Foreign Direct Investment Dynamics, Innovation, and Economic Growth in China and Europe: Theoretical, Empirical, and Policy Perspectives

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Tian Xiong

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Dean: **Prof. Dr. Nils Crasselt**
Schumpeter School of Business and Economics, University of Wuppertal

Examination Committee

Prof. Dr. Werner Bönte - 1st Examiner
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Schumpeter School of Business and Economics, University of Wuppertal

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To

my husband Fredrik,

my parents Yan and Jianmin,

and my grandmother Fenglian

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PREFACE

This dissertation comprises three chapters that delve into the effects of cross-border investment and financial market dynamics on innovation and modern economic growth in the course of multinationalism.

Chapter 2 of the dissertation was co-authored with my supervisor, Prof. Dr. Paul J.J. Welfens. The main research question was explored jointly by both authors. Prof. Dr. Paul J.J. Welfens contributed the theoretical framework. I authored the introduction, developed hypotheses, specified the model, conducted empirical analysis, and composed the conclusion. An earlier version of this paper is available online as EIIW Discussion Paper No.247:

Welfens, P.J.J., & Xiong, T. (2018). *The Effects of Foreign Direct Investment on Regional Innovation Capacity in China* (EIIW Discussion Paper No. 247). Retrieved from European Institute for International Economic Relations website: https://eiiw.wiwi.uni-wuppertal.de/en/publications/discussion-papers/no-247/

Chapter 3 is a standard-alone paper. A previous version of this paper has been published as a discussion paper with the EIIW:

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Chapter 4 is a collaboration with Prof. Dr. Paul J.J. Welfens, who designed the conceptual framework and developed the theories. The author of this dissertation performed the empirical analysis, including data preparation, regression analysis, and result interpretation. The conclusion was a joint effort. This research is within the Deutsche Bundesbank project "Institutional Changes and Economic Dynamics of International Capital Markets in the Context of BREXIT" and has been published in the journal International Economics and Economic Policy:

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CHAPTER 1 -
INTRODUCTION

1.1 General Introduction

1.1.1 Innovation, financial market, and economic growth of the modern economy

In modern Economics, technological progress and innovation have been acknowledged as the main drivers of productivity growth and increasing economic welfare (Fagerberg, Srholec, & Verspagen, 2010). Particularly noticeable since the turn of the 21st century, the new technological revolution is developing rapidly, the cycle of transformation of scientific and technological achievements and industrial renewal is constantly shortening, and the role of science and technology (S&T) as the foremost productive force is becoming more prominent. At the same time, financial markets continue to play a crucial role in facilitating resource allocation and optimization by meeting the capital needs of market participants, thereby promoting innovation and sustaining economic growth (Purewal & Haini, 2022). With the growing interdependence between finance and the real economy, as well as locations and economic units across international borders, there is greater recognition that the dynamics and the interconnectedness of these factors can have a far-reaching and widespread impact on the world economy.

Neoclassical growth theory has identified technological change as a key driver of countries' economic growth (Solow, 1956, 1957). Based on the basic theory from the Solow growth model, output growth can be primarily explained by the change in total factor productivity along with the contribution of physical capital accumulation. Technological change is treated as an exogenous term, which is also criticized as the main drawback of neoclassical growth theory because this assumption fails to explain the core determinant of growth rate. In the spirit of explaining the growth of technological progress, a large number of subsequent contributions to the literature have focused on understanding the origin of technological changes. Studies of

the new growth theory and endogenous models of economic development showed that technological change is not "manna from heaven" (Freeman, 1994, p. 463). Instead, it is the result of intentional investment in productivity-driving factors, and the main factor is found to be the stock of knowledge embodied in humans and technology (Lucas, 1988; Romer, 1986, 1990). Humans advance their knowledge and skills from education or experience, and technological knowledge can create value through the continuous exploration, development, and implementation of technology. Therefore, investments in research and development (R&D) activities, for example, and international technology transfers or spillovers, are essential in supporting the growth of technological progress (Coe & Helpman, 1995; Griliches, 1979; Grossman & Helpman, 1990).

Moreover, many innovation studies, beginning with the work of Joseph A. Schumpeter, recognize micro-level technological progress as an essential contributor in leading technological change and further affecting economic growth at the macro level. Schumpeter views innovation as one step of this process that involves implementing new ideas and is generally associated with market commercialization (Schumpeter, 1942, 1947). As a major actor in the market, firms are corporate organizations with heterogeneous knowledge stocks and the primary aim of profit maximization (Arrow, 1962; Pitelis & Teece, 2009). This nature leads firms to try to create and maintain sustained competitive advantages and thus play an essential role in knowledge accumulation, creation, and diffusion (Barney, 1991).

Technological change also has a profound impact on the process of globalization. For instance, the continuous development in information and communication technology (ICT) and faster modes of transportation have further changed the way economic activities are organized (Narula, 2005, p. 45). In turn, firms can target new markets more quickly and accurately and reallocate parts of their business globally to seek greater efficiency and effectiveness. In this process, more knowledge will be generated and accumulated at different levels of aggregation through domestic technological efforts, as well as foreign technology from the import and export of intermediate and finished products, the internalization of foreign technological knowledge, or the spillover effects from inward foreign direct investment (FDI) (Lall, 1992; McKern, Yip, & Jolly, 2021). As a result, 'foreign' involvement in, and influence on, other countries' innovation activities are increasing along with a more liberal trade and investment environment.

In recent years, the mode of innovation has also become more open and requires good use of external resources (Luo & Tung, 2018). However, technological frontiers and technological advances are still generally concentrated in developed economies for countries worldwide (United Nations Conference on Trade and Development [UNCTAD], 2021a). As developed countries entered and completed the industrialization phase earlier, many domestic companies gained access to major innovation resources and opportunities, and thereby have developed strong innovation capabilities. Meanwhile, the promotion of science, technology, and innovation (STI) is regarded as an important national development strategy, reflected mainly in increasing public financial support programs for, and complementary private investment in, S&T; the development of high strategic technologies and industries alongside the reinforcement of basic research; the improvement of intellectual property rights (IPR) protection as well as the refinement of information collection and evaluation of STI performance, thus creating a favorable environment for accelerating the transformation of scientific and technological achievements into practical productivity (Organization for Economic Co-operation and Development [OECD], 2018). This further provides an impetus for economic and social development and assists countries in gaining the initiative in national economic and technological competition.

For developing and emerging economies, R&D and technological change are also seen as necessary and essential to climbing the development ladder and catching up with developed countries (Kalotay, Pollan, & Fredriksson, 2005). The study of Fagerberg and Verspagen (2002) even highlights the urgency of encouraging innovation in those economies, as their empirical findings suggest that innovation has become increasingly important for economic growth over time. However, the major difference is attributed to the fact that these economies have constrained resources, weak technological innovation capability, and backward innovation systems (UNCTAD, 2021a). These characteristics will hinder incentives and opportunities for innovation and delay economic growth. As a result, foreign sources of technology have long been a significant driver of innovation in developing and emerging economies and have accounted for a large share of productivity growth, especially in their early industrialization phases (Fu & Hou, 2021). Likewise, knowledge diffusions through international channels can also significantly contribute to strengthening technological capabilities for developing and emerging economies.

1.1.2 Innovation and FDI in China

While the developed economies, represented by Western Europe and the United States (US), are still the leaders in S&T in the world today, the global innovation landscape is being reshaped by the rise of a number of emerging economies, particularly represented by China (Fu, McKern, & Chen, 2021, p. 735). The innovative success of China can be traced back to its opening up and economic reforms in the late 1970s. With the expectation that the technological capabilities of domestic firms and industries will largely benefit from the inflows of foreign capital and accompanied by advanced knowledge and technologies, a series of incentive policies have been introduced and adopted aimed at creating a fertile environment for international investment (F. Liu, Simon, Sun, & Cao, 2011; Y. Lu, Tao, & Zhu, 2017). In addition, China has become a popular investment destination resulting from its large, low-cost labor force and huge market scale and potential. During this period, the main innovation activities were adopting foreign technologies and learning by engaging in reverse engineering (Fu & Hou, 2021). While continuously opening up the Chinese market to attract foreign investors, Chinese companies are also becoming more proactive in competing in the global marketplace and participating in international innovation collaborations. At the same time, preferential domestic policies and financial support incentivize domestic companies to go abroad to acquire advanced knowledge and technology by investing in and acquiring foreign firms (Fu & Hou, 2021).

However, a series of challenges have emerged in China due to new demands for sustained domestic economic development and participation in the global market. After decades of rapid growth, China's economy has entered a new development phase. Due to increasing labor costs, the labor-intensive growth factors that China previously relied upon have lost their comparative advantages, and the focus of industrial development has gradually moved toward the high-tech and service sectors (W. Chen & Tang, 2014; Fu & Hou, 2021). While China has invested considerably into innovation, allowing a subset of industries to close the gap with the technological frontier, it still lags behind developed economies in general high-tech and modern service industries, and its economy remains highly dependent on energy, natural resource consumption, and foreign technology (The State Council of the People's Republic of China [The State Council, PR China], 2005). With the aim of maintaining its national competitiveness and avoiding the possibility of falling into the middle-income trap, China has started to stimulate the development of indigenous innovation. In 2006, indigenous innovation was identified by the Chinese government as a strategic priority, and the focus of innovation

began to shift from external knowledge acquisition to internal knowledge creation (Fu & Hou, 2021). Meanwhile, as a late-comer to the global market, Chinese firms need not only to explore and integrate their internal and external S&T resources but also to overcome their competitive disadvantages (Liang, Lu, & Wang, 2012; Luo & Rui, 2009). The Chinese government is also under pressure to continue strengthening and updating its experience and approach in coping with a new multilateral milieu.

In conjunction with the above points, an important question to be answered here is to identify the impact of foreign resources on the development of China's innovation: Does China's innovation continuously benefit from its ongoing integration into global markets? Or has it ultimately struggled with the integration or search process and lost the ability and opportunity to innovate? In order to answer these questions objectively, detailed research based on empirical evidence is particularly relevant and essential here.

1.1.3 Financial markets and economic disintegration in the European Union

Despite the seemingly irresistible trend towards economic globalization and regional integration, as well as the attempts of more developing and emerging economies to increase their influence in the global economy, many developed countries are nonetheless experiencing a rapid rise in political and economic uncertainty and increased national protectionism. The international community will continue to face new challenges in the way it interacts economically, politically, and socially.

The United Kingdom (UK) voted to leave the European Union (EU) in a 2016 referendum, an event that came to be known as Brexit[1], which is seen as marking a significant departure from the growing globalization and political integration that has taken place since World War II (Sampson, 2017). It is a complex, historical, political, and economic outcome that will bring profound changes to the economic development of the UK, the EU, and even the world. For the UK, the high market uncertainty associated with Brexit will lead to significant financial market volatility, which will likely cause a depreciation of the domestic currency and drive up

[1] Brexit is a portmanteau term derived from a combination of "Britain" and "exit", referring to the UK's departure from the EU.

its nominal interest rate and inflation rate. As a traditional financial powerhouse, the UK has developed a mature financial market that attracts many foreign investments into the banking sector and offers well-developed financial services for foreign enterprises. Its financial services exports account for a large proportion of the UK's service exports, while the EU single market is the main importer of British financial services (European Affairs Committee, 2022). However, after the implementation of Brexit, the UK-based banks may lose the advantage of providing financial services directly throughout the EU single market. As a result, they may reorganize their corporate activities to spin-off part of their businesses to legally separate subsidiaries or develop more sophisticated digital banking services as an alternative, while domestic and foreign investors are likely to adjust their investment strategies and seek profits elsewhere (Eichengreen, 2019; Welfens, 2017a, p. 210).

Meanwhile, the UK and the EU would trade under the terms of the World Trade Organization (WTO) if no new agreement would be reached. The UK's withdrawal from the EU single market will lead to the erection of new borders and behind-the-border barriers to trade between the UK and the EU member countries, thereby increasing the cost of trade on both sides. The higher restrictions on the exchange of goods and services due to Brexit could harm transactions and investments between the UK and the EU27 and further impact international trade and investment. These pressures could lead the UK government to lower regulatory requirements or entry barriers in financial markets in order to try to offset a part of the Brexit-related losses. On the one hand, it may serve as a new opportunity for the UK to salvage the purchasing power of its domestic currency and stabilize financial markets. However, as a global financial center, if excessive deregulation occurs in the UK, this could have serious adverse effects on partner countries or even cause global spillover problems for other nations. On the other hand, more relaxed regulatory conditions may also attract more secondary investors who are willing to accept higher uncertainties and lower profit margins, which could pose additional potential risks to the stability of the UK's financial markets.

Financial markets have played a considerable role in promoting economic growth in the EU28 countries and OECD countries, respectively. Prior to Brexit, most wholesale banking activities of EU27 countries were located in London and the UK, not least because of the British deregulation of financial markets under the governments of Prime Minister (PM) Margaret Thatcher and the unfolding of the EU single market of 1993 with its four freedoms, including free capital flows. The leading role of the UK as a global financial center is reinforced in the

context of the service specialization within the EU28. Therefore, it is crucial to understand what the impact of Brexit on the financial markets and economic development of the EU27 - and of the UK - itself will be. With the EU being the most successful regional integration club in terms of the number of member countries and economic output, the withdrawal of a strong ally is undoubtedly a heavy economic blow to the process of regional integration in Europe and will result in a negative signal for regional integration internationally (Sampson, 2017). In addition, a series of restricted US trade and investment policies and trade frictions with China during the presidency of Mr. Donald Trump has enhanced the volatility of global capital markets. In the face of the multiple challenges posed by political and economic turbulence, an emphasis on rationalizing domestic economic development and strengthening international cooperation is becoming increasingly important.

1.2 General Framework

This dissertation focuses on studying the effects of cross-border investment and financial market dynamics on innovation and modern economic growth in emerging and developed economies during the course of multinationalism. Two key research questions are addressed in this dissertation:

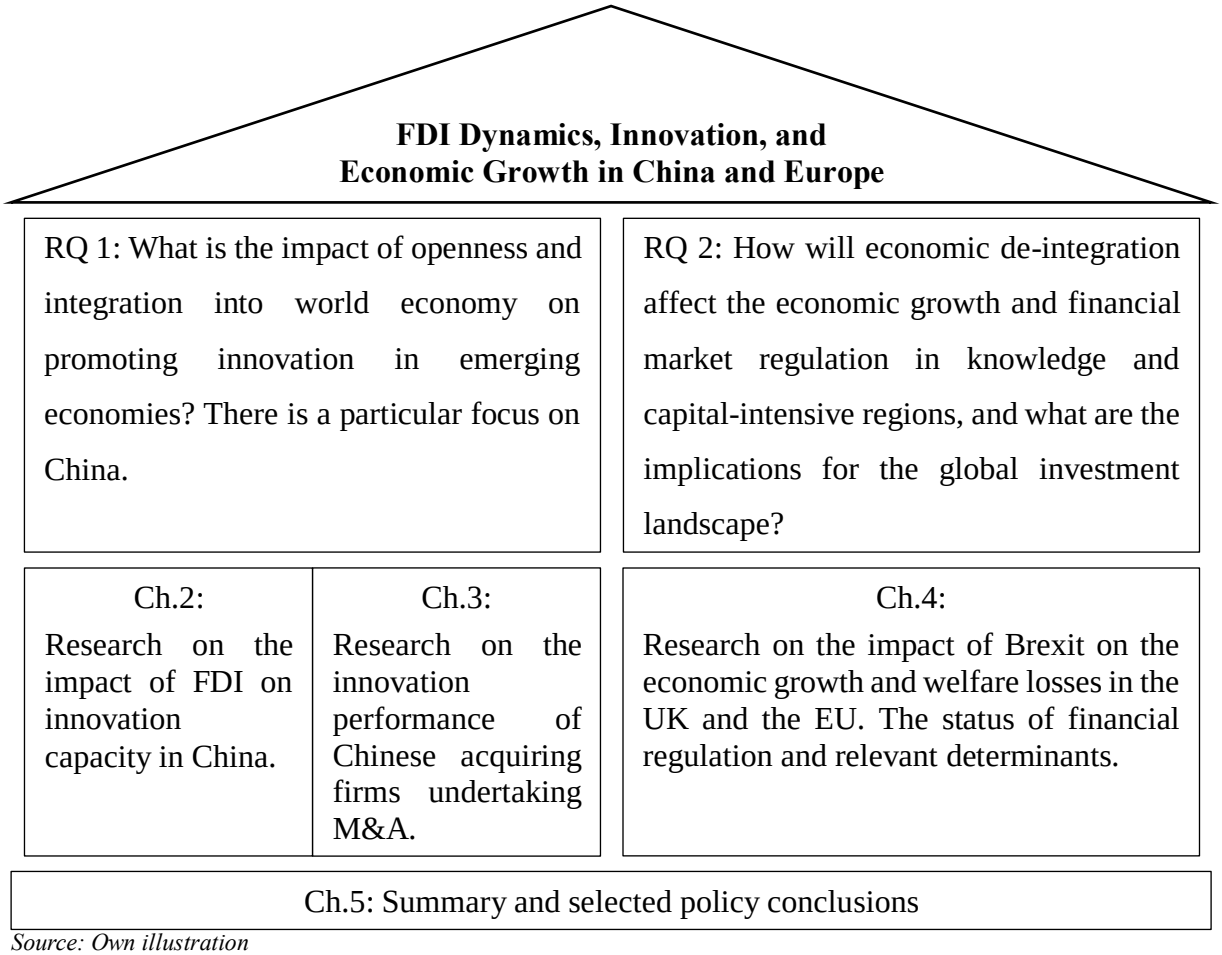
1) What is the impact of openness and integration into the world economy on promoting innovation in emerging economies? Here, there is a particular focus on China.
2) How will economic disintegration affect economic growth and financial market regulation in knowledge- and capital-intensive regions, and what are the implications for the European and global investment landscape?

Thus, these two important topics of modern economic dynamics - the latter in a neutral meaning of the word dynamics -will be analyzed in this dissertation. The subsequent Chapters 2 and 3 mainly focus on answering the first question. Two quantitative analyses were conducted to empirically examine the influence of FDI on innovation output with a specific focus on China. Chapter 2 focuses on understanding how inward FDI impacts China's innovation capacity at the provincial level. In this study, my co-author and I investigated the impact of the FDI stock intensity on the innovation output on a regional level based on an alternative knowledge production function. We further studied the influence of the FDI stock intensity on innovations with different novelties and regions with different economic strengths. Chapter 3 aims to tackle the first research question by examining the innovation performance of Chinese multinational

enterprises (MNEs) during outward internationalization. I tested empirically whether the innovation performance of Chinese enterprises has been affected by acquiring firms from the EU market. For this purpose, I created an original dataset containing Chinese multinationals investing in the EU28 market through mergers and acquisitions (M&A) to provide detailed evidence on whether the innovation performance of acquirers has improved post-M&A. I also estimated the innovation performance of acquiring firms with different levels of technological intensity and types of corporate ownership. Chapter 4 seeks to answer the second research question through a qualitative analysis to define the impact of Brexit on economic growth and welfare losses in the UK and the EU27, together with a quantitative analysis to understand the status of financial regulation and determinant factors. The main consequences for financial markets and real economic implications are taken into account with the policy options proposed.

The conceptual framework of this dissertation is illustrated as follows (cf. Figure 1.1):

Figure 1.1: Research agenda of this dissertation



Source: Own illustration

This dissertation aims to contribute to the literature by providing theoretical insights and empirical evidence on the contribution of cross-border investment to regional innovation development in China and the innovation growth of Chinese MNEs, as well as the impact of Brexit on the financial and real economies of the UK and EU. The three papers in this compilation are intended to make a modest contribution to filling some relevant knowledge gaps by focusing on macroeconomics, complemented by microeconomic (and managerial aspects) and political economy approaches. Policy conclusions based on the main findings will also be drawn to provide practical implications for firms and governments in emerging economies in integrating internal and external S&T resources to promote innovation performance according to their respective development paths and needs. In light of the immediate and long-term impact of Brexit on the UK and European economies, this analysis will present ideas on how developed countries should consolidate multilateralism as an approach to the global economy, based on an analysis of the immediate and long-term impact of Brexit on the financial and real economies of the UK and Europe and a call for a more substantial risk management response.

The following subchapters provide a brief summary of each chapter.

1.3 Chapter Overview

Chapter 2 addresses the impact of the FDI stock intensity on innovation capacity in China. Based on the concept that innovations are knowledge-based activities, a key issue in open economies is how international factor inputs are related to the innovation process. My co-author and I propose a compact method of growth decomposition relying on an alternative knowledge production function. This new approach emphasizes that broader international Schumpeterian dynamics should be considered in a globalizing world economy, as reflected in understanding the role of cumulative cross-broader investment in knowledge accumulation. Therefore, inward FDI stock inputs are treated as part of the intensity of economic globalization in order to analyze their contribution to the growth of knowledge stock.

From this perspective, we empirically investigate the effects of inward FDI stock intensity on innovation output, as proxied by accumulated patent applications, for 31 selected Chinese provinces from 2000 to 2015. Moreover, we divide patents into different categories with

respect to the degree of novelty to examine how FDI stock intensity contributes to the output of innovations with different novelty or complexity. Moreover, we study the effects of the FDI stock intensity between high-novelty and low-novelty innovations within and between two regions (i.e., coastal and inland regions), which obtain heterogeneous economic development statuses for historical and geographical reasons.

Estimating panel fixed-effects (FE) models, we find a positive effect of an increasing FDI stock intensity on improving China's overall innovation capacity. However, the significant effect diminishes as the novelty of innovations increases. Regions with a higher intensity of FDI stock increase their low-novelty innovation capacity, but the impact on high-novelty innovation capacity is insignificant. Meanwhile, the empirical results show that the developed coastal region in China can effectively benefit from a higher FDI stock intensity in improving its low-novelty innovation capacity, but a significant promotion of high-novelty innovation capacity is not evident. On the other hand, the less developed inland region lags significantly behind the coastal region in reaping the benefits embedded in FDI to generate more of the different kinds of innovations.

In Chapter 3, I intend to understand the validity of Chinese firms' access to external knowledge and technology from developed economies through M&A activities. In addition, whether or not there is a difference in terms of the impact on the innovation performance of acquiring firms with differing technological intensities and differing types of corporate ownership is studied in detail.

Although existing research suggests that Chinese firms especially try to improve their innovation performance by engaging in outward internationalization in developed economies, detailed investigations of the consequences of this approach are limited (Fu, Hou, & Liu, 2018; Piperopoulos, Wu, & Wang, 2018). One of the major restrictions is the lack of readily available data. For this reason, I compiled a new dataset of firm-level data for Chinese acquiring firms undertaking M&A in the EU28 to investigate the effects on the acquiring firms' innovation performance. The information on M&A deals was constructed by crosschecking and harmonizing data from Bureau van Dijk's (BvD) Orbis and Zephyr databases and SDC Platinum from Thomson Reuters. Patent information is collected from the Worldwide Patent Statistics Database (PATSTAT) from the European Patent Office (EPO). In the end, I have a sample consisting of 230 Chinese M&A acquirers in the EU market covering the period from 2010 to 2018.

By estimating Zero-Inflated Negative Binomial (ZINB) models, the findings suggest that the overall innovation performance of Chinese acquiring firms does not improve significantly after merging with or acquiring firms in the EU28 countries. However, after differentiating firms by various technological intensities, we observe a significant improvement in the innovation performance of medium-low- and low-tech firms after undertaking M&A, but the same effect is not observed for high- and medium-high-tech firms. Likewise, after distinguishing firms by the type of corporate ownership, we find that private-owned enterprises (POEs) are able to enhance their innovation performance in the post-M&A era. In contrast, state-owned or state-controlled enterprises (SOEs) show no significant differences in their innovation performance. Further analysis reveals that differences in terms of the type of corporate ownership do not significantly impact the innovation performance of Chinese technology-intensive firms following their M&A activities in the EU28.

Chapter 4 provides theoretical and empirical analysis to study the immediate- and long-term impacts of Brexit on economic growth, associated welfare effects, and the evolution of the quality of the financial markets in the UK and the remaining 27 EU member countries. More specifically, this paper aims to answer the following three questions, which concern the main Brexit-related consequences for financial markets and its real economic implications:

1) How strongly will Brexit affect the level of the growth path of British per capita income and the long-run growth rate?
2) How significant are the welfare losses for the UK and the EU27?
3) How will the quality of financial markets in the UK and the EU evolve in the context of Brexit, and what are the relevant determinants?

First, as the final status of Brexit was unclear back at the time of writing this paper, we propose that a hard Brexit or no-deal scenario is more likely after systematically analyzing the existing academic research and public reports. To reflect this situation, this study assumes that the EU27 will impose higher import tariffs on some of the UK's exports to the EU market. By incorporating trade and FDI variables and treating the EU27 as one economy, we employ a modified two-country macroeconomic growth model to analyze the influence of Brexit on the UK's economic growth in the long term. The results derived by using this model suggest that Brexit may have different effects on the long-run per capita income growth rate in the UK, depending mainly on the relationship between the tariff-related FDI and trade dynamics. However, it is likely that Brexit will dampen the level of the UK's growth path and the steady-state growth rate of per capita income due to the negative impact of higher tariffs on trade and

the subsequent negative impact of the reduction in terms of the foreign capital stock and exports on the growth rate of knowledge.

Second, the short- and medium-term effects of Brexit and the corresponding welfare impacts are discussed from the perspective of financial markets. In the hard Brexit or no-deal Brexit scenario, we believe that the UK will suffer a substantial depreciation of the Pound and a rise of the nominal interest rate and inflation rate in the short term. By adopting the Branson Model as the theoretical foundation, we simulate the main changes in financial markets led by Brexit under the setting of three markets: Money, domestic bond, and foreign bond markets. Additionally, we consider the impact of the adjustment mechanism in the financial and foreign exchange markets associated with the Dornbusch-type exchange rate overshooting problem and the role of a lower interest elasticity of the demand for money.

Due to the dominant effect of reduced market access to the EU27, medium-term changes are mainly reflected in the UK's growing current account deficit and the decline in its stock of foreign bonds. Besides, exchange rate overshooting is very likely in the short term because strong measures in terms of monetary policy may be taken as a reaction to Brexit. Concerning welfare losses analysis, we want to add aspects to existing calculations by focusing on the welfare costs related to reduced real demand for money. Concerning a possible long-run Brexit-related output loss and a narrowing market share of the British pound (GBP) in global foreign exchange reserves, the role of a falling interest elasticity of the demand for money is again emphasized for the welfare analysis. With expected higher inflation and a higher nominal interest rate in the UK, we found that a Brexit-related 10% gross domestic product (GDP) reduction could imply an additional 0.67 times the reduction of welfare loss in the money market through reduced real demand for money. For the EU27, negative welfare effects could be expected as real GDP in the EU27 is assumed to decline by 1-3% in the long run due to the negative spillover effects from the UK.

Lastly, we discuss how financial market quality evolves post-Brexit based on descriptive and empirical analyses. The quality of financial markets is measured from two dimensions: Financial services trade barriers and the effectiveness of financial services regulation. Additionally, factors likely associated with the change of the financial service trade barriers are empirically examined using a panel data analysis with the pooled ordinary least squares (OLS) estimation for the data of the UK and 21 selected EU countries from 2014 to 2017. We observe that the UK exhibits low FDI inflow barriers and is amongst only a few countries with reduced trade barriers for the commercial banking sector. However, it is not a country with

particularly low barriers to financial services trade. Several factors, namely internet intensity, inward FDI stock intensity, and trade openness, are found to influence the level of trade liberalization in financial services positively. Furthermore, a higher level of FDI restrictiveness in the financial sector will also significantly lead to a more protective attitude towards services trade in the EU market.

In the final chapter of this dissertation, the main findings and policy implications, which are derived from the results presented in Chapters 2 to 4, are discussed. The conclusion and an outline of avenues for future research will be presented.

CHAPTER 2 -
THE EFFECTS OF FOREIGN DIRECT INVESTMENT ON REGIONAL INNOVATION CAPACITY IN CHINA

2.1 Introduction

Knowledge is widely accepted as a key driver of economic growth in the modern economy. For this reason, a nation's pace of innovation is essential in explaining its economic development since innovations arise from carrying out a range of knowledge-based activities involving the practical implementation of existing or newly developed information and knowledge (OECD & European Statistical Office [Eurostat], 2018). Among other things, the knowledge of a unit concerns its ability to process and apply information for different purposes, and the accumulation of knowledge can be achieved through the reorganization and optimization of internal knowledge bases as well as the acquisition and integration of external knowledge assets (OECD & Eurostat, 2018).

FDI has also long been considered an essential factor in promoting innovations and is a major source of access to advanced external knowledge, which is especially important for developing economies where domestic firms or industries may be relatively uncompetitive and technologically backward (Blomström & Kokko, 1997; Lall, 1992; L. Wang, Meijers, & Szirmai, 2016). Multinational enterprises, as the micro agents of FDI, are the main drivers of R&D and usually possess certain firm-specific advantages (FSAs) with access to international capital markets (Fu, 2015, p. 48; Fu & Hou, 2021; J. Wang & Blomström, 1992). Thus, along with their market entry, the flows of capital, intermediate goods, and skilled labor can influence local knowledge accumulation and diffusion, further affecting and reshaping innovation success in the host economy in various ways. On the one hand, FDI has the potential to bring with it advanced technological and managerial know-how as well as a more competitive environment, which will provide valuable resources and opportunities for domestic innovation activities, stimulate a greater willingness to innovate, and reduce the costs and risks of developing these technologies (Buckley, Clegg, & Wang, 2002; Caves, 1974). On the other

hand, FDI can lead to more negative effects, such as "market stealing" and "skill stealing" when competition for talents and resources is too fierce and foreign-local linkages are limited (Aitken & Harrison, 1999; A. G. Hu & Jefferson, 2002; Tian, 2007).

Our research focuses on examining the impact of inward FDI on the innovation capacity of emerging economies, with China's provincial innovation capacity as the main object of study. China has achieved remarkable economic growth over the past decades, and the growing critical role of knowledge capital has been evidenced (Scherngell, Borowiecki, & Hu, 2014). Knowledge transferred or diffused through international channels has largely contributed to significant productivity gains, product-industry diversification, and intellectual capital generation, especially in China's initial stages of industrialization (Fu & Hou, 2021; G. C. Xu, 2011). With the goal of establishing a complete innovation ecosystem and transforming the economy towards an innovation-driven economy, besides the great emphasis on promoting domestic R&D efforts, the Chinese government also placed considerable attention on attracting FDI aimed at acquiring advanced knowledge and technologies to enhance further its nation's innovation capability (Cheung & Lin, 2004; Ning, Wang, & Li, 2016).

In the meantime, substantial regional disparities in terms of innovation assets and FDI distributions have been realized, and further guidance and actions have been and are being taken aimed at narrowing the inequality across regions that can hinder the overall development of China's S&T base (Ning et al., 2016; Y. Wang, Ning, Li, & Prevezer, 2016). For example, in the 12th Five-Year-Plan (FYP) for the Economic and Social Development of China (2011-2015), the Chinese government emphasized the importance of attracting more inward FDI to technology-intensive industries and has especially encouraged foreign firms to invest more in inland China (Xinhua News Agency, 2011). In 2017, in a notice issued by the State Council to promote and encourage inward FDI through several "further actions", it was again emphasized that a series of preferential policies would be provided to stimulate inward FDI into China's inland region (The State Council, PR China, 2017).

However, it is not yet entirely clear to what extent the inward FDI and the accompanied foreign knowledge remain valuable for achieving sufficient innovation and growth momentum in different regions in China. Firstly, cross-border knowledge transfer and diffusion have certain financial and time requirements; the local knowledge stock, technological effort, and absorptive capacity can also determine to some extent the level of effective external resources identification and internalization (W. M. Cohen & Levinthal, 1989; Fu, 2015, p. 48). Secondly,

China's economic growth has slowed. With the increased pressure of an increasingly aging population and labor costs, as well as the worry of falling into the middle-income trap, the next stage of China's international economic catching-up process will have to put a greater emphasis on how to use and allocate existing resources efficiently (Glawe & Wagner, 2017). Lastly, the indigenous innovation strategy was transformed into a national strategy for China in 2006. Although foreign subsidiaries are also recognized as essential actors in achieving comprehensive innovation (Fu & Hou, 2021; S. L. Zhao, Cacciolatti, Lee, & Song, 2015), how to sufficiently utilize and integrate foreign resources into the national innovation system at different stages of development and ultimately achieve innovation-driven development is still an important topic to be explored.

By implementing a panel data analysis, this study investigates the effects of the inward FDI stock intensity on regional innovation capacity in China by analyzing 31 provinces from 2000 to 2015. We do so through the lens of an alternative knowledge production function proposed by Jungmittag and Welfens (2017), which those authors applied in a European regional study, allowing us to examine how foreign capital participation through FDI affects regional knowledge accumulation. In order to provide a more comprehensive and contemporary understanding of the role of FDI in promoting innovation capacity at the regional level in China, we further observe the effects of the FDI stock on innovation output with different levels of novelty and its impact on innovation output in two different economic development regions.

Our findings confirm the important role of inward FDI stock intensity in positively affecting innovation output in China, but the effect gradually diminishes with an increase in innovation novelty. Regions with higher intensity of FDI stock increase low-novelty innovation capacity, but the impact on high-novelty innovation capacity is insignificant. From the regional perspective, the more developed coastal region is able to benefit from the resources and knowledge carried by FDI in achieving more minor innovations, but the positive effects of FDI on promoting major innovations are not significant. In contrast, the relatively backward inland region lags significantly behind the coastal region in generating innovations that benefit from FDI. Among the selected variables that play an important role in promoting innovation capacity in China, a substitution effect is revealed between inward FDI stock intensity and R&D personnel intensity in enhancing low-novelty innovation capacity. A potential complementary relationship between these two factors may exist when stimulating innovations with high novelty.

The present paper is organized as follows: Section 2.2 presents the conceptual basis drawing on the relevant literature for this analysis and the development of our hypotheses. Section 2.3 takes a close look at the model specification. Data sources and econometric methods are described in Section 2.4. The main empirical results and the robustness tests are provided in Section 2.5. Section 2.6 incorporates a series of conclusions, discussions, and policy options.

2.2 Conceptual Background and Hypotheses

Innovation can be viewed as a step that involves the implementation of new knowledge or technology and is typically associated with market commercialization (Schumpeter, 1942, 1947). Thus, successful innovation depends largely on the accumulated knowledge that can contribute to the novelty or complexity of innovations by accelerating innovation processes or providing the necessary foundations (Roper & Hewitt-Dundas, 2015). Since intellectual capital can be increased by adopting a consistent pattern of accumulation and using internal and external resources in line with one's characteristics and needs, innovation is cumulative and path-dependence (Fu, 2008).

FDI has been recognized as a major source of technology and knowledge channeling due to the anticipation that it carries with innovative knowledge, especially knowledge that is new to innovators in the host region and not directly available in the market, which yields additional spillover effects or positive externalities (Blomström & Kokko, 1997; Fu & Gong, 2011; Y. Wang et al., 2016). The entry of MNEs into the market can directly improve the technology and productivity of indigenous firms by operating their global R&D programs or localizing their R&D activities (Blomström & Kokko, 1997; Fu, 2015, p. 49). Besides, technology spillovers from foreign-invested firms may facilitate technological change in host country firms. The knowledge, either embedded as tacit knowledge or codified in the products or technology processes of foreign MNEs, may spillover to local firms through the demonstration of new technologies, technical assistance to their local suppliers and customers, or skilled labor turnover (Crespo & Fontoura, 2007; Javorcik, 2004; Kokko, 1994). Simultaneously, the magnitude and scope of spillover effects of FDI depend on the conditions in the recipient region and the strength of the linkages between various other factors. Therefore, the absorptive capacity of the local firms and organizations, i.e., the ability to identify, assimilate, and exploit knowledge in the environment, is decisive (W. M. Cohen & Levinthal, 1989, 1990).

Considering that knowledge spillovers decay with geographical, communication, and institutional distance, sufficient complementary assets strengthen a region's receptivity to new ideas and its ability to absorb new ideas and technologies (Fu, 2008; Krugman, 1991; Usai, 2011).

Since the reforms and opening up of 1979, China has been encouraging foreign capital participation in its economic development and has succeeded in attracting large amounts of international direct investment, making China the second-largest recipient of FDI in the world in recent years (UNCTAD, 2020). During the 2000s, FDI became essential to China's innovation system (M.-C. Hu & Mathews, 2008). Over the decades, China has also made considerable progress in developing and improving its domestic innovation system, including intensive investment in S&T, cultivating and attracting innovative talents, upgrading its industrial structure, and strengthening IPR protection (Fu, 2015, p. 15; OECD, 2016). With the expectation that domestic players will largely benefit from the presence of FDI, central and local governments have introduced and adopted a series of incentive policies aimed at removing investment barriers and creating a fertile environment for FDI (F. Liu et al., 2011; Y. Lu et al., 2017). In the meantime, the increasing coverage and quality of education and transportation and communication infrastructure facilitate the dissemination of knowledge and efficiency gains, thus creating new opportunities for learning and incentives for innovation (X. Wang, Xie, Zhang, & Huang, 2018). Based on the above evidence, we suggest that:

> ***Hypothesis 1:*** *FDI stock intensity is positively associated with the regional innovation capacity.*

However, innovations vary in novelty, and the effects of FDI on innovation also depend upon the nature of the knowledge demanded and the accumulation process. In order to achieve innovations with a higher degree of novelty, higher costs and organizational requirements are usually required. High-novelty innovations often have specific technical requirements that involve a continuous and appropriate integration of the breadth or/and depth of knowledge obtained. Thus, to be able to benefit from foreign investments, an effective pattern to facilitate the interaction between external and internal activities should be established, which is essential to create more learning opportunities and reduce uncertainty and path dependency (Cheung & Lin, 2004; Fu, 2008). At the same time, the transfer of resources between foreign parent companies and their subsidiaries is not costless, especially when it comes to advanced knowledge and technologies. For the purpose of maintaining a dominant competitive position

in markets and the consideration of relatively weak local IPR protections, foreign enterprises will undertake various measures to prevent or reduce the technology spillover effects on domestic enterprises, which also largely limit the spillover effects from FDI (Fu, Pietrobelli, & Soete, 2011; Grimes & Du, 2013). Thus, the positive outcome with high novelty related to FDI needs to be realized through sustained investment and over a more extended period, while innovations with low novelty are more likely to benefit from the demonstration or imitation effects of FDI.

While there is a rich literature on empirical evidence that adapts different methods to understand the impact of FDI on innovation output with different levels of novelty in China, the existing findings are moving towards a trend from a uniformly positive influence to a more bifurcated one, especially when the role of absorptive capacity and indigenous innovation is taken into account. Cheung and Lin (2004) emphasize the demonstration effects of FDI due to the noticeably significant results for those patents regarded as being technically less sophisticated in all regions using provincial-level data from 1995 to 2000. The findings of Bo (2007) confirm the importance of this "learning-by-watching" effect from FDI, but the author notes that reaching a certain threshold of human capital is the necessary pre-condition for having higher value-added inventions. A similar conclusion was suggested by Y. Chen (2007) finds that FDI positively affects only general and minor innovations. The author further proposes the existence of a crowding-out effect between FDI and domestic R&D activity. The research from A. G. Hu and Jefferson (2009) finds that industry FDI intensity has a strong positive effect on patent application rates in China. However, by comparing the corresponding patenting behavior of foreign and domestic firms in conjunction with the patent-R&D link, the authors argue that Chinese firms are opportunistic, while foreign firms prefer local customization to develop new technologies. Fu et al. (2011) also emphasize that to fully realize the benefits of international technology diffusion, indigenous innovation efforts, well-developed governance structures, and conducive innovation systems are indispensable. Hence, we expect the positive effects of FDI to be more visible in innovation with less sophistication required. Accordingly, the hypotheses are formed as follows:

> ***Hypothesis 2a:*** *The increase in FDI stock intensity will negatively contribute to the regional high-novelty innovation capacity.*
>
> ***Hypothesis 2b:*** *The increase in FDI stock intensity will positively contribute to the regional low-novelty innovation capacity.*

China's unique economic development experience has made it a transition economy with both low-cost sourcing and high differentiation innovation capabilities (S. L. Zhao et al., 2015). The coastal provinces (i.e., the coastal region), which have been opened relatively early to foreign investors compared to the other provinces of China, enjoyed a series of preferential policies and benefited from export-oriented industrialization. Companies had the privilege of enjoying a more flexible business environment as well as access to preferential tax rates and land in several special economic zones (SEZs) organized in the early years (McKern et al., 2021; Sharma, Wang, & Wong, 2014; G. C. Xu, 2011). It is, therefore, unsurprising that the market has gradually entered a mature industrial stage in the coastal provinces, and more knowledge and technology-intensive companies and industries are getting concentrated in this area, which generates positive agglomeration effects (Qi, Liu, Qi, & Liu, 2019; L. Wang & Szirmai, 2013; D. Zheng & Kuroda, 2013). Later on, a series of published national strategic development plans stated the intention to further develop China, with a prominent role for innovation in economic development, by systematically promoting a group of industries with advanced technology (F. Liu et al., 2011; National Development and Reform Commission [NDRC], 2016). As a result, there is a higher incentive and opportunity to innovate in coastal areas, and the region has a higher ability to recognize and absorb the knowledge and technology brought by foreign investment.

