences the degree and effectiveness of institutionalism of Sino- EU S&T cooperation.

10.3.2.3 Mutual Trust

From Case 3, Dragon Program, we can see that the effectiveness of institutionalism of its S&T cooperation is high in all four phases; and compared with the level of intensity and the level of effectiveness, its degree of cooperation is relatively low. There was no formal agreement on the Dragon Program; it relied too much on personal relationships.

Karl Bergquist, director of the ESA's International Relations Department, said that: "Sometimes people say, we must have an agreement on Dragon, and then I said, 'but it works, why we need agreement if it works?'……The reason why we can do this without agreement is we have very good person to person relations which is fundamental when you run international cooperation……Without the very good personal chemistry between the organizers, I'm not so sure that it would have worked so well. [475] When there is mutual trust among the two sides, the low degree of cooperation will not influence the level of intense and the level of effectiveness.

10.3.2.4 COVID-19 Crisis

Covid-19 is an infectious disease of the respiratory system. It was first discovered in Wuhan, Hubei Province, China at the end of 2019. Since then, the disease has

[475] Record 5: Interview with Karl Bergquist, ESA; Dragon

spread on a large scale and spread rapidly in various countries around the world. So far, there are nearly 40 million confirmed cases worldwide, and it is still spreading. It has had unprecedented impact on the global scale.

2020 is therefore a critical juncture open to various future scenarios. It was believed by many people as the first true 21st century crisis.[476] Trump blamed China's handling of the coronavirus pandemic and asked for China to account for having "unleashed this plague onto the world". China believes that the accusations made by the United States are unreasonable and China has done a good enough job of responding to COVID-19.

The EU provided a middle way between the Trump accusation and the China defense, it proposed a resolution at WHO for an independent inquiry in China about the origins of the virus epidemic in Wuhan. This proposal was accepted by the large majority of WHO members and has implications for research cooperation. The COVID-19 crisis is therefore pushing the convergence between China and the EU in the field of S&T cooperation.

First, China and Europe have already carried out active cooperation in the field of COVID-19 vaccine R&D.As early as the beginning of the epidemic, companies from China and the EU have cooperated to jointly develop COVID-19 vaccines. In March of this year, Shanghai Fosun Pharmaceutical Group and Germany's BioNTech reached a vaccine R&D cooperation intention to jointly promote the development of mRNA (messenger ribonucleic acid) COVID-19 vaccine clinical

[476]History Factory. (2020). "The First True 21st-Century Crisis" <https://www.historyfactory.com/insights/the-first-true-21st-century-crisis/> last visited on 1, 2021

trials and subsequent commercialization in China. Ugur Sahin, founder and CEO of BioNTech said that the cooperation is an important step in accelerating the development of an mRNA vaccine against the COVID-19 worldwide. Fosun Pharma brought rich development experiences and extensive networks in the Chinese pharmaceutical market.[477] In addition, the British Glaxo Smith VKline(GSK) Vaccine Company and Chinese Clover Biopharmaceutical Co., Ltd. have also carried out R&D cooperation on recombinant protein vaccines.[478] At the 22ndEU-China summit held on June 22, 2020, China and the EU expressed their willingness to continue in-depth cooperation in vaccine and drug research and development.[479]

Second, although the COVID-19 crisis has hit the global economy, Chinese investors still have a strong interest in investing in European S&T innovation projects. European countries are eager to cooperate with other economies to alleviate the negative impact of the epidemic on the European economy. Liselotte Odgaard, a researcher at Hudson Institute believes that the COVID-19 crisis has promoted the development of Sino-EU S&T cooperation, more and more S&T cooperation projects between China and the EU may challenge the US leadership in the field of scientific and technological innovation. She said that: "Europe is forecast to shrink its economy more that 12% and China was already trying to buy the key technologies, companies in Europe in artificial intelligence, robotic

[477]Xinhua Net. (2020). "China-EU cooperation helps the global COVID-19 vaccine R&D 'speed up'" 新华网：中欧合作助力全球新冠疫苗研发"提速"
<http://www.xinhuanet.com/world/2020-06/24/c_1126157417.htm> last visited on 1, 2021
[478]Xinhua Net. (2020). "China-EU cooperation helps the global COVID-19 vaccine R&D 'speed up'" 新华网：中欧合作助力全球新冠疫苗研发"提速"
<http://www.xinhuanet.com/world/2020-06/24/c_1126157417.htm> last visited on 1, 2021
[479]European Council. (2020). "EU-China summit via video conference, 22 June 2020"
<https://www.consilium.europa.eu/en/meetings/international-summit/2020/06/22/> last visited on 1, 2021

technology, telecommunication, and other areas. And that effort has been enhanced now, China wants to buy at a lower price, and a lot of people in Europe need the money, so they want to sell.”[480]

