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FDIs, Patents and Geopolitical Influence: China's Road to Sustainable Technological Sovereignity

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Abstract

China is emerging as a global leader in green technologies, driving significant advancements in renewable energy, electric vehicles, and sustainable infrastructure. Through substantial public investments in innovation and strategic industrial policies, the country has established itself at the forefront of the green tech revolution, fostering the development and deployment of clean energy solutions both domestically and internationally. However, the competition between the United States and China has intensified in recent years, particularly in the domains of digital and green technologies. This rivalry has evolved from an economic contest into a broader geopolitical struggle for leadership in renewable energy and clean technologies, with nations recognizing that these advancements are crucial not only for economic growth but also for future security.

In this context, this dissertation investigates the role of foreign direct investment (FDI) in advancing the Chinese green economy. By constructing a comprehensive dataset of fully Chinese-owned firms actively patenting in the green sector and employing a gravity model, the study examines the relationship between a firm's engagement in FDI in specific countries and the extent to which it leverages knowledge from those locations. The findings reveal a significant impact of FDIs on the acquisition of technological knowledge, particularly investments targeting technological assets. Moreover, it is observed that Chinese green firms source knowledge from both geopolitically distant and proximate countries, with an increasing trend of investments in nations exhibiting higher levels of political disagreement in recent years.

Keywords: China, FDI, Innovation, Patents, Diplomatic Disagreement

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Abbreviations

APEC – Asian Pacific Economic Cooperation

CCP – China’s Communist Party

CDP – Cassa Depositi e Prestiti (Deposits and Loans Fund)

CFIUS - Committee on Foreign Investment in The United States

CPC – Cooperative Patent Classification

DFT – Dependence on Foreign Technologies

EV – Electric Vehicle

FDI – Foreign Direct Investment

FIRRMA – Foreign Investment Risk Review Modernization Act

FYP – Five Years Plan

GAT– General Agreement on Tariffs and Trade

GDP – Gross Domestic Product

GERD – Gross Expenditure on Research and Development

GII – Global Innovation Index

IPC – International Patent Classification

IPR – Intellectual Property Right

ITAR – International Traffic in Arms Regulations

KFW – Kreditanstalt Für Wiederaufbau (German National Promotion Institute)

M&A – Merger and Acquisition

MENA – Middle East and North Africa

MEP – Mega-Engineering Program

MLP – Medium and Long Term Program of Science and Technology

MNC – Multinational Corporation

MNE – Multinational Enterprises

MOFCOM – Ministry of Commerce of the PRC

MOST – Ministry of Science and Technology of the PRC

NDAA – National Defense Authorization Act

NDRC – National Development and Reform Commission

NEA – National Energy Administration

NRDC – National Reform and Development Commission

PPP – Purchasing Power Parity

PRC – People’s Republic of China

R&D – Research and Development

S&T – Science and Technology

SEI – Strategic Emerging Industry

SEZ – Special Economic Zone

SOE – State-Owned Enterprise

STIP – Science and Technology Industrial Plan

STP – Science and Technology Progress to Economic Growth

UNCTAD – UN Conference on Trade and Development

WTO – World Trade Organization

Introduction

1.1 Thesis introduction

The increasing advancement of the Chinese economy in recent decades has been the subject of many recent studies. However, the case of the People's Republic of China is particular as its institutional framework and the attitudes of successive governments influence policies extensively on the domestic and international economy. Economic policies have seen a shift since post-Mao Zedong, with the opener Deng Xiaoping, from Chinese-style communism to Chinese-style capitalism with socialist overtones. Its definitive opening from 2001 onward, with entry into the WTO has significantly positively affected the Chinese economy.
This dissertation will discuss the investment policies outlined by the Chinese administration, particularly FDI, to see how these have influenced technological knowledge in the green sector.

1.2 Research Topic and Research Question

The present study is directed toward the analysis of subjects pertinent to geopolitics and geo-economics. The aim is to shed light on topics of interest at the intersection of these two major branches of social studies, particularly having China and its role in global politics and economics as an area of interest. More specifically, we will analyze the development of investment attitudes of Chinese multinational corporations through FDIs and its subcategories- FDIs with innovative content, greenfield FDIs, greenfield FDIs with innovative content, M&As, and M&As with innovative content. This practice has seen a major boom in recent decades and has been the subject of various studies in the geoeconomics literature. The context in which this analysis is brought is the Second Technology War, involving China and the US. For this reason, the object of our study also covers geopolitical issues and acquires significant relevance.
In terms of the topics covered in this study and our research question, the objective is to identify the relationship between FDI (and its subcategories), patents, and a geopolitical variable- specifically, diplomatic disagreement at the level of the United Nations- in order to understand how China- its MNEs- has managed to acquire current technological knowledge within the green sector. In addition, the frequency and amount of investments made by China in various countries around the world will also be outlined as key aspects.

We will try to understand how far investment influences knowledge acquisition and whether China follows a geopolitical friendship paradigm in its investments or whether the decision to invest is dictated purely by economic and technical interest in acquiring strategic assets such as know-how, skills, routines and managerial practices.
This topic appears to be relevant both at the European and international level as we have been able to observe a change in the attitude of the United States in accepting foreign investment, particularly from China, and the adoption of increasing sanctions toward companies from the People's Republic. Moreover, it is a salient issue at the European level in general, but more specifically with regard to Germany and France, which have changed their approaches to inward investment from China.

1.3 Thesis Outline

The paper is organized starting with an account of Chinese history, highlighting the change of course brought about by Deng Xiaoping. The new attitude of the Chinese administration turns more toward science, technology and trade opening as incisive factors for the country's substantial progress. In addition, at the level of international ties, we can see a significant rapprochement with the U.S., a country that has played a key role in China's changing positioning in the international chessboard.
Subsequently, the importance of a long-term vision in structuring economic and political plans will be highlighted. This will be a key factor as it will lay the groundwork for trade opening and WTO entry in 2001. Finally, we will conclude the first part of the chapter of literature by illustrating industrial policies, especially the 863 plan, a forerunner of future Chinese programs.
We will continue the same chapter with an emphasis on the key factors of our study, FDI and "techno-geopolitics". After an illustration of inward FDI, we will cover outward FDI, the subject of our study, and innovation-related investment geopolitics.
In the next chapter the relevance of technical knowledge acquisition in green technology will be discussed. The most recent industrial plans, which, as we will see, have an important focus on science and technology, will be explained. In addition, the socio-political relevance of the green issue, a topic that is prominent in the Chinese population and has had a significant implication on the policies adopted by the administration, will also be addressed.
Then, we will discuss with the methodology chapter the empirical analysis. We will specifically explain the data used, the design of our gravity equation and the rationale behind the application

of such a model, and, finally, all the variables present. We will close this chapter by explaining the descriptive statistics, which are an indispensable part of the present study as they give us substantial insights into the scale of Chinese investment and the rationale behind the investments.

Next, the results chapter will be covered, presenting our findings and highlighting the discussion on the analysis.

Finally, we will conclude with the salient aspects of the present study, the limitations of the analysis and explain the implications for managerial practices and public policies.

2. China’s Struggle for Technological Leadership

2.1 “Imitating the West to beat it”

2.1.1 Deng Xiaoping’s Reforms

The deteriorating condition of Mao's "continuous revolution" initiatives, along with the serious security challenges confronting the PRC, created the conditions for a slow process of Chinese-American reconciliation. Commencing in the latter part of 1969, a sequence of hidden encounters took place between Beijing and Washington. In spring 1971, the Chinese and Americans engaged in ping pong matches, first in Japan and then in Beijing. This event marked the global recognition that the years-long political climate of intense hostility between China and the United States were gradually diminishing (Chen, 2001). In October 1971, the PRC, which had before been barred from joining the United Nations since its founding in 1949, asserted its membership in the UN and became a permanent member of the Security Council. This statement alone clearly indicated that Chinese foreign relations, both in general and specifically towards the United States, were about to embark on an entirely new phase. The conversations between US president Richard Nixon and Mao Zedong and Premier Zhou Enlai in Beijing during the events of the "week that changed the world" in February 1972, provided confirmation of this fact. The Sino-American statement was formally ratified in Shanghai on February 28, 1972. It was an unorthodox document. Furthermore, the text not only elucidated areas of agreement but also underscored the disparities between Beijing and Washington, as both parties employed their own terminology to delineate their distinct approaches towards strategic global matters. They agreed that neither party should pursue dominance in the Asia-Pacific region and both stated their opposition to any attempts by any other country or group of countries to establish such dominance, with an implicit target on the Soviet Union. The twenty-year Sino-American conflict concluded. Undoubtedly, the Chinese-American reconciliation stands as one of the 20th century's most significant and consequential events (Chen, 2019).