In contrast, due to the backward economic development and the lack of innovation opportunities and inputs in inland areas, the technological or know-how spilling over from the technology leaders is typically hard to reach or identify by innovation actors in the inland region (Fu, 2008; Yang & Lin, 2012). There has been encouragement from the Chinese central government vis-à-vis attracting more FDI into both central and western provinces (i.e., the inland region) since the late 1990s through a series of economic development plans, such as the "Great Western Development" plan and "the Rise of Central China Plan." Although a higher record in FDI inflows has been realized in these regions, the regional disparities in FDI intensity between coastal and inland remain substantial (Fu, 2008; S. Li & Park, 2006). Additionally, evidence shows that firms from more developed southeast provinces tend to relocate production facilities to inland provinces, but most relocations seek cheap labor and raw materials (Kroll, 2016; S. L. Zhao et al., 2015). Also, studies by (Ran, Voon, & Li, 2007; L. Wang et al., 2016) claim that the spatial spillover effects of FDI are generally unfavorable and point out that the gain from FDI in the eastern region is at the cost of the central and western regions. Thus, the following hypotheses are proposed:

Hypothesis 3a: *The increase in FDI stock intensity will positively affect the high-novelty innovation capacity in the coastal region.*

Hypothesis 3b: *The positive contribution of increased FDI stock intensity to low-novelty innovation capacity is higher in the coastal region than in the inland region.*

2.3 Model Specification

The analysis of innovation typically using the knowledge production function, as proposed by (Griliches, 1979, 1990), is considered to be a useful concept for empirically studying the relationship between an innovation output index and the relevant factor inputs. Usually, the relationship between R&D-related investment as the input and the resultant patenting activity as the output is studied (Czarnitzki, Kraft, & Thorwarth, 2009).

In this study, an alternative knowledge production function conducted by Jungmittag and Welfens (2017) is followed to understand the effects of FDI on the host country's innovation capacity. This theoretical model takes a broader view to relate the international factor inputs to the innovation process of an open economy, adapting from general analytical frameworks of both Griliches' knowledge production function and the knowledge formation process included in endogenous growth literature (Grossman & Helpman, 1991a; Jones, 1995; Romer, 1990). The approach considers an inter-related knowledge-output relationship, using the accumulated stock of knowledge as a nexus, to propose a compact and direct method of growth decomposition to identify the role of foreign capital participation intensity in promoting the long-run equilibrium stock of knowledge.

Firstly, it is assumed that the knowledge production function holds in the economy where the level of knowledge (A) is seen to positively contribute to the increment of new knowledge per unit of time (dA/dt). Thus, the knowledge production function is given as follows:

$$dA/dt = \left[\left(\frac{X}{L} \right)^{n'} \left(\frac{\alpha^* K}{Y} \right)^{\beta''} \right] A^{\beta'} - (\delta' - f' \frac{L'}{L}) A \qquad (2.1)$$

Where new knowledge accumulation in an economy, approximated by patent applications, is a positive function of the knowledge gains resulting from the degree of economic globalization

and R&D effort. The economic globalization intensity can be represented by considering the efficiency gained from trade inputs measured by the exports per capita (X/L), as well as the share of foreign ownership in a region's capital stock represented by α^*. Hence, α^*K is identical to the inward FDI stock (K^*), so the FDI stock intensity (K^*/Y) can be used to indicate the degree of foreign involvement in the economy. The R&D investment is expressed as the ratio of R&D researchers (L_A) to total employment (L) and δ_A is the depreciation rate of knowledge. The rest are positive parameters, i.e., $0<\beta_A<1;\beta_Y>0;f_A>0;0<\delta_A<1;n_A>0$.

From a long-run equilibrium perspective, the elasticity of new knowledge creation with respect to output (ΔA_A) can be assumed to be equal to the elasticity of the stock of knowledge in relation to output (A_A) with a constant ratio of $a=\Delta A_A/A_A$ in the steady state. Thus, the growth rate of A_A and ΔA_A is identical. Accordingly, with per capita income equal to y=Y/L, real exports are taken from the equation X=xY, where 0<x<1, the long-run equilibrium stock of knowledge $A^{\#}$ is equivalent to the long-run equilibrium stock of patents. The steady-state solution is given by:

$$A^{\#}=\left((xy)^{n_A}\left(\frac{\alpha^*K}{Y}\right)^{\beta_Y}\Big/\left(\delta_A-f_A\frac{L_A}{L}\right)\right)^{1/(1-\beta_A)} \tag{2.2}$$

After taking the logarithms and defining $\delta_A=1-\delta_Y$, where δ_Y is a non-depreciation rate, $\ln(1-\delta_Y-f_A(L_A/L))$ can be approximated by $-\delta_Y-f_A(L_A/L)$ as the latter converges to zero. Thus, we can write the equation as:

$$\ln A^{\#}=\left(\frac{n_A}{1-\beta_A}\right)(\ln x+\ln y)+\left(\frac{\beta_Y}{1-\beta_A}\right)\ln\left(\frac{\alpha^*K}{Y}\right)+\left(\frac{1}{1-\beta_A}\right)\left(\delta_Y+f_A\frac{L_A}{L}\right) \tag{2.3}$$

In addition, since the domestic ability to recognize and absorb relevant external innovation resources also determines knowledge stocks to some extent (W. M. Cohen & Levinthal, 1989, 1990), regional absorptive capacity and complementary assets are jointly considered to capture the spillover effects of FDI to improve the explanatory power of the model. The baseline estimation equation for empirical implementation can be extended as follows:

$$\begin{aligned}\ln(y_{i,t})=&\beta_0+\beta_1\ln(fdi_{i,t})+\beta_2(rdpt_{i,t})+\beta_3\ln(rgdppc_{i,t})+\beta_4\ln(x_{i,t})+\beta_5\ln(hc_{i,t})+\beta_6\ln(\inf_{i,t})\\&+\beta_7\ln(fdi_{i,t})\times inland_j+\mu_i+\delta_t+\varepsilon_{i,t}\end{aligned} \tag{2.4}$$

Where the dependent variable $y_{i,t}$ stands for stock of patents, the explanatory variables are the inward FDI stock intensity ($fdi_{i,t}$), the full-time equivalent of R&D personnel ratio ($rdpt_{i,t}$), real regional GDP per capita ($rgdppc_{i,t}$), export-GDP ratio ($x_{i,t}$), human capital quality ($hc_{i,t}$), and information and communication technology infrastructure ($inf_{i,t}$). The term $inland_j$ indicates two economic regions in China, and the dummy takes a value of 1 if a province belongs to the inland region and 0 if a province belongs to the coastal region. The list of the Chinese provinces in each sub-region mentioned can be found in Appendix Table 2.3. μ_i denotes the unobservable, time-invariant individual-specific effect, δ_t is the year-specific effect, and $\varepsilon_{i,t}$ are the idiosyncratic disturbances; i refers to the provinces of China (i =1, ... 31), and t denotes time (t =2000, ... 2015).

2.4 Data Description

2.4.1 Data source and selection

This study uses data from 31 Chinese provinces, and the time dimensions are that for each province with the annual data ranging from 2000 to 2015. Data have primarily been collected from secondary resources, i.e., the China National Intellectual Property Administration (CNIPA), the China Industry Economy Statistical Yearbook (CIESY), the China Statistics Yearbook (CSY), the Ministry of Science and Technology of China (MOST), the National Bureau of Statistics of China (NBSC), and the International Monetary Fund (IMF).

In the course of collecting the appropriate and relevant data, a series of limitations of existing data and sources, especially for regional-level research, became apparent. Firstly, the lack of data integrity and consistency. For example, data is unavailable in many cases, especially before 2000 or for certain underdeveloped provinces, such as Tibet and Qinghai. Secondly, there is a marked discrepancy between national-level data and the sum of provincial data. The reason for this problem from the NBSC is the different collection and calculation systems in different provinces, as well as the overstatement of economic growth figures by regional governments. These issues are discussed in more detail by Koch-Weser (2013). Lastly, detailed definitions or calculation methods for certain variables are either vague or missing.

2.4.1.1 Patent

Since patent stock data are not directly available, the dependent variable is computed from the number of patent applications using the perpetual inventory model with the base year 1999. Following this broadly applied method (B. Xu & Chiang, 2005), the initial value of the patent stock is calculated as $PAT^{S_0} = PAT^{f_0}/(g+\delta)$, where PAT^{f_0} is patent applications in 1999, g indicates the average growth rate of patent applications in the first ten years (2000-2009), and δ is the depreciation rate, which is assumed to be 15%. Patent stocks are calculated as $PAT^{S}_{t} = (1-\delta)PAT^{S}_{t-1} + PAT^{f}_{t-1}$.

Three kinds of accepted domestic patent applications at the regional level were selected as the patent flows. Based on the explanation from the second amendment of the Patent Law of China[2] in 2000, invention creations that are filed as a patent can be classified into three types, i.e., inventions, utility models, and designs. Usually, invention patents are treated as major innovations that are subject to the highest review standard and receive 20 years of protection to protect inventions with high novelty and non-obviousness; utility model patents protect minor inventions fit for practical use, and design patents are used to guard new shapes or patterns (Fu, 2008; Y. K. Kim, Lee, Park, & Choo, 2012; The State Council, PR China, 2001).

In accordance with the traditional discussion on the strengths of using patents as a measurement of innovation (see, e.g., Pakes & Griliches, 1980 and Smith, 2009), despite a certain specific influence from domestic patent subsidy programs, as discussed in the study of Dang and Motohashi (2015), patent statistics still serve as an informative and meaningful indicator of innovation in China. After comparison with other alternative measurements, we believe that the number of accepted domestic patent applications has several advantages, allowing it to best estimate the outcomes of regional innovation. Firstly, the number of accepted domestic patent applications was deemed to be a more complete indicator that takes the diffusion of technology processes into account, an aspect which has been neglected with regard to many other indicators such as the new product sales revenue or the proportion of new products in sales. Secondly, the chance of omitting innovation outcomes or affecting the time lag due to the assessment and approval process is smaller than the granted domestic patent applications. However, the limitations of using the number of patent applications cannot be ignored. For

[2] Amended according to the "*Decision on Amending the Patent Law of the People's Republic of China*" at the 17th Session of the Standing Committee of the Ninth National People's Congress on 25th August 2000.

instance, not all inventions are patentable and patented, or the (economic) significance of patents can differ greatly across sectors or in a given technological field (OECD, 2009, pp. 27–28; Trajtenberg, 1990).

2.4.1.2 FDI stock intensity

For the same reason, i.e., a lack of valid data on provincial-level FDI stocks and capital stocks, the variable of primary interest, namely the FDI stock intensity, is computed as a ratio of the capital obtained by industrial enterprises with foreign funds to total investment in fixed assets. This variable refers to the total capital invested in industrial enterprises by foreign investors, which is seen as a good indicator in referring to the propensity of foreign participation at the provincial level.

2.4.1.3 R&D researchers' input

The number of full-time equivalent R&D personnel relative to the resident population is used to reflect direct input from the R&D sector. The full-time equivalent refers to the sum of the full-time persons and the full-time equivalent of part-time persons converted by the workload. According to the standard knowledge production function, R&D expenditure is considered to be a broader measure of research effort due to the inclusion of both labor and physical capital. We tested this variable empirically and found it to be highly correlated with the R&D personnel variable used in our sample, so only the latter was retained in the main analysis.

2.4.1.4 GDP per capita

In order to control for the different development stages of each province, as well as to capture the effect of growth potential across regions, regional real GDP per capita was included in the estimation. It has been derived from the per capita nominal provincial GDP adjusted by the real growth indices of per capita provincial GDP, constant on the price of per capita nominal provincial GDP in 1999.

2.4.1.5 Export-GDP ratio

A region with a higher share of exports to GDP can expect a higher degree of openness, which will largely facilitate the flow and accumulation of knowledge and generate more opportunities for innovation and creativity due to the need to meet diverse customer preferences and requirements (Coe & Helpman, 1995; Grossman & Helpman, 1991b). The export-to-GDP ratio is calculated as the total value of provincial exports of destinations and catchments (adjusted

by the Renminbi (CNY)/US dollar (USD) market exchange rate) relative to nominal provincial GDP.

2.4.1.6 Human capital

The level of human capital largely determines the quality of the workforce. A high level of human capital will effectively improve the efficiency of the use of relevant factors of production and increase the returns to innovation (Borensztein, Gregorio, & Lee, 1998; B. Xu, 2000). Human capital is measured by the ratio of people with a college degree or above to the population over the age of six. The fraction of people with higher education is used to capture the role of knowledge workers, which largely represents a region's awareness and capacity to recognize and absorb external resources (Chi & Qian, 2010; Fu, 2008). A higher quality of local human capital is expected to be positively associated with knowledge stocks and diffusion.

2.4.1.7 Information and communication technology infrastructure

As telecommunication and information infrastructure can effectively facilitate the flow and sharing of knowledge in the broader network, it is regarded as an important factor in compressing the spatial and temporal distance of knowledge production (Qi et al., 2019). As access to the Internet is mainly achieved through broadband in China (R. Li & Shiu, 2012), the level of telecommunication and information infrastructure is approximated by the ratio of the length of long-distance fiber optic cable lines to the land area of each province.

A general description of the main variables and the expected effects on innovation output are listed in Table 2.1.

Table 2.1: An overview of the main variables

Variables	Acronym	Description	Expected sign	Source
Innovation output	pat_app_all	Cumulative accepted domestic patent applications		CNIPA
	pat_app_inv	Cumulative accepted invention patents		
	pat_app_uti	Cumulative accepted utility model patents		
	pat_app_des	Cumulative accepted design patents		
FDI stock intensity	fdi	The ratio of foreign capital obtained by industrial enterprises to total investment in fixed assets	+/-	CIESY, CSY
R&D inputs	rdpt	The ratio of the number of full-time equivalent R&D personnel to the resident population	+	MOST, NBSC
Real GDP per capita	rgdppc	Real provincial GDP per capita, constant on the price in 1999	+	NBSC, CSY
Export-GDP ratio	x	The ratio of the total value of provincial exports of destinations and catchments (adjusted by the CNY/USD market exchange rate) to nominal provincial GDP	+	NBSC, IMF
Human capital	hc	The ratio of people with college education and above to the population above six years old	+	NBSC
Telecommunication and information infrastructure	inf	The ratio of the length of long-distance optical cable lines(km) to provincial land area (km2)	+	NBSC
Inland	inland	Value 1 if a province belongs to the inland region, value 0 if a province belongs to the coastal region	+/–/Ø	NBSC

Notes: CNIPA is shorthand for China National Intellectual Property Administration, CIESY stands for China Industry Economy Statistic Yearbook, CSY means China Statistical Yearbook, MOST refers to Ministry of Science and Technology of China, NBSC is the abbreviation for National Bureau of Statistics of China, and IMF is the International Monetary Fund.
Source: Own compilation

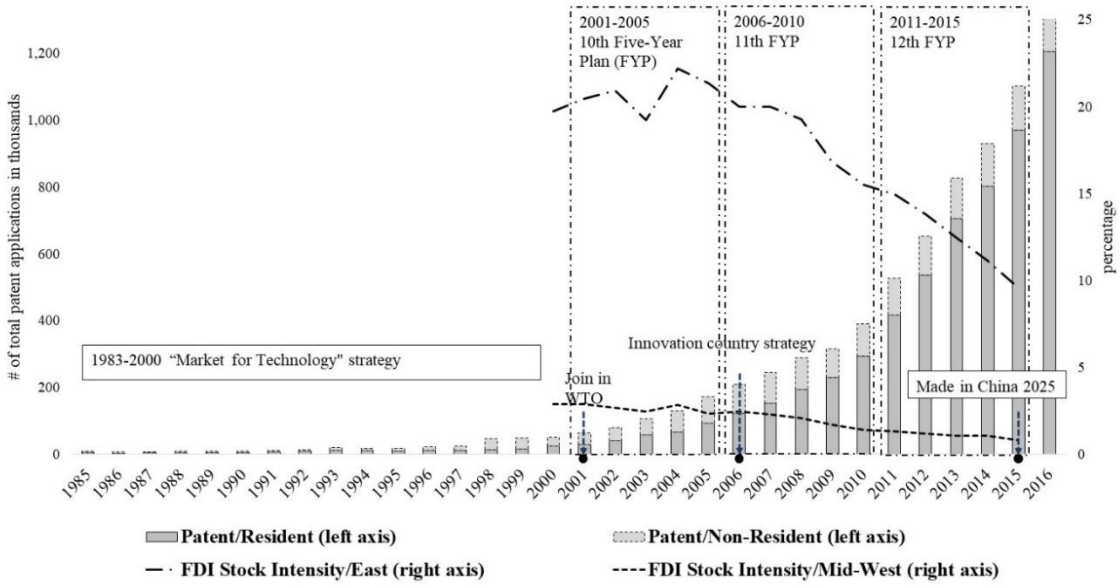
2.4.2 Descriptive results

As shown in the bar chart in Figure 2.1 below, the total number of patent applications grew slowly from the promulgation of the Chinese Patent Law in 1984 until the beginning of 2000. This period is also known for the adoption of the "Trading Market for Technology" strategy by the Chinese government (Mu & Lee, 2005). Thereafter, and in particular, after China's accession to the WTO in 2001, the number of total patent applications in China continued to increase incrementally and soared to over 1.3 million in 2016, which accounted for a nearly 25-fold increase compared to the number in 2000. By comparing the number of patent applications filed by Chinese residents (in grey) and non-residents (in light grey), the number of patent applications filed by domestic applicants has exceeded that of foreign applicants since

circa 2005 and is still surging to reach 1.2 million in 2016. By contrast, the number of patents applied for by Chinese non-residents has remained unchanged over the same period.

The FDI intensity in eastern and central-western regions from 2000 to 2015 is represented by lines in Figure 2.1. These data are obtained by taking the average of the provincial FDI stock intensities for the eastern and central-western provinces in China, respectively. The dash-dotted line indicates that the FDI stock intensity of the eastern region has experienced a significant increase since 2000. After reaching a peak in 2004, the average FDI stock intensity in the 11 eastern provinces experienced a significant decline. Meanwhile, the intensity of FDI stock in the central-western region, shown by the dashed line, maintained a relatively stable growth trend until around 2006 and then demonstrated a slight decline. However, the difference in FDI stock intensity between the two regions is shrinking, reflecting that the gap in foreign investment participation between the two regions is narrowing year by year.

Figure 2.1: Trends in total patent applications by filing office and inward FDI intensity ratio in China, 1985-2016



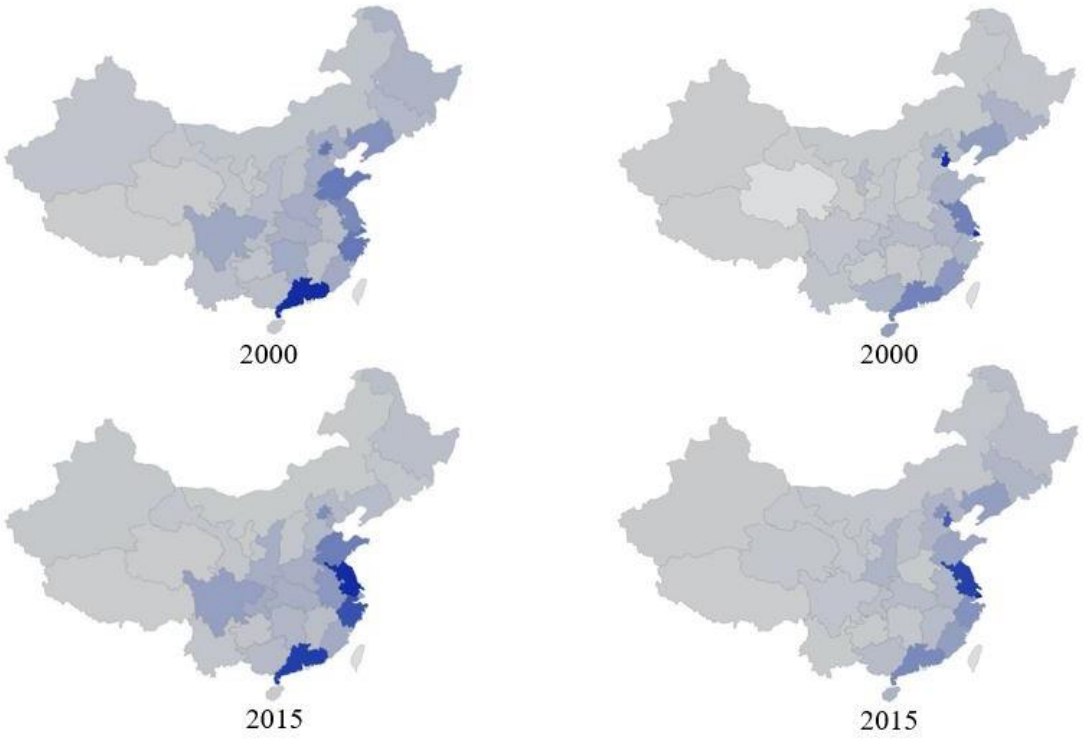
Source: China National Intellectual Property Administration, China Statistical Yearbook, China Industry Economic Statistic Yearbook. Own illustration

Figure 2.2 compares the provincial level of the patent counts and the FDI stock intensities in China between 2000 and 2015. The maps on the left show the total number of patent applications in 2000 and 2015, and the maps on the right display the FDI stock intensity by provinces in the same years. The darker the shaded area, the higher the quantity or intensity respectively. Both graphics individually show a discernible concentration in the eastern region for patent applications and FDI stock intensity. The situation has not changed much over the

past 16 years. Still, there are some noticeable internal changes. As demonstrated in Figure 2.2 (a), it is clear that the most innovative provinces are situated in eastern China after all these years. However, in 2015, the innovative hub moved from the Pearl River Delta[3] area in 2000 to the Yangtze River Delta (YRD)[4]. Meanwhile, there was a slow trend of innovation expansion in the central-western region from 2000 to 2015. Compared to other inland provinces, the emerging area in southwestern China has stood out since 2000 with relatively high innovation output. A similar situation emerges for the FDI stock intensity, as shown in Figure 2.2 (b), where the eastern area remains the primary choice for inward FDI stock in China between 2000 and 2015. In 2015, The FDI stock intensity in China illustrated a growing trend in the eastern provinces, especially in the YRD area, and slow growth in the middle and western provinces.

Figure 2.2: Number of domestic patent applications accepted and FDI stock intensity by provinces in 2000 and 2015

(a) Number of domestic patent applications (b) FDI stock intensity



Notes: Darker-shaded area indicates higher counts or intensity.

Source: China National Intellectual Property Administration, China Industry Economy Statistic Yearbook, China Statistical Yearbook. Own illustration

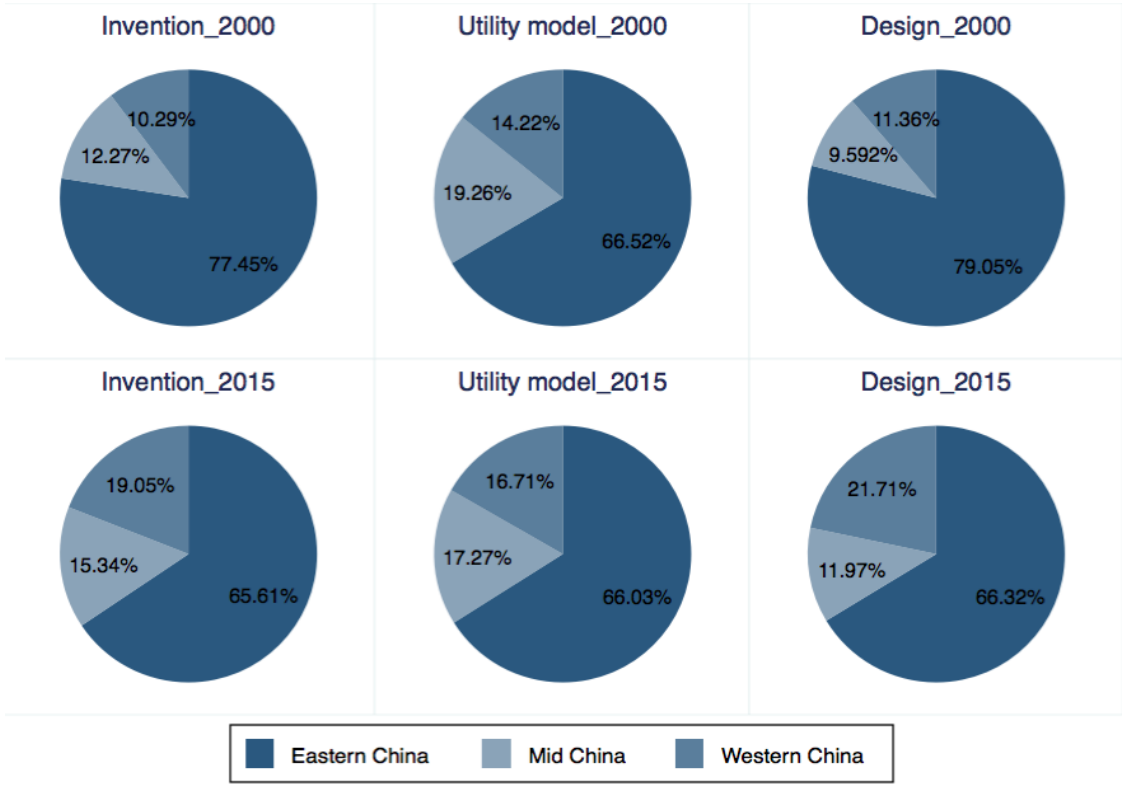
[3] Guangdong; Hong Kong, China; Macao, China

[4] Shanghai; Jiangsu; Zhejiang

Upon a closer look at the proportion of the three different kinds of domestic patent applications in 2000 and 2015 (see Figure 2.3), we can see that the eastern region has an absolute leading position in terms of the number of all three kinds of patents among all sub-regions, with each type accounting for about 2/3^{rds} of the respective total.

The middle and western regions account for approximately 10% of the total innovation output for each, measured by the number of patents at the beginning of the compared period. The mid-China region leads slightly in generating invention and utility model patents compared to the west-China region. Interestingly, the proportion of all kinds of patents for the central-western region significantly increased until 2015. The considerable improvement is mainly in invention and design patents, which rose by almost 10% each year in 2015 compared with the figures in 2000. Moreover, the catching-up process in advanced technology and industrial product design innovations is more visible in the western provinces; the amount of invention and design patents had doubled by 2015 and even overtook the same kinds of patents in central provinces. Instead, the change in innovation output in the central region is negligible. However, the main development in the western region might be concentrated in just a few provinces in the emerging areas, which have already exhibited an advanced innovation ability since 2000.

Figure 2.3: Three kinds of domestic patent applications in sub-regions of China in 2000 and 2015



Source: China National Intellectual Property Administration, National Bureau of Statistics of China. Own illustration

2.5 Empirical Analysis

2.5.1 Estimation method

This study intends to understand the effects of FDI stock intensity on the regional innovation capacity of China using data from 31 selected provinces over the period 2000-2015. Panel data analysis is thus considered an appropriate method as it provides more informative data, increases the degrees of freedom, and reduces multicollinearity amongst explanatory variables (Baltagi, 2021, pp. 6–9).

Before proceeding to the estimation, we first test for cross-sectional dependence (CD), aiming to apply the appropriate unit root tests in the next step (Driscoll & Kraay, 1998; Pesaran, 2004). In this work (see Appendix Table 2.4), the null hypothesis of cross-sectional independence was strongly rejected for all series. Thus, we employ the cross-sectionally augmented Dickey-Fuller (CADF) panel unit root test developed by Pesaran (2007) that controls for CD to test the existence of common panel stationarity. Based on the results in Appendix Table 2.5, we can reject the null hypothesis that the variable contains a unit root in favor of the alternative that all individual variables are stationary with and without trend, at least in the first differences. Furthermore, according to the results of descriptive statistics, pairwise correlations, and computed variance inflation factors (VIF) for the principle regression variables reported in Appendix Table 2.6, the correlations between variables exhibit the expected signs, and the test results from VIF are all lower than the acceptable level of 10 (Kutner, 2005, p. 409). Therefore, all regressors can be included in the same regression, and multicollinearity is not considered to be an issue.

Then, we consider the possible existence of specific effects in different provinces that may affect the estimation results, and therefore, the presence of individual-specific effects is tested. All results of applied diagnostic tests for each model are reported in Table 2.2. According to the statistics of an F-test, we can significantly reject the null hypothesis in favor of the alternative hypothesis, in which at least one dummy parameter is not equal to zero. Thus, we can conclude that the FE model is superior to the pooled OLS estimator (Baltagi, 2021, p. 18). Following this, the model with random effects (RE) is also examined by a Lagrange multiplier (LM) test. The null hypothesis of the LM test, which assumes that variances across entities are zero, can be rejected based on a significant result. This indicates that the RE model has better goodness-of-fit to the data in comparison to the pooled OLS model (Breusch & Pagan, 1980).

When both fixed- and random-effects can be observed in the panel data, the Hausman specification test is conducted to compare the two models. The test's highly significant result at a 5% significance level rejects the null hypothesis that the model with RE is more efficient than FE (J. A. Hausman, 1978). Therefore, the model with FE is chosen to deal with the problem of unobserved individual effects or individual-specific characteristics of the provinces in China. Furthermore, fixed time effects are included in each model because the null hypothesis of all years jointly equal to zero is rejected by the significant results less than the usual significance level. Driscoll-Kraay standard errors are obtained to provide robust estimations due to the disturbances being indicated to be cross-sectionally dependent, groupwise heteroscedastic, and autocorrelated (Driscoll & Kraay, 1998; Hoechle, 2007).

Finally, endogeneity issues may also emerge, such as the time required to recognize and absorb knowledge from FDI and to have an impact on the innovation output of a region and the possibility that FDI may be intentionally located in regions with higher levels of innovation capacity. In this study, we, therefore, lagged the values of all continuous independent variables by one year to mitigate possible dynamic endogeneity between FDI and the dependent variable, as suggested by many researchers (see Fu, 2008; Tian, Lo, & Song, 2016; Usai, 2011, among others). Also, an interaction term between FDI and R&D is added to the model to capture the endogeneity problem of innovative regions possibly attracting more FDI (L. Wang et al., 2016). Ultimately, we use a two-way fixed-effects model with Driscoll-Kraay standard error estimates.

2.5.2 Estimation results

The estimated main results are presented in Table 2.2. We report the estimations in column 1 using the explained variable measured by the accumulated total number of patents in the natural logarithm. Columns 2 to 7 contain the regression outcomes using log-transformed cumulative invention (_inv), utility model (_uti), and design (_des) patents as output variables. As can be seen in the lower part of the regression table, the estimated coefficients of all control variables are reported, which bear the expected signs and are statistically significant in almost all estimations. All models have a good statistical significance and can explain more than 85% of the variations of domestic patent stocks with within R^2 statistics above 0.85, and the F-test values are significant at the level of 0.05.

Table 2.2: Regression results

DV: pat_app	(1) ln(_all)	(2) ln(_inv)	(3) ln(_uti)	(4) ln(_des)	(5) ln(_inv)	(6) ln(_uti)	(7) ln(_des)
L1_ln(fdi)	0.091***	0.003	0.066**	0.172***	0.084	0.184***	0.503***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.05)	(0.03)	(0.05)
L1_ln(fdi) × L1_rdpt	-0.093	0.253	-0.104	-0.390*	0.195	-0.19	-0.630**
	(0.17)	(0.15)	(0.22)	(0.20)	(0.17)	(0.22)	(0.22)
L1_ln(fdi) × inland					-0.093*	-0.137***	-0.382***
					(0.05)	(0.02)	(0.04)
L1_rdpt	1.703**	2.508***	1.744***	0.973**	2.475***	1.695***	0.834*
	(0.59)	(0.75)	(0.56)	(0.43)	(0.75)	(0.55)	(0.43)
L1_ln(rgdppc)	0.740***	0.859***	0.514***	1.397***	0.826***	0.466***	1.262***
	(0.12)	(0.12)	(0.12)	(0.18)	(0.13)	(0.13)	(0.23)
L1_ln(x)	0.139**	0.155***	0.231***	0.095	0.161***	0.240***	0.118
	(0.05)	(0.04)	(0.05)	(0.09)	(0.04)	(0.05)	(0.09)
L1_ln(hc)	0.326***	0.352***	0.254**	0.395***	0.343***	0.240**	0.357***
	(0.10)	(0.09)	(0.09)	(0.12)	(0.09)	(0.09)	(0.12)
L1_ln(inf)	-0.078	-0.143*	-0.092	-0.073	-0.121	-0.059	0.021
	(0.09)	(0.08)	(0.06)	(0.14)	(0.07)	(0.06)	(0.12)
_cons	9.841***	8.006***	9.697***	6.387***	8.160***	9.924***	7.021***
	(0.33)	(0.44)	(0.29)	(0.49)	(0.46)	(0.33)	(0.68)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	464	464	464	464	464	464	464
# of Province	31	31	31	31	31	31	31
F-test	5.47+E6***	9.10+E6***	2.84+E6***	4140.3***	2816.8***	2523.0***	5189.1***
Hausman test	42.69***	51.76***	45.31***	36.56***	48.23***	44.30***	39.75***
Within R-sq	0.937	0.956	0.941	0.853	0.956	0.942	0.859

Notes: L1 represents a lag of 1 year, ln() means the variable took natural logarithm. Robust standard errors are reported in parentheses.
*Significance levels: * p<0.10, ** p<0.05, *** p<0.01*

In Model 1, we tested the effect of our primary variable on total patent stocks. We find that the estimated coefficient of the one-year lagged FDI stock intensity is positive and statistically significant at the 0.01 level. This outcome suggests that a one-percent increase in 1-year lagged FDI stock intensity is positively associated with a 0.09 percent change in total patent stocks. In this case, we cannot reject **Hypothesis 1**, which proposes that FDI stock intensity is positively associated with the regional innovation capacity.

Hypothesis 2a expected that the FDI stock intensity would negatively contribute to the high-novelty regional innovation capacity. Invention patent stock is used to measure the major innovation output, and the regression result is shown in column 2. According to the findings, although the FDI variable is positively associated with invention patent stocks, suggesting that a higher FDI stock intensity will lead to a higher stock of innovations with high novelty, the effect is insignificant at the usual significance level. Therefore, we do not find empirical evidence to support Hypothesis 2a.

Hypothesis 2b states that the increase in FDI stock intensity will positively contribute to the low-novelty regional innovation capacity. Both utility model patents and design patents are considered to indicate the innovation output with low novelty separately, and the results are given in columns 3 and 4. As expected, the FDI stock intensity lagged by one year positively impacts the accumulation of less sophisticated patent applications. The utility models and designs are predicted to increase by 0.07 and 0.17 percent with a one-percent increase of the 1-year lagged FDI stock intensity. The change in effect is significant at the 1 percent level in both models, ceteris paribus. So, the findings provide strong support for this hypothesis.

In Model 5, we interact the FDI variable with the region dummy, enabling us to test whether a higher FDI stock intensity will positively affect the high-novelty innovation capacity in the coastal region, as proposed by **Hypothesis 3a**. The coastal region is selected as the reference group in this study. As reported in column 5, the estimated coefficient of FDI shows that a 1 percent increase of the FDI variable will lead to a 0.08 percent increase in invention patents; however, the effect change is insignificant even at the 10 percent level. Thus, our empirical findings only partially support the positive impact of inward FDI stock intensity on innovation with high novelty in the coastal region.

The analysis results presented in Models 6 and 7 identify the effects of FDI stock intensity on innovations with low novelty between the two regions. **Hypothesis 3b** predicts that the positive

contribution of increased FDI stock intensity to low-novelty innovation capacity is higher in the coastal region than in the inland regions. The findings displayed in both columns show that for every percent increase of the 1-year lagged FDI stock intensity will lead to a 0.14 ($p<.01$) and 0.38 ($p<.01$) percent lower increase in utility model patents and design patents in the inland region than in the coastal region. Therefore, the facts propose that the inland region is significantly falling behind the coastal region in benefiting from a higher FDI stock intensity in producing innovation output with lower novelty. Thus, Hypothesis 3b cannot be rejected by the findings.

Regarding other jointly tested variables, R&D personnel intensity, real GDP per capita, export-GDP ratio, and human capital quality are essential in enhancing regional innovation capacity in China. The significant impact of telecommunication and information infrastructure was not found in this data sample. Among the selected variables, R&D personnel intensity has the strongest impact on producing more patents despite designs. In addition, the estimated results of the interaction term between FDI and R&D variables send an interesting message. Even though the effect is only significant for the design patents, in general, there is a substitution effect between FDI stock intensity and R&D personnel intensity when generating more low-novelty innovations. Conversely, a potential complementary relationship remains between these two variables in stimulating high-novelty innovations.

2.5.3 Robustness check

According to the multiple annual reports on patent survey data from the Chinese Patent Office, the average period of patent R&D activities is mainly less than and does not include three years (see, for example, Development Department of CNIPA & Intellectual Property Development & Research Center of CNIPA, 2016). Thus, to check the robustness of the results, the authors lagged all regressors by two years to replicate the estimates. As documented in Appendix Table 2.7, the estimation results remain stable.

2.6 Conclusion and Discussion

2.6.1 Conclusion

This paper investigates the effects of the inward FDI stock intensity on China's regional innovation capacity. At the same time, we are exploring its impact on high- and low-novelty innovation capacity and the different innovation capacities in regions with diverse economic development. By adopting an alternative knowledge production function, which includes the economic globalization input effects into the innovation process, the role of cross-border investment on knowledge accumulation is taken into consideration to analyze the effects of FDI stock intensity on innovation capacity.

By estimating FE models using provincial data from 2000 to 2015, our empirical findings demonstrate that the contribution of FDI stock intensity to China's overall innovation capacity remains significant. However, the positive impact diminishes gradually with the increase in the inventiveness of innovations. Our results show that the positive impact of FDI stock intensity is only seen for innovations with relatively low novelty, where FDI stock intensity has the greatest impact on generating more design patents, followed by utility model patents. On the contrary, the significant effects of FDI on promoting more high-novelty innovations cannot be identified in this study.

Moreover, when further distinguishing the provinces into coastal and inland regions according to their economic development status, FDI stock intensity is shown to have significantly different effects on these two regions' innovation capacities. In the more economically developed coastal region, as the intensity of FDI stock increases, the low-novelty innovation capacity also increases significantly, and the increment will be significantly higher than that in the inland region. However, an equally important positive impact on the high-novelty innovation capacity from increased FDI stock intensity cannot be found in the coastal region. In the less developed inland region, consistent with previous conjectures, the impact of FDI stock intensity on both high- and low-novelty innovation capacities is negligible compared to the coastal region.

Finally, R&D personnel intensity, real GDP per capita, export-GDP ratio, and human capital quality are positively and significantly associated with patent accumulation. Among others, R&D personnel intensity displays the strongest impact on generating more kinds of patents.