Third, in the post-epidemic era, European companies are optimistic about the Chinese market and increase investment in China. Since the outbreak of COVID-19, the number of China-Europe freight trains has increased, and this has continued to play a role in epidemic prevention and control, resumption of work and production, and stabilization of the global supply chain.[481] On the one hand, in the context of the difficult recovery of global trade, European companies continue to ship local products to China to attract the Chinese market; on the other hand, European multinational enterprises continue to expand their business and investment in China, and they take concrete actions to cast a vote of confidence in the continued improvement of China’s economy and deepening of its opening to the outside world. This year, at the end of May, the German Volkswagen Group, the largest European car company, announced an investment of 2.1 billion euro in China to promote the development of electric vehicle business.[482] In July, the French Danone Group announced an investment of 100 million euro to expand its business in China.[483] Li Jian, global senior vice President of Danone said: “The

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[480]Ifeng. (2020). “US think tank: China and Europe may deepen scientific and technological cooperation after COVID-19” 凤凰网：美智库：疫情后中欧或深化科技合作
<https://tech.ifeng.com/c/7wbutuzBBRI> last visited on 1, 2021

[481]China.org.cn. (2020). “European companies continue to favor the Chinese market in the post-epidemic era” 中国网：后疫情时代欧洲企业继续青睐中国市场
<http://news.china.com.cn/2020-09/03/content_76664089.htm> last visited on 1, 2021

[482]The Economic Times. (2020). “Volkswagen AG pumps 2 billion euros into China electric vehicle bet, buys stakes in 2 firms”
<https://economictimes.indiatimes.com/news/international/business/volkswagen-ag-pumps-2-billion-euros-into-china-electric-vehicle-bet-buys-stakes-in-2-firms/articleshow/76084090.cms> last visited on 1, 2021

[483]Danone. (2020). “Danone invests €100 million to strengthen Specialized Nutrition in China, further serving Chinese health needs while becoming the biggest B Corp™ company in Asia”
<www.danone.com> last visited on 9, 2020

COVID-19 pandemic did not stop the Chinese government from promoting a new round of high-level opening-up. We have seen the implementation of the Foreign Investment Law, which has provided legal guarantee for higher levels of opening up. The success experiences of a series of free trade zones have been further replicated, and the cross-border e-commerce comprehensive pilot zone has continued to expand. Danone firmly believes in the development potential of the Chinese market and will continue to take root in China in the future by gradually expand investment and increase technological innovation."[484]

Fourth, the epidemic has promoted Sino-EU cooperation in the field of digital economy and technology. This year, Liu He, Vice Premier of the State Council of China, and Margrethe Vestager, Executive Vice President of the European Commission, co-chaired the EU-China High-level Digital Dialogue in the form of video conference. The two sides focused on strengthening digital cooperation, earnestly implemented the important consensus reached by leaders of both sides, and held pragmatic and constructive discussions on topics such as communication technology standards, artificial intelligence, and non-food product safety. The two sides agreed that the current vigorous development of digital technology and digital economy is having a profound impact on economic and social development, production and lifestyle, and the global governance system; it is playing an extremely important role in the global fight against COVID-19. As two major economies and important digital forces in the world, China and the EU are of great significance to further strengthen digital communication and exchanges in the context of the global pandemic of COVID-19 and its severe impact on the world

[484]Xinhua Net. (2020). "Spotlight: China-EU economic ties resilient despite global trade woes", <http://www.xinhuanet.com/english/2020-09/18/c_139378933.htm> last visited on 1, 2021

economy.[485]

It’s clear that China and the EU have a broad space for cooperation in the post-epidemic era. The two sides can not only strengthen economic and trade cooperation and boost the recovery of the world economy, but also have a lot to do in cooperation to deal with COVID-19, develop green and low-carbon economy and digital economy, and promote sustainable development.