By 1978, Deng Xiaoping became China's *de facto* leader. United States, as perceived by Deng Xiaoping, were expected to have a pivotal role in China's pursuit of modernity and beyond. Following the crucial visit of U.S. President Richard Nixon to China in the spring of 1972, which closed the twenty-year Sino-U.S. conflict, a "tacit alliance," as described by Henry

Kissinger, rapidly formed between Beijing and Washington (Kissinger, 1972). The foundation of the partnership was built upon strategic and geopolitical factors, which arose as a result of what both nations judged as significant security risks posed by the Soviet Union. The geopolitical and strategic significance of the new alliance that Deng and the post-Mao Chinese leadership aimed to establish with Washington would persist intact. Significantly, China's implicit partnership with Washington was to support Deng's fresh initiative of seeking assistance from the United States and the capitalist Western countries to modernise China. Regarding this matter, Deng was prepared to relinquish the "revolutionary country" designation that China had consistently asserted throughout the Maoist period. In addition to the Chinese leadership's aspiration and action to adopt the "world market", which is governed by global capitalism, as the primary driver of its modernisation efforts, China, during the period of reform and opening up, would also progressively assume a position of influence inside the established international systems and institutions strongly controlled by the United States and the capitalist West. Hence, from the Chinese standpoint, the global cold war concluded in several significant aspects in the mid- and late 1970s, rather than the late 1980s and early 1990s, with the reconciliation between China and the United States and, notably, Deng's initiation of the "reform and opening-up" initiative. Over forty years have elapsed since that pivotal moment in China's overall foreign relations and its specific dealings with the United States. China's economy, society, people, and worldwide perspective have been profoundly altered by the reform and economic liberalisation process. Since its beginning, China's reform and opening-up movement has been marked by a collaborative involvement between the PRC and the United States in the global sphere. Even after the conclusion of the global Cold War, although it has placed pressure on this partnership, it has not weakened it. As a consequence of China's expanding and intensifying reform and opening-up process in the post-Cold War era, its economy has become more interconnected with the global market controlled by global capitalism, while being governed by a "communist" government (Chen, 2019).

Another key aspect was the paradigm shift brought about by Deng; there was a transition from the "anti-scientific" thinking of Mao[1] to the semi-capitalist, innovation-oriented thinking of Deng. This, together with Deng's overall vision of foreign policy, laid the foundation for a Chinese change of pace toward modernity and exponential economic growth.

[1] Mao Zedong promoted the so-called Cultural Revolution which had a significant negative impact on Chinese evolution.

On March 18, 1978, the little helmsman gears up the scientific march with a historical speech. Below you can see an excerpt of Deng's speech, this helps us understand how the process of Chinese economic opening up began, which is crucial to our study:

"The very fact that we are holding this great gathering today, unprecedented in the history of science in China, clearly indicates that the days when the Gang of Four - Wang Hongwen, Zhang Chungiao, Jiang ling and Yao Wenyuan - could arbitrarily sabotage the cause of science and persecute intellectuals are gone forever. Never before have the entire Party and the people been so interested in science and technology and paid so much attention to it. A large number of scientists, technicians, workers, peasants and military personnel are actively participating in the movement for scientific experiment. Young people are interested in science and are eager to study it. The whole nation is joining with enormous enthusiasm in the march toward the modernization of our science and technology. We have splendid prospects ahead of us[2]".

These are the words with which Deng Xiaoping begins his speech, we can immediately read two fundamental aspects of Deng's policy: the departure from the past, repudiating what the "Gang of Four" committed regarding the slowdown of culture and, especially, science; and an acceleration regarding a profound political change for "reform and opening up". He initiates the four modernizations: agriculture, industry, national defence, and science and technology, explaining that only through these the socialist system can be more effectively consolidated (Goldman, 1989).

Subsequently, the industrial sectors on which China should focus its efforts are identified: "A number of new industries, including atomic energy, computers, semiconductors, astronautics, and lasers, have been founded on the basis of the emerging new sciences. [...] In particular, the development of computers, cybernetics and automation is rapidly increasing the degree of automation of production. [...] Mainly the power of science, the power of technology[3]". In this subsequent part of Deng Xiaoping's speech, we can identify the industries that the Chinese leader want his country to focus on, pinpointing them as strategic.

In these excerpts we can see how Deng acknowledges that the country is living in underdevelopment compared to other world powers: "Backwardness must be recognized before it can be changed. One has to learn from those who are ahead before one can catch up

[2] https://dengxiaopingworks.wordpress.com/2013/02/25/speech-at-the-opening-ceremony-of-the-national-conference-on-science/

[3] *Ibidem.*

and surpass them[4]". In addition, another relevant aspect is highlighted: "Independence does not mean closing the door to the world[5]". Thus, Deng inaugurates what will become the "learning from the West" campaign, using to one's advantage what good is being done in capitalist societies, while the reference of science as "wealth created in common by all mankind[6]" sweeps away two decades of Maoism applied to science. Deng wants a China in which "being red" does not exclude the technical knowledge and degree of expertise of Chinese technicians and officials; Deng wants a China with a "red and experienced" force that includes a large number of scientists, engineers and technicians according to world standards (Pieranni, 2020).

In order to achieve his goal of modernizing science and technology, Deng plans to first redirect the entire Chinese society towards science and technology, and thus, absorb knowledge from more advanced countries. For our purpose, it is necessary to emphasize the steps that laid the foundation for China's technological power, which was propelled by Deng Xiaoping's diplomatic initiatives combined with scientific and economic collaborations.

Consequently, the first country to be involved in his plans is the United States. Deng came to the U.S. in 1979 as the first leader of the People's Republic of China to visit. He does not go to the country as a head of state, also because he is not officially one, instead, he presents himself as a *de facto* leader. Moreover, his aim is to seal a rapprochement between China and the United States both for the future post-Cold War geopolitical order and for Chinese technological development. Thus began the era of dialogue with the "American friends" (Global Times, 2021)

To fully grasp Deng's intention, Evan A. Feigenbaum's (1999) contribution in "China's Techno Warriors" is of great use. In fact, he writes that the concept of "independent development" applied to technology, which is one of the salient themes of China's scientific and political debate from the 1980s to the present day (via the so-called indigenous innovation of the 1990s and Xi Jinping's drive for self-sufficiency) "is not to be understood as autarky". Deng wants to highlight a fundamental concept: "China would acquire imported technology from abroad, while pursuing a reduction in foreign dependence" (Feigenbaum, 1999).

Deng's trip to the US is seen as a success. In the second half of 1978, the government of the PRC had defended the position that diplomatic normalization should precede deeper cooperation in science and technology, in particular government-based cooperation. Chenxi Xiong (2001) highlights one aspect: scientific cooperation came first. In fact, in July 1978 the

[4] *Ibidem.*
[5] *Ibidem.*
[6] *Ibidem.*

Chinese leader received the largest official US scientific delegation ever sent to another country, led by President Jimmy Carter's top scientific advisor, Frank Press. In addition, in October of the same year, a relatively high-ranking Chinese delegation travelled to the U.S., led by Chinese scientist-diplomat Zhou Peiyuan.

At this meeting "informal and verbal" understandings were agreed upon, these were later added to the agreement on scientific cooperation between governments formally signed in January 1979 (Xiong, 2001).