Nevertheless, by viewing the interaction between FDI and R&D variables, we identify a substitution effect between FDI stock intensity and R&D personnel intensity on encouraging more low-novelty innovations and a potentially complementary relationship in stimulating high-novelty innovations.

2.6.2 Discussion

From a policy perspective, the above evidence suggests that it is still effective to attract more FDI in order to gain valuable advanced technology and managerial competencies to enhance regional innovation capacity in China. Therefore, strengthening the IPR protection regime and the continuous optimization of administrative procedures is necessary to provide a friendly environment and incentives for innovation promotion.

In an emerging economy, high R&D inputs and extended learning and adoption processes are a pre-condition for benefitting from the advanced technology and knowledge transfer and spillovers from FDI, in particular, to achieve more major innovations. Investing in promoting research fields in universities and research labs that match the local conditions to expand the role and importance of skilled labor and researchers is necessary. At the same time, providing and organizing practical training education and programs to enhance the practical skills and know-how of the workforce is equally crucial but somewhat neglected. More intensive cooperation between universities, training schools, and enterprises should be activated. This would provide various opportunities for students and researchers to put their gained knowledge into practice and allow firms to enhance their productivity and innovativeness by cooperating on product/process innovation projects and their search for well-educated staff.

For minor innovations and designs, it is beneficial to imitate and adapt existing technologies to enhance the innovation capacity with relatively low technical content and avoid the high cost of independent innovation (Fu & Gong, 2011; Lai, Peng, & Bao, 2006). Therefore, continuing efforts to encourage FDI participation and enhance the interaction could be doubly significant. Foreign subsidiaries often invest in their staff so that training and skill upgrading are emphasized in a way that is quite crucial for knowledge-intensive production. Also, the tenure of part of the staff in foreign subsidiaries in China is typically quite long. It thus could help to contribute to improvements in industry standards or regional standards in relevant employment fields.

Regarding the sub-regional level, the eastern provinces have developed solid innovation capabilities and absorptive capacities that can eliminate the path dependence of FDI-led knowledge spillovers in generating extra low-novelty innovations. They should further develop their innovation capacities by adopting the resources and opportunities brought by FDI to achieve technological and industrial upgrading.

In inland China, the essential innovation assets and opportunities are constrained, and the local innovative capabilities are not efficient in absorbing knowledge transferred or diffused from FDI, which further limits innovation incentive and ability. In order to overcome these weaknesses and benefit from foreign knowledge and technology, local governments should play an important role in actively encouraging high-quality FDI into inland China by launching beneficial policies and giving guidance to those industries with comparative advantages to match the domestic resources and development needs and search for new opportunities.

Different provinces or areas should develop their individual specifications vis-à-vis attracting more FDI and promising technological and know-how spillovers. Moreover, the inland region should intensify cooperation with firms and organizations in the eastern region and study their experience in undertaking FDI projects to reduce the economic and time costs of a trial-and-error process. At the same time, it is important to strengthen environmental regulation policies, raise awareness of local environmental protection, consider the natural environment's protection while accepting foreign investment, and not follow the old path of simply exchanging natural resources for capital and technology.

Certainly, there is still room for further enhancement of this study. Although using lagged values of exogenous variables to mitigate the endogeneity between FDI and patent applications is generally recommended, finding the ideal instrumental variable would facilitate an optimal control for this endogeneity problem, thus enhancing the predictive power of the estimation.

2.6.3 Appendix

Table 2.3: The selected sub-regions of China: Respective East-, Mid- and West- Provinces

Region	Eco. Region	Name	Numbers
Coastal region	Eastern region	Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, Zhejiang	11
Inland region	Central region	Anhui, Heilongjiang, Henan, Hubei, Hunan, Inner Mongolia, Jiangxi, Jilin, Shanxi	9
	Western region	Chongqing, Gansu, Guangxi, Guizhou, Ningxia, Qinghai, Shaanxi, Sichuan, Tibet, Xinjiang, Yunnan	11

Source: National Bureau of Statistics of China. Own compilation

Table 2.4: Pre-estimation test on cross-section correlation (CD test)

	Variable	CD-test	p-value	Average correlation coefficient	Absolute correlation coefficient
(1)	ln(pat_app_all)	84.82	0.00	0.98	0.98
(2)	ln(pat_app_inv)	84.79	0.00	0.98	0.98
(3)	ln(pat_app_uti)	84.95	0.00	0.99	0.99
(4)	ln(pat_app_des)	80.98	0.00	0.94	0.94
(5)	L1_ln(fdi)	34.87	0.00	0.42	0.55
(6)	L1_rdpt	76.52	0.00	0.92	0.92
(7)	L1_ln(rgdppc)	83.21	0.00	1.00	1.00
(8)	L1_ln(x)	27.83	0.00	0.33	0.55
(9)	L1_ln(hc)	71.97	0.00	0.87	0.87
(10)	L1_ln(inf)	64.73	0.00	0.81	0.81

Table 2.5: CADF panel unit root test

		Levels				1st differences			
		constant		constant+trend		constant		constant+trend	
	Variable	Z(t-bar)	p-value	Z(t-bar)	p-value	Z(t-bar)	p-value	Z(t-bar)	p-value
(1)	ln(pat_app_all)	7.86	1.00	3.78	1.00	-1.67	0.05	0.91	0.82
(2)	ln(pat_app_inv)	2.72	1.00	3.63	1.00	-3.67	0.00	-2.64	0.00
(3)	ln(pat_app_uti)	7.33	1.00	4.01	1.00	-2.74	0.00	-1.87	0.03
(4)	ln(pat_app_des)	5.79	1.00	3.81	1.00	-1.55	0.06	0.16	0.57
(5)	L1_ln(fdi)	-1.25	0.11	-5.81	0.00	-11.73	0.00	-8.56	0.00
(6)	L1_rdpt	-2.16	0.02	-0.68	0.25	-8.62	0.00	-4.27	0.00
(7)	L1_ln(rgdppc)	1.48	0.93	5.55	1.00	0.02	0.51	1.12	0.87
(8)	L1_ln(x)	2.82	1.00	0.27	0.61	-6.38	0.00	-5.11	0.00
(9)	L1_ln(hc)	-5.19	0.00	-2.75	0.00	-13.86	0.00	-10.94	0.00
(10)	L1_ln(inf)	-4.35	0.00	-3.46	0.00	-11.84	0.00	-8.55	0.00

Table 2.6: Descriptive statistics and pairwise correlations

	Variable	Obs	Mean	Std. Dev.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	ln(pat_app_all)	496	10.06	1.73	1.00									
(2)	ln(pat_app_inv)	496	8.56	1.81	0.98*	1.00								
(3)	ln(pat_app_uti)	496	9.27	1.70	0.99*	0.96*	1.00							
(4)	ln(pat_app_des)	496	8.74	1.81	0.97*	0.92*	0.93*	1.00						
(5)	L1_ln(fdi)	464	-3.5	1.36	0.52*	0.46*	0.49*	0.56*	1.00					
(6)	L1_rdpt	465	0.16	0.20	0.55*	0.62*	0.51*	0.50*	0.49*	1.00				
(7)	L1_ln(rgdppc)	465	2.7	0.69	0.72*	0.77*	0.66*	0.71*	0.46*	0.69*	1.00			
(8)	L1_ln(x)	465	-2.8	0.74	0.36*	0.27*	0.32*	0.44*	0.55*	0.28*	0.38*	1.00		
(9)	L1_ln(hc)	465	-2.71	0.63	0.63*	0.71*	0.60*	0.55*	0.36*	0.72*	0.81*	0.19*	1.00	
(10)	L1_ln(inf)	465	-2.28	0.88	0.79*	0.79*	0.77*	0.77*	0.63*	0.51*	0.58*	0.33*	0.54*	1.00

*Notes: * shows significance at the .05 level*

Table 2.7: Robustness test with two-year lagged independent variables

DV: pat_app	(1) ln(_all)	(2) ln(_inv)	(3) ln(_uti)	(4) ln(_des)	(5) ln(_inv)	(6) ln(_uti)	(7) ln(_des)
L2_ln(fdi)	0.070***	-0.011	0.056**	0.151***	0.094	0.211***	0.485***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)	(0.05)	(0.05)
L2_ln(fdi) × L1_rdpt	-0.088	0.249	-0.115	-0.344**	0.168	-0.234	-0.600***
	(0.13)	(0.17)	(0.19)	(0.13)	(0.19)	(0.21)	(0.11)
L2_ln(fdi) × inland					-0.119**	-0.175***	-0.377***
					(0.05)	(0.04)	(0.05)
L1_rdpt	1.556***	2.192***	1.644***	0.963***	2.127***	1.549***	0.759***
	(0.47)	(0.67)	(0.44)	(0.27)	(0.67)	(0.43)	(0.24)
L1_ln(rgdppc)	0.691***	0.815***	0.481***	1.341***	0.774***	0.420***	1.210***
	(0.12)	(0.11)	(0.12)	(0.19)	(0.12)	(0.14)	(0.22)
L1_ln(x)	0.117*	0.136***	0.209***	0.0573	0.142***	0.217***	0.0743
	(0.06)	(0.04)	(0.05)	(0.10)	(0.04)	(0.05)	(0.09)
L1_ln(hc)	0.354***	0.389***	0.262***	0.427***	0.381***	0.251***	0.403***
	(0.08)	(0.08)	(0.07)	(0.10)	(0.07)	(0.07)	(0.10)
L1_ln(inf)	-0.120	-0.174**	-0.114*	-0.166	-0.142*	-0.066	-0.062
	(0.09)	(0.07)	(0.06)	(0.14)	(0.07)	(0.05)	(0.12)
_cons	9.877***	8.141***	9.699***	6.307***	8.353***	10.01***	6.976***
	(0.31)	(0.37)	(0.28)	(0.56)	(0.39)	(0.34)	(0.66)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	433	433	433	433	433	433	433
# of Province	31	31	31	31	31	31	31
F-test	4.68+E6	733.0	723.4	3027.6	2111.0	2575.8	1885.6
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Within R-sq	0.937	0.956	0.941	0.847	0.957	0.943	0.852

*Notes: L1 and L2 represent a lag of 1 year and 2 years respectively, ln() means the variable took natural logarithm. Robust standard errors are reported in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01*

CHAPTER 3 -
MERGERS AND ACQUISITIONS BY CHINESE MULTINATIONALS IN EUROPE: THE EFFECTS ON THE INNOVATION PERFORMANCE OF ACQUIRING FIRMS

3.1 Introduction

Knowledge is well recognized as an essential element of factor-driven economic growth. With globalization and technological advances, companies from both developed and developing economies have more options and face new challenges in generating new knowledge when operating on a global basis (Dunning & Lundan, 2008, p. 126). Multinational enterprises, as one of the main contributors to knowledge creation and diffusion, often use the international expansion function to seek the necessary resources and global experience (Narula & Zanfei, 2009). As late-comers to the global market, emerging-market multinational enterprises (EMNEs) have been changing the global dynamics of outward FDI and the landscape of international expansion by learning from past acquisitions and investment partners. Simultaneously, EMNEs begin to upgrade their innovation capabilities with a more proactive attitude to continually reshape the world economy (Luo & Tung, 2018; Papanastassiou, Pearce, & Zanfei, 2020).

Since the beginning of the 21st century, EMNEs have been under increased pressure to improve their "soft" power in strengthening companies' growth and international competitiveness (Child & Rodrigues, 2005; Papanastassiou et al., 2020). Along with other primary motivations, there is clear evidence of an increasing tendency of EMNEs to appropriate their innovativeness by acquiring sophisticated technology and know-how from foreign firms or their subsidiaries in advanced economies (Amendolagine, Giuliani, Martinelli, & Rabellotti, 2018; Luo & Tung, 2007, 2018; Rui & Yip, 2008). This is frequently done by engaging in M&A, which is perceived as an effective channel for knowledge exploration, especially in areas in which such

knowledge is difficult to acquire through trade or by way of imitation (Deng, 2009; Edamura, Haneda, Inui, Tan, & Todo, 2014), or for firms with no direct or relatively less experience seeking quick access to intangible assets (Fu et al., 2018; Y. Liu & Woywode, 2013).

The fast growth of internationalization activities by Chinese multinationals in the EU, as well as the strong incentive for knowledge acquisition from Chinese multinationals and the government, serve as an interesting and representative case of EMNEs in practice. First, China is currently the largest source country of outward FDI worldwide (UNCTAD, 2021b, p. 23). M&A purchases from Chinese investors in the EU experienced a significant increase and became the dominant market entry model (Kratz, Huotari, Hanemann, & Arcesati, 2020). It is also found that investors from China are willing to pay higher premiums when acquiring large stakes in companies (Achleitner, Bazhutov, Betzer, & Keppler, 2021). Second, the EU, predominantly Western European countries, is often regarded as an attractive investment destination for investors seeking knowledge and technological know-how because of the substantial knowledge reserves and the large variety of innovations on hand (Alvandi et al., 2015; Cozza, Rabellotti, & Sanfilippo, 2015). Last, the government has significantly supported Chinese multinationals investing abroad due to the expectation of benefiting from advanced external resources to progress further along global value chains (Fu et al., 2018; Kwok, Lau, & Summers, 2018). Although the Chinese economy experienced rapid growth in the past decades, and a subset of industries narrowed the gap with the technological frontier, its high-tech and modern service industries are still lagging (The State Council, PR China, 2005).

In recent years, the restrictive domestic and international investment condition has led to a decline and new challenges to the internationalization via M&A of Chinese firms (UNCTAD, 2020, p. 32). At home, the Chinese government has tightened its outward FDI controls and even forbade certain types of firm internationalization since 2017, especially investments grouped as “non-radical” activities were affected (General Office of the State Council, PR China, 2017). Abroad, the global investment environment is also becoming more complicated and challenging. A major concern about losing domestic technology and labor to multinationals from emerging countries has contributed to a more restrictive economic and institutional environment (Giuliani, Gorgoni, Günther, & Rabellotti, 2014).

Exploring and absorbing external knowledge can be costly and time-consuming due to the complexity and high risk of the process and the trade-off of related resources (Bertrand & Capron, 2015). EMNEs illustrate a strong incentive to improve competitiveness in the global

market with constrained resources and competencies to learn from a trial-and-error process and face mixed pressures from dynamic internal and external institutional environments. The possibility of achieving a higher knowledge base via outward M&A or, eventually, struggling in the integration process and losing the ability and opportunity to innovate makes the study essential. Prior studies on this topic have either focused primarily on MNEs from advanced regions and countries that are discrete in terms of experience and resources (Cloodt, Hagedoorn, & van Kranenburg, 2006; Narula, 2017; Piperopoulos et al., 2018) or the findings are still limited and inconsistent (Amendolagine et al., 2018; Anderson, Sutherland, & Severe, 2015; Buckley, Elia, & Kafouros, 2014).

Therefore, this research adds further evidence to the seminal studies in this area by focusing on the change in innovation performance of Chinese multinationals internationalized via M&A in the EU28 from 2010 to 2018. The contribution of this study is twofold: First, to make the analysis possible, the author constructed a unique longitudinal dataset containing comprehensive coverage of and recent information on the patent applications of Chinese multinationals and their M&A deals in EU countries by harmonizing data from several sources. Second, by applying the ZINB estimation to capture the potential influence of firms' patenting behavior on innovation performance measures, several new insights are revealed concerning the innovation output of Chinese firms following EU M&A.

The main results suggest that Chinese acquiring firms can expect a positive return vis-á-vis innovation performance by exploring developed foreign markets through M&A. However, significant improvements have occurred for a few technological front-runners acquirers rather than the vast majority. Meanwhile, there is still a clear distinction between firms with different levels of technological intensity or different forms of corporate ownership. The author observes a significant improvement in the innovation performance of lower intermediate-tech firms after undertaking M&A, but the same effect is not observed for upper intermediate-tech firms. POEs are, compared to other Chinese MNEs ownership types, the main investors in the EU market and substantially benefit from M&A in terms of developing their innovation output. On the other hand, SOEs generally obtain higher innovation outcomes than POEs but show no discernible differences in innovation performance after having undertaken M&A. Further analysis shows that Chinese technology-intensive firms' innovation performance does not differ significantly following their M&A activities in the EU28 between POEs and SOEs. Thus, the empirical findings help address the current technology adoption approach and result using

external knowledge from China, providing new perspectives for deploying existing and new policy instruments when investing in the EU.

The paper is organized as follows. Section 3.2 reviews the relevant aspects of the existing literature, followed by the development of hypotheses in Section 3.3. Section 3.4 explains the sample and data selection process and the model specification. Section 3.5 takes a close look at the results of the empirical analysis. Section 3.6 incorporates the conclusions and presents a series of recommendations.

3.2 Related Literature

Since the 2000s, benefiting from more research and detailed evidence, there has been an increase in valuable insights into the firm performance of EMNEs (Papanastassiou et al., 2020). However, in the existing relevant literature, less emphasis has been placed on understanding the consequences of outward FDI, especially of M&A in the context of EMNEs in developed economy markets (Ai & Tan, 2020; Amendolagine et al., 2018; Buckley et al., 2014; Papanastassiou et al., 2020). In addition to the relatively scant research, only a relatively limited number of studies have investigated the impact on innovation performance (Fu et al., 2018), and the findings appear to be inconsistent (Anderson et al., 2015; Lin & Lin, 2010).

Some findings have suggested an adverse outcome in improving the innovation performance of EMNEs via cross-border M&A activities. A primary concern is the typically high level of uncertainty and cost for firms to explore and integrate foreign knowledge, as well as the challenge of discontinuing duplicate R&D in the post-acquisition period (Bertrand & Capron, 2015; Fu et al., 2018). Despite facing common difficulties and challenges regarding M&A and knowledge integration, EMNEs are often seen as lacking the competence to leverage and transfer the value of the acquired resources and to combine them optimally with their domestic assets (Luo & Tung, 2018; Yakob, Nakamura, & Ström, 2018). Researchers argue that resulting from limited ownership advantages, weak international experience, and lack of absorptive capacity, EMNEs are 'unlikely to be able to integrate acquired assets successfully' (Narula, 2012), or it will take a considerably long time to enhance their FSAs via the international acquisition of technology (Rugman, 2009; Rugman & Li, 2007). Therefore, EMNEs will most likely struggle to recognize and learn from acquired companies' valuable

knowledge and experience. Instead, they are most likely to rely on their country-specific advantages, such as cheap natural resources and labor, to operate in the global market (Ramamurti & Singh, 2009, p. 157; Rugman & Li, 2007).

More recent research tends to have mixed conclusions. For example, several case studies show that cross-broader investments will not significantly affect EMNE's innovation performance. Hansen, Fold, and Hansen (2016) provide a detailed case study of a Chinese multinational from the biomass power plant industry that invested in Denmark via acquisitions to obtain necessary technology and knowledge assets. The authors identify insufficient innovation capability building and argue that this is largely associated with distrust of the Chinese parent company and IPR protection, as well as difficulties in managing differences in working practices and long-distance communication. The findings of Spigarelli, Alon, and Mucelli (2013), studying the acquisition of a small Italien firm by a Chinese SOE, display that the expected knowledge-enhancing effect of operating in advanced countries is often postponed or reduced because of the lack of synergies and significant cultural differences alongside the acquirer's weak competitive advantages and managerial skills.

Moreover, a series of empirical analyses discovered limited effects of outward FDI on the innovation performance of EMNEs under certain conditions. Using an event study methodology, Anderson et al. (2015) researched firms' innovation activities at home and abroad between 1998 and 2012. They find that granting patents to domestic Chinese investors significantly increased in the wake of strategic asset-seeking acquisitions in developed markets, such as the US, Japan, and Europe. However, the innovation performance of acquired firms does not show a significant change, and the absorptive capacity of SOEs and POEs do not significantly differ. By analyzing the M&A undertaken by Chinese and Indian medium- and high-tech companies in the EU28 and the US from 2003 to 2011, Amendolagine et al. (2018) reveal that EMNEs have higher innovation output after investing in the region with higher innovative capacity but are unable to benefit from innovative target firms. Instead, they explain that a higher innovation performance after acquisition primarily relies on the knowledge base status of the acquiring EMNEs rather than how innovative the target firm or location is.

In addition, other studies have concluded a positive influence of internationalization activities in generating innovation output. A theoretical research contribution (Y. Liu & Woywode, 2013) proposes that Chinese investors apply a 'light-touch' integration strategy as an efficient tactic to stimulate intra-group knowledge exchange by giving considerable autonomy to the local-

acquired firms, especially with rich technological competencies in the post-acquisition phase. This finding echoes the results of (Karabag, Borah, & Berggren, 2018; Schüler-Zhou & Schüller, 2013; Tsai, 2002) on a higher intra-group knowledge exchange due to increased motivations and initiatives. The empirical findings of the study by Edamura et al. (2014), which used propensity score matching and a difference-in-difference estimator to investigate the effects of M&A from Chinese MNEs in the developed market on firms' performance, suggest that the intangible assets of the acquiring firms have increased after outbound M&A transactions and that the unaffected R&D intensity implied a complementarity relationship between acquiring and acquired firms. In another similar study that extended the sample to include outward FDI activities, Cozza et al. (2015) claim that a positive and significant influence from M&A on EMNEs' productivity could be expected. However, the positive influence from M&A is smaller than for greenfield investment, and the former is more used for qualitative improvement. Piperopoulos et al. (2018) identify that outward FDI could enhance the innovation performance of Chinese MMEs' subsidiaries in high-tech industrial sectors.

Also, the positive effect will be more substantial when the investments are geared toward developed countries. Applying a Tobit model with RE to analyze first-hand data collected from firms via a purpose-designed survey from Guangdong province in China, Fu et al. (2018) find that outward direct investment leads to an increase in the innovation performance of Chinese acquirers, although the impact is shaped by internal and external factors such as firm characteristics and investment destinations. Furthermore, they hold the "innovation springboard" view of the motivation for Chinese investment in developed countries and find that outward FDI and in-house R&D overlap for Chinese multinationals.

The appropriate research methods and data have generally improved considerably, from the aforementioned analysis of single case studies to further selected specific industries to more comprehensive studies. Compared to the previous literature, more recent studies tend to conclude a positive impact of outward direct investment on the innovation performance of acquiring firms for EMNEs. Furthermore, the empirical studies focusing on specific industries or generalized groups discovered a more successful story. Nevertheless, most studies mainly focus on an aggregated country-level analysis, a single industry with high technological intensity, or a few selected leading technology firms. General investigations covering all types of investors using micro-level data are considerably limited. Findings emphasize that an innovation improvement through M&A is a complicated process, the positive outcomes depend

upon the investment incentive and dynamic capability of a firm, and the key characteristics of the firm will also affect its approach to knowledge acquisition and the degree of knowledge to be progressed (W. M. Cohen, 2010, p. 195; W. M. Cohen & Levinthal, 1990).

3.3 Hypotheses

Based on the empirical evidence presented in Section 3.2, the following hypotheses are put forward concerning the effects of cross-border M&A on the innovation performance of Chinese acquiring firms.

3.3.1 M&A and innovation for Chinese multinationals

The internationalization process of firms is seen to sufficiently assist knowledge accumulation by creating great learning potentials and practices (Johanson & Vahlne, 1977; Pearce, 1999). Overseas investments not only allow companies to exploit economies of scale and scope offered by new markets but also provide direct access to resources, which can support companies in increasing their knowledge base in day-to-day operations and enhance their dynamic capability to continuously explore, integrate, and reconfigure efficiency gains (Caves, 1989; Meyer, Wright, & Pruthi, 2009; Teece, 2014; Teece, Pisano, & Shuen, 1997). M&A, in particular, allows two or more firms to benefit from synergies and complementarities by transferring and leveraging each other's knowledge and resources, thereby further enhancing firms' capabilities with new technical and organizational components to facilitate the appropriation of new knowledge and the generation of innovations (Cassiman, Colombo, Garrone, & Veugelers, 2005; Mudambi & Swift, 2011; Vermeulen & Barkema, 2001). For instance, the subsidiaries of EMNEs can access frontier knowledge and advanced technological capacity by engaging in local networks, which allow for the exploration and/or exploitation of specialized knowledge (Kafouros, Buckley, & Clegg, 2012). Such opportunities and strategy implementations contribute the most to knowledge transfer and experience accumulation by allowing more control of acquired strategic assets and familiarization with the external knowledge bloc from new customers, suppliers, competitors, and governments (Johanson & Vahlne, 2009; Luo & Peng, 1999; von Hippel, 1988).

Moreover, M&A has proven to be an effective mechanism for accessing and sourcing a firm's strategic assets, which has been defined by Amit and Schoemaker (1993, p.36) as "a set of difficult to trade and imitate, scarce, appropriable and specialized resources and capabilities that give a company the competitive advantage." Therefore, acquisitions might provide companies with opportunities to explore and utilize codified knowledge in the foreign market and facilitate the diffusion of tacit know-how (Fu et al., 2018; Kogut & Zander, 1993). This feature is especially attractive to and beneficial for less innovative multinationals aiming to broaden and deepen their knowledge base, shorten the learning curve through replication and reconstruction of product development, and thus improve their ability to develop new knowledge at the early stage of development. It even prepares to introduce and develop other new technologies in the future to overcome the late-comer disadvantage in global competition.

Additionally, EMNEs can enjoy extra gains by expanding in the existing developed markets. In developed markets, the target regions have broader absolute knowledge bases and more extensive market demands, which offer higher learning opportunities with intensive information and knowledge exchanges (Amendolagine et al., 2018). Amighini, Rabellotti, and Sanfilippo (2013) find that host countries with a high share of R&D expenditure in the manufacturing sector are generally attractive to Chinese investment. At the same time, Chinese multinationals are continuously catching up by improving their technical ability and expanding upon their international organizational experience. Research has found that Chinese investors typically invest in the main sectors of expertise that each EU country specializes in and tend to pursue a long-term investment strategy aimed at substantial production and innovation development through cooperation with European subsidiaries (Alvandi et al., 2015, pp. 24–25). This could assist Chinese multinationals in meeting the mainstream international standards quickly and enable them to gain attractiveness and bargaining power in utilizing technological resources and collaborating in international R&D (Ai & Tan, 2020; Child & Rodrigues, 2005).

In brief, along with a solid technological-oriented investment incentive and growing innovation and organizational capacity, Chinese acquirers are targeting innovative locations and utilizing an effective channel to acquire foreign assets. Accordingly, I predict that:

> ***Hypothesis 1****. The subsequent innovation output of Chinese acquiring enterprises will improve significantly with M&A undertaken in the EU.*

3.3.2 Multinationals with different degrees of technological intensity

Even though there are great learning opportunities and resources from investing and operating internationally, the proposed innovation-enhancing effect from cross-border M&A is not uniform and is somewhat shaped by many other determining factors. Firstly, the outcome might vary depending on the nature of the knowledge and the accumulation process (W. M. Cohen, 2010, p. 165). Secondly, it requires adequate incentives and resources for acquiring firms to continuously explore or exploit embodied knowledge through various channels (W. M. Cohen & Levinthal, 1989; March, 1991). Finally, the sufficient strategies and dynamic capabilities required to co-evolve within the internal and external institutional environments are also essential for firms to survive in the long term (Cantwell, Dunning, & Lundan, 2010; Nelson & Winter, 1982). Overall, even if the aforementioned demands are fulfilled, the expected effectiveness of knowledge acquisition cannot be guaranteed due to the possibility of either no noticeable improvement being realized or even the inadequacy of the acquired knowledge (Huber, 1991).

EMNEs are generally seen as being different from developed economies' MNEs mainly due to the different resources and experience available and the possibility of strong government involvement at home (Buckley et al., 2014; Cuervo-Cazurra & Genc, 2008; Goldstein, 2009, p. 74). The "hard" technical skills and "soft" capacities of EMNEs are weaker, especially in terms of technological know-how, brand names, and management capabilities, in comparison to advanced MNEs (Awate, Larsen, & Mudambi, 2012; Buckley et al., 2014; Madhok & Keyhani, 2010; Ramamurti & Singh, 2009). Thus, EMNEs might require an early internationalization strategy in order to access the assets necessary to compensate for competitive disadvantages or to escape from domestic institutional disadvantages (Child & Rodrigues, 2005; Luo & Tung, 2007; Rui & Yip, 2008). On the other hand, certain "home-country advantages" can support firms' learning process and ability to recognize relevant and valuable resources in the host country by enhancing the home country's knowledge base and technological specialization, such as a sustained increase in technical education and investment in S&T, and sufficient support in developing innovative abilities through policy guidance and financial support from home-country institutions (Rabbiosi, Elia, & Bertoni, 2012; Rui & Yip, 2008).

The high-technology-intensive firms (hereinafter "high-tech firms") are considered to be "more innovative, more efficient, pay higher wages, and are more successful than low-technology-

intensive firms" (Zawislak, Fracasso, & Tello-Gamarra, 2018). Therefore, high-tech firms are expected to exhibit a higher ability to recognize the value of new and external information, exploit and acquire knowledge via external learning, assimilate it, and extend it to their internal systems to generate innovations (W. M. Cohen & Levinthal, 1990). Mathews (2002) points out that due to the character of licensed product designs, opening knowledge spillovers in high technology clusters, and the possibility of purchasing start-ups and receiving technical support from specialized consulting firms, the barriers around "tacit knowledge" are minimalized. For these reasons, the late-movers, such as most companies in high-tech industries from China, can replicate and imitate the products with a relatively more accessible and possibly cheaper production process. Therefore, they benefit from avoiding sunk investments in old technologies and leapfrogging to new technologies (Awate et al., 2012).

However, one should consider the nature of the high-tech industry. It involves intensive technological content, fierce competition, and high degrees of uncertainty and risk while - at the same time - the knowledge distance between the majority of Chinese high-tech firms and the Western technological frontier still exists (Fu et al., 2018). A significant amount of investment in advance is required, and the learning process will be "more complex, more time consuming and full of risks" (Cloodt et al., 2006). Furthermore, knowledge transfer is closely tied to the willingness to cooperate and trust between the participants, and ongoing communication and interpretation are emphasized (Johanson & Vahlne, 2009). Nevertheless, due to host governments' increasing concern for national market security protection and the desire to maintain the target company's competitiveness, high-tech industries are often associated with sensitive sectors with high entry and transfer barriers (Alvandi et al., 2015; Hennart, 2012). Last, a matched international experience and organizational expertise are required to achieve continuous learning from M&A (Luo & Tung, 2018). A series of research contributions suggest that Chinese acquiring firms intend to have less control or give full autonomy to the target firms in high-tech sectors or with strong technological competencies, while at the same time are less likely to have local partners if the institutional distance is large (Alvandi et al., 2015; Beule, Elia, & Piscitello, 2014). In any case, Chinese acquirers shoulder higher costs and uncertainty to develop adaptive and transformative approaches to integrate knowledge from external sources and create innovations. Thus, the following hypothesis is formed:

Hypothesis 2a. *The innovation output of Chinese acquiring enterprises in the high-technology sector will decline after conducting M&A in the EU.*

Innovation also occurs in and is important for low-technology-intensive firms (hereinafter "low-tech firms"). A firm being grouped in the lower technological intensity industry does not mean having low innovative frequencies or opportunities (Reichert, Torugsa, Zawislak, & Arundel, 2016). Despite the widely held belief that lower-tech firms passively experience the evolution of technology, there is a group of firms that actively contribute to the change of technical breadth and depth. More importantly, they are distributed across various industries (Mendonça, 2009). At the same time, with less intensive technological content and a smaller technology gap, it is more likely that the low-tech sector will catch up through external technology acquisition and consume fewer resources compared to high-tech sectors. This would further increase the possibility that the technological followers from China could offset the competitive advantages of the technological leader (Fu et al., 2018).

In the face of an increasing global technological diversification and crossover of firms' technology portfolios, the strategic flexibility of the firms in the low-tech industries, due to their market-driven features, may allow them to have a high awareness and absorptive capacity vis-á-vis external technologies and knowledge. Thus, it also allows them to effectively generate or improve product/process innovations that can be transferred to economic uses (Mattes, Huber, & Koehrsen, 2015). A good combination of different innovation/non-formal R&D-based capabilities can help less technology-intensive firms achieve innovation success (Reichert et al., 2016), which is especially true for firms from developing countries (Zawislak et al., 2018). On the other hand, as mentioned in the research of Hirsch-Kreinsen, Jacobson, and Robertson (2006) and Reichert et al. (2016), most low-tech firms rely on externally developed technologies. They are key users of innovative products and technologies generated in high-tech industries, and there is a strong interdependence between these types of firms (Santamaría, Nieto, & Barge-Gil, 2009). Thus, supplier-led characteristics enable low-tech firms to utilize advanced manufacturing technologies. Their superior dynamic capabilities allow them to efficiently acquire appropriate technologies from external sources and effectively function in a new environment. For the above reasons, the author proposes that:

Hypothesis 2b. *The innovation output of Chinese acquiring enterprises in the low-technology sector will rise after conducting M&A in the EU.*

3.3.3 Multinationals with different types of corporate ownership

It is noteworthy that EMNEs are also embedded in societies. The different home- and host-country governmental environments will also influence the incentives and capabilities of firms in knowledge learning and generating directly or indirectly. In the meantime, home-country characteristics play an integral role in the investment behavior and learning process of Chinese MNEs (Amighini et al., 2013; Buckley et al., 2007; Rabbiosi et al., 2012). A firm's ownership, in particular, can reflect the mixed moderating effects of incentives, resources, and capabilities on firm innovation outcomes (Genin, Tan, & Song, 2020). For instance, Chinese MNEs might enjoy potential capital and policy support from the state, which encourages them to internationalize (Ramamurti & Singh, 2009, p. 82) or to be mandated to accelerate their learning process (Mathews, 2002). However, they may also face credibility deficits and thus face low incentives for collaboration in the host countries due to possible ambiguous home-country political and social practices (Amendolagine et al., 2018; Gao, Zuzul, Jones, & Khanna, 2017).

The intention of promoting innovation through internationalization activities is strong for SOEs. A supportive finding (Ramasamy, Yeung, & Laforet, 2012) shows that it is more prevalent among SOEs to acquire strategic assets, such as technology, brands, and know-how, to compete in the global market and maintain domestic market share. Moreover, SOEs are seen as the primary vehicle for implementing government programs. Thus, they will actively invest in innovation resources in response to the government's call to build an innovation-oriented economy (Zhou, Gao, & Zhao, 2017).

Furthermore, although the innovation performance of SOEs is generally believed to be lower than that of POEs, the high concentration of resources and the reorganization of recruitment can help SOEs to perform well in allocating scarce resources and attracting talents, as well as to avoid the typical agent problem (Kroll & Kou, 2019). In addition, the innovation competencies of SOEs can be facilitated by the linkages to organs of state governance (J. Li, Xia, & Zajac, 2018). In emerging economies, SOEs often operate in strategically essential sectors, and they still enjoy privileged access to financial and regulatory support, such as receiving investment subsidies and/or tax reductions from the government (Fu et al., 2018; Song, Yang, & Zhang, 2011; Zhou et al., 2017). Despite gaining valuable substantive resources, access to policy information can lead to even more opportunities to stimulate

(inter-)organizational coordination, which can help reduce investment risk and innovation barriers (Amighini et al., 2013; Howell, 2017).

However, despite enjoying the government-related advantages, SOEs also receive institutional pressure to reflect multiple objectives when making investment decisions (Genin et al., 2020; Ramamurti & Hillemann, 2018). They need to follow the national guidance and pursue political mandates or commercial interests when participating in the design of globalization strategies or claiming credit for the organizations (Child & Rodrigues, 2005; Song et al., 2011). These goals, which are irrelevant to the development of corporate innovation, will disrupt the learning motivation and opportunities for SOEs, weaken the organizational resources for technological innovation, and hinder the integration of external resources (J. Li et al., 2018; Zhou, Tse, & Li, 2006). Furthermore, due to complex organizational structures and a higher reliance on government resources, SOEs have been found to have weak incentives to engage in innovation and are less efficient at transferring acquired critical inputs into innovation outputs than POEs or foreign enterprises (Ayyagari, Demirgüç-Kunt, & Maksimovic, 2011; Cui & Jiang, 2012; Kroll & Kou, 2019). Therefore, even though the main players in the Chinese market, especially in the manufacturing sector, are still SOEs (Zhou et al., 2017), which have certain advantages in managing scarce resources and often enjoy certain financial and information privileges, their generally lower productivity, multi-investment strategies, and complex organizational systems can lead to unfavorable effects on the exploitation and exploration of external resources.

Along with the aforementioned evidence on Chinese SOEs in particular, SOEs often face a perceived legitimacy deficit and higher institutional pressures in the host region, especially if the government of the target country worries that acquisitions by Chinese MNEs could lead to the wholesale transfer of technology and job positions to China (Meyer, Ding, Li, & Zhang, 2018, p. 214). For example, a higher level of regulatory scrutiny in sensitive industries in the form of FDI screening regimes has been implemented in most European economies (European Commission [EC], 2017; UNCTAD, 2021b), which could affect the strategy and performance of firms (M. W. Peng, Wang, & Jiang, 2008). The following hypothesis summarizes the discussions:

> ***Hypothesis 3a.*** *The M&A that Chinese enterprises undertake in the EU will negatively influence the post-acquisition innovation performance of SOEs.*

Interestingly, the study of Ramasamy et al. (2012) shows that the incentive of Chinese POEs to seek knowledge and technology through outward FDI is not apparent. Currently, the host economy's technical advantages do not seem attractive to POEs, who are more driven by market expansion (Ramasamy et al., 2012). Besides, the constrained capital-raising environment in the domestic market for POEs might also affect the motivation to invest abroad to gain access to capital (Xiao, 2004). Also, it is worth noting that Chinese POEs have less learning experience than SOEs and foreign enterprises because they have only been allowed to invest abroad since 2003 (Buckley et al., 2007). Therefore, POEs may suffer more from 'newness' and 'smallness' than SOEs (Liang et al., 2012). In other words, POEs will bear more pressure to build and leverage their "ambidexterity" as a result of the necessity to exploit not only their FSAs but also overcome competitive disadvantages (Liang et al., 2012; Luo & Rui, 2009).

In fact, POEs from China follow the traditional way of investing abroad to exploit their firms' specific advantages further and enhance their organizational capacities (J. Lu, Liu, & Wang, 2011). When investing in the OECD countries, POEs are found to be even more attracted by the host country's strategic assets than SOEs (Amighini et al., 2013). In addition, POEs from technology-intensive industries are more active in strategic asset-seeking FDI and proactively engaged in organizational learning via outward FDI (J. Lu et al., 2011). Many researchers find evidence that Chinese POEs generally have higher productivity levels (Dougherty, Herd, & He, 2007; Morck, Yeung, & Zhao, 2008). They are not necessarily less capable of absorbing acquired strategic assets than SOEs, which receive more support (Anderson et al., 2015). Unlike SOEs, Chinese POEs do not have highly internalized production systems, over-employment, or social responsibilities. The higher level of flexibility allows them to have advantages in organizational capacity to identify opportunities in international markets quickly, pursue a rapid decision-making process, and effectively adapt to new environments and knowledge (Liang et al., 2012). On the other hand, POEs are also facilitated by the liberalization of regulations and supported by the government when investing abroad, benefitting from the "Going abroad" strategy since 2001, and the constraints to POEs in terms of financial support and the administrative process have been mainly reduced (Luo, Xue, & Han, 2010). More importantly, POEs are perceived to be more transparent and effective, showing a long-term orientation and a stronger willingness to learn (Y. Liu & Woywode, 2013). Thus, the following hypothesis:

Hypothesis 3b. *The M&A that Chinese enterprises undertake in the EU will positively influence the post-acquisition innovation performance of POEs.*

3.3.4 Interaction of high technological intensity and corporate ownership types

In order to gain a higher level of innovativeness and efficiency for the sustained growth of China's economy - to climb the global value chain and to avoid the possibility of the middle-income trap, the innovation-driven economic growth strategy has been prioritized to maintain national competitiveness (NDRC, 2016; The World Bank & The Development Research Center of the State Council, PR China, 2013). The recent innovation strategy "Made in China 2025" prompted ten major development industries aiming to systematically promote the improvement of advanced technology industries in the hope of transforming China from a large manufacturing country with low added value to a manufacturing powerhouse (The State Council, PR China, 2015).