[485] European Commission. (2020). “EU-China: Commission and China hold first High-level Digital Dialogue” <https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1600> last visited on 1, 2021
People.cn. (2020) “China-EU High-level Digital Dialogue was held” 人民网：中欧数字领域高层对话举行 <http://world.people.com.cn/n1/2020/0911/c1002-31857318.html> last visited on 1, 2021

Epilogue

When I concluded my analysis in January of 2021, it was evident that the institutionalization of Sino-EU Science & Technology Cooperation was gaining more momentum. From the end of 1998 to 2021, there was a continuity of newer forms of agreements leading up to the Comprehensive Agreement on Investment (CAI), including constructive debates surrounding the "Made in China 2025" initiative. My research demonstrated that these developments were not critical junctures but part of an ongoing process of deepening cooperation.

At that time, the successful conclusion of the CAI negotiations between the EU and China seemed to signal a further strengthening of their partnership. However, the three years following January 2021 have witnessed significant events that have shed new light on the institutionalization process and altered the trajectory of Sino-EU relations.

First and foremost, the anticipated ratification of the CAI was suspended in the EU. This halt in progress indicated a cooling of relations that contrasted sharply with the optimism of early 2021. The CAI has not been ratified, and 'Made in China 2025' now appears to be a potentially critical juncture. Furthermore, the outbreak of the Russia-Ukraine war drastically altered the geopolitical landscape. Europe's robust support for Ukraine has strained its ties with China, which has maintained a more neutral stance in the conflict.

Additionally, the Biden administration, continuing the policies of the Trump administration, did not give up on the Trump administered tariffs but maintained them. This continuity in U.S. policy has had a ripple effect, influencing Europe's approach to its relationship with China. These developments have collectively contributed to the stagnation, if not to a crisis, of Sino-EU cooperation, diverging from the expected advancements outlined in my thesis.

In response to these complexities, the "geopolitical" European Commission under Ursula von der Leyen has adopted the formula of "de-risk, not decouple." This approach suggests that while EU-China cooperation will continue, it will be pursued with greater caution and strategic consideration. The EU aims to mitigate risks associated with its economic and technological dependencies on China without completely severing ties. This nuanced stance reflects a recognition of the intricate balance required in maintaining productive yet prudent international partnerships.

In conclusion, while my analysis captured a moment of optimism and potential in Sino-EU relations, the subsequent events post-January 2021 have underscored the dynamic and often unpredictable nature of international relations. The combination of geopolitical conflicts, shifting alliances, and sustained policy stances has significantly impacted the trajectory of Sino-EU cooperation, providing new contexts and challenges for future research and policy-making.

In light of the developments following January 2021, it is essential to direct attention toward a detailed examination of the final two hypotheses. The landscape of Sino-EU relations has transformed significantly, prompting a reevaluation of previously held assumptions about the institutionalization of cooperation. The evolving nature of international relations necessitates a continual reassessment of theoretical frameworks and hypotheses. As global dynamics shift, particularly with the cooling of relations evidenced by the suspension of the CAI ratification and the geopolitical tensions resulting from the Russia-Ukraine war, the relevance and applicability of earlier observations may diminish. This realization highlights the need for adaptability, acknowledging that static models cannot adequately capture the complexities of these international interactions.

The concept of "Made in China 2025" emerges as a potential critical juncture within this context. While it holds promise as a significant turning point for Sino-EU cooperation, it is crucial to approach this notion with caution. Critical junctures are not simply isolated events; they require a confluence of factors that provoke fundamental shifts in the status quo. The rarity of such junctures suggests that premature conclusions about their impact may lead to misguided interpretations. Therefore, it is imperative to investigate whether this initiative truly represents a pivotal moment in the trajectory of Sino-EU relations or merely a phase in the ongoing evolution of institutional cooperation.

The recent geopolitical shifts necessitate a reconsideration of some conclusions drawn in this dissertation. Accepting that a turning point may be upon us requires a nuanced understanding of how existing hypotheses may need to be reformulated in light of these changes. Recognizing the fluidity of international relations allows for the identification of areas where hypotheses may still hold, as well as those that require modification or further exploration. This reconsideration invites an expansion of the hypotheses, especially in acknowledging the potential impact of recent developments on the dynamics of cooperation.

Ultimately, this epilogue serves as a reminder of the dynamic nature of international relations and the necessity for adaptability in academic inquiry. By reflecting on the implications of critical junctures and the complexities of current geopolitical contexts, a more robust understanding of the factors that shape global interactions can be achieved. As this study moves toward its final stages, the insights gained from this examination will not only enhance the depth of analysis but also provide a foundation for future research endeavors. Engaging with these evolving concepts ensures that the discourse surrounding Sino-EU relations remains relevant and insightful.

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