2.1.2 The Importance of the Long-term Vision

On 9 October 1983, Premier Zhao Ziyang addressed the State Council, speaking explicitly about a "new technological revolution". It was that speech that paved the way for today's China, for at that juncture the groundwork was laid for long-range programs that would influence the balance of the country and the world for decades to come. Zhao reads in the "third wave" of Alvin Toffler's book[7] the destiny of China, a wave that would transform the past into a new future in which an emerging civilization would triumph through new energy sources, new production methods, new family structures, new educational models and new business organisations. For Zhao, Toffler is talking about China.

In order to understand the close connection between Zhao and Toffler, the work of economist Julian Gerwitz (2019) is of great help. Gerwitz explains how Toffler's work affected Zhao vision: "it provided the sense of urgency and expediency for Zhao to realize that, given the low level of scientific and technological prowess, if China was to take advantage of the "third wave" transformations, this would require a long-term process that had to begin immediately (Gerwitz, 2019)". On 15 May 1984, the National People's Congress approved Zhao's ideas and the groundwork was laid for the ambitious and incisive 1986 project, the one that set the foundations of China as we know it today.

The 1986 project seeks not only to achieve the concept of the "third wave" (Toffler, 1980) so that it can be a representation of it, but, above all, there is a constant search for an autonomous and self-sufficient development, at this stage the so-called Chinese characteristics flourish, modelling capitalism on the Chinese reality (Pieranni, 2020).

[7] According to Toffler, in his book 'The Third Wave', he theorises the existence of three waves of change that would go through human history: the first would give birth to the agricultural society; the second would be characterised by the Industrial Revolution and the third, it is the one already explained within the text and is the one that strikes Zhao, finding great similarities with what for him would be the destiny of Chinese society.

This is the historical period in which the group of four scientists - Wang Ganchang[8], Wang Daheng[9], Chen Fangyun[10], Yang Jiachi[11] - are particularly central to the scientific community but also have a great influence on politics. This shows the new importance of science and technology in Chinese society, culture and politics.

These four scientists, together with most prominent Chinese political figures, are the ones who will develop the "863 plan".

The 863 plan was explicitly modeled after Europe's Eureka initiatives and United States' "Strategic Defense Initiative" (i.e. "Star Wars") under Ronald Reagan, the aim was to keep up with the world's most powerful economies (Mao et al., 2021).

It envisaged the simultaneous development of dual-use technologies, applicable in both civil and military spheres. Initially, it focused on the development of seven strategic priority areas: laser technology, space, biotechnology, information technology, automation and manufacturing technology, energy, and advanced materials - in the mid-1990s, Beijing expanded these areas, increasing the weight of cutting-edge technology products, such as supercomputers. The 863 plan, in addition to focusing on the practical side, is a real declaration of intent, for instance, by allocating between 2 and 5 per cent of the budget to basic research (the very research Deng spoke about in the speech quoted above) on topics such as Einstein's special relativity and the postulates of space-time. This research will allow China to create an ecosystem capable of enabling the scientific community to be more adept in terms of study, elevating the role of scientists who had suffered many ideological limitations during the Maoist period (Pieranni, 2020).

Furthermore, as specified by Feigenbaum (1999), the program sought to structure a symbiosis between science, engineering and industrialization, pushing for "the dissemination of tenders in areas that included production aid". Moreover, the organization of China's scientific process was also changed: "thematic groups of experts who have to make decisions on objectives report to management staff in the seven main fields" (Feigenbaum, 1999). These fields refer to two areas of interest, namely the military and the civil, but the two areas of interest are not totally separated. Furthermore, the seven main fields talk to each other, thus, there are communicating segments. The program also introduced an important innovation that sped up the process: a

[8] Nuclear physicist, Wang Ganchang was the President of China Institute of Atomic Energy and a major player in the "two bombs and a satellite" program.

[9] Optician, Wang Daheng is considered the father of Chinese optics and a major player in the "two bombs and a satellite" program

[10] A nuclear physicist, Chen Fangyun like Wang Ganchang is also considered one of the fathers of the Chinese atomic bomb, and is regarded as the forerunner of the Chinese Beidou satellite positioning system.

[11] Specialized in biomedical electronics, Yang Jiachi is considered the father of China's space programs.

hierarchy designed to divide the work between various groups for the evaluation of complex technologies. These were then “broken down into constituent focal areas and then amalgamated into the formulation of program objectives”. In practice, “this means that a telecommunications committee leads a fiber committee, which in turn leads the groups in charge of broadband, switches, and so on. Communication between levels is smooth and flat: the hierarchy is established by convenience, not by command” (Feigenbaum, 1999).

The plan was presented to Deng Xiaoping on 3 March 1986. Deng took little time to grasp the primary role the program could play in Chinese growth, hence, on March 5 1986 he instructed the State Council to convene a meeting immediately. Over the next few months, several panels with many experts followed one another to conduct rigorous executions and demonstrations. The goal is ambitious, aiming for world leadership in several important high-tech fields, narrowing the gap with the developed countries, driving scientific and technological progress in the indicated areas and creating a new generation of top technical talent for the future. To conclude, the specific areas outlined above are identified and, on 18 November 1986, the Central Committee of the Chinese Communist Party and the State Council approved the scheme, which in 1987 became official under the name 863 plan, from the date it was launched (March 1986).

An interesting example of Chinese scientific and technological progress during these years is the development of the Great Wall 0520CH.

The 1980s and 1990s not only transformed China into the "factory of the world" but also saw the growth of a budding electronics industry for the domestic market. This aimed to help China catch up with global advancements and provide professionals, like journalists, with the computers they needed for writing. By 1983, the office of the Ministry of Electronics Industry had defined its goals, namely, to move towards Ibm-like personal computer models for a mass market. The ministry began to organize itself until the need came to achieve a concrete result: to show China's first personal computer at a national exhibition in August. The person who led the research team was Wang Zhi, former deputy director of the State Administration of Information Technology. By August of that year, they had achieved the result. The personal computer was shown in public for the first time, the Great Wall 0520CH with a 10M hard disk, 256K memory, 8-inch display and, most importantly, the ability to write and see Chinese characters on the screen (Pieranni, 2020).

On December of that year, a photo was published in the American magazine “BusinessWeek” showing a ship with unfurled sails ploughing through the waves, a five-star red flag flying at the top of the mast, and the Great Wall personal computer waving its right arm to greet the people. The article, entitled “China's Great Wall joins the personal computer competition”, reads: “This is China's first surprise attack on US computer capital” (Business Week). The Chinese mass computer industry was born, and shortly afterwards, others would follow. Other items began to appear in the Chinese market, as the leadership began to take the measure of the global market, moving between the need to take what its industry needed from abroad and the need to develop technological self-sufficiency (Boulton et al., 2000).

2.1.3 Trade’s Openness (2001)

As mentioned above, China began its economic reforms in the late 1978. In fact, Deng Xiaoping's speech initiated a season of reform and opening up, seeking integration into the international trade system (Hye at al., 2016).

Again, as with the entire recent history of Chinese politics, from Mao onwards, it is appropriate to illustrate the leaders who have led certain key periods. In this case, the figure of Jiang Zemin is crucial, he contributed to bring China into the global marketplace. Moreover, he was a leader considered original and *sui generis*, a very complex figure; Jiang Zemin was a pragmatic and non-doctrinaire leader. On the other hand, while continuing Deng's opening up policies from an economic point of view, as mentioned above, from a domestic policy prospective he was a profound conservative, it was with him that the so-called surveillance state began to take shape, which would become impressive with Hu Jintao (Gilley, 1998). According to Gilley (1998), Jiang Zemin should be regarded as a significant leader in Chinese history for several reasons: “For his role in bringing both stability and growth in China after 1989; for his wise approach to the shortcomings and excesses of the reform era under Deng Xiaoping; for his part in outlining a future Chinese state capable of combining growth and economic and social freedom with authoritarian rule; and for his likely enhancement of China's role in the world” (Gilley, 1998).

Before leaving his role, Jiang Zemin ratified China's entry into the WTO, made official in December 2001. It is essential to highlight the relationship between trade openness and economic growth to grasp the role that it played in China’s outstanding growth.

China has moved away from a centrally controlled economy toward a market-driven model, resulting in significant economic growth and advancements in social development.