Following the reform of the state-owned sector, and in keeping with the so-called principle of "grasping the big and releasing the small," state-owned businesses have been increasingly concentrated in a few large state-supported business groups (Yiu, 2011). At the same time, most of the companies selected to become key R&D forces in China are required to have strong innovation and technology capabilities as well as strategic assets; however, this group is still mostly composed of SOEs (Yiu, 2011). Thus, assuming both POEs and SOEs are motivated by enhancing their innovation performance when investing in the high-tech manufacturing industry in developed economies, SOEs are more likely to handle M&A with higher returns effectively because they often obtain critical resources and receive more support from the home country. These specific advantages could enable SOEs to undertake more strategic assets-rich and demanding M&A cases. Therefore, the above arguments lead to the following hypothesis:

Hypothesis 4. *For Chinese acquiring enterprises in the high-tech sector, the innovation output of SOEs will be higher than that of POEs after conducting M&A in the EU.*

3.4 Methods

3.4.1 Sample

To empirically investigate the consequences concerning the innovation performance of Chinese MNEs merging with and acquiring firms from developed economies, the author constructed a data sample consisting of 230 Chinese acquiring firms that had undertaken M&A transactions in the EU28 countries from 2010 to 2018.

3.4.2 Variables

3.4.2.1 Patent

The number of patent applications has been used to measure the innovation performance of selected Chinese acquirers. The patent data source is the EPO's PATSTAT, provided by BvD Orbis. The author utilized the unique firm identity number from the sample to search for patents in the regional, international, and national patent offices of the EPO, World Intellectual Property Organization (WIPO), and EU28, respectively. The duplicate patent applications published in different patent offices have been removed. In order to integrate the patent data, patents carry the priority date as the reference date because the priority date will reflect the proper period of the discovery of both domestic and foreign inventions (OECD, 2009, p. 53). However, if the priority date is unavailable, the publication date is used to proxy it based on the general estimation that the application is published 18 months after it is filed (OECD, 2009, p. 19).

In this study, the focus will be on innovation output as a means to gain an understanding of the innovation performance of Chinese acquiring firms. Patent frequency has been widely recognized as a good indicator for measuring innovation performance in terms of innovation outputs (Pakes & Griliches, 1984). Using patent frequencies in this way has both notable strengths and weaknesses (Smith, 2009, pp. 158–160). Patent data usually do not suffer from retrospective bias and success bias since they are collected continuously and systematically (Dahlin & Behrens, 2005). As a measure of technological novelty, they represent a valid and close link to important inventions (Griliches, 1990; Schmookler, 1966, p. 18). Patent statistics cover a broad range of technologies and are fairly consistent within industries (W. Cohen,

Nelson, & Walsh, 2000; OECD, 2009, p. 27). In addition, Ahuja and Katila (2001) summarize several findings, which claim that patents indeed have an economic significance due to the property rights conferred to the assignee and that they are also closely related to other measures, such as new products and innovation counts. Therefore, patent data are believed to be the best choice in indicating firms' innovation performance for this study. It should, however, be noted that some inventions may not be patentable and that inventions that are patented can differ greatly in terms of economic value or be skewed across technical fields and industries (Griliches, 1990; Trajtenberg, 1990).

3.4.2.2 M&A

The variable of primary interest, M&A, is measured by dummies. The post-acquisition period, which starts one year after an acquisition takes effect, is equal to one; otherwise, it is zero. The data were collected from two M&A databases, BvD Zephyr and SDC Platinum, using the following approach. Firstly, the author filtered those M&A transactions with a share acquisition of at least 10 percent in EU28-located companies and an effective date between 1 January 2010 and 31 December 2018. Secondly, those transactions in which the acquirers' parent company was not located in China were excluded. The information was cross-checked using data from the Orbis database, the firms' official websites, and annual reports. Thirdly, after having dropped transactions with duplicated or incomplete information, acquirers being individuals rather than corporate entities, and affiliates that were either acquired or dissolved over the analysis period, 467 cross-border M&A deals by 357 companies were observed. Finally, only those firms that had undertaken M&A between 2012 and 2016 were retained for the analysis to allow the observation of innovation outputs from acquiring firms at least two years before and after the acquisition. Therefore, the final sample contains 230 firms with 321 M&A deals.

3.4.2.3 Technological intensity classifications

The present study employs the sectoral approach[5] of the EC in order to classify the economic sectors of firms into different groups based on their level of technological intensity (measured by the ratio of R&D expenditure to value-added) in accordance with the statistical classification of economic activities of the European Community (NACE Rev.2) at a 2-digit level. Firms from various manufacturing (MFG) industries can be aggregated into four categories: high-,

5 A detailed explanation of the classification and calculations can be found on the website of the EC via, https://ec.europa.eu/eurostat/cache/metadata/en/htec_esms.htm, accessed on 18.10.2020.

medium-high-, medium-low-, and low-technology industries, henceforth referred to as H-tech, MH-tech, ML-tech, and L-tech. In this research, both H-tech and MH-tech are treated as high-technology sectors, and the ML-tech and L-tech industries are aggregated as low-technology sectors. Firms in the service sector were grouped as knowledge-intensive services (KIS) and less knowledge-intensive services (LKIS) using the same criteria.

3.4.2.4 Corporate ownership type

A binary variable has been used to indicate the types of corporate ownership; 1 refers to SOEs, and 0 is POEs. The information on firms' ownership was harmonized using Orbis and SDC Platinum data, which was cross-checked against publicly available sources. These sources include the official websites and annual reports of companies and Chinese state agencies, such as the State-owned Assets Supervision and Administration Commission of the State Council (SASAC)[6]. In doing so, the accuracy and integrity of the ownership information have been largely enhanced due to a higher chance of including both listed and non-listed Chinese MNEs and cross-checking the details from multiple reliable sources.

3.4.2.5 Control variables

In this research, several control variables are taken into account to keep other possible explanatory factors of an acquiring firm's innovation output and investment decision constant.

The size of the Chinese acquirers has been controlled by taking a log transformation of the number of employees. A relative consensus view derived from abundant studies is that larger firms are more likely to associate with and benefit from incremental innovations because of higher profitability and organizational ability from monopolistic activities and cost-spreading advantages (W. M. Cohen, 2010, p. 140; W. M. Cohen & Klepper, 1996). Large firms are anticipated to be able to re-invest in more R&D and their workforce, thereby enjoying higher production and additional bargaining power to exploit economies of scale and scope (Klepper & Simons, 2005). Several studies show a decline in R&D productivity as a company grows larger or a closer U-shape relationship between R&D productivity and firm size (Lerner, 2006; Pavitt, Robson, & Townsend, 1987; Scherer, 1965). For Chinese multinationals investing in the EU market, a positive moderating effect of the firm size is expected to assist firms to better

6 A list of 97 central state-owned enterprises is available on the website of SASAC http://www.sasac.gov.cn/n2588035/n2641579/n2641645/index.html, accessed on 21.11.2020.

engage in organizational learning and have more substantial financial and organizational capabilities to adapt to new environments, thereby promoting innovation.

Similar expectations apply to firms' experience, which reflects the knowledge intensity of an organization. This variable is proxied using the number of years since the establishment of the acquiring firm in this study. Prior literature demonstrates that firms with greater experience enjoy increasing returns to the scale of information and network externalities, which in turn allow for the development of management and coordination capabilities (Amendolagine et al., 2018; Cozza et al., 2015). A higher level of maturity can influence a firm's ability and willingness to take risks when making investment decisions (V. Z. Chen, Li, Shapiro, & Zhang, 2014). However, for Chinese acquirers, the findings from Luo & Tung (2007; 2018) suggest a different impact because Chinese MNEs may seek access to strategic resources in developed countries at an early stage of the firms' development. This behavior could lead to Chinese firms gaining early access to accumulating international experience and R&D resources.

At the same time, a firm's financial performance (measured by an acquirer's revenue to total assets) is included due to its influence on profitability (Amendolagine et al., 2018). Also, it is considered a standard feature together with firm size to control for potential spillover effects (X. Liu & Buck, 2007). Furthermore, the technological intensity level of target firms is taken into account. If a target firm belongs to the high-technology sectors or KIS cluster, the dummy value is equal to 1; otherwise, 0. It is because there is a high likelihood of those firms containing stronger strategic and knowledge-intensive assets, reflecting a possibly more complex and longer learning process. Additionally, it can also capture the possible "light-touch" effect.

In the end, year dummies and industry-fixed effects are included to control for common shocks, business cycle fluctuations, and technological opportunities. The selected variables are described in the following Table 3.1:

Table 3.1: The description of the selected variables

Variables	Symbol	Description	Expected sign	Source
Innovation performance	y	The number of patents of an acquiring firm		Orbis, PATSTAT
M&A	L_M&A	Value 1 for lagged one-year acquisitions for all years after the year the M&A was initially made, otherwise 0	+	Orbis, Zephyr, & SDC
Acquirers' technological intensity category	MFG tech: H-tech, MH-tech, ML-&L-tech	Value 1 if an acquiring firm is H-tech, value 2 if an acquiring firm is MH-tech, value 3 if an acquiring firm is ML- & L-tech	+/-	Orbis, Zephyr, SDC, & EC
Acquirers' ownership type	SOE	Value 1 if an acquiring firm is state-owned or state-controlled, value 0 if an acquiring firm is private-owned	+	Orbis, Zephyr, & SDC
Acquirers' size	Size	Log (The number of employees)	+	Orbis, Zephyr, & SDC
Acquirers' experience	Age	The number of years since the establishment of the acquiring firm	+/-	Orbis, Zephyr, & SDC
Acquirers' financial performance	Fin	The return on assets (acquirer's revenue to total assets)	+	Orbis, Zephyr, & SDC
Targets with upper intermediate technological intensity and knowledge-intensive assets	Tar U-tech | KIS	Value 1 if a target firm belongs to the group of the H-tech, MH-tech, or KIS; otherwise, 0	+/-	Orbis, Zephyr, SDC, & EC
Acquirers with high technological intensity and knowledge-intensive assets	Acq H-tech | KIS	Value 1 if an acquiring firm belongs to the group of the H-tech or KIS; otherwise, 0	+/-	Orbis, Zephyr, SDC, & EC

Notes: PATSTAT refers to the Worldwide Patent Statistics Database; SDC stands for the database SDC Platinum from Thomson Reuters; EC is the abbreviation of the European Commission

Source: Own compilation

3.4.3 Empirical method

The concept of the knowledge production function will be applied to understand innovation as the stock of valuable economic knowledge of firms and the relationship between inputs and outputs (Griliches, 1990; Pakes & Griliches, 1980).

The outcome of interest is measured by patent applications (y_{it}). According to the statistics summarized in Table 3.3 and the frequency distribution of the outcome variable in Appendix Figure 3.2, patent counts were only taken as non-negative integer values with the variance significantly exceeding the sample mean; the values cover a wide range with around half of the

counts being zero and with a long right tail. Thus, the dependent variable indicates a possible discrete and significant overdispersion (Cameron & Trivedi, 2009, p. 555, 2013, p. 89). Additionally, the possibility of having "excess zeroes" might exist with the patent counts due to some firms not having made patent applications, not because they had no patent-worthy discoveries, but because they decided against filing a patent for other reasons, such as considering the cost of obtaining a patent to be too expensive or the company wanting to keep innovations as a trade secret (Kanwar & Singh, 2018). For the aforementioned reasons, despite applying the Poisson regression model (PRM) to analyze the count data, the models for Negative Binomial (NB) data and Zero-Inflated data are jointly compared, resulting in an advance in handling data with a highly skewed distribution and zero inflation (Cameron & Trivedi, 2013, p. 80, 2013, p. 139; J. Hausman, Hall, & Griliches, 1984; Mullahy, 1986).

Table 3.5 in the appendix provides a series of goodness-of-fit statistics to diagnose the optimum models. The Pearson dispersion statistic is significantly greater than 1, indicating the data is likely to be Poisson over-dispersed (Cameron & Trivedi, 2013, p. 358). A lower log-likelihood value and smaller measures from the information criteria fit tests based upon the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) specify that the NB models and ZINB models are generally preferred over the PRM and Zero-Inflated Poisson (ZIP) models (Cameron & Trivedi, 2009, p. 346). Moreover, the positive and significant statistics from the Vuong test support the view that the ZINB model and ZIP model are superior to the NB model and PRM model, respectively (Greene, 2012, p. 863; Vuong, 1989). A consistent result is also suggested by the likelihood ratio test statistics, which show the ZINB specification significantly improves the overall fitting of the data compared to the NB specification. (Blonigen, 1997; Cameron & Trivedi, 2013, p. 357; J. Hausman et al., 1984). Overall, given the consistent results of the applied tests, the ZINB model with heteroscedasticity-robust standard errors is considered to be the most efficient among the selected estimations.

A zero-inflated model assumes that there are two possible unobserved cases for each observation (Long & Freese, 2014, p. 535). In the latent group A ("always 0"), a firm does not have patents; in the other group –A ("not always 0"), a firm might have the probability to produce positive output but obtain no patent applications. Thus, these possibilities are included as a binary process using the logit model to identify which group an observation belongs to. Let φ_{it} stands for the probability of an individual being in group A, then the probability for the other case is $1-\varphi_{it}$, the overall probability of 0 is a mixture of two types of 0s is shown in

equation (3.1)-(1). For those observations that have counts including zeros, the probability of each count is assumed to follow a gamma distribution, which is shown in equation (3.1)-(2):

$$\Pr(y_{it}=k_{it})=\begin{cases}\varphi_{it}+(1-\varphi_{it})\Pr(y_{it}=0\mid x_{it},A_i=0) & if\ k_{it}=0 \quad (1)\\ (1-\varphi_{it})\Pr(y_{it}=k_{it}\mid x_{it},A_i=0) & if\ k_{it}>0 \quad (2)\end{cases} \tag{3.1}$$

The equation used for estimating the density of expected counts as a mixture of the above two components can be expressed as:

$$\begin{aligned}E(y_{it}\mid x_{it},z_{it}) &= \exp(x_{it}^{'}\beta)(1-\varphi_{it}(z_{it}^{'}\gamma))\\ &= \exp(\beta_0+\beta_1 Size_{it}+\beta_2 Age_{it}+\beta_3 Fin_{it}+\beta_4\delta_i^{TarU-tech/KIS}+\beta_5\delta_i^{MFGtech}+\beta_6\delta_i^{SOE}\\ &\quad +\beta_7\delta_{it}^{M\&A}+\beta_8\delta_i^{SOE}\times\beta_7\delta_{it}^{M\&A}+year_i+industry_i+\varepsilon_{it})(1-\varphi_{it}(z_{it}^{'}\gamma))\end{aligned} \tag{3.2}$$

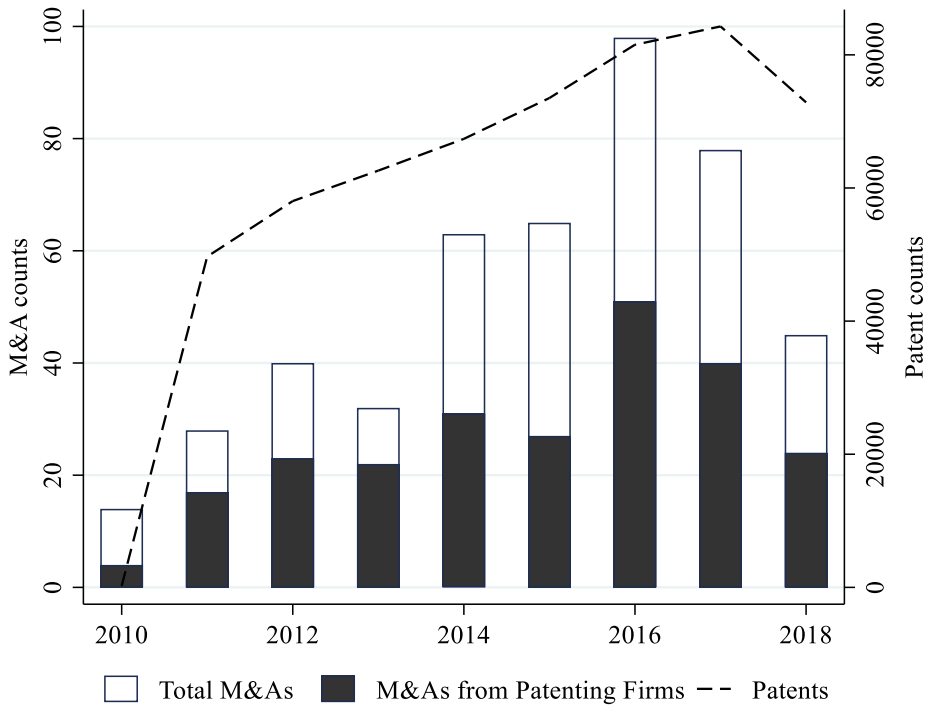
Where y_{it} indicates the number of patents for firm i in year t. The vector $x_{it}^{'}$ contains the covariates specified in explanatory variables and β stands for the corresponding coefficients to be estimated. A set of variables that reflect a firm's characteristics are included. They are $Size_{it}$, Age_{it}, Fin_{it} and TarU-tech/KIS_i referring to the firm's size, age, financial performance, and the technology intensity of target firms, respectively. The categorical variable $MFGtech_i$ represents the manufacturing industry classifications of acquirers; 1 to 3 is for H-tech, MH-tech, and ML-&L-tech, respectively. SOE_i denotes the corporate ownership types of acquirers: 1 if a firm is an SOE, 0 if a firm is a POE. $M\&A_{it}$ refers to the Chinese firms' M&A activities: 1 if a firm has undertaken an M&A deal and after, 0 otherwise. The probability of the logistic link function is denoted as $\varphi_I(z_{it}^{'}\gamma)$, given the covariate vector of inflation variables $z_{it}^{'}$, γ is the parameter vector. The factors that might inflate the number of zeroes are considered as firm age, firm size, financial performance, and if the acquiring firm belongs to the H-tech or KIS group (yes=1, no=0). The time and industry effects in the sample will be captured by $year_i$ and $industry_i$, and ε_{it} is the error term to capture the residual variation.

3.5 Results

3.5.1 Descriptive analysis

Figure 3.1 displays the general development of M&A by Chinese acquiring firms in the EU from 2010 to 2018 (lhs) using the sampled dataset. According to the trend demonstrated by the bar charts in the graph, one can observe that the number of M&A deals undertaken by Chinese MNEs in the EU increased significantly from 2010 until peaking in 2016, followed by a rapid drop in the following two years. This trend is in line with the general findings from research on Chinese outward M&A transactions in the EU (Kratz et al., 2020), which can, in one aspect, reflect the reliability of the study sample. The total number of M&A activities and the M&A from Chinese acquirers who applied for at least one patent during the time (in black) share a similar growth trend among all years. M&A by firms that file patent applications for their innovation outcomes make up a considerable share of the total number of M&A activities, accounting for roughly 50% on average. The number of patent applications of the acquirers who had M&A deals in the EU28 between 2012 - 2016 is also illustrated (rhs). The line graph shows that the sum of patents of these acquirers rose gradually from 2010 to 2017 and again declined after 2017.

Figure 3.1: Cumulative M&A deals and patent applications of Chinese acquirers in the EU



Source: BvD Orbis and SDC Platinum. Own illustration

The following two-way table shows the summarized statistics of individual MFG technological intensity classifications and firm ownership types (Table 3.2). The first row presents the observations of the categorical variables, while the second row includes the means of patent applications. In general, it is noticeable that MH-tech firms or POEs undertake a major share of the M&A investment. The results in the last column show that the MH-tech group accounts for almost half of the total observed frequency (558/1116) among the four classifications, followed by the H-tech, L-tech, and ML-tech groups. The average patent applications of each MFG-tech group allow us to see that the H-tech group occupies the absolute leading position in receiving patents among the groups. Surprisingly, although the number of firms from the ML-tech or L-tech groups is less than the MH-tech group, the average patents received from the former two groups are not very different from the latter. The results in the last row (Total) show that the frequency of POEs is almost double that of SOEs, but the average patents received for the POEs is approximately half the ratio for SOEs. The results in the center part of the table indicate that the major innovative power is H-&MH-tech SOEs.

Table 3.2: The matrix of Chinese acquirers by MFG technology classifications and ownership types

	Acquirer's Ownership		
MFG Technology	SOEs	POEs	Total
H-tech	**72**	**207**	**279**
	171.54	141.29	149.10
MH-tech	**225**	**333**	**558**
	227.60	74.03	135.95
ML-tech	**36**	**72**	**108**
	145.11	84.53	104.72
L-tech	**72**	**99**	**171**
	52.06	73.86	64.68
Total	**405**	**711**	**1116**
	179.09	94.65	125.29

Notes: The first row presents frequencies, while the second row contains the means of patent applications
Source: BvD Orbis, SDC Platinum, European Commission, official websites and annual reports of companies, and Chinese state agencies. Own elaboration

3.5.2 Regression results

The data sample for hypotheses testing excludes HUAWEI TECHNOLOGIES CO., LTD. and MIDEA GROUP CO., LTD. due to the reception of a considerably high number of patent applications. The descriptive statistics and pairwise correlations of the selected variables for the regression analysis are reported in Table 3.3. In general, the correlations between variables

exhibit the expected signs and present low correlations among the regressors, together with computed results of VIF, which are all lower than the acceptable level of 10 (Kutner, 2005, p. 409), specify that multicollinearity should not be a serious concern.

Table 3.3: Descriptive statistics and pairwise correlations of selected variables

	Variable	Obs	Mean	Std. Dev.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Patents	2052	132.3	467.6	1.00								
(2)	Size	1132	8.09	2.05	0.38*	1.00							
(3)	Age	1872	16.12	8.39	-0.01	0.02	1.00						
(4)	Fin	1200	0.55	0.43	0.02	0.00	-0.18*	1.00					
(5)	Tar U-tech | KIS	2052	0.57	0.49	0.10*	0.02	-0.05*	-0.07*	1.00				
(6)	MFG tech	1116	2	0.71	-0.07*	0.05	0.08*	0.00	0.30*	1.00			
(7)	SOE	2052	0.39	0.49	0.06*	0.13*	0.11*	0.07*	-0.06*	0.13*	1.00		
(8)	L M&A	2052	0.39	0.49	0.10*	0.10*	0.23*	-0.11*	-0.01	0.08*	0.02	1.00	
(9)	Acq H-tech | KIS	2052	0.38	0.49	-0.02	0.00	-0.07*	-0.13*	0.07*	1.00*	-0.02	-0.04	1.00
	Mean VIF = 1.81					1.14	1.25	1.11	1.22	3.84	1.10	1.17	3.66

*Notes: Correlations are measured via Bravais-Pearson, and Cramer's V statistics are taken for dummies. * shows significance at the .05 level*

The hypotheses are tested concerning the results presented in Table 3.4. The output variable is the number of patents per year for all regressions. The upper part of the results, labeled as count on the top left, shows coefficients for the change in the expected count for the firms that obtained patents. The lower part, labeled as inflate, corresponds to the binary process. Model 1 was included as the baseline model and contained only control variables. The MFG technological classifications and the firm's ownership type are individually added in Models 2 and 3, respectively. The variable of primary interest L_M&A is included in Model 4, and together with the former two variables in Model 5. Models 6 to 10 are presented based on the sub-samples to test the hypotheses. The positive results of the natural logarithm of the dispersion parameters (lnalpha) in all models indicate overdispersion in the data. Robust standard errors are included in parentheses.

In Models 1 to 5 using full data samples, among those firms who obtain patents, the coefficients of firms' size, age, and financial performance are positive and statistically significant in all estimations. In other words, acquiring firms with a larger scale, more experience, or better financial performance is expected to be positively associated with the probability of generating more patents. However, by viewing the lower set of coefficients, both the size and the age of a firm significantly influence the odds of not having patents but with adverse effects. As the size

of a firm increases, the higher the chance that a firm receives a patent; the rise in a company's age, on the contrary, increases the likelihood of not having a patent.

In addition, the coefficients of the control variables in Model 1 show the expected signs. The regression results in column 2 indicate that the MH-tech firms produce notably more patents than ML-tech and L-tech firms, but a similar result cannot be determined for the H-tech group, holding everything else constant. In column 3, SOEs are seen to have better innovation performance than POEs by observing the positive coefficient of the ownership variable; the difference, however, is insignificant.

Hypothesis 1 expected that the subsequent innovation output of Chinese acquiring enterprises will improve significantly with M&A undertaken in the EU. The positive coefficient of the L_M&A variable in both Models 4 and 5 only partially supports this hypothesis. All else equal, Chinese acquirers who have the opportunity to apply for patents are estimated to have a higher expected innovation output of 26% [exp(0.229)-1]% after acquisition (Model 4). If we include the MFG technological classification and the ownership type in the model, as shown in Model 5, being post-acquisition increases the expected innovation output of Chinese acquiring firms by 21% [exp(0.193)-1]%, but the effects are not significant at the 5% level, holding other variables constant.

Hypothesis 2a states that the innovation output of Chinese acquiring enterprises in the high-technology sector will decline after conducting M&A in the EU. Based on the regression results reported in column 6, the estimated coefficient of the lagged M&A is positive for H-&MH-tech firms, which indicates that firms in the high-technology sector can obtain a higher expected patent count in the post-acquisition era among those who file patents. However, this result is statistically insignificant at the given significant levels, which partially rejects Hypothesis 2a.

Hypothesis 2b, according to which the innovation output of Chinese acquiring enterprises in the low-technology sector will rise after conducting M&A in the EU, is tested using the sub-sample in Model 7. Among the firms who applied for patents, a higher innovation outcome for acquirers is evidenced after undertaking M&A activities in the EU in comparison to the pre-acquisition period, with the expected number of patents increased by a factor of 2.60 [exp(0.958)]. However, the change in effect is statistically significant only at the 10% level, which provides weak support for Hypothesis 2b.

Hypothesis 3a predicts that the M&A that Chinese enterprises undertake in the EU will have a negative influence on the post-acquisition innovation output of SOEs. In column 8, it can be seen that an additional number of patents from Chinese SOEs are expected according to the results from the count equation. However, the result is not significantly different after merging with or acquiring companies from the EU, even at the 10% significance level. Thus, Hypothesis 3a can be partially rejected by the finding.

In contrast, **Hypothesis 3b** states that the innovation output of POEs will increase after having M&A in the EU. Within Model 9, the coefficient of L_M&A shows that the expected number of patents increased by a factor of 2.17 [exp(0.777)] when a firm goes from the pre-M&A period to the post-M&A period, holding other variables constant. The change in effect is highly significant and provides empirical support for Hypothesis 3b. This result suggests that a strong positive effect of M&A on the firms' innovative performance can be identified for POEs among those that file patents.

Hypothesis 4 assumes that for Chinese acquiring enterprises in the high-technology sector, the innovation output of SOEs will be higher than that of POEs after conducting M&A in the EU. The interaction term of M&A and ownership type is added to test this hypothesis. According to the regression result reported in column 10, the coefficient of this interaction shows a positive sign. However, the change in effect is statistically insignificant at the usual significance level. Therefore, there is no strong evidence showing that after Chinese firms had M&A activities in the EU, among the companies that filed patents and grouped in the upper intermediate technology sector, SOEs are more likely to generate additional higher innovation output than POEs.

Table 3.4: ZINB analysis on acquirers' innovation outcomes

		(1)	(2)	(3)	(4)	(5)	(6) H-&MH-tech	(7) L-&ML-tech	(8) SOE	(9) POE	(10) H-&MH-tech
Count	Size	0.426***	0.482***	0.422***	0.424***	0.475***	0.468***	0.448***	0.525***	0.428***	0.470***
		(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.08)	(0.04)	(0.05)	(0.04)
	Age	0.058***	0.069***	0.059***	0.057***	0.068***	0.071***	-0.029	-0.020	0.084***	0.072***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)	(0.01)
	Fin	0.918***	0.502**	0.870***	0.924***	0.470**	0.347	-0.307	1.324***	0.777***	0.356
		(0.20)	(0.20)	(0.21)	(0.20)	(0.21)	(0.23)	(0.41)	(0.34)	(0.24)	(0.23)
	Tar U-tech | KIS	-0.010	0.058	0.001	-0.010	0.050	0.067	-0.660	0.229	0.123	0.096
		(0.14)	(0.15)	(0.14)	(0.14)	(0.15)	(0.19)	(0.44)	(0.29)	(0.21)	(0.19)
	H-tech		0.127			0.144					
			(0.19)			(0.19)					
	MH-tech		0.691***			0.661***					
			(0.19)			(0.19)					
	SOE			0.134		0.105	0.302*	-0.907**			0.185
				(0.13)		(0.14)	(0.15)	(0.43)			(0.23)
	L_M&A				0.229	0.193	0.269	0.958*	-0.020	0.777***	0.165
					(0.18)	(0.19)	(0.18)	(0.54)	(0.17)	(0.26)	(0.25)
	L_M&A × SOE										0.210
											(0.28)
	Constant	-4.432***	-4.977***	-4.399***	-4.388***	-4.890***	-4.337***	-2.214*	-4.943***	-4.552***	-4.345***
		(0.58)	(0.60)	(0.59)	(0.58)	(0.61)	(0.69)	(1.15)	(0.85)	(0.72)	(0.68)
Inflate	Size	-0.410***	-0.466***	-0.410***	-0.410***	-0.466***	-0.458***	-0.599***	-0.398***	-0.399***	-0.459***
		(0.05)	(0.08)	(0.05)	(0.05)	(0.08)	(0.09)	(0.18)	(0.07)	(0.08)	(0.09)
	Age	0.060***	0.056***	0.060***	0.060***	0.056***	0.036	0.050**	0.081***	0.058***	0.036
		(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
	Fin	0.249	-0.986**	0.248	0.250	-0.984**	-1.158**	-0.772	0.711**	-0.042	-1.161**
		(0.25)	(0.47)	(0.25)	(0.25)	(0.47)	(0.55)	(0.65)	(0.36)	(0.41)	(0.55)
	Acq H-tech | KIS	-0.243	-1.133***	-0.248	-0.242	-1.127***	-0.621**		-0.100	-0.431*	-0.621**
		(0.17)	(0.27)	(0.17)	(0.17)	(0.27)	(0.28)		(0.27)	(0.25)	(0.28)
	Constant	1.663***	2.567***	1.660***	1.666***	2.570***	2.513***	4.413***	0.814	1.737***	2.516***
		(0.45)	(0.60)	(0.45)	(0.45)	(0.60)	(0.73)	(1.44)	(0.81)	(0.55)	(0.73)
	lnalpha	0.474***	0.361***	0.474***	0.471***	0.357***	0.316***	0.394**	0.089	0.597***	0.316***
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.17)	(0.10)	(0.13)	(0.09)
	Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Industry dummy	Yes	No	Yes	Yes	No	No	No	Yes	Yes	No
	Observations	953	712	953	953	712	534	178	389	564	534
	Log lik.	-4000.4	-3271.2	-3999.9	-3999.7	-3270.4	-2635.8	-618.5	-1802.5	-2146.9	-2635.4
	Wald Chi-sq	439.2***	430.7***	433.4***	436.5***	427.2***	354.8***	104.3***	307.7***	348.6***	375.6***
	AIC	8048.9	6584.4	8049.7	8049.4	6586.7	5313.6	1276.9	3655.0	4343.9	5314.9

*Notes: Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

3.5.3 Robustness check

To check the robustness, the author tested the results by replacing the continuous regressors with their one and two years lagged form. The results are persistent in the tests according to the outcomes included in the appendix (Table 3.6 and Table 3.7). Furthermore, two former excluded companies, i.e., HUAWEI TECHNOLOGIES CO., LTD. and MIDEA GROUP CO., LTD., were re-included into the data sample. According to the test results shown in Appendix Table 3.8, similar results are presented in testing hypotheses 2b to 4. However, I observed an enormous impact on the parameter of the L_M&A variable after adding these two companies. The effects of M&A became positive and highly significant with regard to the increase of patents received after having undertaken M&A activities in the EU. Therefore, it is necessary to treat these two firms carefully.

3.6 Conclusion and Discussion

3.6.1 Conclusion

This study is mainly interested in whether Chinese MNEs can enhance their innovation performance after merging with and acquiring firms from developed markets. In addition, how the innovative performance of acquiring firms with different levels of technological intensity and types of corporate ownership varies in the post-M&A era compared to before. In order to investigate these questions, this research conducted an empirical study with a primary focus on Chinese acquirers undertaken M&A in EU28 countries from 2010 to 2018.

This research contributes to the existing literature in several ways. Due to detailed data on Chinese M&A in the EU being very limited, in this study, the author constructed a comprehensive firm-level dataset by harmonizing and cross-checking various data sources. Moreover, this research adopted a ZINB estimation method to account for the overdispersion and zero inflation in the data; the results of several goodness-of-fit tests suggest that this specification significantly improves the fitting of the data. Meanwhile, the empirical findings show that the size and age of Chinese acquiring firms have different impacts on firms' opportunities to file patents. Therefore, this should be taken into account when using patents as an indicator of innovation performance. More importantly, several new insights and practical

implications are discussed in the context of Chinese multinationals leveraging external resources through cross-border M&A to improve their innovation performance.

In contrast with the author's prediction, this study does not find conclusive evidence about the positive impact on innovation outcomes of Chinese acquiring firms after having M&A in the EU market over the sample period. Instead, the resultant improvement in innovation performance differs among diverse firms in terms of technological intensity degrees and ownership types.

In this analysis, a significant enhancement of the innovation performance cannot be identified for the H-&MH-tech firms after investing in the target market through M&A, except when including the two giant innovation hubs. This finding aligns with the results of Amendolagine et al. (2018), who analyzed Chinese and Indian H-&MH-tech firms following cross-border acquisitions in the EU28 and the US between 2003 and 2011. The reasons behind this less-than-optimal outcome could be multifaceted: It may be due to the intrinsic features of innovations with high added value, which are often related to high uncertainty, risk, and long-term investment needs. Thus, an apparent increase in innovation outcomes of acquiring firms is not visible, at least in the short term. Also, the unmatched technological capacity and international organizational experience could be the reasons for those Chinese multinationals failing to mobilize external resources or manage the acquired knowledge and technology from the target firms and regions to reinforce their innovation performance. It is also likely that there are higher technological barriers and tighter controls on knowledge flow within the sector in the host market, which generates fewer opportunities for knowledge spillover to the acquiring firms. Alternatively, the purpose of H-&MH-tech firms' M&A investments is to promote a higher quality level of innovation. Therefore, the positive impact of M&A on innovation is not directly reflected in the number of patents filed.

Notwithstanding, a consistent weak improvement in innovation has been evidenced for the ML-&L-tech acquirers after purchasing or merging with firms from the EU market. Hence, the idea that M&A can provide additional opportunities and necessary resources to ML-&L-tech companies to advance their innovation performance is supported. Companies with a lower technological intensity also contribute to the breadth and depth of technological development covering a wide range of industries. Together with the market-driven characteristics, ML-&L-tech firms might be able to recognize and absorb external technological and managerial know-how to enhance their innovativeness at a relatively fast speed. However, the experience and

financial performance of ML-&L-tech firms are found to be negatively associated with the number of patents. This finding might reflect previous findings, such as Cozza et al. (2015), that acquisitions are favored by firms who desire early access to intangible assets or search for financial support.

Meanwhile, all of the results of this paper strongly support the hypothesis that POEs can significantly improve their innovation performance after having undertaken M&A in the EU market. Although POEs are considered to have less international M&A experience in comparison to their global counterpart and bear the later-comer disadvantage, they are nevertheless the major and active investment players who have successfully explored and leveraged foreign resources to advance their innovation performance. Therefore, an essential step to support the internationalization process of POEs involves lowering the regulatory restrictions on outward investment and developing a mature financing system to provide necessary financial support for POEs.

3.6.2 Recommendations

Since the possibility of higher innovativeness exists for Chinese firms through merging with and acquiring firms in the EU, it is essential to ensure a modest investment environment to secure continuous investment incentives and cooperation interests for both parties, particularly in the current weak domestic and international economic conditions. From the perspective of cross-border investment, the deepening of the Comprehensive Agreement on Investment (CAI) could offer a good opportunity to reduce investment frictions by providing a regulatory framework for investors and strengthening governmental communication and coordination between China and the EU. From the domestic market perspective, the facilitation of outward investment, such as simplifying administrative procedures and optimizing financial service reform, should be continuously promoted, especially for POEs.

In order to encourage firms to internalize their assets, especially intangible assets, in an efficient, effective, and sustainable manner, appropriate stimulation should be provided targeting different groups. For high-tech manufacturing firms, a continuous openness to external information and resources is considered to be essential. For instance, continuous and rational increases in R&D capital, workforce investment, and observation of innovation

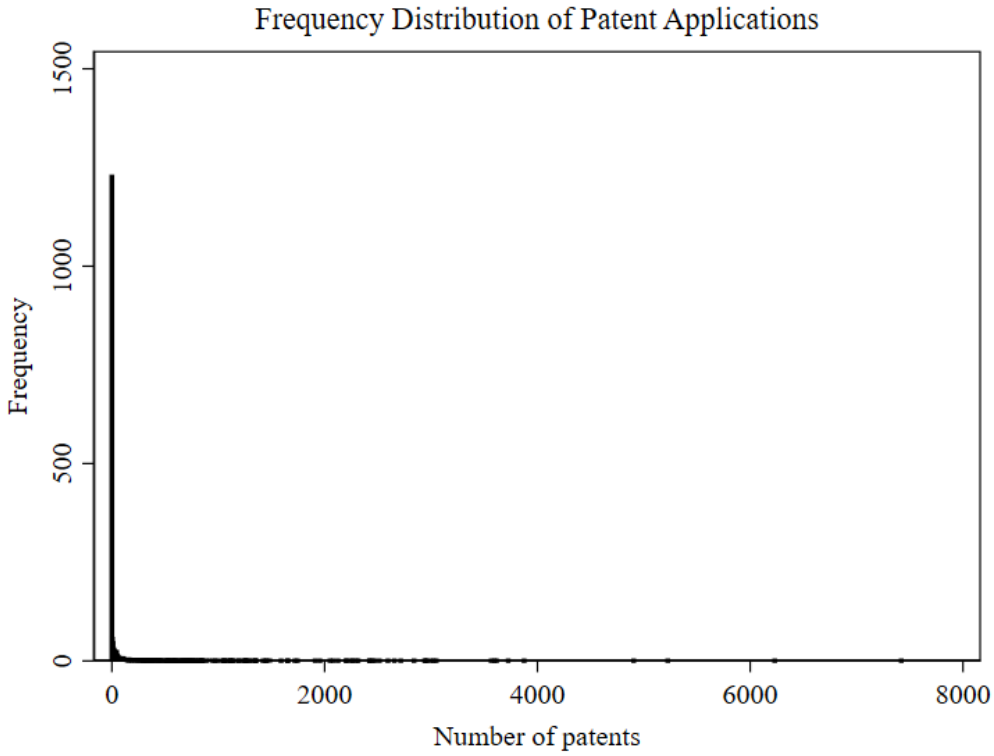
performance are effective ways to increase firms' knowledge stocks and improve learning capabilities. Providing executives with specialized training programs, acquiring experienced management personnel, and developing suitable corporate development strategies can benefit firms' innovation and competitiveness. Additionally, firms should develop their main strengths and characteristics through rational investment, maintain a healthy financial capability, and have a clear understanding of the target environment in order to improve their ability to explore and utilize external resources effectively.

3.6.3 Limitations and future research

The limitations of this study can also provide several valuable ideas for future research. Firstly, although China is a very representative case in the study of outward investment from emerging economies, the findings should not be overgeneralized. Future research could be extended to other emerging economy countries, and comparative analysis could be conducted. Secondly, the reasons behind the insignificant change in innovation performance after engaging in M&A can be further explored, especially for H-tech firms and SOEs. It might provide more comprehensive suggestions for improving innovation outcomes for those firms on various knowledge paths. Thirdly, while in this paper, firms are distinguished on the basis of corporate ownership, some researchers (Cheng, Fan, Hoshi, & Hu, 2019) have argued that it is not only the type of corporate ownership but also the political connections that play an essential role. This might indeed provide a different picture but is not considered in this article. Finally, future research could identify whether there are more international collaborations between EMNEs and developed MNEs in generating higher innovative outputs due to M&A. Whether or not more researchers from emerging economies are participating in international R&D after M&A would be a particularly important avenue for future research to identify the international knowledge spillover effects.