A significant milestone occurred when China joined the APEC in November 1991. China further solidified its role by chairing APEC in 2001 and hosting the annual leaders' meeting in Shanghai. After 16 years of negotiations under the GATT, China concluded the agreement, leading to its accession to the WTO on December 11, 2001. Membership in the WTO facilitated China's emergence as the top destination for FDI and integrated its economy into the global production chain. Over recent years, China's GDP has grown at an average rate of 9 per cent per year, showcasing a faster growth rate compared to other economies and exemplifying an endogenous growth model (World Bank, 2015).

In terms of trade, China was the thirtieth largest trading country in 1977. However, by 2000, it had ascended to the seventh largest trading nation and climbed to the fourth position in 2002, surpassing Canada, the United Kingdom, and France. By 2008, China became the third largest trading nation, and in 2010, it rose to the second largest in both exports and imports, surpassing Japan's GDP to become the world's second largest economy (World Bank, 2015).

This has been achieved through openness to trade and has increased greatly with WTO entry.

At that time, China could still be defined as a developing country. Grossman and Helpman (1991) argue that developing countries gain advantages from the innovations originating in developed nations. Moreover, Romer (1990) explains that openness to trade stimulates and increases spillover effects. In addition, trade linkages between developed and developing countries stimulate the accumulation of human capital in the latter (Young, 1991). With regard to human capital, its composition should also be noted. Indeed, as Feenstra (1996) points out, there is less skilled talent available for research and development in smaller and lesser developed countries. Hence, for them, in order to achieve the necessary level of skilled human capital, they must open up to trade to benefit from the spillover effect mentioned above (Romer, 1990) and reach the desired level of economic growth. Furthermore, Bruno (1987) asserts that greater trade openness leads to lower unit costs, heightened competition among domestic manufacturers, and better resource allocation efficiency, ultimately fostering long-term economic growth. Edwards (1992) supports this by indicating that countries with more liberalized trade policies tend to experience faster growth compared to more closed economies. He emphasizes that open economies grow at a significantly quicker pace than their closed counterparts. Additionally, Dollar (1992) points out that the real exchange rate distortion index and the variability of the real exchange rate serve as measures of trade liberalization.

We can observe, as outlined by the literature, the relevance of the trade openness in influencing a country’s economic growth, and it was the case of China. Above all, its access into the WTO has opened the door to investment, both inward and outward, and this has played a key role in China's industrial policies.

2.1.4 Industrial Policies

China has an extensive history of economic planning. China's post-1978 industrial policy has largely followed the selected model of its East Asian neighbors (Japan, Singapore, and South Korea). More specifically, a number of industries were chosen first, and then various bundles of policy measures were used to assist the targeted industries in meeting their competitiveness goals (Mao et al., 2021), only recently China has begun to experiment with horizontal industrial policies (Jiang and Li, 2018).

In 1986, China started to take a more extensive approach to industrial strategy, closely following the "national innovation system" in OECD countries (Lundvall and Borras 2006). China's plan focusing on SEIs, as determined by following projects known as 863 plan (also recognized as "National High-tech R&D Program"), 973 plan (also known as "National Key Basic Research Program", released in March 1997), and "Medium and Long-term Plan for Science and Technology (2006-2020)" (released in March 2003), were explicit in the approach they took of selecting key technologies and industries: closely replicating those identified by leading economies such as OECD countries (Chen and Naughton, 2016; Zhi and Pearson, 2017). The SEI efforts have thus been expressly planned to foster quick technical catching-up and even leapfrogging by Chinese industries and enterprises in order to "seize the commanding heights of the new technological revolution" (Wan Gang, minister of Science and Technology, MOST – cited in Chen and Naughton, 2016). Under Premier Zhu Rongji (1998-2003), economic strategy, including industrial policies, took a short break, in part because the government's primary goal was to foster an economy that was more market-driven and contain hyperinflation. However, under Premier Wen Jiabao (2003-2013), industrial and science and technology policies were dramatically rejuvenated, institutionalized, and rationalized (Liu et al. 2011; Heilmann and Melton, 2013; Cheng and Naughton, 2016). There are various aspects worth considering.

Primarily, the organizational structures for economic planning, which included developing industrial policy, were rationalized. In particular, an influential super-planning organization, the NDRC, was established. The NDRC's primary responsibility is to originate and manage significant industrial and economic policies across several ministries (e.g., Ministry of Education, Ministry of Finance), relevant government agencies (e.g., the central bank, state-owned commercial banks), and industries. Furthermore, an additional and more empowered MOST was established to oversee S&T policy development. Additionally, industrial, scientific and technological strategies, which were previously dissociated under Prime Minister Zhu Rongji were substantially more tightly integrated (Mao et al., 2021).

Secondly, policy procedures became more formalized and rationalized. MOST is in charge of originating and drafting science and technology policies in consultation with scientists. At the same time, while the highest leadership has final say, the NDRC is in charge of setting up and implementing industrial policy with contributions and input from scientists, economists, local governments, and other ministries. Furthermore, critical policies, such as the Medium and Long-term Plan for Science and Technology (2006-2020) and the SEIs programs, were to be released by the highest levels and serve as a long-term guide for industrial policy. All of these techniques have provided policy continuity over a significant time frame.

Mao et al. (2021) provide data on China's industrial and S&T policies during a crucial period (2000-2012), shedding light on the targets and effectiveness of these policies. At the beginning of 2000, China continued to be a developing country with limited resources. As a result, China's industrial strategy was extremely selective: only a few industries were targeted for interventionist policies, while the bulk of others were completely ignored. To study what these policy-focused industries are, these scholars filter them out employing the Government Document Information System database (Huang et al., 2015), which comprises all of the policy documents released by China's governmental agencies at the ministry level and above (e.g. the State Council). Following the data's operationalization, they have a list of 72 four-digit industries that are expressly addressed in industrial strategy documents (Mao et al., 2021).

China's industrial policy aimed at emerging sectors may have succeeded due to the country's policies began to foster innovation in emerging industries, approaching the technical frontier after 25 years (1978-2002) of rapid catching-up through imitation. Moreover, there is significant evidence distinguishing between the direct and indirect (spillover) effects of multi-pronged policy measures. The study by Mao et al. (2021) has significant implications for our purpose, as well as the literature on industrial policy and the significance of comparative advantage fostering economic development in developing countries.

The efficacy of industrial policy is determined by the relative level of industrial growth in comparison to the international industrial frontier. To some extent, Mao et al.'s (2021) findings are consistent with the theoretical insight advanced by Acemoglu et al. (2006), who argue that when a country is in its early stages of expansion, it ought to motivate firms to embrace an investment-based strategy to promote the usage or imitation of advanced technologies, as evidenced by the policies adopted by China at the beginning of its industrial plans. As a country approaches the technological frontier, it should pursue a more innovative strategy, for example, the shift from “made in China” to “created in China”. This is what China is pursuing, in some sectors, such as green, with great success evidenced by the knowledge it now holds in this field. Furthermore, Lin (2012) has argued that the success of industrial policy is not solely determined by static or even latent comparative advantages. Instead, by focusing on emerging sectors in which firms in advanced nations are also ambiguous about technological orientation, developing countries with significant R&D capacities, such as China, may promote quick technological catch-up by their domestic companies: ambiguity about the technological future can be a significant advantage for developing-country firms. Thus, while a country's overall industrial strategy should be based on comparative advantage, carefully designed industrial policies aimed at specific growing industries can be effective even if they contradict comparative advantage principles (Mao et al., 2021).

2.2 FDI’s Relevance for China

2.2.1 Inward FDI’s

From the creation of the People's Republic of China in 1949 to the implementation of economic reforms in 1978, China received essentially no foreign investment. In the 1980s, joint venture initiatives culminated in a stream of FDI inflows, driven mostly by the transfer of the majority of Hong Kong's manufacturing to South China. The amount of inward FDI in China rose from $430 million in 1982 to $144 billion in 2017, 0.21% of GDP and 12% of GDP respectively (Hu et al., 2019). Specifically, inward FDI peaked at $1 billion in 1984 and reached $4.4 billion by 1991 (MOFCOM). With a renewed emphasis on foreign investment attractiveness at the onset of 1992 and the formal introduction of a market economic system that year, inward FDI inflows expanded dramatically, hitting US$ 11 billion in 1992 and rising to a peak of US$ 45 billion per year in 1997-1998. Following a decrease to roughly US$ 40 billion per year in 1999-2000, and China's entrance to the WTO in 2001, incoming FDI have consistently increased (MOFCOM). By 2009, China had collected an inward FDI stock of $473 billion[12], well exceeding other significant countries that were developing or transitioning such as Brazil ($401 billion), India ($164 billion), and Russia ($253 billion). From 2000 to 2009, China attracted more FDI than any other emerging or transition economy, achieving an unprecedented US$108 billion in 2008 (UNCTAD, 2010).

[12] China recalculated the stock of FDI inflows more in line with internationally recognized standards.

In 2008, inward FDI flows in Brazil were US$ 45 billion, India $42 billion, and Russia $70 billion. As a consequence of the worldwide financial crisis, China's FDI inflows plummeted to US$ 90 billion in 2009, while Brazil's fell even further to US$ 26 billion, Russia's to US$ 39 billion, and India's to US$ 35 billion (UNCTAD, 2010). China's FDI inflows rebounded sharply in 2010 and continuing to grow with $144 billion in 2017 (Hu et al., 2019). The comparatively strong growth of inward FDI into China throughout both the Asian crisis of 1997-1998 and the financial crisis of 2007-2009 indicates international investors' perceptions of China as a dependable risk-avoidance destination. Foreigners have been able to invest in China's stock markets as Qualified Foreign Institutional Investors (QFIIs) since 2002, and as their conditions have relaxed, a growing number of QFIIs have established offices in China. Foreign banks have also extended their activities as they have been progressively authorized to provide a variety of financial services to Chinese businesses, including foreign currency services since 2002, Chinese yuan services since 2006, and credit card issuing from 2007 (Davies, 2010).

At the same time, although the booming home market has continued to interest manufacturers, the rise in labor expenses caused by a series of protests in foreign affiliates has encouraged investors to consider new ventures in lower-cost nations like Vietnam and Bangladesh. China's inward FDI looks to be primarily sourced from Asian economies (Hu et al., 2019). As of 2008, 39% of China's inward FDI stock came from Hong Kong (China), 7% from Japan, 5% from Taiwan Province of China, 5% from the Republic of Korea, and 4% from Singapore. The United States and the European Union each contributed 7%, with the United Kingdom and Germany accounting for somewhat less than 2% of total inward FDI (UNCTAD, 2010).

The huge proportion of Chinese inward FDI connected via Hong Kong (China), as well as Caribbean and various other fiscal havens, makes it difficult to provide a comprehensive picture of its origin. Hong Kong's matching inward FDI and outward FDI numbers indicate that many of these flows were transmission to China[13], with some round-tripping[14]. In 2008, the European Union showed a significant share (7%), as Japan (7%), and the United States (7%). FDI resides in China's eastern coastline regions, particularly Guangdong and Shanghai (Davies, 2010). Guangdong's appeal as an FDI endpoint in the 1980s stemmed primarily from

[13] In 2007, 2008, and 2009, Hong Kong received US$ 54.3 billion, US$ 59.6 billion, and US$ 48.4 billion in FDI inflows, while outflows totaled US$ 61.1 billion, US$ 50.6 billion, and US$ 52.3 billion, according to UNCTAD's World Investment Report 2010: Investing in a Low-Carbon Economy (New York and Geneva: United Nations).

[14] The practice of "round-tripping" involves establishing special purpose entities in non-Chinese territories, such as Hong Kong. This allows foreign investors to benefit from tax advantages offered in China. Estimating round-tripping is impossible due to its potential to fool authorities. The usage may be in decline due to the elimination of foreign investment incentives.

its lax regulation, relative distance from the capital, Beijing (and thus from the government's control), closeness to the region's biggest port, Hong Kong, which was seeking to eliminate its manufacturing sector, and the fact that it included all but one of the nation's SEZs. Shanghai, with its solid industrial foundation and strategic location as an important port at the entrance of the Yangtze, attracted a lot of inward FDI. A third significant development region has emerged in the former industrial heartland of Northeast coastal China (Davies, 2010).

Efforts to increase FDI in China's less industrialized hinterland, specifically Central and West China, are ongoing. However, while the material infrastructure has been significantly enhanced, and cheaper labor costs are making the interior more appealing as wage pressures rise in Guangdong, the more prosperous coastal areas, with their more developed corporate environments and local markets, continue to receive the majority of inward FDI (Davies, 2010).

In terms of great investors, China has a large number of Fortune Global 500 enterprises. Nokia was ranked second on the official list of the largest international affiliates by sales value in 2008, with GM's Shanghai branch coming in eighth. The main foreign affiliate, Hongfujin Precision Industry, is owned by the Foxconn Technology Group of Taiwan Province, a firm critical to technology production. Greenfield investment dominated inward FDI until the late 1990s, due to policy and practical considerations. Prior to the late 1990s reforms, the majority of enterprises were state-owned and hence unavailable for acquisition, and there was no legislative framework for international mergers and acquisitions (Davies, 2012).

Acquisition targets were accessible in the first decade of the twenty-first century as significant state-owned firms were divested, the domestic private sector expanded, and legislation governing overseas M&As were created[15]. M&As have become a significant source of FDI inflows, with several medium-sized purchases taking place. The appeal of China's rapidly increasing domestic consumer market has fueled the surge in cross-border M&A activity. Recent major greenfield investments have also tended to focus on China's domestic market; nevertheless, despite the country's rising cost base in comparison to regional competitors, large investments in export production continue to be made. Daimler, Volkswagen, Yulon, Hyundai, and BMW have made significant greenfield investments in autos and automobile components: China has become the world's largest car market (Davies, 2010)

FDI has generally been considered to contribute sophisticated technology and managerial expertise (Buckley et al., 2002; Caves, 1974; Fu, 2008).

[15] OECD, Investment Policy Review of China: Open Policies towards Mergers and Acquisitions (Paris: OECD, 2006), updated in OECD, Investment Policy Review of China: Encouraging Responsible Business Conduct (Paris: OECD, 2008).

The various analyses lead to the conclusion that there are FDI spillover effects on technology. Hu and Jefferson (2002), using Chinese data, explain that FDI introduced in developing countries can promote the development of various aspects such as green innovation, providing external capacity and resources, creating new jobs and simplifying technology and management skills (Qin et al., 2022).

This knowledge, whether integrated as tacit or codified in items or technology procedures of companies with international investments, is typically unknown to host-region entrepreneurs. FDI, as an external information source, can support regional innovation in a variety of forms (Wang et al., 2016). FDI impact on technology involve local firms' learning through imitation (e.g., reverse engineering) of foreign firms' products and technologies, through labor market turnover whereby highly qualified employees from the FDI subsidiary move to local firms bringing with them valuable knowledge; through "demonstration effects" whereby novel technologies and goods developed in alternative markets are seen in the destination economies and native firms duplicate them in their own R&D efforts. Moreover, according to Buckley et al. (2007), Cheung and Lin (2004), Fu (2008), and Tian (2006), also vertical or linking effects occur when FDI subsidiary enterprises connect with local suppliers in their value chains.

In simple terms, the many forms of links and exchanges among foreign enterprises pursuing FDI and local players result in knowledge spillovers that boost local knowledge generation. Cheung and Lin (2004) discovered positive spillovers from FDI on indigenous innovation in China by analyzing the amount of local patent applications at the level of the province between 1995 and 2000. Fu (2008) discovered that FDI has a strong beneficial impact on regional innovation capability in China. Liu and Zou (2008) also show that greenfield FDI has a favorable impact on local Chinese enterprises' creativity (Wang et al., 2016).