3.6.4 Appendix

Figure 3.2: Frequency distribution of patent applications



Source: BvD Orbis. Own illustration

Table 3.5: The model comparison using pooled Poisson, NB, ZIP, and ZINB

Model	Pearson dispersion statistic	Log likelihood	AIC	BIC	LR test
Poisson	1763086*	-140822.11	281674.20	281737.80	
NB		-3083.57	6199.14	6266.98	
ZIP		-140649.60	281355.30	281474.00	
ZINB		-3173.09	6372.17	6427.29	
XTPoisson		-15821.38	31674.76	31742.60	
XTNB		-2748.26	5530.52	5602.60	
NB nested in XTNB					670.19*
NB nested in ZINB					36.40*
XTNB nested in ZINB					-633.80

*Notes: * shows significance at the .01 level*

Table 3.6: Robustness test - lag continuous independent variables by one year

		(1)	(2)	(3)	(4)	(5)	(6) H-&MH-tech	(7) L-&ML-tech	(8) SOE	(9) POE	(10) H-&MH-tech
Count	L_Size	0.353***	0.378***	0.348***	0.352***	0.373***	0.346***	0.627***	0.347***	0.418***	0.349***
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.05)	(0.05)	(0.04)
	L_Age	0.051***	0.058***	0.052***	0.051***	0.057***	0.058***	-0.091***	0.002	0.068***	0.057***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)	(0.01)
	L_Fin	1.056***	0.664**	0.969***	1.068***	0.589**	0.492	-0.296	1.432***	0.665**	0.457
		(0.24)	(0.26)	(0.24)	(0.24)	(0.26)	(0.30)	(0.38)	(0.41)	(0.29)	(0.30)
	Tar U-tech | KIS	-0.062	0.083	-0.053	-0.061	0.057	0.019	-0.283	-0.058	-0.075	-0.008
		(0.15)	(0.17)	(0.15)	(0.15)	(0.17)	(0.21)	(0.42)	(0.33)	(0.22)	(0.21)
	H-tech		0.203			0.236					
			(0.20)			(0.20)					
	MH-tech		0.699***			0.645***					
			(0.18)			(0.19)					
	SOE			0.213		0.218	0.409**	-1.048***			0.504**
				(0.14)		(0.15)	(0.17)	(0.37)			(0.24)
	L_M&A				0.321	0.322	0.338	1.293***	0.093	1.015***	0.412
					(0.20)	(0.21)	(0.21)	(0.38)	(0.20)	(0.28)	(0.27)
	L_M&A× SOE										-0.152
											(0.29)
	Constant	0.805*	0.625	0.823*	0.831*	0.667	1.459***	1.098*	1.484**	0.249	1.450***
		(0.43)	(0.51)	(0.43)	(0.44)	(0.53)	(0.54)	(0.67)	(0.76)	(0.56)	(0.54)
Inflate	L_Size	-0.420***	-0.471***	-0.420***	-0.420***	-0.471***	-0.470***	-0.593***	-0.432***	-0.392***	-0.469***
		(0.06)	(0.08)	(0.06)	(0.06)	(0.08)	(0.10)	(0.19)	(0.08)	(0.08)	(0.10)
	L_Age	0.057***	0.051***	0.058***	0.057***	0.051***	0.024	0.051**	0.090***	0.049***	0.024
		(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
	L_Fin	0.072	-1.209**	0.070	0.0725	-1.219**	-1.357**	-0.851	0.563	-0.325	-1.363**
		(0.26)	(0.47)	(0.26)	(0.26)	(0.48)	(0.53)	(0.61)	(0.38)	(0.42)	(0.54)
	Acq H-tech | KIS	-0.263	-1.072***	-0.269	-0.262	-1.069***	-0.614**		-0.126	-0.404*	-0.615**
		(0.17)	(0.26)	(0.17)	(0.17)	(0.26)	(0.28)		(0.28)	(0.24)	(0.28)
	Constant	1.894***	2.848***	1.893***	1.894***	2.850***	2.925***	4.440***	1.037	2.017***	2.925***
		(0.45)	(0.62)	(0.45)	(0.45)	(0.62)	(0.74)	(1.54)	(0.86)	(0.55)	(0.74)
	lnalpha	0.403***	0.325***	0.401***	0.398***	0.316***	0.278***	0.209	0.095	0.508***	0.277***
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.18)	(0.11)	(0.12)	(0.09)
	Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Industry dummy	Yes	No	Yes	Yes	No	No	No	Yes	Yes	No
	Observations	832	622	832	832	622	467	155	338	494	467
	Log lik.	-3700.0	-3057.3	-3698.6	-3698.5	-3054.6	-2473.8	-558.5	-1676.0	-1983.9	-2473.7
	Wald Chi-sq	234.2***	167.5***	258.4***	230.5***	199.0***	174.9***	150.8***	201.6***	199.7***	175.6***
	AIC	7446.0	6154.7	7445.2	7444.9	6153.3	4987.6	1155.1	3400.0	4015.9	4989.3

*Notes: Robust standard errors in parentheses. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 3.7: Robustness test - lag continuous independent variables by two years

		(1)	(2)	(3)	(4)	(5)	(6) H-&MH-tech	(7) L-&ML-tech	(8) SOE	(9) POE	(10) H-&MH-tech
Count	L2_Size	0.353***	0.353***	0.343***	0.355***	0.347***	0.315***	0.607***	0.362***	0.335***	0.318***
		(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)	(0.07)	(0.06)	(0.05)	(0.05)
	L2_Age	0.036***	0.038***	0.036***	0.034***	0.037***	0.038***	-0.108***	-0.001	0.043**	0.037***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)	(0.01)
	L2_Fin	1.030***	0.744***	0.952***	1.012***	0.674***	0.585**	-0.028	1.434***	0.758***	0.556**
		(0.23)	(0.23)	(0.22)	(0.23)	(0.23)	(0.25)	(0.43)	(0.43)	(0.29)	(0.24)
	Tar U-tech | KIS	-0.024	0.181	-0.027	-0.016	0.162	0.086	-0.140	-0.347	0.011	0.058
		(0.17)	(0.19)	(0.17)	(0.17)	(0.19)	(0.24)	(0.46)	(0.45)	(0.25)	(0.24)
	H-tech		0.257			0.285					
			(0.21)			(0.22)					
	MH-tech		0.626***			0.569***					
			(0.18)			(0.19)					
	SOE			0.228		0.192	0.392**	-1.292***			0.507*
				(0.16)		(0.16)	(0.19)	(0.40)			(0.28)
	L_M&A				0.273	0.225	0.092	1.788***	0.104	0.627**	0.180
					(0.21)	(0.22)	(0.21)	(0.46)	(0.24)	(0.27)	(0.27)
	L_M&A× SOE										-0.172
											(0.32)
	Constant	1.231**	1.083**	1.286**	1.265**	1.145**	1.901***	1.430*	1.826**	1.449**	1.884***
		(0.50)	(0.53)	(0.51)	(0.50)	(0.55)	(0.57)	(0.79)	(0.92)	(0.70)	(0.58)
Inflate	L2_Size	-0.398***	-0.442***	-0.399***	-0.398***	-0.441***	-0.456***	-0.491***	-0.432***	-0.364***	-0.456***
		(0.06)	(0.08)	(0.06)	(0.06)	(0.08)	(0.10)	(0.19)	(0.09)	(0.08)	(0.10)
	L2_Age	0.050***	0.045***	0.051***	0.050***	0.045***	0.013	0.053**	0.098***	0.039**	0.013
		(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)
	L2_Fin	-0.032	-1.286**	-0.033	-0.033	-1.305**	-1.423**	-0.969	0.617	-0.427	-1.427**
		(0.28)	(0.51)	(0.28)	(0.28)	(0.52)	(0.55)	(0.71)	(0.41)	(0.41)	(0.56)
	Acq H-tech | KIS	-0.264	-1.001***	-0.269	-0.263	-0.999***	-0.584**		-0.098	-0.390	-0.585**
		(0.18)	(0.27)	(0.18)	(0.18)	(0.27)	(0.29)		(0.31)	(0.25)	(0.29)
	Constant	1.929***	2.767***	1.929***	1.930***	2.772***	3.092***	3.571**	0.843	2.083***	3.091***
		(0.48)	(0.65)	(0.48)	(0.48)	(0.65)	(0.77)	(1.51)	(0.93)	(0.56)	(0.77)
	lnalpha	0.344***	0.285***	0.339***	0.340***	0.280***	0.218**	0.125	0.105	0.434***	0.217**
		(0.08)	(0.09)	(0.08)	(0.08)	(0.09)	(0.10)	(0.17)	(0.11)	(0.13)	(0.10)
	Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Industry dummy	Yes	No	Yes	Yes	No	No	No	Yes	Yes	No
	Observations	703	529	703	703	529	398	131	282	421	398
	Log lik.	-3117.9	-2598.2	-3116.5	-3116.9	-2596.6	-2094.1	-478.9	-1413.9	-1675.5	-2093.9
	Wald Chi-sq	193.6***	130.4***	202.2***	196.2***	137.3***	114.8***	127.4***	137.0***	162.1***	115.8***
	AIC	6279.8	5234.3	6279.0	6279.8	5235.2	4226.1	993.9	2873.9	3397.1	4227.8

*Notes: Robust standard errors in parentheses. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 3.8: Robustness test - re-inclusion of two companies with leading patent applications

		(1)	(2)	(3)	(4)	(5)	(6) H-&MH-tech	(7) L-&ML-tech	(8) SOE	(9) POE	(10) H-&MH-tech
Count	Size	0.473***	0.539***	0.474***	0.466***	0.534***	0.540***	0.448***	0.525***	0.456***	0.542***
		(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.08)	(0.04)	(0.05)	(0.04)
	Age	0.092***	0.110***	0.092***	0.088***	0.105***	0.105***	-0.029	-0.020	0.106***	0.106***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)
	Fin	1.391***	0.959***	1.400***	1.380***	0.949***	0.808***	-0.307	1.324***	1.125***	0.819***
		(0.22)	(0.21)	(0.23)	(0.22)	(0.21)	(0.22)	(0.41)	(0.34)	(0.26)	(0.22)
	Tar U-tech | KIS	0.196	0.314**	0.191	0.201	0.297*	0.320*	-0.660	0.229	0.371*	0.343*
		(0.15)	(0.16)	(0.15)	(0.15)	(0.16)	(0.18)	(0.44)	(0.29)	(0.19)	(0.18)
	H-tech		0.296			0.299					
			(0.20)			(0.20)					
	MH-tech		0.701***			0.698***					
			(0.21)			(0.21)					
	SOE			-0.034		-0.047	0.097	-0.907**			-0.009
				(0.12)		(0.13)	(0.14)	(0.43)			(0.22)
	L_M&A				0.519***	0.394**	0.408**	0.958*	0.020	1.042***	0.314
					(0.18)	(0.19)	(0.19)	(0.54)	(0.17)	(0.22)	(0.24)
	L_M&A× SOE										0.192
											(0.28)
	Constant	-5.735***	-6.751***	-5.736***	-5.600***	-6.592***	-6.035***	-2.214*	-4.943***	-5.427***	-6.044***
		(0.57)	(0.59)	(0.57)	(0.56)	(0.58)	(0.61)	(1.15)	(0.85)	(0.69)	(0.60)
Inflate	Size	-0.428***	-0.466***	-0.428***	-0.427***	-0.467***	-0.456***	-0.599***	-0.398***	-0.424***	-0.456***
		(0.05)	(0.08)	(0.05)	(0.05)	(0.08)	(0.10)	(0.18)	(0.07)	(0.08)	(0.10)
	Age	0.053***	0.061***	0.053***	0.052***	0.060***	0.040	0.050**	0.081***	0.049***	0.040
		(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.03)	(0.01)	(0.03)
	Fin	0.214	-0.992**	0.213	0.213	-0.975*	-1.155**	-0.772	0.711**	-0.170	-1.156**
		(0.26)	(0.50)	(0.26)	(0.26)	(0.50)	(0.57)	(0.65)	(0.36)	(0.44)	(0.57)
	Acq H-tech | KIS	-0.261	-1.175***	-0.259	-0.260	-1.172***	-0.676**		-0.100	-0.452*	-0.677**
		(0.17)	(0.29)	(0.17)	(0.17)	(0.29)	(0.30)		(0.27)	(0.26)	(0.30)
	Constant	1.875***	2.433***	1.877***	1.891***	2.450***	2.385***	4.413***	0.814	2.087***	2.384***
		(0.43)	(0.60)	(0.43)	(0.43)	(0.60)	(0.73)	(1.44)	(0.81)	(0.53)	(0.73)
	lnalpha	0.594***	0.487***	0.593***	0.578***	0.476***	0.414***	0.394**	0.089	0.671***	0.414***
		(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.17)	(0.10)	(0.11)	(0.07)
	Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Industry dummy	Yes	No	Yes	Yes	No	No	No	Yes	Yes	No
	Observations	967	721	967	967	721	543	178	389	578	543
	Log lik.	-4186.1	-3393.6	-4186.1	-4182.3	-3391.3	-2750.1	-618.5	-1802.5	-2314.5	-2749.9
	Wald Chi-sq	568.6***	545.9***	573.7***	608.0***	552.7***	582.3***	104.3***	307.7***	622.9***	598.7***
	AIC	8420.3	6829.2	8422.2	8414.6	6828.7	5542.2	1276.9	3655.0	4678.9	5543.7

*Notes: Robust standard errors in parentheses. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01*

CHAPTER 4 -
BREXIT PERSPECTIVES: FINANCIAL MARKET DYNAMICS, WELFARE ASPECTS AND PROBLEMS FROM SLOWER GROWTH

4.1 Introduction

As regards the EU-UK withdrawal deal obtained by PM May in November 2018, the basic perspective for the UK is to continue its deep links with the EU for several years link in an effective customs union for goods while facing no continued market integration in financial services, and the UK would regain control over labor mobility and no longer pay membership contributions to the EU. After 2018, further EU27-UK negotiations on the future relationship would begin: Once the EU and the UK have struck a free trade agreement (FTA) - this could take a few years - Brexit would be fully implemented, but Northern Ireland and the Republic of Ireland would remain in a weak form of an EU single market so that a hard border between Northern Ireland and Ireland would be avoided. However, the failure of PM May to get a majority for her deal in Parliament on December 11, 2018 (with May postponing the vote rather than risk defeat) has raised new uncertainties for the UK and the entire Brexit process, respectively. High Brexit-related uncertainties (including potential dynamics towards a no-deal case) will cause considerable financial market volatility as well as a high Pound depreciation rate. Moreover, global capital market volatility has also been reinforced by the US trade policy and other unclear policy signals from the Trump Administration. For example, President Trump's tweets on a truce with China in the field of trade policy conflicts in early December in the context of the G20 meeting in Argentina. Initially, markets understood the President's tweets to mean that there is a US-China agreement on no further escalation of the trade conflict between the two countries, but the rather hesitant signals from China and statements by the White House economic advisor Larry Kudlow raised doubts about the message the President had published via his Twitter feed. This means that more nervous international financial

markets overlap with the Brexit impulses whose effects have become visible after the June 2016 EU referendum in the UK but which are not so easy to identify and quantify.

Concerning the UK and the Eurozone, the Brexit dynamics could create transitory problems for both and some other EU countries. The December 2018 reforms of the Eurozone - strengthening the European Monetary System (EMS) as a kind of European IMF - could contribute to stabilizing the Eurozone. However, the bank-national bonds nexus is still rather strong and could indeed remain strong as long as there is no requirement for prudential supervisors (which means the European Central Bank (ECB) for the largest banks in the Eurozone) to provide some special bank equity for government bonds without triple-A rating. With many German and other European banks selling Italian bonds in 2018, there could even be a quasi-de-internationalization of EU bond markets: EU countries outside Italy are selling Italian bonds to hedge funds in many countries and to banks and other institutional investors in Italy.

The UK will leave the EU on March 29, 2019, possibly under a deal in the sense of a UK-EU agreement that would bring free trade in goods for a few years, followed later by an EU-Canada Comprehensive Economic and Trade Agreement-type FTA. In this case, there would be a transition period for the UK in the EU single market until 2020. It should be noted that any investor dispute settlement agreement would not be a full substitute for free FDI within the EU single market. The alternative could be a no-deal case, which means that the UK-EU relations would basically follow current WTO rules, and there would be no transition period. In the latter case, there could be technical problems that could, for example, impair the availability of pharmaceutical products in the UK and the EU27, respectively. The big companies in various sectors have made all kinds of preparations for various scenarios. A second referendum on EU membership cannot be ruled out for 2019.

Regarding the output effects of Brexit, the Bank of England's analysis (Bank of England, 2018) has shown that all variants of Brexit considered would bring about an extended period of rather modest real income growth for the UK, as well as higher inflation for several years (see Table 4.1). Many firms in the UK held high liquidity positions in late 2018 as part of firms' investment plans had been postponed in the context of the Brexit uncertainties. This is partly related to the British political system and the politically divided public (Brexiteers versus Remainers) and partly to the anticipated Brexit process itself.

Table 4.1. Effects of EU withdrawal scenarios, Bank of England forecasts

	Effect in Level of GDP at December 2023 Relative to Pre-referendum May 2016 Trend (in % GDP)	Effect in Level of GDP at December 2023 Relative to BoE's November 2018 *Inflation Report* Forecast (in % GDP)	Unemployment Peak (%)	Inflation Peak (%)
Economic Partnership **- Close**	-1.25%	1.75%	4%	2.25%
Economic Partnership **- Less close**	-3.75%	-0.75%	4%	2.25%
No Deal, No Transition **- Disruptive**	-7.75%	-4.75%	5.75%	4.25%
No Deal, No Transition **- Disorderly**	-10.50%	-7.75%	7.50%	6.50%
WTO (at the end of the transition period) **- Prepared**	-5.25%	-2.50%	4.50%	3%
WTO (at the end of the transition period) **- Unprepared**	-8.25%	-5.50%	5.50%	3.25%

Source: EIIW summary representation of the findings of Bank of England (2018), EU withdrawal scenarios, and monetary and financial stability

The study by Korus and Celebi (2018) indicates an asymmetric response of the Pound exchange rate to positive Brexit news - read soft Brexit - and negative Brexit news (i.e., hard Brexit). The analysis of Kadiric and Korus (2018) shows that corporate bond risk premiums (i.e., the corporate interest rate minus government bonds interest rate) for financial sectors in the UK have increased due to the Brexit referendum result, and for certain long-term maturities in the non-financial sectors, there are also Brexit-related increases in corporate risk premiums in the Eurozone. Brexit is thus found to be an event that significantly affects financial markets in many sectors and maturities, respectively. As regards the risk premiums of corporate bonds in the Eurozone, some sectors also show a significant rise in risk premiums for certain sectors (in the years immediately before 2019). Hence, the expected Brexit implies a dampening of investment in the UK and the Eurozone. The findings for the UK and the Eurozone could certainly be applied - with a similar methodology - to countries strongly exposed to Brexit, such as Denmark, Ireland, Netherlands, Belgium, Germany, and Italy. The last country has no strong trade links with the UK, but the populist Italian Conte government has created a nervous situation in Italian bond markets in the second half of 2018 - with strong temporary increases in government bond risk premiums (Italian interest rate minus German government bonds interest rate) and hence Italian bond markets might be exposed to medium-term Brexit dynamics in particular ways.

Since the UK leaves the EU28 single financial market, banks, investment funds, and insurance companies from the UK will relocate part of their activities to the EU27 for regulatory reasons. There will be a doubling of certain financial services in newly fragmented EU28 markets (EU27 plus the UK after March 29, 2019), which goes along with reduced liquidity for both the UK and the EU27. This welfare loss is simply the mirror effect of the previous welfare gains from EU integration in the single market for the EU28. The new post-Brexit fragmentation of financial markets in the EU28, with EU27 wholesale markets largely remaining in the City of London at first (the starting point in early 2019 is that about 60% of that wholesale market is based in the UK), raises three questions:

- How strongly will Brexit affect the level of the British per capita income growth path and the long-run growth rate?
- How big are the welfare losses which can be expected from Brexit for the EU27 and the UK?
- How much could one reduce barriers to financial services trading within the EU27 in order to partly offset the new EU27-UK fragmentation, on the one hand, and on the other hand, to generate welfare gains for the EU27 per se? - A challenge that could be mastered if one knows more about the drivers of barriers to financial services trade in industrialized countries.

4.2 UK Growth Aspects in the Context of Brexit, FDI, and Protectionisms

4.2.1 Brexit-led major economic changes

Brexit is a complex historical politico-economic step that is comprised of several major economic changes for the UK and the Eurozone plus the EU, respectively:

- Trade links between the UK and the EU are likely to be weakened;
- there will be changes in FDI inflows which should reduce in the long run;
- additionally, there will be changes in immigration, probably lower immigration from EU countries (while public concern about immigration seems to have reduced in the UK as the economy is close to full employment and since immigration figures have declined after 2016);
- part of the adjustment dynamics in the context of Brexit concerns financial markets - dominantly in the first stage of Brexit implementation. This leads to analytical interest to financial markets and their interaction with the real economy;
- since Brexit implementation is taking place in a period of increasing US protectionism from the Trump Administration, the broader picture is obtained only if transatlantic

perspectives are included. This indirectly relates to the role of the WTO, which will be crucial for the UK and the 'Global Britain' approach of the May government.

As regards the EU, Brexit entails losing about 1/5th of the GDP, 1/8th of the population, and about 1/6th of exports (World Bank, 2018). This means that the EU27's global positioning will be weaker than that of the EU28. The first FTA that was signed by the EU after the Brexit referendum in the UK was the treaty with Japan in late 2017. Considering the UK government's information campaign of 2019 - under PM Cameron - there are serious doubts that this was in line with good standards. For example, those witnessed in the Scottish independence referendum of 2014 (UK popularity functions indeed indicate that a pro-EU majority could have been the result one would normally expect if the aforementioned good standards had been met; see Welfens, 2017a, 2017b). After the EU referendum of 2016, a two-year negotiation process between the EU and the UK has unfolded. However, by October 2018, no results were forthcoming except a framework UK-EU Withdrawal Agreement, which suggested that close to €40 billion would be paid in several installments once the UK left the EU and that Northern Ireland should technically remain in the EU single market in order to avoid the introduction of a new hard border regime between Northern Ireland and the Republic of Ireland, but it is rather unclear how such a solution within Brexit would look.

With time pressure building up strongly for finding an EU-UK trade agreement in autumn 2018, there is still little indication of significant nervousness or uncertainty in the markets. However, many market participants were concerned about Brexit - and certainly about a no-deal Brexit on March 29, 2018, which would rule out the envisaged transition period until 2020. Beyond Brexit itself, markets seem to be concerned about Italy. Italy was facing a 3% spread for government bonds in October 2018, and with its populist Conte government, whose upward revision of deficit-GDP ratios reflects the political will to implement the introduction of a basic (tax-financed) income and the restoration to a rather generous pension system. Moreover, the implementation of a hard anti-immigration policy is part of the new Italian policy, whose initiatives focus not least on the European elections in May 2019. Anti-immigration policy initiatives, in turn, are an element of populism (Eichengreen, 2019) and have been the common denominator in the UK under Prime Ministers Cameron and May, in the US under the Trump Administration, and in Italy under the new Conte government.

The Brexit implementation year (i.e., 2019) will be a complex period of challenges in politico-economic terms:

- This is the official Brexit year which could bring great changes in exchange rates and short-term interest rates.
- Many London banks will have half-completed relocating staff and business fields to the Eurozone, where such relocations could stimulate financial innovation. - Competitions in a static sense will hardly be reinforced since the big banks are relocating from the UK to the EU27, which means that the 'too big to fail' problems could be reinforced in the Eurozone and the EU27, respectively.
- Also, skilled supervisors in the Eurozone will be at a premium in a situation with the relocation of specialized banking and other financial services to the Eurozone, for example, in the field of derivatives. This could create new macroprudential risks in a situation in which the European Systemic Risk Board (ESRB) will most likely lose the UK (certainly as a member country if there is Brexit, and it seems that the UK is not very likely to seek observer status).
- The WTO dispute settlement mechanism will be ineffective from mid-2019 as the Trump Administration blocks the re-elections of judges to the WTO appellate body.
- US protectionism has intensified under the Trump Administration and is likely to have negative international effects on trade and output growth in the medium term, as already emphasized by the IMF (2018b).
- US interest rates, which have increased already in 2018, are expected to increase further in 2019. This could then undermine financial stability in countries such as Argentina, Brazil, Turkey, and South Africa, as well as other countries, while the Eurozone, Switzerland, and the US, could see new safe-haven effects. Safe-haven effects in the UK could also occur but are likely to be weaker than in the US and most Eurozone countries.
- The UK will want to further reduce corporate tax rates, and this is bound to create new political conflicts between the post-Brexit UK and the EU27. Leaving the EU will strongly weaken UK FDI inflows following the logic of the FDI gravity equation. The results in the subsequent Table 4.2 (Welfens & Baier, 2018, p. 16) show hypothetical combinations of changes in the statutory corporate tax rate, which would be necessary to neutralize the combined effects of losing EU single market membership (hard Brexit) and the various cases of an assumed increase in the foreign share of the target capital stock (e.g., due to increasing M&A activities in the period 2015-2020). Italicized numbers are the required policy action in the sense of reducing the UK statutory corporate tax rate. If, for instance, the increase in the foreign share of the UK capital stock - driven by a real Pound devaluation - would be 5%, the statutory corporate tax rate would have to decrease by 8 percentage points in order to neutralize a hard Brexit in the long run. The cells with italic numbers indicate the case of a hard Brexit. The effects of a hard Brexit on cumulated UK FDI inflows thus could be considerable and indeed could create massive conflicts over corporate taxation to the relationship of the UK/EU27.

Table 4.2. Scenario-matrix for corporate tax and FDI inward stock changes on FDI inflows

		Decrease in Corporate Tax Rate					
		-5%	**-6%**	**-7%**	**-8%**	**-9%**	**-10%**
Increase in foreign share of target capital stock, lagged (UK)	**0%**	18.50%	22.20%	25.90%	29.60%	33.30%	37.00%
	1%	20.40%	24.10%	27.80%	31.50%	35.20%	***38.90%***
	2%	22.30%	26.00%	29.70%	33.40%	37.10%	***40.80%***
	3%	24.20%	27.90%	31.60%	35.30%	***39.00%***	***42.70%***
	4%	26.10%	29.80%	33.50%	37.20%	***40.90%***	***44.60%***
	5%	28.00%	31.70%	35.40%	***39.10%***	***42.80%***	46.50%
	6%	29.90%	33.60%	37.30%	***41.00%***	***44.70%***	48.40%
	7%	31.80%	35.50%	***39.20%***	***42.90%***	46.60%	50.30%
	8%	33.70%	37.40%	***41.10%***	***44.80%***	48.50%	52.20%
	9%	35.60%	***39.30%***	***43.00%***	46.70%	50.40%	54.10%
	10%	***37.50%***	***41.20%***	***44.90%***	48.60%	52.30%	56.00%

Notes: For alternative foreign-owned shares in the UK capital stock (bold figures), the required corporate tax rate change for the case of a no-deal Brexit has been indicated. The figures in italics show the "compensation corporate tax rate change" needed to neutralize a hard Brexit. Adapted from "Brexit and Foreign Direct Investment: Key Issues and New Empirical Findings," by P. Welfens and F. Baier, 2018, Int. J. Financial Stud. 6, p.16. Copyright 2018 by Multidisciplinary Digital Publishing Institute.

4.2.2 Brexit-related economic losses for the UK

The UK has already suffered from the EU 2016 referendum decision, as can be seen by Welfens and Hanrahan (2018), who look, amongst others, at the Office for Budget Responsibility (OBR) forecast revisions. The autumn 2015 forecast is taken as a benchmark because most observers and market participants had not anticipated the Brexit majority vote of June 23, 2016, i.e., the OBR had not assumed any Brexit in its forecast. Comparing the November 2017 OBR revisions with the 2015 forecasting results of OBR for the UK's output development gives a rough idea of the order of magnitude from Brexit-related economic losses: 4% is the answer for 2016-2020 (including here the forecast horizon of the OBR forecast of November 2015).

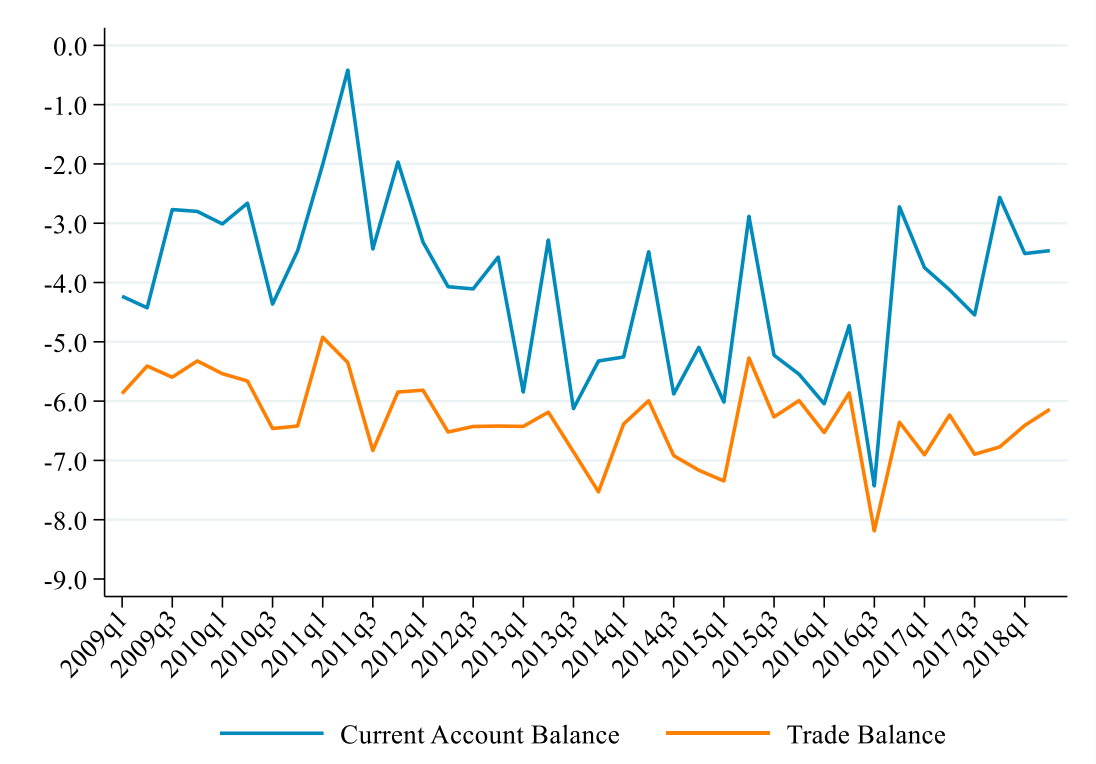
Born et al. (2017), in an analysis that compares the UK's output development with that of an adequately constructed synthetic counterfactual (80% of the synthetic reference group's performance is Japan plus Hungary, whose combined GDP growth performance replicated that of the UK to a large extent over many years) that the UK's output loss for the period of 2016

to end of 2018 - based on forecast values of the Bank of England for output in 2018 - is about 2.2%. Thus, within a decade, an income loss of about 6-12% seems to be realistic. Here the case of a no-deal has been excluded, and such a case would indeed be worse. A fairly broad FTA between the EU and the UK could thus bring about a 10% output loss if one picks a plausible figure that is roughly in line with the UK's Treasury analysis of 2016 (HM Treasury, 2016). In this sense, in 2030, the UK's income will be about 10% lower than in the case of continued EU membership. This makes it quite clear that the UK government will face strong pressure to reduce corporate tax rates and to start new and possibly excessive deregulation of financial markets. Both of these elements of the UK post-Brexit policy are destined to lead to conflicts with EU member countries.

The problem of reduced economic growth in the UK thus has to be picked up in the following analysis, for example, when one considers the demand for money and hence certain aspects of economic welfare. One may mention that standard insight from the EU's QUEST macro model implies that a 6% output loss in the UK will go along with a 1% output loss in the EU27, which in turn should have an adverse repercussion effect on the UK of about an additional 0.2% in terms of output loss.

Brexit plus overlapping high financial market dynamics will not be easy to digest for certain countries, including the UK - and possibly Ireland, the Netherlands, Belgium, and Malta, just to name the countries with relatively strong trade links to the UK. As regards the experience gained from the UK financial market reaction of 2016/17, one may emphasize that the strong real Pound depreciation did not significantly improve the UK trade balance (European Commission, 2018). As shown in Figure 4.1, the improvement of the UK's current account-GDP ratio in 2017/18 largely reflects the impact of the Eurozone economic recovery and the expansion of the US economy and, indeed, the world economy. Strong nominal and real depreciations of the Pound could raise risk premiums in the UK bond market, which could dampen investment. At the same time, exports could slightly increase, but the net effect on output would be negative. The main effect of a strong (unanticipated) nominal Pound depreciation is a medium-term increase of the inflation rate and, thus, a fall of the real wage rate leading to higher employment - this is a specific version of the Philips curve effect (Welfens, 2017a).

Figure 4.1. Current account balance and trade balance of the United Kingdom (% of GDP, quarterly data)



Source: Authors' calculations based on data available from Eurostat

The following analysis looks firstly into long-run aspects of the Brexit-led impact on the UK's economic growth in the context of trade diversion and effects related to FDI. The subsequent analysis will focus on selected financial market perspectives and offer basic theoretical reflections, primarily employing the Branson model (Branson, 1977), which lends itself naturally to a short- and medium-term analysis of the Brexit effects. The Dornbusch model of overshooting (Dornbusch, 1976), which seems to be also relevant in several ways in the context of Brexit in the medium term. Moreover, it will be asked how the quality of financial markets will evolve in the context of Brexit in the Eurozone and the UK, respectively. The quality could be measured by financial service barriers to trade and the effectiveness of banking/financial services regulation. Finally, a considerable list of policy issues - including overlapping transatlantic aspects - and options are discussed.

From a New International Political Economy perspective, the complex Brexit case requires considering more aspects than a standard analysis (and this leaves out the political psychology aspects, which to some extent will indeed affect the Brexit process. For example, one may doubt that the rather unfriendly atmosphere at the EU summit in Salzburg in September 2018 was a good signal from the EU to PM May, who looked to be rather isolated in some scenes

shown on TV, creating a new impulse for a more emotionalized debate in the UK that subsequently emerged and which makes the already difficult negotiations even more difficult).

To the extent that Brexit is a historical but otherwise rather isolated political step in the history of Western countries post-World War II, the focus on a kind of normalization in the medium term and the long term could reinforce expectations that stability and prosperity in Europe and worldwide could be restored. If, however, other major international policy changes - linked, for example, to new protectionism and populism - are on the agenda, the Brexit dynamics might be part of the broader medium-term destabilization of OECD countries and the world economy, respectively.

4.3 Theoretical Perspective on Long-Run Growth

An adequate macro model is an analytical key to understanding the impact of protectionism, and Brexit indirectly pushes the EU27 towards imposing certain tariffs (or Non-Tariff Barriers) on the UK's exports. This holds if the UK and the EU would ultimately not agree on no Brexit or a Norway option for the UK, namely to be in the European Economic Area in the future. It is useful to consider a macro model with trade, inward FDI, and a foreign tariff (t^* ; an import tariff of the EU27 imposed on country 1, namely the UK). In a two-country model only with trade - no FDI - the findings would be rather simple; namely, the foreign tariff in country 2 will cause a substitution effect and an income effect. However, in the presence of cumulated inward FDI (plus possibly also outward FDI), the situation is more complex, as has been shown in a compact approach by Welfens (2018b): Let us denote the export-GDP ratio as x, real GDP as Y, the capital stock as K, knowledge as A and labor as L ($0<\beta<1$; parameter $x'>0$) - the macro production function considered is:

$$Y = K^{\beta}\left(AL\right)^{1-\beta}\left(1+x'x\right) \tag{4.1}$$

Here, international trade and exports, respectively, are assumed to raise GDP through specialization gains - a formula that should hold for open economies as well as the world economy (which one might otherwise dub a closed economy). L is assumed to be constant.

As regards x (denoting the real exchange rate as q^*; parameters $q' > 0$, $t'' > 0$) a simple equation is used:

$$x = q' q^* - t'' t^* \tag{4.2}$$

Denoting the income tax rate as τ and real gross national product (GNP) as Z, savings S consists of purely domestic savings $S_1 = s(1-\tau)Z$ plus retained earnings/savings (denoted as S_2) by foreign subsidiaries which own a share α^* of the capital stock in country 1 (home country), where - with competition in goods markets and factor markets - the share of profits in Y is equal to β. As foreign subsidiaries (in the UK) export to country 2 (the EU27), the profits of foreign subsidiaries are negatively influenced by a foreign import tariff t^* (parameters $t''^* > 0$, $s' > 0$), so that the aggregate savings S can be written as $S = S_1 + S_2$ (where $Z = (1-\alpha^*\beta)Y$, savings of foreign subsidiaries are based on profits which are assumed not be taxed in the host country):

$$S = s(1-\alpha^*\beta)(1-\tau)Y + s'\alpha^*\beta(1-t''^* t^*)Y \tag{4.3}$$

Savings thus is negatively influenced by foreign import tariffs (t^* in country 2), and one of the new transmission channels relevant to the open economy growth model is cumulated inward FDI in country 1. Foreign investors' ownership in the UK capital stock was about 16% in 2016, according to OECD figures.

Finally, the following progress function is assumed (a denotes the growth rate of knowledge and a'' is a positive parameter, a^* is the exogenous foreign growth rate and x'' is a positive parameter), which suggests that the presence of foreign subsidiaries stimulates the international transfer of technology, see the first term in the following equation (4.4). On top of this comes an effect related to the export intensity which follows the arguments of Melitz (2003) and Jungmittag (2004); the latter's empirical evidence for EU countries has shown that high-technology exports stimulate productivity growth, so that not Smithian specialization (a general specialization effect) but rather a Schumpeterian specialization is crucial for knowledge growth.

$$a = \alpha^* a'' a^* + x''(q' q^* - t'' t^*) \tag{4.4}$$

The export intensity x positively influences the knowledge growth rate a. Imposing the goods market equilibrium condition - assuming a balanced budget and zero net exports - means $S = dK/dt + \delta K$ (δ is the rate of capital depreciation), which results, using the function

$A(t)=A_0 e^{\cdot at}$ (where A_0 is the initial knowledge level, $e^{\cdot}$ is the Euler's number and t is the time index) in the following steady-state solution (#) for the per capita income level y:= Y/L:

$$y\# = (1+x^{\cdot}(q^{\cdot}q^{*}-t^{\cdot\cdot}t^{*}))^{\frac{1}{1-\beta}} A_0[\frac{s(1-\alpha^{*}\beta)(1-\tau)+s^{\cdot}\alpha^{*}\beta(1-t^{\cdot\cdot *}t^{*})}{\alpha^{*}a^{\cdot\cdot}a^{*}+x^{\cdot\cdot}(q^{\cdot}q^{*}-t^{\cdot\cdot}t^{*})+\delta}]^{\frac{\beta}{1-\beta}} e^{\cdot(\alpha^{*}a^{\cdot\cdot}a^{*}+x^{\cdot\cdot}(q^{\cdot}q^{*}-t^{\cdot\cdot}t^{*}))t} \quad (4.5)$$

Thus, Brexit, meaning that the EU27 will impose an import tariff t^{*} on the part of UK exports, has an ambiguous effect on the UK level of the growth path. An adverse effect is likely since the tariff-related negative FDI impact in the numerator is likely to dominate the trade-related negative tariff impact on the growth rate of knowledge in the denominator. There is also a negative tariff effect on the growth rate of knowledge, so Brexit will dampen both the level of the UK growth path and the steady-state growth rate of per capita income. This new approach can also be used with two-way FDI and could also be useful for a broader analysis of the effects of Trump's tariff policy. The tariff aspects of Brexit and its impact on growth are crucial; on top of this come financial market effects, part of which refer to higher volatility and changing capital flows.