2.2.2 Outward FDI's: Go-Global Strategy

The beginning of China's openness started completely in 2001, with China's accession to the WTO. With it, the so-called "Go-Global Strategy" was also inaugurated. This strategy pursued by Chinese firms was of particular importance in enabling them to switch gears from technology imitators to indigenous inventors and innovators. The strategy served to fill a gap due to various factors such as a late development of the Chinese economy, only made possible by Deng Xiaoping onwards, and complexities due to the institutional framework. Indeed, strategic asset-seeking happens when relatively new organizations with limited technological skills attempt to close the gap by purchasing creative firms for required resources (Wesson, 2004). When FDI is driven by a quest for assets incorporated in other companies, or by competitive constraints which require firms to obtain assets or reorganize quickly, firms increasingly adopt M&A as a route of entering the market (UNCTAD, 2006). Asian enterprises are primarily eager in acquiring better resources and talents in advanced host nations that are unavailable in their own countries (Makino et al., 2002). As new international actors, Chinese enterprises typically engaged in cross-border M&A with the primary goal of acquiring and controlling strategic assets, which is unusual among emerging economies (Deng, 2007, UNCTAD, 2006).

Furthermore, purchasing strategic assets through M&As can assist Chinese enterprises gain legitimacy, social acceptance, and market reputation. Indeed, looking at the current political climate in the US, concerns arise regarding China's predatory political approach (Zeng and Li, 2019) and these practices can be helpful.

In developing markets like China in 2006, formal institutional obstacles such as inadequate legal frameworks and poor IPRs impeded the pursuit of innovation, making it difficult for enterprises to devote resources to R&D or build worldwide brands (Khanna and Palepu, 2006). As a result, Chinese enterprises rarely developed new goods or processes; instead, they competed and actually, still compete in some sectors, on quantity as well as low cost products. In high-tech industries, Chinese enterprises preferred to engage in agency business operations - for example, assisting foreign firms in selling and distributing their products in the Chinese market - rather than creating innovative capabilities (Ling, 2006). As big foreign rivals continued to expand into China, Chinese enterprises found themselves in an increasingly unfavorable situation. As a result, Chinese companies needed to seek outside FDI to avoid the competitive disadvantages of operating solely in the home market, where rivalry was getting progressively tough (Deng, 2009).

It is clear that Chinese enterprises frequently had needs for knowledge resources - know-how, soft skills, routines, managerial practices, implicit knowledge - but they struggled to obtain technological expertise and other intangible assets at home since local key factor markets were immature. Furthermore, given the rapidity and scope of technological and organizational transformation required to capitalize on WTO membership, Chinese firms may have been unable to internally cultivate competitive assets because internal capability development was costly and path-dependent on the firm's existing strengths (Dierickx & Cool, 1989).

According to Luo and Tung (2007), when faced with institutional and market limitations locally, emerging marketing companies can use outward FDI to rapidly gain or buy crucial resources from advanced MNCs in order to compensate for competitive fragility and rival better against global competitors. China's thirst for M&A has been boosted further by mature MNEs' readiness to trade or transfer their technology, know-how, or brands because of financial constraints or restructuring demands. As established multinational corporations become more inclined to sell company segments outside of their main strengths, a substantial rise in foreign acquisitions has been possible (Deng, 2009).

In many situations, these company sectors include assets such as patents, brand names, and existing marketing channels that are both inaccessible or cannot be replicated domestically (Hemerling et al., 2006). Critical assets can also be transmitted rather simply via M&A because the resources purchased are not limited by a company's existing skills (Lane et al, 2001).

Furthermore, the influence of host nation governments has received significant academic attention (Khoury and Peng, 2011; Meyer et al., 2009). However, in our scenario the role of the MNEs' home country governments in implementing outward FDI is crucial. From an institution-based perspective, since MNEs are affected by the "rules of the game" both at the national and international level, the involvement of MNCs' home country governments cannot be overlooked (Peng et al., 2008).

As a political force, the Chinese government has had both a positive and negative impact on Chinese FDI, facilitating SOEs and inserting itself as an additional institutional barrier to "normal" private firms (Peng, 2012). Until the mid-1990s, China's government heavily banned outward FDI in order to preserve foreign exchange. It began to play a more favorable role in supporting outward FDI in the late 1990s (Luo et al., 2010). Starting in the beginning of the 2000s, the Chinese government deployed a variety of policy measures to encourage outward FDI, including low-interest financing, attractive exchange rates, lower taxation, and subsidized insurance for expats. Evidently, a huge number of Chinese enterprises have reacted to these regulatory incentives by expanding abroad (Cui and Jiang, 2010).

Fiscal heavens are consistently ranked as the top destinations for China's outward FDI, however, the only explanation for these odd FDI trends is the previously described money round-tripping. Hence, some Chinese MNEs engage in these "tax havens" to become "foreign based" corporations, which then allow them to make investments in China as foreign investors and benefit from tax as well as other advantages in their home countries. Hong Kong has long fulfilled such a role (Peng, 2012). However, as Chinese authority over Hong Kong has grown considerably, considering it as China's, some Chinese multinationals are forced to travel to remote locations such as the Caribbean in order to prevent from being penalized against local firms (Witt and Lewin, 2007; Yamakawa et al., 2008). This pattern of Chinese outward FDI also demonstrates the Chinese government's detrimental role in discriminating against certain local companies, particularly non-state-owned ones (Ahlstrom et al., 2010; Huang, 2003).

Compared to other transitional economies, China has set clear guidelines for the types of outward FDI it wishes to encourage and has been able to persuade enterprises to follow its rules (Deng, 2004). Furthermore, business strategic decisions in China are heavily influenced by a combination of political and economic factors (Tsui et al., 2004). Notably, the Chinese government has been fostering a favorable climate that encourages strong Chinese enterprises to invest abroad with the goal of becoming internationally competitive MNCs, following in the footsteps of Japanese and Korean trading houses. As a result, the government has developed a number of measures as institutional support for the acquisition of foreign expertise, such as value-added taxes and preferential financing (UNCTAD, 2005).

With significant government assistance, certain strong Chinese firms have been rapidly modernizing, and many of them have come to be globally competitive, owing mainly to ambitious foreign expansion (Zeng and Williamson, 2003).

The push for Chinese enterprises to invest internationally has gained traction with the continuing execution of the "go global" plan, which is regarded as one of four main thrusts to help China adapt to the tendency of economic globalization (Deng, 2009). Hence, government policies and incentives are particularly crucial when Chinese enterprises use FDIs as a significant mode of foreign expansion.

With the onset of intensive FDI practices of Chinese multinationals towards the above-mentioned countries and also passing through some tax havens, some countries decided to protect themselves as they began to realize the potential consequences for the local security, economy, and companies with possible related transfers of technological knowledge in key sectors (Deng, 2009).

2.2.3 Techno-Geopolitics and FDI

China's recent ascent as a foreign investor in the United States has elicited fresh criticism as stakeholders and policy actors perceive Chinese FDI as distinct from that of other nations (Meunier, 2019). Chinese FDI is a relatively new occurrence that started in 2000 when the Chinese administration encouraged its commercial and SOEs to expand internationally, Chinese FDI has since surged. Chinese ventures in the United States is broadly distributed throughout several sectors, including agriculture, technology, and movie distribution.

Government officials in the United States have faced a dilemma in deciding whether to accept these investments due to their financial advantages or to decline them based on multiple worries. One of these reasons arises from the misconception held by some myopic politicians that China is still a developing economy (Meunier, 2019). Historically, the primary advantages of FDI for the host country have been derived from the transfer of local technology. However, due to the frequent acquisition of American companies by Chinese enterprises for the purpose of obtaining technology, these conventional advantages may not come reality. The second danger arises from the political attributes of the Chinese government. Particularly, the absence of transparency in the governance framework of Chinese enterprises, a significant number of which are partially or fully owned by the state, poses challenges for Americans to evaluate the exact objectives of investment. Given that China is a geopolitical adversary rather than a military partner, national security is a third significant issue. Chinese investments in sensitive sectors have the potential to result in espionage, the integration of U.S. technology into Chinese weaponry, and circumstances where investments contribute to political influence, causing politicians to self-censor their criticism of Chinese policy. The aforementioned problems indicate that investment originating from China may require particular examination. Indeed, China has consistently been the leading country of origin for investment transactions assessed by the CFIUS since 2011 (Jackson, 2018).