4.4 Financial Market Perspectives

There will be short-term, medium-term, and long-term Brexit effects on the UK, the EU27, and the world economy. Starting with the announcement on December 10, 2018, that the vote on the EU-UK Brexit deal would be postponed. PM May has indirectly given an impulse for higher financial market volatility in the UK and a new period of devaluation for the Pound; the less likely it seems that a soft Brexit works politically, the more likely either a hard Brexit or no-deal Brexit scenario. Such polar alternatives could be difficult for markets to digest, and the Volatility Index (VIX), as well as the Credit Default Swap prices for UK bonds, could go up.

The year of the UK's official exit from the EU, 2019, should see economic effects in financial markets that are similar to those of the Brexit referendum year of 2016. Short-term effects will be a strong depreciation of the Pound and a rise of the UK nominal interest rate, as well as a higher inflation rate. A remarkable impact was the rise of FDI inflows in the UK in 2016 when strong real deprecation occurred, followed by a massive reduction of FDI inflows in 2017 by 92% compared to 2016, when global FDI inflows were reduced by 18% (OECD, 2018). This

time, however, there will be stronger effects on the real economy, most certainly if there should be a no-deal Brexit. Brexit will bring about a series of medium-term economic effects:

- A major depreciation of the exchange rate and, therefore, a strong increase in the inflation rate. This will reduce the real wage rate and thus should lead to a rise in the demand for labor. The Bank of England is unlikely to reduce the interest rate much in a post-Brexit scenario since reducing the interest rate would further stimulate a currency depreciation. There is a caveat, namely the no-deal Brexit, which could bring a serious recession so that the Bank of England could reduce the nominal central bank rate and continue or reinforce aggressive open market policies.
- The UK - no longer serving as a hub for the continental EU countries - will face a strong decline in greenfield investments, while international M&A, stimulated by the real depreciation of the Pound, will increase. The latter effect is explained by the Froot-Stein effect and real depreciation, respectively (Froot & Stein, 1991). The net effect in the medium term could be higher net capital inflows, which would dampen the initially strong nominal and real Pound deprecation.
- The share of foreign ownership in the UK capital stock will increase from 17% in 2016 to about 25% or 30% in 2025, so the difference between the GDP and GNP will increase. If an additional 15% of the capital stock were owned by foreigners in 2025 and assumed a share of profits in GDP of 1/3rd (a standard order of magnitude in leading OECD countries), the effect would be a reduction of long-run GNP by 5%. One should consider the problem that the structural British current account deficit will increase with higher profits from UK subsidiaries going to parent companies in the US, Japan, Korea, China, and EU27. The current account deficit-GDP ratio will reduce in the medium term if there are increased capital inflows (relative to GDP) in the UK so that net capital inflows reduce. This is a mechanical view of the mirror side of the current account and the capital account balance.
- After a wave of international M&A in the first years after the implementation of Brexit, the UK current account deficit relative to GDP could increase: (1) Because the very strong initial real depreciation will give way to some appreciation - read a more modest medium-term depreciation than in the short term. (2) The implication of disintegrating UK production networks in the EU, partly coming under the pressure of higher local content requirements post-Brexit, will raise the unit production cost in the UK so that UK export growth should slow down. Moreover, as leading bankers will have moved from London to the EU27, reduced competition in the banking market will bring about higher financing costs in the UK.
- The initial years after the implementation of Brexit in 2019/20 could go along with considerable financial instability in UK financial markets. This could reflect the effect of a quasi-forced relocation of some of the leading banks from the UK to the EU27. However, the UK could also pay the price in the form of facing more powerful competition from financial services firms in the EU27. The adjustment process is not necessarily smooth. Moreover, the risk of insufficient regulatory experience in the EU27 could also contribute to financial instability in the EU27, of course, with spillover effects to the UK: If complex financial services, including derivatives markets, are shifted from the UK to the Eurozone, there will be an initial lack of experience on the part of supervisors with respect to financial products that so far have not been the standard focus of Eurozone/EU supervisory institutions. At least the Eurozone reforms from December 2018 - strengthening financial market integration and the role of the EMS - have reinforced the institutional setup of the Eurozone.

A key issue for the UK will be whether or not the UK current account will improve: If the real depreciation of the Pound in 2019/20 should, after several quarters, improve the trade balance and the current account, respectively, the UK's foreign indebtedness would clearly reduce. If, on the other hand, the partial economic destruction of UK production networks in Europe should undermine the UK's export competitiveness (partly due to high local content requirements), the UK's export growth to the EU27 countries could be reduced. Assuming that equivalence rules agreed upon by the EU and the UK will not be a full substitute to the passporting status relevant so far, many London City banks will relocate activities to the EU27 or - in the case of US banks - to the US. Thus, there are two negative structural impacts on the UK current account:

- Ambiguous impacts on UK net exports of goods and services;
- in the context of the international relocation of London City banks' activities, the bilateral current account surplus in the UK services balance will reduce.

If the net effect on the UK current account is negative, the foreign indebtedness of the UK will increase. This could also put more pressure on the Bank of England to keep interest rates at a higher level than prior to Brexit; this might, in the future, be a new constraint on British monetary policy.

As regards the financial system stability analysis, the IMF's FSAP update on the UK from 2016 (IMF, 2016, p. 32) notes that "*...effective cooperation and collaboration arrangements have been established with foreign supervisory and resolution authorities. This allows UK authorities, in their capacity as both home and host supervisors of cross-border banking groups, to share information and cooperate with foreign authorities for the effective supervision of banks and banking groups. At the same time, the implementation of the international post-crisis reform agenda and national initiatives may have implications for correspondent banking relationships and for the provision of financial services by UK banks to certain categories of customers, notably money transmitters and non-profit organizations.*"

It is, however, not clear that cooperation and collaboration with the EU27 indeed will be adequate. It is extraordinary that the IMF published a financial system stability assessment on the Euro (IMF, 2018a) in July 2018, but for the UK, there is no publication of an IMF update. So, there is unnecessary uncertainty amongst market participants in the year prior to the Brexit date in 2019. It also seems not to be wise that the EU/European Banking Authority will publish its stress test only in November 2018 (Welfens, 2018c).

4.4.1 Brexit in the Branson Model and overshooting aspects: A medium-term perspective

4.4.1.1 Brexit in the Branson Model

From a British point of view, Brexit will bring two important changes in the context of the Branson model, which reflects a portfolio theoretical perspective (see Figure 4.2). The model is a setup with the money market, the domestic bond market, and the foreign bond market so that investors have a choice between money (M), domestic bonds (B), and foreign bonds (F^*). Total nominal wealth is $A^{'}$, and all assets are gross substitutes; the desired share ($h^{"}$) of money in total wealth is a negative function of both the domestic nominal interest rate i and the foreign interest rate i^*. A medium-term perspective on Brexit is to assume that the current account post-Brexit - despite a real Pound depreciation - has worsened due to a dominant reduced-EU27 market access effect, so the F^*F^* curve portraying foreign bond market equilibrium in e-i-space will shift upwards on the MM curve (portraying money market equilibrium). What happens with the MM curve? Let us look at the equilibrium condition for the money market and the MM curve in e-i-space, respectively ($h^{"}$ is the desired share of money in total private sector nominal wealth:

$$A^{'} = M + B + eF^* \tag{4.6}$$

Where M and B are the stock of money and domestic bonds, respectively. F^* is the stock of foreign bonds expressed in foreign currency - read $ - and e is the nominal exchange rate in € per $; the shares of the three assets are $h^{"}$ for money, $b^{"}$ for domestic bonds, and $f^{"}$ for foreign bonds, and these must sum up to unity: $1=h^{"}+b^{"}+f^{"}$; due to this condition we have only two independent equilibrium conditions for the three assets):

MM curve (money market equilibrium):

$$M = h^{"}(i, i^*)\left[M + B + eF^*\right]; h_i^{"} < 0, h_{i^*}^{"} < 0 \tag{4.7}$$

Alternatively, we can write $M/[M+B+eF^*]=h^{"}(i,i^*)$; the actual share of money in total wealth must be equal to the desired share. Subsequently, a setting with zero expected inflation is considered so that the nominal interest rate i can be replaced by the real interest rate. The

equilibrium condition for the domestic bond market (BB) and the equilibrium condition for the foreign bond market (F^*F^*) read:

$$BB: B = b^{"}(i, i^*)[M + B + eF^*] \tag{4.8}$$

Where $b^{"}$ has a positive partial derivative with respect to i (negative with respect to i^*):

$$F^*F^*: eF^* = f^{"}(i, i^*)[M + B + eF^*] \tag{4.9}$$

The desired share $f^{"}$ has a positive partial derivative with respect to i^* (negative with respect to i). Differentiation of the equilibrium condition for the foreign exchange market gives $(1\text{-}f^{"})(F^*de+edF^*)=A'(f_i^{"}di+f_{i^*}^{"}di^*)+f^{"}(dM+dB)$. Hence, a fall of the stock of F^* ($dF^*<0$) for a given interest rate i will shift the F^*F^* curve upwards since the exchange rate will have to increase: $de=-edF^*/F^*$.

Differentiation of the equation for the money market equilibrium (MM) gives:

$$(1-h^{"})dM = A'h_i^{"}di + A'h_{i^*}^{"}di^* + h^{"}dB + h^{"}(F^*de + edF^*) \tag{4.10}$$

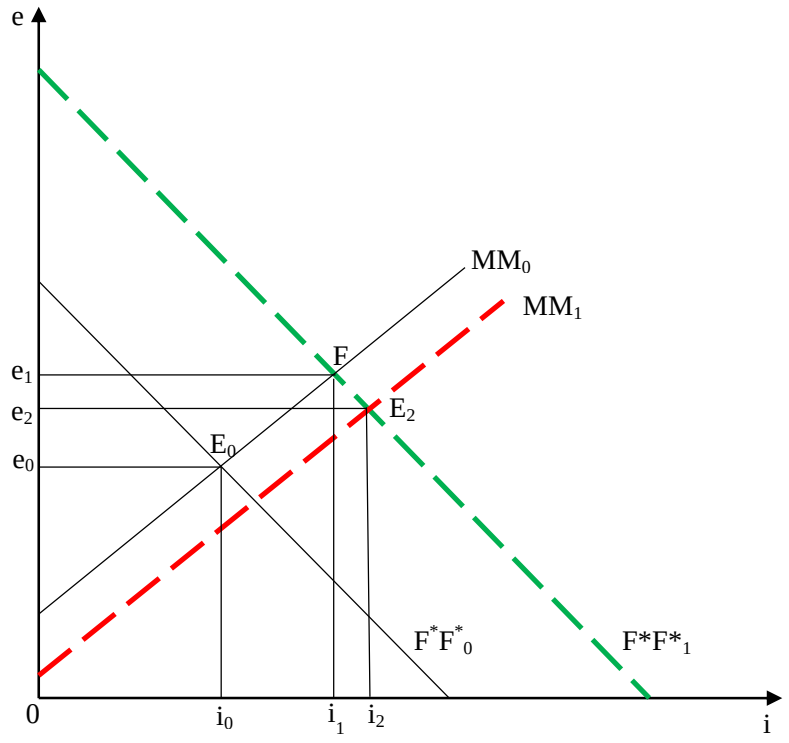
Solving for de/dF^* gives (for given stocks of M and B as well as i^*, respectively) here $de=-edF^*/F^*<0$. Moreover, $di/dF^*=h^{"}e/(-A'h_i^{"})>0$. A fall of F^* will thus bring about a rightward shift of the MM curve so that the interest rate will rise in the new equilibrium; the downward shift of the MM curve dampens the depreciation of the exchange rate. The rightward shift of the MM curve will be reinforced if the interest elasticity falls in absolute terms. Subsequently, the F^*F^* curve shifts to the left if the stock of foreign bonds is falling since - as a net effect - the supply of foreign bonds is falling. Thus, at a given exchange rate, the domestic interest rate i must rise so that the demand for foreign bonds falls. The case of a worsening current account in the UK post-Brexit does not require F^* to be negative. If Brexit should - unexpectedly - bring about a medium-term improvement of the current account and a current account surplus, the UK's interest rate would fall, and the nominal exchange rate might appreciate (or slightly depreciate).

However, the situation of the UK's trade balance has only modestly improved after the strong real Pound devaluation in 2016 (as shown in Figure 4.1). To the extent that Brexit raises the price of imported intermediate inputs or replaces cheap production in EU27 subsidiaries

through more costly value-added in the UK - in line with higher local content requirements post-Brexit - the UK's export growth will slow down. This, plus a lower bilateral financial services net export to the EU, could worsen the UK's current account, at least as a temporary phenomenon.

Suppose Brexit brings about a financial market fragmentation in the EU28, as is to be expected. A common financial EU28 market subject to EU regulation will no longer exist post-Brexit, i.e., the interest elasticity will fall in absolute terms ($-A' h_i''$ will fall). Hence, the exchange rate deprecation is reinforced while the interest rate increase is dampened. The most important aspect in the medium term could be the fall of the stock of foreign bonds (relative to GDP, which could also enter the demand curve in the Branson model). With Brexit bringing more restricted access to the EU single market, the UK's current account deficit may be expected to increase in the medium term.

Figure 4.2. Brexit effects: A fall of the stock of foreign bonds (F*) in the Branson Model (Assuming a Brexit-induced current account deficit of the UK)



Source: Own representation

As regards capital markets adjustment, there are several issues in the context of Brexit. For instance, the market power of banks in the Eurozone could increase since it is mainly the big London banks that are relocating activities to the Eurozone. Also, specialized financial services

that so far have been offered by small innovative banks and financial services suppliers might not be available in the EU27 markets post-Brexit, and somewhat higher markups for financial services will be the consequence in the Eurozone and the EU27.

The London financial market could suffer from a reduced range of differentiated financial services since some of the big foreign banks have relocated activities either to New York or to EU27 cities (Welfens, 2019). As a result, the UK will have to import certain financial services in the future, including services that used to be exported by the UK (the result being a negative impact on the current account).

4.4.1.2 Dornbusch-type Overshooting Aspects and Elasticity Considerations

The adjustment mechanics in foreign exchange markets and financial markets will take effect, not least because of the reduced interest elasticity of the demand for money. In a Dornbusch-type macro model (Dornbusch, 1976), with price stickiness, there could be overshooting in the foreign exchange market so that the Pound depreciation, in the long run, will be smaller than in the short run. Moreover, a short-run overshooting is likely as the monetary policy will react in the UK; however, the medium term could also bring about supply-side shocks (e.g., the government stimulates FDI inflows in order to spur product innovations and process innovations), this could dampen the overshooting phenomenon. It is not fully clear that the Dornbusch-type overshooting is relevant in the Brexit process, namely if all central banks follow simple Taylor rules. The overshooting problem occurs basically in the case of an unanticipated monetary policy expansion; however, the complexity of the Brexit dynamics suggests that one should indeed consider this aspect. The subsequent considerations are not intended to replace any full econometric modeling or quantification of Brexit effects, but they nevertheless highlight crucial transmission aspects which are worthy of attention.

With a lower interest elasticity of the demand for money (in absolute terms), overshooting will be bigger than in a setting with high-interest elasticity as is implied, for example, by the Dornbusch model, with sticky prices, in the modified version of Gartner (2001), see Appendix 4.1. The initial Dornbusch model version with regressive exchange rate expectations could be useful since rational expectations are rather implausible given the fact that the complex historical Brexit can hardly be covered by a simple extension of available macro models. In the case of monetary policy, exchange rate overshooting could indeed occur in this context. However, even with perfect foresight about exchange rate developments and supply-side shocks, which are highly relevant in the context of Brexit, some overshooting of the exchange

rate - depending on parameters - is possible. If there are demand shocks and/or strong supply shocks, monetary policy and fiscal policy might adopt rather strong policy measures.

Several relevant research has provided valuable insights, such as the empirical findings by Frankel (1984); for more recent empirical Pound/Dollar exchange rate modeling, see Dritsaki (2018), and the paper by Siourounis (2003) are useful in the context of the UK. However, various exchange rate models were only partially satisfactory with respect to the Dornbusch model and the Branson model, respectively. At least with some drift parameters included in the empirical modeling worked for the UK and some other countries. Hence, the implications suggested here for the Brexit issues have some limitations.

The adjustment of the UK's current account will be important for Brexit adjustment in the UK, not least since a change in the current account-GDP ratio would affect the outcome of the Branson model (see also Appendix 4.2). It is interesting to note that Belke and Ptok (2018) find hysteresis export effects of the EU and the Eurozone separately, while UK exports are not affected by hysteresis effects. Hysteresis export effects are mainly explained through sunk international investment/marketing costs faced by firms that aim to export goods. One may add the additional aspect that within international production networks, part of the exports relies on imported foreign intermediate products so that hysteresis effects could occur both on the export and the import sides. It is not fully clear why UK exports would show no hysteresis effects; if this is indeed the case, Brexit-induced real exchange rate changes would have a faster effect on the UK export side (concerning exports going to the EU27) than on the EU27's exports to the UK.

Elasticity aspects of the trade balance could become important in the case of Brexit for the UK as well as for other countries. One key question of current account adjustments in the context of real exchange rate changes and a strong Pound depreciation, respectively, concerns the Marshall-Lerner condition. As has been shown for the case of an economy with only (cumulated) outward FDI, the augmented Marshall-Lerner condition (Welfens, 2018d) relevant for such an economy is stricter than the standard Marshall-Lerner condition. To improve the current account condition requires that the sum of absolute import elasticities in the home country (η) and the foreign country (country 2; η^*) exceed unity. We must have as the modified new Marshall-Lerner condition that:

$$\eta + \eta^* > 1 + \left(1/(1 + \lambda/\alpha\beta^*)\right) \quad (4.11)$$

Where β^* is the share of profits in foreign GDP, α is the ratio of the outward FDI stock in the host country's capital stock, and λ the ratio of the home country GDP relative to foreign GDP (in home country units). A ranking of countries' outward FDI stock as a percentage of the source country's capital stock in 2014 (with a comparison for 1980) can be found in Appendix Table 4.11. The analytical point is that exports are not proportionate to foreign GDP but to foreign national income (Z^*=Y^*+ net factor income from abroad) and that imports are not proportionate to GDP but to the national income in country 1. This will not necessarily bring a strong sharpening of the traditional Marshall-Lerner condition as the size of parameters in the various cases are important, and the case of two-way FDI is different from the asymmetrical FDI case.

Dornbusch shows that overshooting should be expected if there is an aggregate demand shock and particularly if there is a monetary policy shock, but he also shows that the type of disturbance matters for the phenomenon of overshooting (supply-side shocks trigger no overshooting) and that giving up the assumption of perfect substitutability of domestic and foreign bonds could lead to a setting of no-overshooting (and the short-term impact of monetary policy depends on the assumption that market participants have with respect to the future monetary policy orientation).

The interest elasticity of the demand for money also affects the standard policy multipliers in macro models. Empirical analyses will have to clarify how large the change in the interest elasticity of the demand for money in the UK and the Eurozone/EU27 will be. Finally, the size of the interest elasticity of the demand for money plays a role in the UK welfare loss from Brexit.

4.4.2 UK welfare loss: Money market aspects

Standard aspects of Brexit-related welfare losses have been analyzed for the case of a no-deal Brexit (Welfens, 2017b). However, one may add additional aspects related to the real demand for money. Additional welfare costs have to be considered, and if the real income elasticity of the real demand for money in the UK should be close to unity, a long-run Brexit-related output loss of 10% would imply an additional welfare loss of a similar size through a dampening of

the real demand for money in the UK. It is true that one should anticipate that a Brexit-related income-dampening effect of 10% (UK Treasury medium estimate in 2016 report) to 18% (Erken et al., 2017) will materialize over about 15 years so that part of the future welfare losses has to be discounted by the long run real interest rate of the UK which, however, is fairly low since the Transatlantic Banking Crisis.

The highly integrated EU28 wholesale banking market will partly disintegrate, which implies the range of financial assets available post-Brexit in the EU27 and the UK, respectively. The choice could become more narrow as the substitutability of assets will reduce; hence, the interest elasticity of the demand for money will reduce, which implies welfare losses both in the EU27 and in the UK. See i-(M/P) space in Figure 4.3, with i denoting the nominal interest rate and M/P real money balances (M is the nominal stock of money, P is the price level; $m^d(Y,i)$ is the real money demand that depends positively on the given real income Y_0 and negatively on the nominal interest rate i), the real demand for money curve will become steeper than before.

Post-Brexit, the reduction of asset substitutability in the EU27/UK could deepen over time to the extent that the UK adopts deregulation of banks and financial markets that impose a different institutional and legal framework on UK banking activities. Indeed, deregulation, or "regulatory optimization and the reduction of anti-competitive market distortions," is a crucial concept in the Institute of Economic Affairs (IEA) 'Plan A+ Creating a prosperous post-Brexit UK' which was launched in September 2018 and was hailed by leading Brexiteers as an alternative approach to PM May's so-called "Chequers Plan." An in-depth review of the modeling employed by the IEA would shed some light on the role of banking and financial market deregulation; unfortunately, the relevant footnote (Footnote 28) is missing from the document (Singham & Tylecote, 2018). Only in the second quarter of 2019, immediately post-Brexit, will there still be a common single market framework for the EU27 and the UK in the case of a no-deal situation (with a treaty adopted in the UK and the EU there will be a transition period until the end of 2020).

4.4.3 GBP foreign reserve holdings: Welfare aspects

In mid-2018, the GBP stood for a market share of about 5% of global foreign exchange reserves (IMF, 2018). Those reserves could reach about $12,000 billion in the global economy in 2019. If one assumes that the difference between the interest paid on UK bonds (and $ bonds and € bonds) held by foreign central banks is 0.5% while the global yield on capital is 2.5%, the annual seigniorage obtained globally from reserve holding in foreign central banks is $240 billion. The Eurozone, standing for a 20% market share in global reserve holdings, thus obtains $48 billion, the US (with a 60% market share) $144 billion, and the UK $12 billion. If Brexit reduces the market share of the GBP in global reserves by 1 percentage point, the UK loses $2.4 billion, and if the GBP market share, after a strong devaluation of the Pound, would fall by 2 percentage points, the UK would lose $4.8 billion which seems to be a likely figure in the medium term; capitalized at 3% this amount to a loss of $148 billion which is about 6% of UK GDP. This aspect has thus far not been considered in the literature.

Only if the Global Britain policy is successful so that the UK's global trade would increase considerably could one expect that the GBP market share could increase. However, the main challenger among reserve currencies is China, whose GDP will increase in absolute terms and relative to world GDP. Therefore, China's role as a global trader is rising in the long run, and one may anticipate that China's market share will strongly increase in the long run. Strong competition between the US dollar, the Euro, and the Renminbi might squeeze out the Pound over time. This problem might have emerged in the medium term (assuming that the € will survive as a stable currency in the long run), but with Brexit, this process could accelerate considerably. The experience of a strong Pound devaluation and higher inflation in 2016 and possibly in the Brexit implementation year plus the following year will reduce the demand for GBP currency reserves if one follows the standard wisdom in the theory of foreign exchange reserve holdings (Eichengreen, Chitu, & Mehl, 2016; Eichengreen, Mehl, & Chitu, 2017; Tavlas, 1990).

As shown in Figure 4.3, to the extent that the Pound depreciation will lead to a higher inflation rate and a higher nominal interest rate (i_1^*), there will be a welfare loss for the UK that can be shown in the usual way (triangle $E^*F^*I^*$) in a graph with the real demand for money. It should also be noted that the reduction of the output growth due to Brexit implies that the normally occurring leftward shift of the real demand for money in the UK will not occur due to lower

growth of output in the first post-Brexit decade; so that an additional welfare loss $A_0^* A_1^* Z_1^* Z_0^*$ is occurring. The output dampening of Brexit thus has a significant welfare effect which thus far has not been discussed in the literature. One may recall that (M3/P)/Y is about unity in the Eurozone. Therefore, the welfare loss from a reduced real demand for money in the UK can easily be calculated. Using a real money demand function in a simplified zero inflation setting gives:

$$m^d = hY - h' r \tag{4.12}$$

Here h and h' are positive parameters, and therefore by solving for r_0 and r_A (for point A), the m_0^d curve leads to the solutions:

$$r_A = hY / h' \text{ (from setting m=0 in the money demand function)} \tag{4.13}$$

Using the point E on $m^d(m_0/r_0)$ we get:

$$m_0 = hY - h' r_0 \tag{4.14}$$

Therefore, we have:

$$r_A - r_0 = hY / h' - (hY - m_0) / h' = m_0 / h' \tag{4.15}$$

It should be noted that the ratio of (M3/P)/Y is about unity for the Eurozone.

The welfare gain Ω from holding money is therefore given by the term (standing for the triangle surface AEH^*):

$$\Omega = 0.5 m_0 \left(m_0 / h' \right) = m_0^2 / 2h' \tag{4.16}$$

The elasticity of the welfare gain with respect to the real money stock is 2. The lower h', the higher the welfare gain.

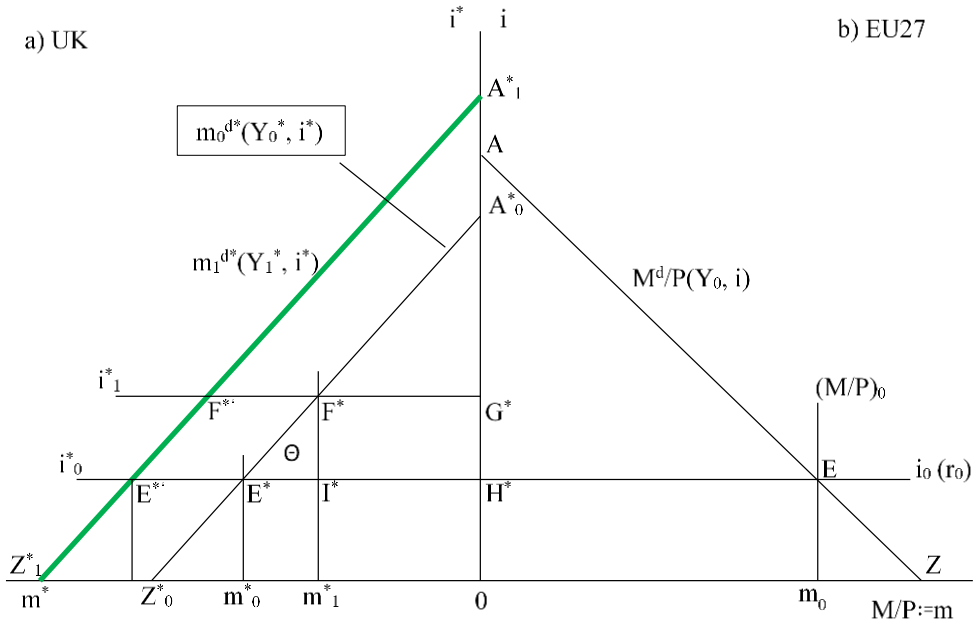
The welfare loss can be restated - with the elasticity of the demand for real money balances with respect to the interest i denoted as $E_{m,i}$ - as $\Omega = rm_0^2/(2|E_{m,i}|m_0) = rm_0/(2|E_{m,i}|)$ and with profit maximization, namely $\beta Y/K - \delta = r$ (we use the production function $Y = K^{\beta}(AL)^{1-\beta}$), one obtains:

$$\Omega = \left(\beta Y / K - \delta\right) m_0 / \left(2\left|E_{m,i}\right|\right) \tag{4.17}$$

Suppose the absolute value of the above elasticity is 0.2, ß=1/3 and Y/K=1/4, and one gets for the simplified case of δ=0, a welfare loss from a 10% GDP reduction is 0.67 times that reduction: Thus, the welfare loss in the money market from the 10% GDP reduction will be 6.7% of the reduced-GDP in the UK.

It should be emphasized that the Eurozone has brought about a long-run reduction of the nominal interest rate, and thus, there was a considerable welfare gain from holding real money balances. At the same time, there is a low interest elasticity of the demand for money in the Eurozone (Dreger, Gerdesmeier, & Roffia, 2016), and a lower Eurozone interest rate has parallel spillover effects on the UK. One should also point out that the creation of the Eurozone - and before the EU single financial market - has raised the interest elasticity of the demand for money as those holding liquidity face a higher range of alternative liquid assets in an integrated financial market. Hence h' has increased, and this negatively affected the welfare gain Ω.

Figure 4.3. Welfare impact of the decline of the Brexit-related output dampening in the UK and the reduction of the UK interest elasticity, respectively



Source: Own representation

4.4.4 Long-term equilibrium and welfare gains from holding real money balances

With profit maximization and a Cobb-Douglas production function $Y=K^{\beta}(AL)^{1-\beta}$ (with K denoting capital, A knowledge, L labor, δ is the capital depreciation rate; $0<\beta<1$), a modified calculation of the welfare loss is rather easy; profit maximization will lead to $(\beta Y/K-\delta)=r$ where r is the real interest rate (and r=i in a setting with price stability).

Considering profit maximization additionally in the form $\beta Y/K-\delta=r$, this represents an aggregate equilibrium (money market equilibrium and a supply-side equilibrium), we have:

$$m_0 = hY - h'(\beta Y / K - \delta) \tag{4.18}$$

Hence, we get:

$$m_0 = (h - h'\beta / K)Y + h'\delta \tag{4.19}$$

Assuming that δ is close to zero, the welfare gain is given by:

$$\Omega = \left[Yh - \left(Yh'\beta / K \right) \right]^2 / 2h' \tag{4.20}$$

Which can be transformed into:

$$\Omega = Y^2 \left[h^2 / 2h' - h\beta / K + h'\beta^2 / 2K^2 \right] \tag{4.21}$$

For a given stock of capital K - hence in the short run - the elasticity of the welfare gain with respect to Y is 2 (see

Appendix 4.3). This is fairly high and a dimension of the Brexit welfare losses not considered thus far. Hence if output falls by 1%, the welfare gain from holding real money balances will fall by 2% ($\ln\Omega=2\ln Y+\ln[...]$). If the UK GDP falls through Brexit by 6%, which is the estimate of the UK Treasury Study of 2016 (HM Treasury, 2016), the welfare loss of holding real money balances would be 12%. In the long run, K will change along with Y, and one may assume that the ratio is given by K=4Y and hence we get:

$$\Omega = Y^2 h^2 / 2h' - Yh\beta / 4 + h'\beta^2 / 32 \quad (4.22)$$

In the special case of h equal to unity and h' equal to 2, we get:

$$\Omega = (Y^2 - Y\beta) / 4 + \beta^2 / 16 \quad (4.23)$$

Since $\beta^2/16$ is close to zero, we can write for the long run with capital adjustment, which is fairly large:

$$\Omega \approx (Y^2 - Y\beta) / 4 \quad (4.24)$$

The ratio of Ω/Y is:

$$\Omega / Y = Y / 4 - \beta / 4 \quad (4.25)$$

Calculate the ratio of the welfare gain as a percent λ of $Y[(\Omega\text{-}Y)/Y=\Omega/Y\text{-}1]$:

$$\lambda = \left[(Y^2 - Y\beta) / 4 \right] / Y - 1 \quad (4.26)$$

This is equal to the following:

$$\lambda = Y / 4 - \beta / 4 - 1 \quad (4.27)$$

It should be noted that a Brexit-related reduction of the absolute value of the interest elasticity of the demand for money will make the demand for money curve for the UK somewhat steeper, which reduces the negative welfare effect to some degree. To the extent that a hard Brexit will bring an output decline of 6-16% of GDP in the UK (see Welfens (2017b); see also Appendix Table 4.8 for a summary table showing the true cost of Brexit). Since there will be negative spillover effects to the EU27, one may assume that real GDP in the EU27 would decline by 1-3% in the long run, so a negative welfare effect could also be observed in the EU27. If the interest elasticity of the UK real demand for money would reduce post-Brexit, the demand for money schedule would be steeper than shown in MM_1, which would reduce the above welfare loss from the demand for money effect.

There is, however, some chance that the welfare effect for the EU27 will remain neutral in the context of the demand for money. Suppose additional UK FDI flows would bring a positive output effect from the supply side, probably through combined greenfield investment effects

plus positive international technology spillovers. Much will depend on UK economic policy reforms.

4.4.5 What to expect for UK FDI and international capital flows post-Brexit

The years 2016 and 2017 have shown in the referendum year of 2016 a strong nominal and real devaluation of the Pound and increased FDI inflows (reflecting a Froot/Stein effect). In the following year, 2017, the massive reduction of FDI inflows apparently reflected the perception of a worsening future British access to the EU single market, and such a series of adjustment effects could also be observed in the face of Brexit implementation. In the year with the massive Pound devaluation - i.e., the year Brexit is implemented - FDI inflows will increase as UK firms can be acquired by foreign bidders both at a discount and more easily.

As the Pound exchange rate will gradually recover and the cost of Brexit for UK firms will become more clear within a year, one may anticipate a strong decline of FDI inflows in 2020/21 and massive outflows of British FDI, which could reach a swing of 10% of GDP if one combines the reduced inflows and the enhanced outflows of FDI. Thus, the UK would have to replace the FDI swing effect by a corresponding portfolio capital inflow through higher interest rates. The rise of interest rates will be rather limited if a crisis in Turkey, Argentina, or other newly industrialized countries would trigger a reinforcement of safe-haven effects. This would stimulate capital outflows from these countries to the US, (rather modestly for) the UK, the Eurozone/EU27, Switzerland, and Singapore.

Given the uncertainties related to Brexit, the capital inflows would concentrate more than normally on the US, the Eurozone (mainly Germany, France, Ireland, and Luxembourg), Switzerland, and Singapore. It cannot be excluded that the interest differentials within the Eurozone would start to rise, while the nominal and real interest rates in Germany and France would decline, and the interest rate of Italy would increase. The benefit for France might be bigger than for Germany since the trade exposure to the Brexit shock is stronger for Germany than for France; it also is relatively strong for Ireland, Netherlands, Belgium, and Malta.

With London banks relocating activities to the Eurozone, these banks will face the requirement to put up additional equity capital. Therefore, there will be politically determined UK capital outflows over several years in this context since the ECB and other prudential authorities will give these banks a certain transition period. It should be noted that the US could record high

banking services exports post-Brexit since US banks with big subsidiaries in the UK are likely to relocate part of those activities back to New York or other US cities. This should reinforce the US services account surplus and help to improve the US current account position.

To the extent that US subsidiaries in the non-banking sector of the UK should suffer from reduced profitability due to Brexit, one should expect lower reinvestment and net FDI from US subsidiaries in the UK. Some US firms, as well as Japanese and Korean firms, will relocate activities to the EU27 market, particularly those firms that used the UK as a gateway to the EU27 but are anticipating post-Brexit new EU barriers to import from the UK in relevant sectors. Clearly, some EU27 countries are to gain from Brexit through the relocation of multinational companies' activities away from the UK; for instance, Ireland, Germany, France, the Netherlands, Belgium, and Austria can expect to benefit here. This also is a list of prospective winners when one considers the decision of EU27 immigrants in the UK who are considering moving back to the EU27. This is a process that could take some time. Certain EU countries also stand to benefit from wealthy UK citizens who will want to get citizenship in EU27 countries. Ireland, Spain, Portugal, Malta, Cyprus, France, and Germany could be winners here, and this could also trigger additional capital inflows into these countries. It is unclear to which extent Italy could benefit here. Luxembourg might face some problems with its big investment funds: With Brexit, they are partially losing access to the special knowledge of UK investment funds with whom the funds in Luxembourg are closely linked. The investment funds of Luxembourg might have to create, therefore special subsidiaries in London in order to minimize this effect.

As regards the UK's current account balance, one may anticipate that the trade balance will improve modestly after a real depreciation of the Pound. The increasing prices of imported intermediate products from the EU27 will partly offset the competitive price advantage from a devaluation of the Pound. With the UK exports of financial services to the EU27 declining in the short term, there will be a negative-transitory effect on the UK's current account. However, the long-run effect could be that London banks and financial service providers will launch a strong export initiative in Asia, North America, and elsewhere. Due to higher innovation dynamics and global network effects, this decision could improve the UK's financial services export surplus vis-à-vis the EU27.

4.5 Financial Services Barrier Dynamics

4.5.1 How will the quality of financial markets evolve in the context of Brexit?

The quality of financial markets can be measured through two dimensions:

- The financial services trade barriers;
- the quality of financial regulations.

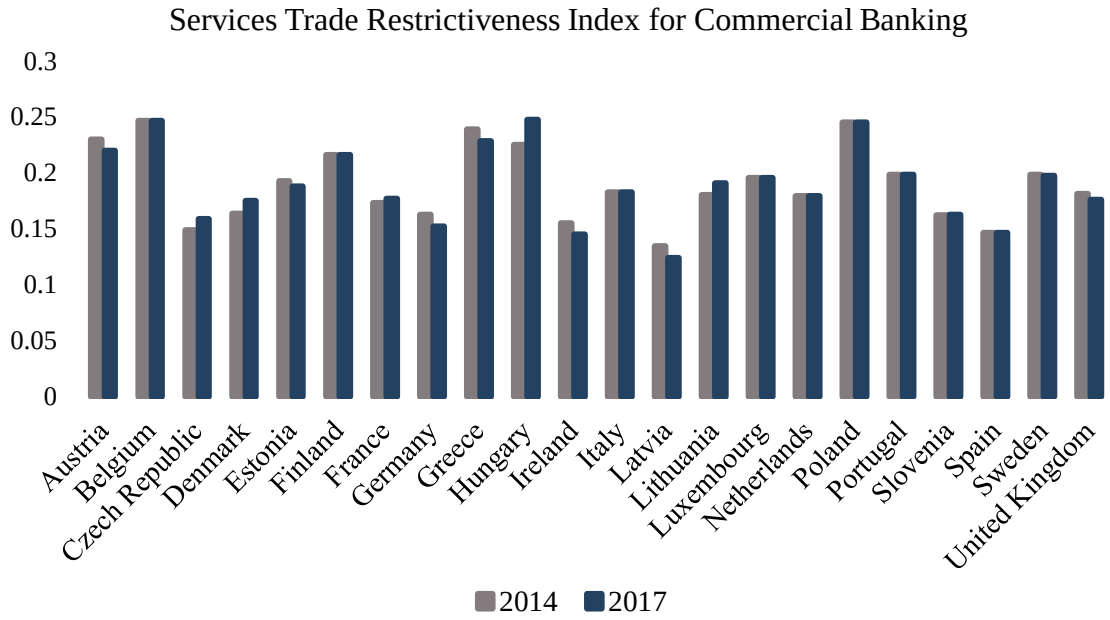
The services trade restrictiveness index (STRI) and the FDI regulatory restrictiveness index (FDI index), which were conducted by the OECD, can be used as informative instruments to understand the trade and FDI barriers in the financial services of EU countries. As regards financial services trade barriers, the OECD has published data for 2014 to 2017. There is also data available for FDI barriers which, of course, undermine optimal global growth - assuming the absence of negative externalities and adequate internalization of externalities, respectively (the latter is partly doubtful if important and influential OECD countries, including the UK and the US, push for excessive deregulation).

By comparing the data of the STRI for the commercial banking sector in selected 22 EU countries between 2014 and 2017, the following Figure 4.4 shows that there are considerable differences in commercial banking trade barriers across EU countries in general. After three years since 2014, Austria, Estonia, Germany, Greece, Ireland, Latvia, and the UK were the only EU countries that had reduced barriers to commercial banking. When we look at the figures for all the financial services covered by the STRI in 2017 (see Figure 4.5), the situation in the insurance sector is very similar to commercial banking; instead, barriers to accounting services are fairly high in many EU countries. After observing the data from the figures mentioned above, we can see that the UK is not a country with particularly low barriers for financial services trade, which is a point that has so far not been visibly debated in the EC. It could be a useful strategy for EU27/Eurozone countries to push the UK to reduce its trade barriers to financial services or to encourage innovation in the EU27 banking markets favored by the relocation of London-based international banks to the Eurozone by having reduced intra-Eurozone/EU27 financial services trade restrictions. One may emphasize two points in the field of financial services trade barriers:

- A reduction of financial services trade barriers in EU27 countries is possible and could easily compensate for anticipated increases in the price of specialized financial services that is no longer easily available from London post-Brexit;
- the EU should consider the reduction of financial services trade barriers as a new strategic field for regional FTAs in the future. Not only since financial services' share relative to GDP is bound to increase in the long run due to the accumulation of capital, but it also an efficient solution to face the challenges of demographic development, namely the aging of societies.

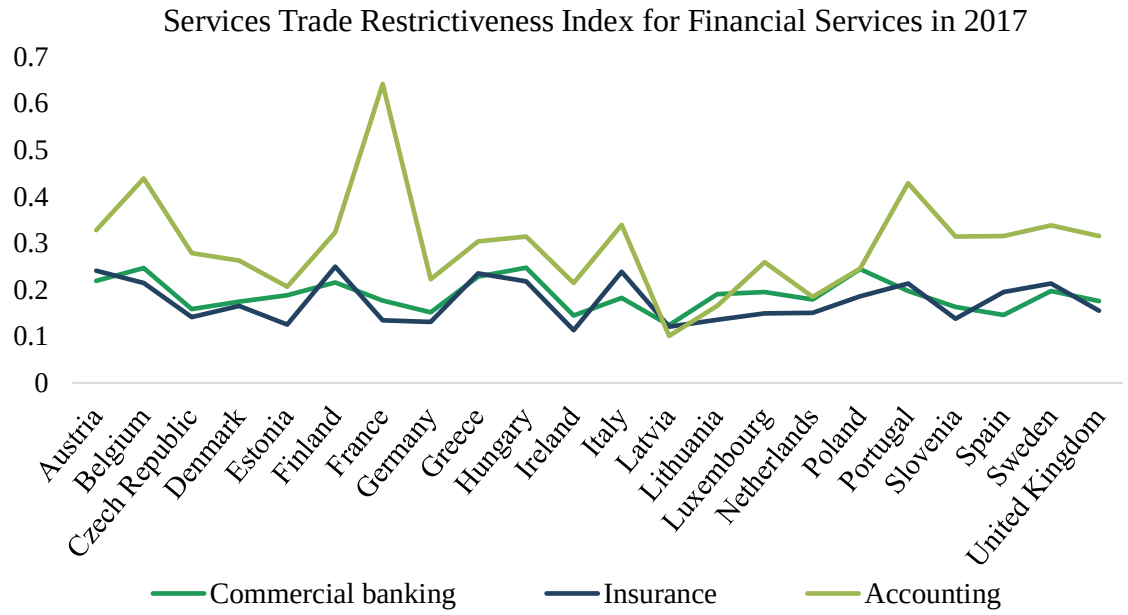
It is up to the EC and the EU member countries to pick up these points in the near term and include them in a new EU growth strategy. Individual EU countries could also be asked to include these points in the presentation on the European semester.

Figure 4.4. Financial services barriers (commercial banking)



Source: Own representation using data available from the OECD

Figure 4.5. Financial services barriers (financial services in 2017)



Source: Own representation using data available from the OECD

In contrast, the FDI indices do not show much variation in the 22 EU countries over time. In Table 4.3, the Eurozone countries like France, Belgium, Greece, Italy, Portugal, and Finland show relatively high FDI restrictiveness; differently, the UK and the last eight countries in the table had very low FDI inflow barriers. One may, however, argue that the inflow barrier indices should be weighted with the share of foreign ownership in the respective country's capital stock. In other words, FDI inflow restrictions will effectively affect not only current FDI inflows but also the willingness of foreign subsidiaries to reinvest in the respective host country. The volume-weighted FDI barriers (see Table 4.4) look different from the simple values in the initial OECD table (Table 4.3).

Table 4.3. FDI restrictiveness in selected EU countries

FDI Restrictiveness	1997	2003	2006	2010	2011	2012	2013	2014	2015	2016	2017
France	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
Belgium	0.152	0.039	0.039	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024
Greece	0.065	0.065	0.050	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Italy	0.033	0.033	0.033	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Portugal	0.159	0.159	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Finland	0.185	0.185	0.055	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Czech Republic	0.175	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Ireland	0.039	0.039	0.039	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Latvia	..	0.022	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Lithuania	..	..	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Germany	0.020	0.020	0.020	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hungary	0.050	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Poland	0.117	0.000	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Austria	0.050	0.050	0.050	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Denmark	0.017	0.017	0.017	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Estonia	0.018	0.018	0.018	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Luxembourg	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Netherlands	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Slovenia	0.223	0.017	0.018	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Spain	0.047	0.047	0.047	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Sweden	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
United Kingdom	0.106	0.083	0.083	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002

Notes: .. represents missing data

Source: Own representation using data available from the OECD

Table 4.4. Volume-weighted FDI restrictiveness in selected EU countries

FDIRRI[a] FDI/CS	1997	2003	2006	2010	2011	2012	2013	2014
Belgium	0.0175	0.0095	0.0110	0.0104	0.0108	0.0056	0.0061	0.0049
Ireland	0.0059	0.0169	0.0088	0.0030	0.0029	0.0037	0.0038	0.0037
France	0.0029	0.0024	0.0029	0.0032	0.0034	0.0032	0.0035	0.0031
Luxembourg	..	0.0012	0.0014	0.0023	0.0028	0.0020	0.0013	0.0025
Portugal	0.0042	0.0084	0.0011	0.0012	0.0010	0.0011	0.0012	0.0011
Finland	0.0033	0.0133	0.0047	0.0010	0.0010	0.0010	0.0009	0.0009
Czech Republic	0.0017	0.0004	0.0006	0.0008	0.0007	0.0008	0.0008	0.0007
Italy	0.0004	0.0007	0.0010	0.0005	0.0005	0.0006	0.0005	0.0005
Hungary	0.0018	0.0004	0.0005	0.0005	0.0005	0.0005	0.0006	0.0005
Netherlands	0.0001	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0004
Lithuania	..	..	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
Sweden	0.0001	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0004
Latvia	..	0.0004	0.0002	0.0003	0.0003	0.0003	0.0004	0.0003
United Kingdom	0.0046	0.0065	0.0103	0.0002	0.0002	0.0003	0.0003	0.0003
Germany	0.0008	0.0014	0.0014	0.0004	0.0004	0.0004	0.0003	0.0003
Poland	0.0022	..	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Estonia	0.0004	0.0016	0.0021	0.0002	0.0002	0.0003	0.0003	0.0003
Greece	0.0010	0.0013	0.0015	0.0004	0.0004	0.0003	0.0003	0.0003
Austria	0.0011	0.0025	0.0041	0.0002	0.0002	0.0002	0.0002	0.0002
Denmark	0.0006	0.0022	0.0017	0.0002	0.0002	0.0002	0.0002	0.0002
Spain	0.0014	0.0032	0.0034	0.0002	0.0002	0.0002	0.0001	0.0001
Slovenia	0.0037	0.0006	0.0007	0.0001	0.0001	0.0001	0.0001	0.0001

Notes: [a] Share of inward FDI stock relative to host country capital stock: own calculation. .. represents missing data
Source: Own calculations using data available from the OECD

4.5.2 Financial market quality and new challenges

The income share of capital in national income is rising in many countries - prior to the Transatlantic Banking Crisis 2007-09, the profit share of banks, in particular, had strongly increased with some normalization after 2010. As long as the new Basel III rules are not implemented, there is an additional risk of a new banking crisis, but one may hope that in the Brexit year, the Bank for International Settlements (BIS) member countries will have implemented the new rules.

There is still a recent history of considerable redistribution from labor to banks, and this artificially increased banks' profitability in OECD countries: The key problem is that loans to private households have been provided on the basis of artificial bundling, namely of loans and

payment protection insurance (PPI). Typically, borrowers were pushed by banks into also taking out PPI from the same bank which offered the original loan; this strange and anti-competitive bundling, which reduces the price elasticity of the demand for loans (and raises overall loan costs artificially), had been declared illegal in the UK in 2011 and by August 2018, the clients of banks have reclaimed more than £30 billion in the UK. Such anti-competitive bundling, which does not reflect the normal result of competitive market dynamics, is also a problem in Germany and many other EU countries where the system still exists.

Nevertheless, a study by iff/ZEW (2012) argued in a report commissioned by the German government that interest rates in Germany are in line with the competition. The study, however, uses neither the analytical concepts of the relevant market in a meaningful way nor does it critically focus on anti-competitive bundling. The German and British case study is not only an example of redistribution of worker's/household's income to profits of banks, but it also is a bad precedent in the sense that such anti-competitive behavior in loan markets can continue over decades and distorts both capital flows and resource allocation. Any professional economic analysis would have come to the conclusion that overdraft interest rates in Germany, much higher than those in the Netherlands, Austria, and many other EU countries, were incompatible with competitive markets. Moreover, the bundling of loans and PPI should have been banned (it is this artificial anti-competitive bundling in credit markets that brings about the strangely high overdraft interest rates. A rough estimate of losses imposed by this strange situation on households buying PPI and loans indicates that about €4 billion per year should be repaid to bank customers - cumulated over a decade, roughly 1.3% of annual GDP).

4.5.3 Empirical analysis of the cross-border barriers in financial services

As explained, the cross-border barriers in various types of financial services are an important analytical challenge in Europe. One may assume that financial services barriers of country i reflect a public and political attitude towards capital inflows in general, and hence, an explanatory variable could be the FDI barriers for the financial sector in the respective country. The internet density of firms stands for the ability to screen international investment opportunities, and if many firms have internet access, one may expect more lobbying for reducing capital import barriers in banking, insurance, and other financial services fields. Moreover, with a higher trade intensity, there should also be a broader need to cope with the

volatility of exports and imports; thus, there could be an increased interest in free financial services inflows. Higher inward FDI stock figures should, in turn, reinforce the lobbying of foreign companies to reduce barriers to financial services in the host countries and should contribute to a lowering of barriers in financial services. A higher per capita income should normally reinforce people's interest in having reduced barriers for imports of financial services: The latter would mean better services and lower prices of financial services. However, there could be a counterargument according to which a high per capita income is largely reflecting high incomes earned in a few sectors, including financial sectors and ICT. These are usually highly concentrated sectors that could easily lobby for higher barriers to financial services inflows since higher foreign inflows imply more import competition and, thus, lower profit rates for domestically offered financial services. A higher outward FDI stock could be a signal that firms have limited confidence in the government in the source country. A rather limited ability of the government in economic policy management suggests limiting financial sector openness since, otherwise, the country's economy could be more exposed to somewhat volatile international capital flows. An alternative view is that higher outward FDI stocks represent a strong economy with many very competitive firms that seek to improve the company's respective international market position via higher outward FDI and in the presence of a perception of a strong home country, the willingness to push for lower financial services barriers could be relatively strong, thus outward FDI has an ambiguous effect on financial services barriers.

In the process of collecting adequate and relevant data to analyze the dynamics of the financial services barriers for the EU, we covered 23 countries (EU28 excluding Bulgaria, Croatia, Cyprus, Malta, and Romania) over the period from 2014 to 2017 in our study. The small data sample is primarily due to the limits of data regarding the STRI. The panel data in this study is strongly balanced and has been collected from secondary resources, namely from the OECD, the Eurostat, and the World Bank.

The dependent variables are constructed as follows: The STRI for the financial sector is chosen as a proxy for financial service trade barriers. It contains 19 major service sectors, and we selected all relevant sectors for financial services. In the end, we have three sectors, commercial banking, insurance, and accounting, based on the industry and service classification of the STRI. Furthermore, we also constructed an overall financial service trade barrier index by taking the mean of the above three financial service sectors' trade restrictiveness index.

The explanatory variables are as follows: The FDI barriers on financial services are taken from the FDI regulatory restrictiveness indices. They are considered to have a positive relationship with the dependent variable. Similarly, the FDI restrictiveness index for financial services, banking, and insurance is included. Despite the influential effects of institutional elements, the impact of inward and outward FDI stocks also plays an essential role in understanding the dynamics of financial services trade barriers. In the empirical analysis, the inward and outward FDI stock intensity, which is the ratio of stocks to GDP, will be used separately. It is also necessary to include the trade openness of each nation. We measure the indicator by the percentage of the sum of imports and exports relative to GDP. Moreover, the GDP per capita for each country during the period is used to control for the income differences between countries. Finally, the internet intensity of enterprises is taken due to the consideration that rising ICT technology might also largely influence the reduction of financial service trade restrictiveness among the countries. An overview and description of the variables are provided in the following table (Table 4.5).

Table 4.5. Description of the variables

Variable	Proxy	Description	Expected sign	Period	Data source
Financial Servies Trade Barriers	Cbank	Services trade restrictiveness index for the commercial banking sector		2014-2017	OECD
	Insu	Services trade restrictiveness index for the insurance sector		2014-2017	OECD
	Acc	Services trade restrictiveness index for the accounting sector		2014-2017	OECD
	STRI_FA	The mean of the above three indices		2014-2017	OECD
FDI Barriers	FDIRes_F	FDI regulatory restrictiveness index for the financial service sector	+	2014-2017	OECD
	FDIRes_B	FDI regulatory restrictiveness index for the banking sector	+	2014-2017	OECD
	FDIRes_I	FDI regulatory restrictiveness index for the insurance sector	+	2014-2017	OECD
Internet Density	LN_INT_E	Internet density of enterprises in logarithm	–	2014-2017	Eurostat
Trade Openness	LN_Openness	Trade openness in logarithm	–	2014-2017	WDI
Inward FDI Stock Intensity	LN_IFDI	The ratio of inward FDI stock to GDP in logarithm	–	2014-2017	OECD
Outward FDI Stock Intensity	LN_OFDI	The ratio of outward FDI stock to GDP in logarithm	–	2014-2017	OECD
GDP Per Capita	LN_GDPpc	GDP per capita in logarithm	+/–	2014-2017	WDI

Notes: OECD is the Organization for Economic Co-operation and Development; Eurostat refers to the European Statistical Office; WDI is the abbreviation of the World Development Indicator database from the World Bank

Source: Own compilation

In this study, we are interested in understanding the effects of selected determinants on the financial service trade barriers of 23 EU countries from 2014 to 2017; thus, a panel data analysis is seen as an appropriate method. The summary of all variables can be found in Table 4.9 in the Appendix. Since the risk of unobserved individual effects or the specific characteristics of individual countries is relatively high, fixed-effects and/or random-effects panel data models are usually chosen to deal with the potential concern (Park, 2011). We will first test whether the fixed effects model gives a significant increase in terms of goodness-of-fit using an F-test compared with the pooled OLS estimator (Baltagi, 2005, p. 13). Following this, the Breusch-Pagan Lagrange multiplier test will be used to test whether there is a significant random effect in the panel data (Breusch & Pagan, 1980). When significant results

for both fixed and random effects can be observed in the test outcomes, then the Hausman specification test is conducted to examine which model is superior (J. A. Hausman, 1978).

According to the aforementioned test results, neither the fixed-effect nor random-effect specification shows a significant rise in the goodness-of-fit; therefore, the pooled OLS model is preferred. Resulting in a moderate correlation between inward FDI stock intensity and trade openness, as well as high levels of correlation between GDP per capita and outward FDI stock intensity (see Appendix Table 4.10). Thus, regressions are run separately to avoid multicollinearity. The estimated regression results can be found in the following Table 4.6.

Table 4.6. Analysis of regression results

Dependent Var.	Cbank		Insu		Acc		STRI_FA	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FDIRes_F	-0.057	-0.001	-0.635	-0.765	4.790***	4.523***	1.366***	1.252***
	(-0.268)	(-0.265)	(-0.443)	(-0.468)	(-1.058)	(-1.010)	(-0.445)	(-0.434)
FDIRes_B	0.013	0.016	0.077**	0.070**	0.132*	0.123**	0.074*	0.069**
	(-0.027)	(-0.028)	(-0.038)	(-0.031)	(-0.070)	(-0.058)	(-0.039)	(-0.032)
FDIRes_I	0.125	0.138	0.208	0.154	0.041	-0.006	0.124	0.095
	(-0.168)	(-0.162)	(-0.184)	(-0.204)	(-0.259)	(-0.236)	(-0.160)	(-0.163)
LN_IFDI	0.003		-0.024***		-0.020**		-0.013**	
	(-0.005)		(-0.007)		(-0.009)		(-0.006)	
LN_GDPpc	-0.002		0.020**		0.036**		0.018*	
	(-0.007)		(-0.009)		(-0.017)		(-0.009)	
LN_INT_E	-0.455***	-0.460***	-0.292***	-0.302***	-0.120	-0.145	-0.289***	-0.302***
	(-0.086)	(-0.082)	(-0.096)	(-0.092)	(-0.254)	(-0.218)	(-0.108)	(-0.095)
LN_OFDI		-0.0002		0.006**		0.014*		0.007*
		(-0.003)		(-0.003)		(-0.007)		(-0.004)
LN_Openness		0.009		-0.041***		-0.045***		-0.026***
		(-0.007)		(-0.009)		(-0.011)		(-0.008)
Constant	2.273***	2.284***	1.456***	1.649***	0.061	0.221	1.263***	1.384***
	(-0.372)	(-0.376)	(-0.439)	(-0.426)	(-0.901)	(-0.886)	(-0.424)	(-0.420)
Observations	86	86	86	86	86	86	86	86
R-squared	0.231	0.243	0.283	0.32	0.544	0.563	0.389	0.407

*Notes: LN means the variable took the natural logarithm; robust standard errors in parentheses. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01*

Columns 1 and 2 present the regression results for trade barriers in the commercial banking sector for 23 EU countries. In general, the trade barriers are largely unaffected by the selected determinants despite the internet intensity. The estimated coefficients of the internet density of enterprises are negative and statistically significant at the .01 significance level. The outcomes show that a one-percent increase in internet density will lead to a 0.45 to 0.46 percent decline in the level of trade barrier for the commercial banking sector based on the results in Model 1 and Model 2, respectively.

As can be seen in columns 3 and 4, the results of both models display that a higher FDI restrictiveness index for the banking sector has a positive and significant effect on insurance trade restrictions. However, a similar effect cannot be found for the FDI indices for financial services and insurance. The estimated results of inward FDI stock intensity, internet density, and trade openness show expected negative signs under the significance level of 5%. Model 3 reveals a highly significant and positive relationship between GDP per capita and insurance trade barriers ($p < .05$). This finding should be considered carefully as, in general, for more developed economies, a more open trend is expected to be seen vis-à-vis the financial service trade.

The FDI index for the financial service sector exhibits a significant and positive impact on the financial services trade barriers with regard to accounting in columns 5 and 6. The estimated regression coefficients show that every one-unit increase in the FDI restrictions of the financial services sector is positively associated with the increase in financial trade barriers for the accounting sector by 4.79 units and 4.52 units at the .01 significance level, respectively. Also, a higher level of FDI restriction for banking contributes to a stricter service trade environment for accounting in both models. Interestingly, the internet density of enterprises does not have a strong influence on the openness of the accounting services trade for 23 EU countries.

The results in the last two columns indicate that a higher level of FDI regulatory restrictiveness for financial services and banking contributes positively and significantly to the increase in financial trade restrictions. However, the same influence is not found in the FDI index for insurance. The other independent variables, inward FDI stock intensity, internet density of enterprises, and trade openness, all show an expected negative sign and strongly influence financial trade barriers. However, GDP per capita illustrated a relatively important positive influence on the growth of financial services trade barriers.

4.6 Policy Conclusions

There are broad risks for the world economy in the context of Brexit in the medium term:

- An overlapping dynamics of the strong exchange rate and interest movements in the EU28 could bring instability to the UK and the Eurozone's new stability risk.
- Higher exchange rate volatility could undermine the global growth of FDI, and the same is true if financial market actors perceive a broader new risk of political instability in the Brexit context.
- Emerging market economies might face new problems if strong financial market reactions in Western Europe overlap with rising US interest rates and increasing protectionism of the US.
- A poorly managed, disorderly Brexit process could stimulate populist forces in Europe and elsewhere. The EU elections 2019 will take place in the shadow of Brexit.
- The Deutsche Bundesbank's decomposition of the VIX (Deutsche Bundesbank, 2017, p. 27) shows that the Brexit referendum went along with increased policy uncertainty. The VIX, however, had reduced relative to its long-term historical mean (i.e., since 1990) because the financial market uncertainty had reduced, and monetary policy also decreased the VIX. A serious problem would occur if Brexit implementation would go along with the combination of new financial market uncertainty and policy uncertainty. Interestingly, the BIS 2018 Annual Report seems to ignore the Brexit issue, which might be interpreted in a way that the BIS does not want to destabilize financial markets. However, by not analyzing the historical Brexit challenge, the BIS implicitly signals how significant the potential risk could be.

The G7, the OECD, the IMF, and the G20, might face the need to pick up the special challenges of Brexit. If there would face an international economic crisis in the context of Brexit dynamics, one may anticipate a massive weakening of the West. The Trump Administration suffers from a lack of competence, particularly in the Treasury and the Department of Commerce, as the Trump Administration has filled only about three-quarters of the roughly 4,000 political appointees of the Obama Administration.

As the analysis (Kadiric & Korus, 2018) shows, one may expect that corporate bond markets in the UK should face increasing risk premiums, dampening UK investment and innovation dynamics. To the extent that the UK government cannot conclude a clear EU-UK trade treaty and adopt a convincing Brexit transition policy, the doubts in capital markets about the long-run quality of UK corporate bonds could be reinforced over time. UK firms could come under pressure to finance investment more on a medium-term basis instead of through long-run bond placements, which brings a bigger exposure of UK firms to post-Brexit shocks and could thus negatively affect UK stock market valuations. This could bring in the context of shorter maturities a higher recession risk for the UK in the future, possibly mitigated by the general

dampening effect of output growth through Brexit so that overinvestment should be less likely than in periods of high trend growth rates. Monetary policy has little room to maneuver, as the interest rate will be shallow at the beginning of the Brexit year. Thus, the role of fiscal policy might be more needed than in previous recessions. However, the relatively high debt-GDP ratio of about 85% will restrict fiscal policy options here. One may recommend that the UK government should, in any case, consider three policy measures to mitigate the Brexit problems:

- It would be adequate to implement additional government support aimed at reinforcing the innovation dynamics of UK firms; such innovation dynamics could help stimulate export and output growth in the UK.
- Brexit will mean an accelerated structural change, and this, in turn, requires that many workers will have to adjust in terms of skills and competencies. The traditionally ultra-low UK public expenditures on retraining should increase from almost zero to about 0.4% of GDP, which would be twice what full-employment Switzerland has recorded in the 2004-2016 period (Germany recorded 0.2% of GDP in 2014-2016; the US had 0.03%, Austria was close to 0.45% and Denmark close to 0.55%, France 0.4%, see Table 4.7).
- The UK might want to consider co-operation in financial regulation with the EU27. If the UK refuses such cooperation, the EU27 will likely impose capital controls on the UK in future crisis periods since the EU27 will want to avoid full exposure to negative spillovers from excessive UK deregulation. The most important barrier to consider by EU countries would be barriers against takeovers in the banking sector from the UK, the US, or other third countries whose regulations are not fully in line with BIS rules and at least broadly equivalent to EU27 regulations.

Table 4.7: Public expenditure on labor market programs in % of GDP(training)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Australia	0.01	0.01	0.01	0.01	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Austria	0.29	0.32	0.39	0.36	0.36	0.50	0.50	0.44	0.44	0.47	0.50	0.46	0.45
Belgium	0.16	0.16	0.14	0.14	0.17	0.17	0.16	0.15	0.16	0.16	0.16	0.16	0.15
Canada	0.08	0.08	0.08	0.08	0.09	0.14	0.13	0.10	0.09	0.08	0.07	0.07	0.07
Denmark	0.52	0.49	0.42	0.37	0.35	0.46	0.68	0.64	0.61	0.60	0.59	0.60	0.53
France	0.31	0.31	0.31	0.30	0.28	0.39	0.41	0.37	0.37	0.38	0.38	0.37	..
Germany	0.44	0.38	0.35	0.30	0.30	0.35	0.27	0.25	0.22	0.22	0.21	0.20	0.19
Greece	0.03	0.04	0.06	0.05	0.09	0.02	0.02	..	0.06	0.10	0.13	0.09	..
Italy	0.22	0.20	0.17	0.18	0.18	0.17	0.15	0.14	0.14	0.15	0.14	0.17	..
Japan	0.04	0.00	0.00	0.00	0.01	0.01	0.03	0.05	0.01	0.01	0.01	0.01	0.01
Netherlands	0.12	0.11	0.10	0.09	0.09	0.12	0.13	0.12	0.10	0.09	0.07	0.07	0.07
Poland	0.09	0.10	0.10	0.10	0.12	0.04	0.04	0.01	0.01	0.01	0.01	0.01	0.01
Spain	0.14	0.17	0.16	0.15	0.17	0.18	0.19	0.19	0.15	0.12	0.12	0.12	..
Switzerland	0.28	0.26	0.21	0.17	0.15	0.18	0.20	0.17	0.16	0.17	0.17	0.18	0.19
UK	0.03	0.02	0.01	0.01	0.01	0.02	0.02	0.01	..	..	..	..	..
US	0.05	0.05	0.04	0.04	0.07	0.05	0.04	0.04	0.04	0.04	0.03	0.03	..

Notes: .. represents missing data

Source: Own representation based on data available from the OECD

There is no reason why the EU27 should not be able to develop a globally competitive banking system and adequate financial services dynamics. However, careful reforms for a sustained stable capital market union would be necessary.

4.6.1 Adverse effects on EU27 countries

One cannot rule out that Brexit will seriously adversely affect a small number of EU27 countries. Possibly including Ireland, the Netherlands, and Malta through trade links, as well as Italy and Greece through confidence problems. The latter, whose core is not Brexit itself but self-inflicted reform deficits, is mainly in the institutional setting of the two respective countries. The Transatlantic Banking Crisis sharply raised deficit-GDP ratios, not least in the UK, where the Cameron government resorted to massive cuts to fiscal transfers from central government to cities/local communities, reaching 3.5% of GDP within five years. In turn, it stimulated anti-EU immigration sentiment as the implied under-provision of local public services was very often considered to be reflective of the impact of immigration, which was not the case. EU immigrants became the scapegoat of many politicians in a partly populist and very unfair anti-immigration campaign that received visible support from the Cameron and May governments. Both of these have claimed that EU immigration stood for a long-term economic burden for the UK, while OECD figures have shown the opposite (Welfens, 2017a).

The EC should be expected to help countries facing a particularly high adjustment burden. Given the Brexit-related shortfall in terms of EU budget financing, achieving a consensus for the next budget period could be rather difficult, and the fact that Italy's populist government is likely to delay any agreement until the last minute in order to get concessions in the field of EU refugee policy. Brexit financial market dynamics could, in turn, destabilize the Eurozone, not least since Brexit raises risks in the UK and EU27 markets, the aforementioned liquidity risks in the UK, and investor risks in the banking sector. Italian, as well as Greek banks, might face problems in maintaining investor confidence. With populist governments active in both countries, there is considerable potential for new intra-EU conflicts, and one should not assume that populist governments have a strong tendency to follow the reform recommendations of national or international experts. Incidentally, in the Brexit referendum campaign in 2016, Minister Michael Gove of the Cameron government had also emphasized that the British public "has had enough of experts," which is a typical view of a populist pro-Brexit politician.

Meanwhile, the UK faces the following challenges:

- The UK will face a massive medium-term decline in FDI inflows. Facing lower FDI inflows and modest economic growth rates, the UK government will consider policy options to raise output growth:
- As a consequence, one can expect that the UK government will strongly reduce its statutory corporate income tax rate (as has been announced by PM May in an official conversation (Giegold, 2018; HM Government, 2018). Taking also into account the FDI gravity modeling analysis of (Welfens & Baier, 2018), the implication is that UK tax rates will strongly decline, most likely due to resistance from trade unions and the Labour Party, respectively.
- If the UK reduces the statutory corporate tax rate, which is a parallel move to the Trump tax reforms of 2017, this will put the EU27 under strong pressure also to reduce corporate tax rates. The effect on income distribution will be to raise the post-tax capital income share in GDP so that social tensions could be generated by Brexit across the whole of Europe.

One should not rule out that the UK will face a somewhat isolated situation once Brexit has been implemented and that political pressure will mount to push other countries to leave the EU. This will be a long-term challenge for the EU27, not least since it seems that Russia is trying to undermine EU stability in some countries in Eastern Europe. With the US no longer supporting EU integration under the Trump Administration and possibly pushing for disintegration (e.g., by reinforcing populist forces in Italy and elsewhere), there is a considerable risk that the EU27 could face rising internal conflicts. Sooner or later, this would also destabilize the Eurozone; indeed, this could also mean risk for monetary stability in the Eurozone once the consensus about the Stability and Growth Pact is further weakened. While medium-term growth and economic policy analysis - for example, the European Semester approach of the EU - is useful, one should not overlook that permanent long-term monitoring is also needed. The situation that Italy in 2015 had the same real disposable per capita income as it had in 1995 should never occur: Growth policy monitoring is a gap at the EU and the IMF level. The EU27 and the Eurozone countries should carefully consider national barriers to financial services; indeed, in the interest of more competition and efficiency gains as well as more innovation dynamics, one may recommend the following:

- Financial services barriers within the EU27 should be strongly reduced where France, Germany, Austria, Belgium, Finland, Estonia, Portugal, Luxembourg, and Greece are countries that follow the good example of Ireland, Italy, and the Czech Republic. This is a rather easy way to stimulate economic growth.
- Progress in terms of the EU banking union and capital market union should be pursued, although this is a field where some adjustment time is needed and sorting out key details is difficult.

4.6.2 Monetary policy

With output growth declining in OECD countries in the medium term and inflation rates above 2%, it is important that the Eurozone's interest rates return to a normal level. Without such normalization of monetary policy, Eurozone monetary policy would hardly have room to maneuver in a future recession. The Eurozone will, however, face a special problem with respect to Italy, where the populist Conte government wants to maintain high deficit-GDP ratios even in an economic upswing which is contradictory: The announcement not to reduce the deficit-GDP ratio will bring about a higher interest rate for Italian bonds, which is already visible in September 2018 (Italian interest rates jumped above the interest rate of government bonds of Portugal in late September). That could eliminate any additional room for government purchase expenditures in the medium term. Since the envisaged higher additional government expenditures are mainly earmarked for raising social expenditures, not for enhanced innovation dynamics or better education, the growth effect of Conte's economic policy will be almost zero. One cannot expect a long-run decline in the Italian debt-GDP ratio; following the Domar rule, the ratio is determined by the trend deficit-GDP ratio divided by the trend output growth rate.

In the UK, monetary policy post-Brexit will face a difficult choice. In the case that there is a no-deal Brexit, and hence the UK experiences a recession, the Bank of England may be expected to reduce the interest rate despite the rise of the inflation rate associated with a strong devaluation of the Pound. If there is a Brexit on the basis of an EU-UK treaty, the UK might face only a mild recession or a modest stagflation situation. The Bank of England could increase the interest rate in order to avoid a substantial rise in the inflation rate. The case for a higher interest rate in the UK is all the more convincing since the largely unanticipated rise of the inflation rate will bring about a fall in the real wage rate, which should help stabilize the UK's employment situation. If the UK should raise the interest rate - more or less in parallel to the US - the pressure on the ECB to also raise the interest rate will become strong. The US would point to a further strong increase of the Eurozone current account surplus (or a rise of the trade balance surplus), and the transatlantic trade conflict, actually a US-EU27 trade conflict, would intensify. This would also create a potential conflict between the UK and the EU27 since the UK would have to decide on what side it takes a position at G7/G20 meetings - the side of the populist US Trump Administration or the EU27.

4.6.3 Multilateralism

The US under the Trump Administration adopted a rather protectionist trade policy in 2018, in particular, starting an open trade conflict with China where alleged China's violations of US IPR are part of the conflict. To some extent, the arguments seem similar to claims made in the course of the US-Japan trade conflict of the 1980s, although the case of Japan was different in many ways. The US was not facing a big bilateral trade conflict and was not in the US complaining about infringements of US IPR. The US economic policy of 2017/18, emphasizing expansionary fiscal policy in an economic upswing, is not in line with textbook wisdom. This only reinforces the trade deficit-GDP ratio, which is a frequent subject of the complaint of the Trump Administration, and also the current account deficit-GDP ratio. The Trump Administration faces a current account deficit vis-à-vis the Eurozone and China, and other countries. It has pulled out of the initial G7 declaration in Canada and has blocked the re-election of judges to the WTO's appellate body so that the WTO trade conflict resolution mechanism will not be operational as of summer 2019.

For the UK (also facing trade deficits vis-à-vis the EU and China), this is an unfortunate development since the UK's Global Britain approach to Brexit suggests that concluding many new FTAs with countries outside Europe could compensate for the likely reduction of UK-EU trade after the implementation of Brexit. The UK cannot implement a functional Global Britain approach - except for a UK-US FTA - if the WTO is not working. However, the post-Brexit UK is likely to become very dependent on the US, which would create an odd political couple, as the UK normally promotes free trade but now would have to follow protectionist US policy largely. To the extent that the US would actively try to undermine the stability of the EU, this would also create an indirect conflict line between the UK and the EU27. The EU27 could have no alternative for saving multilateralism than to seek stronger cooperation with the countries of the Association of Southeast Asian Nations (ASEAN), the Southern Common Market (Mercosur), the Economic Community of West African States (ECOWAS), and other regional trade groups.

US protectionism will slow down global growth, and it also has no positive welfare effect for the US except in the short run. The long-run US welfare effects are clearly negative, as shown by S. H. Kim and Shikher (2017); see also Felbermayr, Steininger, and Yalcin (2017). A big risk for EU financial stability would be if the US further deregulates financial markets while the UK follows suit. This would impose strong pressure on the Eurozone to also come up with

new financial markets and banking deregulation. The pressure from stock markets would be too strong not to do so, and the mechanism is already well known from the years prior to the Transatlantic Banking Crisis 2007-09. US/UK banking deregulation will bring new profit opportunities for banks in the US and the UK so that banks' stock market valuations would increase strongly and make several big Eurozone banks easy prey for an international takeover from the US and the UK, respectively. Therefore, banks in the Eurozone would, in turn, start to lobby strongly for deregulation similar to steps taken in the US and the UK: A US-EU transatlantic mechanism emphasized already prior to the Transatlantic Banking Crisis by Artus and Virard (2005).

US populism, in the form shown by President Trump, is a serious challenge for Western Europe and the stability of the world economy. This holds not least since US protectionist policy vis-à-vis China will cause trade and FDI diversion effects, namely from a big economy, such as China, which since 2016 is already the largest country in the world economy if one considers the World Bank figures at Purchasing Power Parity. The FDI of China will largely be redirected to ASEAN countries so that the EU's leading role in FDI in that area will be undermined in the medium term. Moreover, the share of China's exports that can no longer be exported to the US will be redirected to Europe. The biggest potential problem for the EU28 is that Trumpism could be a structural US problem (Welfens, 2018a). US surveys show that the majority of voters hold the view that hard work is the key to moving up economically. At the same time, there is a broad perception that increased inequality in the US is a problem. The share of national income accruing to the lower half of income earners has fallen from 20% in 1981 to just 13% in 2015 (much more than in Western Europe, where it remained roughly constant at around 20%). Moreover, the majority of US voters think that the inequality problem should be corrected not by the government but rather by big companies. This, however, is a totally illusory expectation and is bound to lead to recurrent voter frustration among the lower-income half of US society - and the Democrats in 2016 had no convincing political offer to make: Suffice to say that in the 2016 presidential elections, Hillary Clinton received only 53% of the votes from income earners with less than $30,000 a year, while in earlier elections Obama had obtained 63% from this group. Donald Trump, by contrast, emphasized the need to take care of the "forgotten men and women" relentlessly in his campaign, and he regularly promised new jobs for industry, mining, and agriculture. Whether or not his policy promises will become a reality is, of course, an open question with rather doubtful perspectives.

It should be emphasized that there is no reason to expect that economic globalization and digital expansion generate much-rising inequality in the world economy if national policymakers adopt adequate reforms and if more international cooperation in the field, e.g., tax policy could be achieved (Welfens & Udalov, 2018). If there is structural Trumpism in the US, the combination of US populism and UK populism could seriously undermine EU integration and the Eurozone. One may argue that Brexit is, without a doubt, a populist project based largely on misinforming voters in the 2016 EU referendum campaign (Welfens, 2017a). To the extent that there is a structural issue of Trumpism, the conclusions to be drawn in EU27 countries are certainly rather broad and most likely will take time to determine at the political level in Brussels and EU member countries.

It seems that the BIS Annual Report of 2017 stated an adequate position when it formulated the view that political instability in OECD countries has become a serious challenge to economic stability (BIS, 2017). In this context, macro-prudential supervision and the analysis of macro-prudential risk should naturally be emphasized:

- In the EU, there should thus be a much greater role for the ESRB.
- An adequate framework of cooperation between the UK's relevant institutions and the ESRB should be established; this could be a rather difficult challenge given the reluctance to cooperate, as shown by some UK institutions in the ESRB work in 2017/2018.
- The Basel III rules should be implemented broadly, and this should include the US - again, a challenge that could turn out to be very serious.

The biggest challenge in the context of Brexit is a weakening of multilateralism and free trade, as well as undermining the role of the West in the world economy. Finally, Brexit is a negative signal to all regional integration areas, which could bring about less regional trade integration and more nationalism and protectionism in the world economy. The global cost of Brexit could, in the end, be higher than the cost of Brexit for the UK. International policy cooperation and rational crisis management should be re-emphasized by European countries. Only four institutions lend themselves to the role of stabilizing the global rules-based system:

- The G20 and the IMF. G20 is a rather new international actor, which consists of a group of heterogeneous countries. However, the Brisbane G20 summit of 2014 showed that the group could nevertheless come up with useful global growth initiatives and even involve adequate monitoring and organizing technical support for the countries involved. By involving the OECD, which, for example, helped to verify for individual

countries the extent to which proposed policy measures would add up to deliver the promised additional 2% of economic growth by 2019.

- The OECD and its global outreach program. It includes, for example, China and India through the OECD Development Centre. With US funding declining, the other OECD countries should consider topping up their funding. The OECD has crucial expertise in organizing international cooperation and could contribute to analyzing the new global interdependency of the US-China-Japan-EU27/UK.
- The WTO, whose role is indispensable for anchoring the rule of law in international trade relations.
- The Bank for International Settlements: Establishing a consistent set of rules for prudential supervision and cooperation in monetary policy is crucial for national, regional, and global stability.

Brexit has many crucial challenges for the UK and the EU27. It is a unique historical step and will bring about serious policy problems. One may hope that there will be a new consensus about maintaining open markets and international policy cooperation in the medium term. For Germany and some other EU countries, there could be specific challenges in the field of current account imbalances. If the UK and US current account deficits should increase relative to the respective GDP, while Germany's and thus the Eurozone's current account surplus-GDP ratio should rise, fiscal appreciation in Germany could be considered in combination with a fiscal devaluation in France and Italy: While Germany, in a period of slow growth and low capacity utilization, would reduce its value-added tax (VAT) rates and modestly increase social security contribution rates. France and Italy could adopt a VAT increase and a considerable reduction of social security contribution rates which brings down real wage costs - and more jobs - while stimulating the export of goods and services (the VAT increase dampens domestic demand for tradable goods). This could help to bring more stability to the Eurozone while helping to reduce the Eurozone's current account deficit-GDP ratio. There is at least a risk that US protectionism will further intensify in the medium term and could indirectly or directly affect some EU countries.

The overlap of transatlantic and Brexit problems implies that the challenges faced by EU27 policymakers are considerable. In the end, it is also clear that the EU27 should adopt serious institutional reforms to reinforce the efficiency of allocation and contribute to more stability in the community and worldwide.

One of the possible surprise events in Brexit dynamics could be that Brexit is not actually fully implemented, for example, after a second referendum. Such a development would certainly also be accompanied by considerable financial market adjustment. One may argue that - beginning with the year 2016 - it has become obvious that European policymakers are not

particularly adept at risk management. While governments require that banks and insurance companies undertake all kinds of risk management. The apparent paradox is that policymakers themselves show very modest ambitions in undertaking risk monitoring and risk management regarding their own activities. There is certainly room for improvement; many governments might learn from national central bankers and prudential supervisory authorities.