The increase in Chinese FDI in the United States has generated consistent political criticism, as several members of Congress have openly criticized the agreements and the procedures involved in their creation. Illustrative instances encompass Lenovo and IBM, China Aviation Industry General Aircraft Company and Cirrus Aircraft, as well as Shuanghui and Smithfield Foods, among other entities (Canes-Wrone et al., 2020). Consequently, political responses prompted the implementation of legislative reforms that enforced more stringent screening protocols. The FIRRMA, which was included into the NDAA of 2019 and enacted in August 2018, significantly overhauled the process required for the CFIUS. At an institutional level, FIRRMA consolidated more CFIUS functions under the Department of the Treasury, established specialized CFIUS policy and personnel roles, designated funding exclusively for CFIUS, prolonged the timeframe for reviews, and broadened CFIUS's jurisdiction to conduct reviews or take independent action. FIRRMA broadened the range of deals included in CFIUS to encompass transactions involving a "country of particular concern" that pursues the strategic goal of obtaining technology that may impact U.S. leadership, as well as transactions that could potentially expose confidential information of U.S. citizens to abuse by foreign governments (Zable, 2018).

The occurrence of these incidents and the following institutional changes demonstrate the U.S.'s implementation of policies to effectively oppose China's progress. Furthermore, matters that may not be within the scrutiny of CFIUS have now come within its authority, including climate change, which is perceived as detrimental to the country. Nevertheless, these regulations primarily serve as strategies to offset China's technological progress in several industries, including green tech, which is taken into analysis in this study.

These dynamics are integral to the ongoing technological competition between China and the United States, which significantly shapes the current geopolitical landscape.

Moreover, foreign investors have always had access to very open investment regulations also in European Union countries, particularly Germany and France. However, in the context of contentious firm takeovers and acquisitions of big European enterprises, particularly by Chinese SOEs, there is undeniable worries in Germany and France about non-EU foreign investment. As a result, systems for screening foreign investments have grown into a more significant issue in cross-border transactions that necessitate a thorough legal risk assessment and management prior to closing (Stompfe, 2020).

This is highlighted by revisions to the applicable laws in Germany and France, which affected also the EU law attitude toward FDI and, in particular, Chinese SOEs, resulting in substantially stricter and more extensive foreign investment control regimes, significantly expanding the corresponding officials' right to track and limit foreign investments (Stompfe, 2020).

The case of the Kuka company is an interesting example from 2016 to 2018 and one of the decisive junctures of manufacturing globalization in the relationship between Germany and China. In 2016, the Chinese Midea, through its subsidiary Mecca, offered to acquire the German robotics company Kuka for 4.5 billion of euros, at a 35% premium to the value of the shares. The acquisition obtains, in December 2016, the approval of the CFIUS, which is required for US activities that include aspects related to the defense industry and therefore subject to the ITAR, which regulate the trade in armaments and military technology in the United States. Kuka remains an independent company, but its acquisition generated a debate in Germany on the need to maintain industrial expertise in high technology (Aresu, 2022).

In addition to US pressure on Berlin's geopolitical alignment, the analysis of national capabilities weighs in. One wonders what might happen to the Mittelstand, the heart of German industry, if it becomes a constant object of Chinese takeovers; 2018 shows the depth of this paradigm shift. The KFW is being told to acquire a 20 per cent stake in the company 50Hertz, which has entered the crosshairs of the Chinese State Grid Corporation of China, that has already owned a significant stake in the Italian energy infrastructure vehicle, CDP Reti, since

2014 (Aresu, 2022). 50Hertz is controlled by the Belgian company Elia, so the Chinese acquisition cannot be relative to a controlling stake: it would have reflected, as in the case of the Italian CDP Reti, the acquisition of stable assets with which Beijing penetrates European markets and builds synergies, as well as accompanying the international growth of its champion State Grid. The German federal government does not accept this type of investment either (Aresu, 2022).

The critical infrastructure nature of the electricity grid leads to clear action against the Chinese investment. In addition, Germany announced that it was prepared to use the powers of foreign trade regulations to deny Chinese operator Yantai Taihai permission to acquire Leifeld Metal Spinning, a provider of mechanical engineering solutions with applications in automotive, aviation and nuclear technology. This led to the withdrawal of the Chinese proposal (Aresu, 2022).

In 2020, the pandemic provides German Economics Minister Peter Altmaier with an opportunity to clarify Germany's new economic security doctrine: “For me, and for the federal government, it is industrially essential to maintain and strengthen the core industries in Germany. Germany is not for sale”. It is therefore the increased awareness of this industrial dynamic that is driving the European processes of scrutinizing foreign investment (Duchâtel, 2021).

3. Chinese MNEs and the Acquisition of Technological Knowledge

3.1 China's Emphasis on Technologies: Industrial Champion

The story of China's unstoppable progress runs through various steps. At the beginning of this section we will review the various initiatives undertaken by the Chinese administration, particularly, the emphasis that has been placed on technologies in industrial planning. Subsequently we will delve in the explanation of these plans and their effects.

First, we will deal not only with a specific industrial plan, but with the growth of industry clusters as boosters for innovation. The Beijing Zhongguancun Science Park is an important example of how the formation of such industry ecosystems can facilitate innovation.

Next, we will discuss the MLP, an ambitious and fundamental plan for the PRC as it is the ones that directly laid the foundation for current industrial plans, including those outlined by Xi Jinping.

In fact, we will also highlight the 14th FYP which aims to produce an increasing amount of indigenous innovation.

The common goal of these two industrial plans, the formation of the Zhongguancun Science Park and the subsequent science and technology parks is to pursue China's technological leadership; for some industrial fields China is already succeeding.

The Zhongguancun scientific park has become the focal point for observing developments in China's electronic industry. Originally known as the "valley of swindlers" due to the initial poor business ethics of early Chinese entrepreneurs, Zhongguancun evolved from a university center to an incubator for the first Chinese tech companies. Today, it serves as a hub for research on cutting-edge technologies, including artificial intelligence, and acts as the national center for technological advancement (Pieranni, 2020).

The history of Zhongguancun is detailed by Dong et. Al (2018). The authors identify four distinct phases.

The first phase, from 1978 to 1988, is marked by Chen Chunxian's influential role. After visiting Silicon Valley in 1980, Chen founded the Beijing Plasma Society's Advanced Technology Development Services Department in Zhongguancun, the first Chinese organization to facilitate business access for science and technology personnel (Dong et al., 2018).

The second phase, spanning the 1980s, saw significant developments with the rise of tech entrepreneurs. Liu Chuanzhi, a computer scientist, founded the ICT New Technology

Development Company in 1984 with an investment of 200,000 Juan from the Institute of Computing Technology of the Chinese Academy of Sciences. Initially named Legend, the company later became Lenovo. Lenovo’s first office was in Zhongguancun, and its first PC was launched in 1990. This era was characterized by state financing for enterprises rather than research, leading to the establishment of many key companies in the park, such as China Potevio and Beijing Stone Electronic Technology. By 1999, Zhongguancun had 6,690 high-tech enterprises, significantly contributing to the region's economy (Dong et al., 2018).

The third phase, from 1999 to 2009, witnessed the emergence of major Internet companies like Baidu and continued expansion of the science park’s infrastructure. During this time, STIPs played a crucial role, expanding across the country and accommodating over 50,000 companies by 2008. These parks were part of the Torch program launched in 1988, aimed at commercializing technological progress and encouraging private companies to enter strategically important markets. STIPs supported high-tech start-ups through technology business incubators, facilitating the growth of small enterprises by leveraging research outputs from universities and research institutes (Tang Ming Feng, 2010; Dong et al., 2018).

The fourth phase, from 2009 to the present, has seen continued growth and the refinement of Zhongguancun's role as a global tech hub. The focus has shifted towards advanced technologies and maintaining the park’s position at the forefront of innovation. This period is marked by a strategic emphasis on balancing domestic technological development with international collaboration and competition. The CCP's strategy includes managing the balance between foreign technology dependence and promoting local innovation, as exemplified by new initiatives such as the 973 program under Jiang Zemin, which aimed to bolster local research and development (Pieranni, 2020).