If a no-deal Brexit should occur, one can only hope that the central banks in the EU28 have a plan for jointly setting special rules for a transition regime with potential limitations on international capital flows or other measures that would help to bring about an orderly transition process. A certain minimum transition time period would also be useful.

4.7 Appendix

Appendix 4.1: Basic Dornbusch Model and Brexit-related overshooting

Overshooting means that the exchange rate will exceed the long-run new equilibrium exchange rate during the transition path. In the basic Dornbusch model (following largely the simplified approach of Gartner, 2001), it is assumed that the expected devaluation rate:

$$d \ln E(e) / dt = \theta(\ln e\# - \ln e) \tag{4.28}$$

Where θ is an adjustment parameter/"learning coefficient" for the new long-run equilibrium exchange rate e#. The smaller the parameter θ is, the slower the change in the exchange rate expectation for a given difference between the long-run nominal equilibrium exchange rate e# and the current exchange rate e_t (the time index t is dropped for simplicity).

Such a regressive expectation formation could be adequate in the case of a very unusual shock, such as Brexit. Rational expectations, based on a macro model, might not work because there is no model which can analytically integrate the complex step of Brexit (it should be noted that overshooting could also occur under perfect foresight and in the case of a supply-side shock if $-\phi' + (1-\psi)/\delta' < 0$, but then the interest elasticity does not matter (Gartner, 2001, chapter 2).

The interest rate parity - assuming that domestic bonds and foreign bonds are nearly perfect substitutes - must be written as $i = i^* + d\ln E(e)/dt$ where i is the domestic nominal interest rate and i^* is the given foreign interest rate. The price level dynamics is described by a Phillips curve of the following form (with P standing for the price level, H is a positive parameter, Y^d is aggregate demand):

$$d \ln P / dt = H(\ln Y^d - \ln Y) \tag{4.29}$$

$$\ln Y^d = \delta'(\ln e - \ln P) + \psi \ln Y + \ln G \tag{4.30}$$

Hence

$$\ln P = \ln e + \delta' \ln G - \left((1-\psi)/\delta'\right) \ln Y \tag{4.31}$$

Money market equilibrium is (with η' denoting the semi-interest elasticity in the demand for money):

$$\ln(M / P) = \phi' \ln Y - \eta' i \tag{4.32}$$

Inserting the interest parity condition along with the exchange rate expectations gives:

$$\ln(M / P) = \phi' \ln Y - \eta' i^* - \eta' (\ln e\# - \ln e) \tag{4.33}$$

This is the curve for the combined monetary and capital market equilibrium, which holds at any point in time and thus implies an instantaneous nominal exchange rate adjustment.

Brexit stands for an unusual and historical policy decision in the UK, and market participants might find it rather difficult to form exchange rate expectations, so the parameter θ would be rather small. Such a low parameter θ along with a reduced interest elasticity in demand for money reinforces the overshooting problem for the Pound.

This, in turn, would mean that in 2019/20, UK FDI inflows could be rather high as foreign investors will exploit the strong devaluation of the Pound. That partly would come in the long run since nominal devaluations since 2016 have raised inflationary expectations, while the weakening of the UK's EU production networks and Brexit, respectively, should contribute to a higher equilibrium UK price level in the long run. To what extent the Bank of England will adopt an accommodating monetary policy is unclear. For the EU27, there would be a strong appreciation effect that would dampen the inflation rate; the nominal - and real - appreciation of the Euro would be rather modest if the Bank of England would strongly increase the nominal interest rate.

Appendix 4.2: Modified Branson Model with stocks

Stock Market Perspective

A useful specification of the Branson model is as follows (with positive parameters h, h', b and b' as well as f and f'):

$$M = \left(1/(1 + hr + h' r^*)\right)\left[M + B + eF^*\right] \tag{4.34}$$

$$B = \left(1/(1 - br + b' r^*)\right)\left[M + B + eF^*\right] \tag{4.35}$$

$$eF^* = \left(1/(1 + fr - f' r^*)\right)\left[M + B + eF^*\right] \tag{4.36}$$

Since the desired shares h", b", and f" add up to unity, only two of the three equations are independent. Let us consider the MM curve and the F*F* curve. Dividing the money market

equilibrium condition by M we get (assuming zero expected inflation so that one may replace the nominal interest rate i by r):

$$1=\left(1/(1+hr+h'r^*)\right)\left[1+(B+eF^*)/M\right] \tag{4.37}$$

Taking logs gives, under the assumption that $hr+h'r^*$ and $(B+EF^*)/M$ are close to zero, the approximation (using ln $\ln(1+x) \approx x$ for x close to zero) after division by M for the MM curve:

$$hr+h'r^* \approx B/M+(F^*/M)e \tag{4.38}$$

$$r \approx (B/hM)-h'r^*/h+eF^*/hM \tag{4.39}$$

$$e \approx \left[(h'r^*)(M/F^*)-B/F^*\right]+(hM/F^*)r \tag{4.40}$$

Note that a rise of F^* makes the curve flatter and also causes a downward shift of the MM curve. For the F^*F^* curve we can state the equilibrium condition with the specification for the demand function as shown gives after division by eF^*:

$$1=\left(1/(1+fr-f'r^*)\right)\left[1+(M+B)/(eF^*)\right] \tag{4.41}$$

Hence we get:

$$1+fr-f'r^*=1+(M+B)/(eF^*) \tag{4.42}$$

$$e=(M+B)/(fr-f'r^*) \tag{4.43}$$

This is a hyperbola F^*F^* in e-i space, and there is a downward shift of the F^*F^* curve if F^* is raised and an upward shift if F^* is reduced. It can be seen that Quantitative Easing (dM= -dB) will not change the position of the F^*F^* curve. There is no doubt that a fall of F^* - due to a current account deficit - will bring about a rise in the nominal exchange rate. As regards the interest rate, the result of a fall of F^* is not unambiguous, but a rise in the interest rate is likely.

The following modified Branson model (Branson, 1977) looks at the money market, the bond market, and the stock market. The desired share of stocks in total wealth is v (z denotes the marginal product of capital, q:=P'/P where P' is the stock market price index and P is the output price index). In principle, this analysis can be combined with a modified neoclassical growth model. In the short run considered here, stocks of M, B, and K are given. One should also note that FDI could be considered in an enhanced model version where a share of K would be owned by foreign investors. A setting with zero expected inflation rate is considered (real interest rate is r), and real wealth is defined as:

$$A' := M / P + B / P + qK \tag{4.44}$$

MM curve (money market equilibrium):

$$M / P = h^B(r, z)(M / P + B / P + qK); hB_r < 0, hB_z < 0 \tag{4.45}$$

KK curve (stock market equilibrium):

$$qK = v''(r, z)(M / P + B / P + qK); v''_r < 0, v''_z > 0 \tag{4.46}$$

The MM curve and the KK curve can be displayed in q-r space. One may use a simple specification where z is assumed to be given:

$$(M / P) = \left(1/(1 + hr + h'z)\right)\left[(M / P) + (B / P + qK)\right] \tag{4.47}$$

Dividing by (M/P) gives:

$$1 = \left(1/(1 + hr + h'z)\right)\left[1 + (B / P + qK)/(B / P)\right] \tag{4.48}$$

Let us assume that hr + h'z is close to zero and that ((B/P)+qK)/(M/P) is also close to zero. Taking logs and using the approximation ln(1+x) ≈ x gives:

$$hr + h'z \approx \left((B / P)/(M / P)\right) + qK/(M / P) \tag{4.49}$$

$$q \approx \left[-(B / P)/K + ((M / P)/K)h'z\right] + \left((M / P)/K\right)hr \tag{4.50}$$

The MM curve has a positive slope in q-r space. For the KK curve, we specify:

$$qK = \left(1/(1 + vr - v'z)\right)\left[(M / P + B / P) + (qK)\right] \tag{4.51}$$

After dividing by qK we get:

$$1 = \left(1/(1 + vr - v'z)\right)\left[(1 + (M / P + B / P)/(qK)\right] \tag{4.52}$$

$$1 + vr - v'z = \left[1 + (M / P + B / P)/(qK)\right] \tag{4.53}$$

$$q = \left[1 + (M / P + B / P)/(qK)\right]/(vr + 1 - v'z) \tag{4.54}$$

This is a hyperbola in q-r space. Quantitative easing in the sense dM=-dB shifts the MM curve upwards and leaves the KK curve in its position so that Tobin's q is raised, which means an increase in the real stock market price index while the interest rate is reduced.

Table 4.8: True cost of Brexit

A Cost-Benefit Analysis of Brexit for the UK (assuming no UK-EU deal is reached)		
1)	Avoiding annual net contributions to the EU of 0.4% of GDP	Capitalized at an interest rate of 3% gives a present value (long-term) of 13.3% of annual national income
2)	Effect of UK imports from the EU burdened with tariffs after Brexit: 0.25% of GDP	8.3% of UK GDP (2016)
3)	Reduced profits for UK firms due to lowering net prices (before EU tariffs) in the EU single market	8.3% of UK GDP (2016)
4)	Reduced output in the UK of 6% in the long term due to worsened access to the EU single market	6% of GDP (2016) according to the UK Treasury analysis (2016) on the advantages of British membership of the EU: assuming a UK-EU deal (in the no-deal scenario: 7.0% of UK GDP)
5)	Macro feedback effect from 4), which would lead to a 1% reduction of income in the EU27, which, in turn, causes an associated further reduction of 0.2% of income in the UK of 1)	0.2% of UK GDP
6)	Non-realization of the benefits due to single market deepening, which was negotiated by Cameron with the EU at the beginning of 2016	4% of UK GDP (according to the UK Treasury analysis (2016) on the advantages of British membership of the EU
7)	Effect of a raised share of foreign ownership of the UK's capital stock as a result of the real depreciation of the Pound from 17% in 2016 to 30% in 2030	4.3% of UK gross national income
8)	Unilateral abolition of tariffs on agricultural products	1% of UK GDP
9)	UK-US "mini-TTIP" agreement	2% of UK GDP
	Total effect in % of gross national income Cost of post-Brexit border controls (2.1% of GDP)* *see Institute for Government (2017)	***-15.8% (net) of UK national income*** Capitalized at an interest rate of 3% gives a present value (long-term) of -6.9% income quasi-loss

Source: (Welfens, 2017b)

Table 4.9: Complementary data on the regression analysis

Variable	Obs.	Mean	Std. Dev.	Min	Max
LN_Cbank	92	-1.678	0.175	-2.086	-1.396
LN_Insu	92	-1.768	0.242	-2.178	-1.385
LN_Acc	92	-1.293	0.339	-2.293	-0.443
LN_STRI_FA	92	-1.546	0.223	-2.161	-1.147
FDIRes_F	92	0.009	0.012	0.002	0.054
FDIRes_B	89	0.052	0.109	0.000	0.500
FDIRes_I	91	0.016	0.027	0.000	0.150
LN_IFDI	89	3.967	0.768	2.338	5.930
LN_OFDI	89	3.460	1.282	1.027	5.957
LN_Openness	92	0.127	0.490	-0.584	1.445
LN_GDPpc	92	10.320	0.572	9.427	11.689
LN_INT_E	92	4.565	0.036	4.443	4.605

Table 4.10: Correlation matrix

	Cbank	Insu	Acc	STRI_FA	FDIRes_F	FDIRes_B	FDIRes_I	LN_IFDI	LN_OFDI	LN_Openness	LN_GDPpc	LN_INT_E
Cbank	1.000											
Insu	0.622	1.000										
Acc	0.279	0.434	1.000									
STRI_FA	0.627	0.763	0.889	1.000								
FDIRes_F	0.063	0.070	0.692	0.511	1.000							
FDIRes_B	0.089	0.234	0.245	0.263	0.151	1.000						
FDIRes_I	0.060	0.173	0.444	0.373	0.539	0.177	1.000					
LN_IFDI	-0.077	-0.389	-0.270	-0.327	-0.270	-0.133	-0.109	1.000				
LN_OFDI	-0.119	-0.019	0.145	0.064	0.051	-0.133	0.238	0.592	1.000			
LN_Openness	0.039	-0.451	-0.427	-0.426	-0.354	-0.155	-0.270	0.766	0.211	1.000		
LN_GDPpc	-0.171	-0.003	0.149	0.060	0.026	-0.132	0.261	0.392	0.862	0.123	1.000	
LN_INT_E	-0.465	-0.251	-0.034	-0.214	-0.091	-0.077	0.052	0.284	0.338	0.134	0.405	1.000

Table 4.11: Outward FDI stock as a percentage of the source country capital stock, 1980 vs. 2014

Country	Outward FDI-Stock available since:	Outward FDI-Stock as Percentage, in 1980:	Rank 1980:	Outward FDI-Stock as Percentage, in 2014:	Rank 2014:
British Virgin Islands	1998			24384,90%	1
Cayman Islands	1980	10,5%	1	824,81%	2
Malta	1992			171,47%	3
Cyprus	1987			126,09%	4
Luxembourg	2002			90,62%	5
China, Hong Kong SAR	1980	0,1%	31	87,14%	6
Ireland	1985			61,70%	7
Switzerland	1983			60,65%	8
Liberia	1980	7,5%	5	39,59%	9
Singapore	1980	1,2%	17	39,59%	10
Netherlands	1980	7,7%	4	29,51%	11
Barbados	1980	0,4%	22	24,34%	12
Sweden	1980	0,9%	21	23,37%	13
Belgium	1980	1,4%	16	19,66%	14
Canada	1980	2,8%	8	17,41%	15
Iceland	1985			15,89%	16
United Kingdom	1980	3,5%	7	15,82%	17
Denmark	1980	0,9%	20	15,12%	18
Norway	1980	0,3%	26	13,50%	19
Austria	1980	0,2%	29	12,27%	20
United States	1980	2,3%	9	11,56%	21
Australia	1980	0,9%	19	11,03%	22
Finland	1980	0,3%	24	10,69%	23
France	1980	1,2%	18	10,57%	24
Israel	1980	0,0%	40	9,80%	25
Germany	1980			9,48%	26
Bahamas	1998			8,73%	27

Country	Outward FDI-Stock available since:	Outward FDI-Stock as Percentage, in 1980:	Rank 1980:	Outward FDI-Stock as Percentage, in 2014:	Rank 2014:
Taiwan (Province of China)	1980	8,5%	3	8,47%	28
Azerbaijan	1996			8,46%	29
Chile	1980	0,1%	32	8,09%	30
Bermuda	1997			7,28%	31
Malaysia	1980	0,4%	23	6,80%	32
Kuwait	1980	2,1%	10	6,79%	33
South Africa	1980	1,4%	15	6,41%	34
Japan	1980	1,7%	13	6,18%	35
Bahrain	1980	3,5%	6	6,10%	36
Togo	1998			6,00%	37
Spain	1980	0,2%	30	5,98%	38
Russian Federation	1993			4,21%	39
Qatar	1995			4,06%	40
Estonia	1992			4,01%	41
Italy	1980	0,3%	25	3,94%	42
New Zealand	1982			3,86%	43
Hungary	1990			3,85%	44
Korea, Republic of	1980	0,1%	34	3,72%	45
Kazakhstan	1997			3,45%	46
United Arab Emirates	1981			3,25%	47
Lebanon	1984			3,12%	48
Portugal	1980	0,2%	28	3,04%	49
Seychelles	1980	2,0%	11	2,72%	50
China, Macao SAR	2001			2,71%	51
Angola	1990			2,49%	52
Georgia	1999			2,34%	53
Brunei Darussalam	1992			2,26%	54
Colombia	1980	0,1%	33	2,25%	55
Slovenia	1992			2,20%	56
Mexico	1980	0,2%	27	2,15%	57
Aruba	1991			2,12%	58
Panama	2009			2,05%	59
Greece	1986			1,78%	60
Philippines	1980	0,0%	38	1,70%	61
Thailand	1980	0,0%	42	1,65%	62
Argentina	1980	1,6%	14	1,65%	63
Mauritius	1989			1,61%	64
Costa Rica	1980	0,0%	37	1,55%	65
Montenegro	2008			1,44%	66
Croatia	1992			1,36%	67
Oman	2003			1,30%	68
Poland	1981			1,27%	69
Brazil	1980	2,0%	12	1,25%	70
Belize	1984			1,25%	71
China	1981			1,24%	72
Honduras	2004			1,17%	73
Lithuania	1995			1,13%	74
Venezuela (Bolivarian Rep. of)	1980	0,0%	44	1,13%	75
Fiji	1980	0,1%	36	1,12%	76
Czech Republic	1993			1,03%	77

Country	Outward FDI-Stock available since:	Outward FDI-Stock as Percentage, in 1980:	Rank 1980:	Outward FDI-Stock as Percentage, in 2014:	Rank 2014:
Turkey	1985			1,01%	78
Saudi Arabia	1980	0,0%	39	0,81%	79
Armenia	2003			0,69%	80
Serbia	2008			0,67%	81
Bulgaria	1987			0,62%	82
Slovakia	1993			0,61%	83
Botswana	1980	10,5%	2	0,58%	84
India	1980	0,0%	41	0,57%	85
Zimbabwe	1983			0,55%	86
Egypt	1980	0,1%	35	0,52%	87
Nigeria	1980	0,0%	43	0,52%	88
Viet Nam	2005			0,52%	89
Cambodia	1992			0,50%	90

Source: Outward FDI stock was taken from the UNCTAD, last requested on 25 July 2018; capital stock was taken from the Penn World Tables 9.0, last requested on 25 July 2018

Appendix 4.3: Welfare Gain from Holding Real Money Balances (with δ>0)

We take the equation as follows:

$$\Omega = \left\{ \left[h - (h' \beta / K) \right] Y + h' \delta \right\}^2 / 2h' \tag{4.55}$$

With assumption K=4Y we get:

$$\Omega = \left\{ Yh - (h' \beta / 4) + h' \delta \right\}^2 / 2h' \tag{4.56}$$

For the special case that h equals unity and h' equals 2, we get

$$\Omega = (Y / 2 - \beta / 4 + \delta)^2 \tag{4.57}$$

If -ß/4 ≈ δ the welfare gain $\Omega = Y^2/4$. This implies that the medium-term elasticity of the monetary welfare gain with respect to the real GDP is equal to 2.

CHAPTER 5 -
GENERAL DISCUSSION AND CONCLUSION

5.1 Summary of Findings

In this dissertation, I have provided theoretical and empirical evidence to analyze the effects of cross-border investment and financial market dynamics in relation to innovation and modern economic growth with a primary focus on selected emerging and developed economies that played an essential role in international markets. I selected China as a representative case for studying the relationship between FDI and innovation performance because of its experience in attracting and utilizing FDI over the past decades and its need to further integrate into the world economy in order to achieve the goal of innovation-driven economic development. At the same time, economic growth and financial market dynamics in the UK and the EU single market have been analyzed in the context of Brexit. This is because this historical, political, and economic event will bring significant changes to Europe, a region known for its technological intensity, as well as being one of the major regions for international capital flows and financial services trade, and a crucial region for the global economy. More specifically, the dissertation focuses on the following two related research questions in detail:

1) What is the impact of openness and integration into the world economy on promoting innovation in emerging economies? Here, there is a particular focus on China.
2) How will economic disintegration affect economic growth and financial market regulation in knowledge- and capital-intensive regions, and what are the implications for the European and global investment landscape?

In the general framework, Chapters 2 and 3 focus on the first research question regarding the contribution of inward FDI capital and outward internationalization to innovation, respectively. Chapter 2 examines how the inward FDI stock intensity influences China's regional innovation capacity. Drawing on an alternative knowledge production function by treating the FDI input effect as representing economic globalization and linking it to knowledge accumulation, we estimate panel data for 31 Chinese provinces over the period 2000-2015 using models with fixed effects.

Based on the theoretically-derived effects and the empirical evidence, our findings confirm the positive role of a higher FDI stock intensity in promoting China's overall innovation capacity, but the significance of the change in effect is diminishing along with the increase in the novelty of the innovation outputs. The results show that only the low-novelty innovation capacity benefitted significantly from a higher FDI stock intensity in a region. However, the positive impact on high-novelty innovation capacity is not significant. Moreover, the empirical results show that the region with high economic strength (i.e., the coastal region) in China can effectively benefit from FDI to achieve more minor innovations, but the positive effects of inward FDI on promoting major innovations are not evident for this region. By comparison, the region with low economic strength (i.e., the inland region) clearly lags behind the coastal region in generating innovations from a higher FDI stock intensity.

In Chapter 3, I tested the impact of outward M&A on Chinese acquiring enterprises' innovation performance. I compared the pre- and post-M&A innovation performance of Chinese acquiring firms investing in the EU market and further researched the impact on acquirers with different technological intensities and types of corporate ownership. For this purpose, I compiled a comprehensive firm-level dataset comprising Chinese firms that engaged in M&A in the EU28 and patent counts filed between 2010 and 2018 by harmonizing and cross-checking data from several databases.

To test 230 Chinese acquiring firms investing in the EU28 countries and controlling for the non-patenting behavior by employing ZINB models, I find that a firm's size and age can adversely affect the odds of not having patents for acquiring firms without patent filings. In other words, the larger a firm is, the higher the chance that it will receive a patent. By contrast, as the age of a firm increases, the likelihood of not having a patent will also increase. For Chinese acquiring firms that receive patents, the overall innovation performance does not significantly improve after merging with or acquiring firms in the EU28. The study also reveals that the major investors are from the high- and medium high-tech sector and POEs after distinguishing between firms with different technological intensities and corporate ownership types. The results show that the innovation performance of medium-low- and low-tech firms improves significantly after undertaking M&A, but the same results do not hold for high- and medium-high-tech firms. Meanwhile, POEs are found to be able to enhance their innovation performance in the post-M&A era, while SOEs do not show significant differences. For more technological-intensive firms, differences in firm ownership type do not affect the results to a large extent.

Chapter 4 addresses the second research question by analyzing the impact of Brexit on economic growth, welfare losses, and the quality of the financial markets of the UK and EU27 member states. In doing so, to foresee future global economic development possibilities and to contribute new ideas to the discussion on having more open and well-regulated financial service markets in the UK and, in particular, the Eurozone post-Brexit. As we assume that a hard Brexit or a no-deal scenario is more likely, a higher trade barrier between the UK and EU27 is therefore expected. From a long-run perspective, we incorporate this increased cost into a modified two-country macroeconomic growth model by positing that the UK's exports to the EU single market will be subject to higher tariffs. The derived results show that Brexit will have a negative impact on the UK's long-term per capita income growth rate, which is mainly realized through the expected negative influence on trade and the subsequent negative impact on the growth rate of knowledge due to a reduction in investment and trade.

In the short and medium term, the impact of Brexit is more complex. For the UK, my co-author and I anticipate its domestic currency, the Pound, will suffer a strong depreciation, followed by an increase in both nominal interest rates and inflation. Subsequently, since market access between the UK and EU27 is likely to be more restricted, the UK's current account deficit will continue to increase, and a fall in the stock of foreign bonds is expected in the medium term. As a result, we see a high probability of exchange rate overshooting in the short term because strong measures in terms of domestic monetary policy are likely to be implemented in response to Brexit. In addition, we calculate an additional welfare cost that is equivalent to 6-12% of the UK's GDP by examining the impact of Brexit on currency demand and foreign reserves. For the EU27, this study shows that the single market may enjoy a welfare gain from holding real money balances due to a possible long-term reduction in nominal interest rates in the Eurozone. Conversely, the negative welfare effects could also arise as real GDP in the EU27 could be weakened by 1-3% in the long run due to negative spillover effects from the UK.

Accordingly, we seek to understand further how the quality of the financial markets in the UK and the EU27 will develop post-Brexit in terms of the changes in the financial services trade barriers and the effectiveness of financial services regulation. Based on empirical evidence on these two dimensions, we find that the UK is not a country with particularly low barriers to trade in financial services among the selected countries, but it is one of the few countries that has reduced trade barriers for the commercial banking sector. Similarly, although the indicator of FDI barriers is generally low for the selected countries, the UK remains one of the lowest. Furthermore, we identify that amongst the EU28 countries, a nation with a lower FDI

restrictiveness in the financial sector, a higher degree of trade and FDI openness, and a better internet infrastructure is more likely to be associated with a higher level of trade in financial services.

5.2 Policy Implications

This research offers multiple practical implications for economies transitioning from labor-intensive to technology-intensive growth. Firstly, the findings presented in this dissertation suggest that openness to foreign influence, either in the form of foreign capital participation in the domestic market or the internationalization of domestic firms in the global market, plays an important role in knowledge accumulation and innovation promotion for Chinese regions (Chapter 2) and firms (Chapter 3). Therefore, it is necessary to continuously improve the level of openness to foreign assets, to strengthen the absorptive capacity as well as the efficiency and efficacy in exploring and exploiting foreign resources, and to actively participate in international dialogue and cooperation. This will contribute to improving comprehensive innovation strength and capabilities, achieving sustained domestic economic growth, and strengthening a country's competitiveness in the global market.

With new demands from rapidly developing internal economic factors and competitive pressures from the changing external environment, China will aim to further improve its industrial innovation capabilities, as well as the quality of its economic growth and the return on its factor endowments (C. Zhao & Jiang, 2021). In this process, FDI has played a crucial role in China's economic development, both directly and indirectly, through capital inputs and associated productivity and knowledge spillovers. In order to achieve the transition to high-quality economic growth, the focus of China's policy towards foreign investment has also changed through removing a series of tax incentives and benefits that were oriented towards incentivizing quantitative FDI in favor of creating a friendly environment for quality-oriented FDI (McKern et al., 2021). Hence, creating a "level playing field" for investment by domestic and foreign firms and eliminating foreign firms' "forced" technology transfer became very necessary and urgent (McKern et al., 2021).

The promulgation of the Foreign Investment Law (FIL) [7]in March 2019 and the corresponding Regulation on the Implementation of FIL (FIL Implementation Regulation)[8], which entered into force in January 2020, together place a great emphasis on foreign investment promotion, protection, and regulation. Notable efforts are evidenced in leveling the playing field between foreign and domestic investors, as well as adding more effective protection rules covering both pre- and post-entry of enterprises. Regarding the pre-entry phase, national persons[9] are granted the freedom to establish foreign-invested enterprises (FIEs) or to cooperate with participating foreign investments. The FIL also defines the basic policy for market entry is equal national treatment plus a "negative list" approach[10], meaning foreign investors and foreign investments will be given equal treatment as their local counterparts unless the negative list restricts or prohibits market access. Moreover, transparency in formulating foreign investment laws and regulations is emphasized through consulting FIEs and providing necessary guidelines for foreign investors[11]. Last but not least, foreign investors and investments are allowed to be facilitated through the establishment of SEZs or through the development of relevant policies by local governments[12]. During the post-entry phase, the FIL specifies a series of measures to strengthen the protection of IPR and to establish a supervision regime. This includes the attendance to increase penalties for IPR infringement, to prohibit any transfer of technology or the cooperation on technology against freewill and normal business rules[13], and to establish a complaint mechanism for FIEs to detect and resolve disputes in a timely manner[14].

While the FIL is seen as a milestone in China's efforts to further deepen its opening up and regulate foreign investment and the investment environment through the rule of law (Zhang, 2022), much remains to be done to fulfill China's commitment to level the playing field for foreign investors and its attempt to strengthen the investment promotion and protection in an

7 Foreign Investment Law of the People's Republic of China [中华人民共和国外商投资法], https://en.ndrc.gov.cn/policies/202105/t20210527_1281403.html, accessed on 18.10.2022

8 Regulation on the Implementation of the Foreign Investment Law of the People's Republic of China [中华人民共和国外商投资法实施条例], http://www.gov.cn/zhengce/content/2019-12/31/content_5465449.htm (in Chinese), accessed on 18.10.2022

9 FIL Implementation Regulation, art. 3.

10 2019 FIL, art. 4.

11 ibid, art. 10. 11. 19.

12 ibid, art. 13. 14. 18.

13 ibid, art. 22.

14 ibid, art. 26.

all-round manner. First, the formulation of the provisions of the FIL and the Implementing Regulation also has certain imperfections and shortcomings. For instance, not all of the important issues raised in relation to foreign investment have been addressed, and the content of certain provisions has been criticized for being too vague and opaque, which leaves room for discretionary interpretation (Y. Zheng, 2021). The author summarizes the main areas that urgently need further clarification and detailed provisions as "*the rules governing the inspection regime, the rules regarding other procedures that foreign investors may need to undergo, and the special management measures imposed on restricted investments stipulated on the negative list.*" (Y. Zheng, 2021, p. 410).

Moreover, while the negative list approach has largely simplified the regulatory process and improved regulatory transparency, foreign investors still have certain concerns. Major investors have called for a continued shortening of the negative list and further easing of restrictions, particularly in the services and ICT sector, to accelerate the pace of market opening. It has also been mentioned that for industries that are not on the negative list, unnecessary approval steps and permits should be circumvented in practice (Zhang, 2022). The final concern with the FIL lies in the practical implementation. What can be expected is that there will be ongoing work and challenges in revising existing laws and regulations to consolidate new ones. It is also necessary to avoid regulatory overlap due to the complex regulatory system in China at the national and sub-national levels. For the full implementation of the FIL, the establishment of a more stable and effective regulatory and institutional environment is of particular importance.

Meanwhile, to further pursue the innovation development goals, China should make certain adjustments in its "going out" strategy and international diplomacy. For China, the environment for foreign technology transfer is getting more stringent, as there is less space for Chinese firms to catch up through learning and imitating on the one hand and high transaction costs due to the lack of trust and cooperation on the other (Fu et al., 2021, p. 764). As argued by Brandt and Thun (2021), within an industrial sector, the medium-end segment is a crucial way to develop new capabilities because both foreign and local firms need to compete for the market by combining and reorganizing their resources, while the low-end segment enjoys certain advantages from the domestic market and the high-end segment is naturally attractive to leading foreign firms. Both of the studies in Chapters 2 and 3 indicate that higher foreign capital participation and foreign asset acquisitions do not significantly contribute to improving the high-novelty invention output and the innovation performance of firms with high-technological intensity, respectively. The findings also reflect the importance of improving domestic

innovation capabilities and developing an effective ecosystem to enhance the absorptive capacity. To best support this, government should provide the necessary policy protection and certain financial incentives for risky and costly R&D activities, and for the commercialization phase of innovation, the government should avoid unnecessary intervention and give way to the market for resource allocation (Fu et al., 2021, p. 762). Furthermore, China should become more engaged with international S&T collaboration and improve its ability to participate in global governance (Xue, Li, & Yu, 2021). It will not only provide more opportunities and options for China's own innovation system reform and for the utilization of international S&T resources but also be vital for strengthening international cooperation to address major global challenges.

Several aspects should be focused on to increase the efficiency in internal and external resources exploration and exploitation towards the attainment of the innovation development goal. First of all, for a nation that intends to shift towards an innovation-driven economic development strategy, establishing a strong IPR regime is essential in supporting domestic innovation. Foreign companies are still reluctant to engage in knowledge exchange partly due to concerns over an inadequate level of IPR protection and rampant patent infringement in China. A developed IPR system can protect not only the intangible property of firms operating in the domestic market but also stimulate the transfer of knowledge and technology from research organizations to commercial enterprises, which offer incentives for first innovators (Huang & Sharif, 2021). Since its promulgation in 1984, Chinese Patent Law has undergone several amendments, and China's legislative environment has continued to improve and align with international standards and frameworks. Moreover, several studies have shown that China's legal system generally favors patent owners and treats domestic and foreign entities equally in the courts (Huang & Sharif, 2021; Lui & Jin, 2018). However, the continuous reform and improvement of the legal system are urgent and necessary, especially in maintaining the legal environment of the market, simplifying administrative procedures, and enhancing the effectiveness of governance and enforcement.

Second, human capital is one of the fundamental elements in strengthening a country's innovation capability and competitiveness, and the development mode of China's economy is increasingly reliant on human capital, so it is critical for China to improve the efficiency of cultivating and utilizing domestic and foreign talents. Domestically, reducing inequities in the distribution of educational resources and fostering students' innovation consciousness and ability are important challenges for China to prepare the domestic labor force for modern

economic and social development. For the former, while China's central government has provided substantial financial support for education in relatively poorer regions in order to redistribute education funding based on the financial capacity of the province, its impact is considered limited (Jain-Chandra et al., 2018). The study of H. Peng, Qi, Wan, Li, and Hu (2020) suggests that it is more important to close the funding gap caused by economic disparities and inequalities in education needs. Therefore, in addition to sustained economic development and ongoing efforts to reduce interprovincial, urban-rural, and individual income disparities, further actions are required in terms of increased central government funding for compulsory education in poorer provinces, especially in terms of improving the employment prospects and teaching capacity of teachers and related personnel. More importantly, adequate coordination and cooperation between central and local governments is key to improving the effectiveness of redistributing educational resources. For the latter, in order to stimulate and nurture local talents to be more innovative and collaborative, in parallel to the reform of traditional educational methods and approaches, which are exam-oriented, integrating maker education in the primary and secondary education systems and offering indigenous innovation/entrepreneurship courses in higher education are suggested to be helpful (Cooke, 2021). Equally important, policymakers can engage multiple stakeholders in innovation education, for example, by strengthening the linkages between the education sector and businesses to provide entrepreneurs with more training programs and learning opportunities, which can be beneficial in stimulating the demand for entrepreneurial and innovative activities (Cooke, 2021, p. 195).

Internationally, one key challenge is attracting and retaining talent and highly-skilled labor from foreign and domestic sources. Not only does China lag in terms of its competitiveness in attracting global talent compared to developed countries such as Europe or the US, but it also loses its own talented domestic workforce to destinations abroad, which is a mismatch with China's need to shift to high-quality development (H. Wang, 2021). A comprehensive incentive mechanism should be developed to encourage the exchange of talent. By launching several high-end overseas talent recruitment programs and introducing subsidized policies, a number of high-level professionals and an increasing number of well-educated talents have been attracted back to China and have made great contributions to the country's economic development (H. Wang, 2021, p. 453). Moreover, further efforts should be made to improve the residency system to make it easier for high-net-worth individuals to obtain work permits and local residency. Most importantly, the establishment of open and effective communication

channels and public platforms for promoting collaboration between domestic and foreign talents in S&T activities is essential. It is for the exchange of high-quality knowledge and experience, which will further contribute significantly to the deepening of China's participation in international innovation collaborations (K. Chen, Feng, & Fu, 2021).

Third, the government can support the recognition and absorption of foreign knowledge spillovers by optimizing internal resource allocation. One aspect is that the positive role of foreign investment in developing China's innovative economy can be undermined by the increasing disparity of innovation resources and opportunities across Chinese regions. In this view, the establishment of SEZs in inland China with preferential regulatory environments, in combination with the advantageous industries in the central and western provinces listed in the "Catalogue of Industries for Encouraging Foreign Investment," which contains information on local, specific labor and resource conditions in each province, will facilitate greater foreign capital flows into these less developed areas. As a result, attractive options are offered for international firms to locate in the inland regions, which may further lead to positive knowledge spillover effects to the local area. Another important aspect is that regulatory constraints and a less favorable institutional environment for the private entrepreneurial sectors will weaken competitive interactions, thereby undermining firms' innovative capabilities as well as their incentive and opportunity to innovate in both domestic and foreign markets. A necessary step will include the adoption of broader freedoms for POEs, i.e., lower barriers to entry in restricted industries and the equivalent access to critical production resources, especially in terms of developing an effective financing system to provide the necessary support that covers the whole life cycle of technology-based enterprises.

This study also takes a close look at the economic consequences of the UK's de-integrate from the EU single market in Chapter 4 and provides implications for the global investment landscape. In general, we discuss that Brexit will harm the UK's long-run growth rate, cause additional welfare losses, and create a high financial market dynamic. On the other hand, Brexit may create attractive opportunities for buyers from emerging economies in the UK due to a lower price of local assets and a larger market led by the depreciation of the domestic currency and outflows of international capital within a relatively short period of time. After the implementation of Brexit, the UK also loses the "passporting right" for the provision of banking and financial services to the EU single market, and FDI inflows are expected to reduce in the long run. At the same time, the UK will adopt a 'Global Britain' approach to offset the losses from Brexit by increasing its financial service exports to Asia and North America and

increasing its outward FDI, especially seeking to enhance innovation in the financial sector to keep its competitiveness. International capital may favor the US market and the EU27 countries with higher openness to trade and investment and better internet infrastructure.

On the basis of the aforementioned discussions in Chapter 4, we expect the UK to enjoy an increase in FDI inflows in the short term, particularly in the form of M&A transactions due to the strong nominal and real depreciation of the domestic currency. However, with increasing market uncertainty and the potential for higher trade barriers between the UK and the EU27, growth in financial services trade is likely to occur in countries with lower barriers to FDI in the financial sector, higher openness to trade and FDI, and higher internet intensity. At the same time, firms suffering from reduced profitability in the UK will reduce their reinvestment and relocate part of their business to the EU27, especially those using the UK as a gateway to the EU27 market. During and after the implementation of Brexit, the UK government may lower regulatory requirements or entry barriers in financial markets to offset some of the losses resulting from Brexit. In addition, London banks and financial service providers may launch a strong export initiative in Asia and North America to compensate to some extent for the decline in the UK exports of financial services to the EU27.

This research also offers implications for the future development of the economic landscape and international cooperation. The findings show that Chinese FDI dynamics have become an important phenomenon from both a source country perspective and the perspective of host countries. As regards the latter, there is a need for differentiation concerning Asian host countries, which in many cases stand for geographically rather close locations so that the "distance variable," which typically plays a role in standard FDI gravity equations, should not play a major role. By contrast, key EU countries and the US stand for a large physical distance from China as well as for some cultural and political differences. Political barriers to free capital flows and free trade might become more important in the future. Thus, it would be important to reinforce the role of the WTO, which has been undermined by the US under President Trump, and even under US President Biden, no major WTO reform has been accomplished, so multilateralism has not been reinforced much in recent years. One should not rule out that big countries, e.g., the US, China, the EU, and India, or the G20 as a broader group, will find sufficient motivation for a new approach to reinforce multilateralism. If economic globalization, however, should be weakened over the coming decade, one has to anticipate slower growth, less intensive trade networks, and lower FDI intensities (FDI inward stock/capital stock in the host country; and FDI outward stock/capital stock in countries abroad). In turn, it might weaken

the broader interest of many countries to cooperate in crucial fields, including global climate policy protection. Further research can shed more light on these topics and policy issues in a long-run perspective. It will also be interesting to find out to what extent the EU27 and the UK, for example, could agree on new forms of cooperation in Europe and possibly on stronger informal cooperation within the G20 framework in the future. China's international policy course could also change in the medium term, not least depending on the ability of G20 countries to cooperate in key fields.

5.3 Limitations and Future Directions

The study in Chapter 2 limits its focus to investigating the impact of the inward FDI stock intensity on innovation output at the regional level. However, it should be noted that sectoral differences are also important. Industry linkages and distribution can also influence knowledge generation and flows, affecting regional innovation to a large extent. Therefore, analyzing the degree of foreign capital participation and regional innovation output at the industrial level may provide additional useful insights to explain the insignificant result regarding high-novelty innovations. Furthermore, although the inland region is observed to lag behind in benefiting from FDI to generate more innovative output than the coastal region, the linkage between the degree of foreign capital involvement and the gap in innovation output change between the two regions were not tested in this study. In other words, whether or not it played any role in widening or narrowing the gap in innovation output between inland and coastal regions as inward FDI stock intensity increased, which could provide a beneficial aspect for policy implications.

In this dissertation, the second study (Chapter 3) did not find a significant enhancement in the innovation performance of high-tech and SOEs after engaging in cross-border M&A in the EU. However, this may stem from the fact that the measure of innovation, i.e., the number of patent applications, does not fully indicate the quality of inventions. Therefore, other indicators, such as patent citations or claims, could be chosen to explore the reasons for this in further detail. In addition, although I have carefully examined the patenting behaviors over the five years before and after the M&A deal for selected acquiring firms during dataset construction, I cannot fully control the inventor's post-acquisition patent filing behavior. It may occur that the acquiring

firm is a subsidiary and generated a new invention after merging with or acquiring the EU firm, but the parent company was registered as the current owner of the new invention.

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