Overall, the evolution of Zhongguancun reflects China's broader strategy of fostering technological innovation and entrepreneurship while adapting to both domestic and global technological landscapes.

Furthermore, we should continue with the explanation of China's industrial planning to show its ability to become an industrial champion. It is worth pointing out that industrial planning is fully integrated with engineering, scientific and technological research plans.

In 2006, the CCP adopted the MLP, one of the most ambitious plans in the history of the PRC. It marked a return to large-scale industrial policies, updating the earlier 863 program. Among other things, the plan also had a political implication, with Hu Jintao and Wen Jiabao seemingly claiming a place in Party history through certain formulas, such as “indigenous innovation” and “innovative country,” which were later adopted by Xi Jinping. The plan aimed to become “one of the world's leading scientific nations” by mid-century and to dramatically reduce dependence on foreign technology, targeting a substantial increase in its GERD (total R&D expenditure as a percentage of GDP) to 2.5% by 2020. The MLPs included “mega-projects”, both civil and military, they intended to enhance scientific capabilities in areas such as electronics, semiconductors, aerospace, medicine production, telecommunications, and clean energy. The 2006 plan was renewed in 2021 by Xi Jinping, who sought to reinforce the concept of shifting from a “made in China” model to a “created in China” model, focusing less on attracting foreign capital and more on attracting human capital, thereby emphasizing innovation over mere investment (Pieranni, 2020).

The MLP set specific goals to achieve by 2020, including increasing China’s GERD as a percentage of GDP to 2.5%, raising the contribution of STP to 60% or more, and reducing the degree of DFT to 30% or less. Additionally, China aimed to become one of the top five countries globally in terms of the number of invention patents granted to its citizens and citations of international scientific papers (Sun and Cao, 2021).

By 2020, China’s GERD as a percentage of GDP was 2.4%, slightly below the 2.5% target. Despite this, there was a significant increase in research and development spending, and the impact of STP improved to 59.5%, up from 40.9% in 2003. The measure of DFT was discontinued in 2016, but it had dropped to 31.2% in that year. This decline was attributed to increased domestic investment in R&D and decreased imports of foreign technology. Triadic patents, which are registered with the U.S. Patent and Trademark Office, European Patent Office, and Japan Patent Office, saw a dramatic rise from 524 in 2005 to 5323 in 2018, moving China’s ranking from 13th to 3rd. There was also a notable increase in references to Chinese international scientific papers, elevating China’s position from 13th to 2nd (Sun and Cao, 2021).

China has consistently improved its position in international innovation rankings. The country’s ranking in the GII rose from 29th place in 2007 to 14th place in 2020 (Cornell University et al., 2020). China has achieved most of the MLP’s objectives, and its national capacity for innovation has been steadily advancing. However, it remains uncertain whether China has truly transformed into an innovation-focused nation, as the fulfillment of MLP’s goals and China’s progress in global innovation benchmarks like GII do not fully capture the country’s overall scientific and technological capabilities. Challenges persist in key technologies such as semiconductors, and the future outlook remains intrinsically unpredictable (Sun and Cao, 2021).

China, the second-largest spender on R&D, has a GERD nearly equal to that of the United States. In 2017, the Chinese government spent $496 billion in current PPP US dollars, accounting for almost 23% of the global total, compared to $549 billion by the U.S., representing 25% of the global total (National Science Board, 2020). Despite not meeting the R&D intensity target set for 2020, China has continued to drive its economic structure transformation and advance towards technology and innovation-driven economic and social development.

R&D encompasses three distinct categories of activities: fundamental research, practical research, and experimental development (OECD, 2015). However, in China, the proportion of GERD allocated to fundamental research remained steady at 5% for several decades before increasing to 6% in 2019. In contrast, the United Kingdom allocated 18.6% of GERD to basic research in 2018, and the United States allocated 16.6%. Furthermore, the share of investment in applied research has been consistently low and decreasing, standing at 11.3% in 2019 compared to the 19.15% allocated by the United States in 2018. This chronic imbalance in favor of experimental development, rather than scientific research, may pose risks to China's long-term prospects in scientific, economic, and social growth (Sun and Cao, 2021).

The reduction in government investment in R&D has led to decreased funding for scientific research at universities and research institutes that rely heavily on government support. The MLP urged the government to maintain a 40% contribution to GERD from 2010 to 2020 (Jia, 2006). However, government contributions to GERD decreased from approximately 40% to around 20% between 2000 and 2019, despite an increase in total funding. This reduction has been mistakenly equated with the enhancement of an enterprise-centered innovation system.

The focus on S&T commercialization in China's S&T system reform may have hindered progress in fundamental research, as evidenced by the administration's preference for allocating R&D funds towards applied research. Enterprises primarily fund and conduct experimental development, but reported figures may be questionable. Studies reveal that over 50% of companies surveyed provided significantly different profit data to local branches of the State Administration of Industry and Commerce and the Ministry of Science and Technology to exploit government incentives (Stuart and Wang, 2016). This suggests that the decrease in the government's share of GERD can be partially attributed to government incentives and data falsification by firms (Sun and Cao, 2021).

The MLP prioritized 16 MEPs and four Mega-Science Programs, with an additional two later added for support (**Table 1**). MEPs aimed to address significant national economic and social development needs by focusing on essential, shared, and pivotal technology for major strategic products. These programs exemplified China's efforts to mobilize and consolidate resources in significant domains while marking a shift from prioritizing specific technologies to integrating the collective efforts of the entire science and technology innovation system (Sun and Cao, 2021).

Table 1: Mega-programs in MLP (2006–2020) and S&T 2030.

Mega-Engineering programs	**Mega-Engineering programs**
1. Core electronic components, high-end generic chips, and basic software	1. Innovative seed industry
2.Extra large-scale integrated circuit manufacturing and technique	2. High-efficiency use of green coal
3. New-generation broadband wireless mobile telecommunications	3. Smart grid
4. Advanced numeric-controlled machinery and basic manufacturing technology	4. Space-terrestrial information network
5. Large-scale oil and gas exploration	5. Big data
6. Large advanced nuclear reactors	6. Intelligent manufacturing and robots
7. Water pollution control and treatment	7. Advanced materials research and their applications
8. Genetically modified new-organism variety breeding	8. Comprehensive environmental improvement in Beijing, Tianjin, and Hebei
9. Drug innovation and development	9. Health security
10. Control and treatment of AIDS, hepatitis, and other major diseases	10. A new-generation of artificial intelligence (added later)
11. Large aircraft	
12. High-definition Earth observation systems	
13. Manned aerospace and Moon exploration	
Mega-Science Programs	**Mega-S&T Programs**
1. Protein science	1. Aero-engines and gas turbines
2. Quantum research	2. A deep-sea space station
3. Nanotechnology	3. Quantum communication and quantum computing
4. Development and reproductive biology	4. Brain science and brain-inspired intelligence
5. Stem cell (added later)	5. National cyber security
6. Climate change (added later)	6. Deep space exploration and probe orbit service maintenance systems

Note: The MLP (2006–2020) identified 16 Mega-Engineering Programs but only made 13 programs public.
Source: Sun and Cao (2021) research based on the MLP and China's 13th 5-Year Plan.

However, applying Goodhart's Law, which states that "when a measure becomes a target, it is no longer an effective measure" (Varela et al., 2014), to MLP's targets for quantifying China's S&T capabilities could be problematic. China's payments for foreign IP grew substantially from $6.63 billion to $37.78 billion between 2006 and 2020. Similarly, receipts for IP rose from $200 million to $8.5 billion during the same period. Despite progress in reducing foreign technology dependence, China still had a larger IP deficit in 2020. This suggests that despite its significant R&D investment, China still needs to procure substantial foreign intellectual property to advance its industry, a cost not fully accounted for in R&D expenses (Sun and Cao, 2021). In addition, China initiated the development of a new MLP (2021−2035) in 2019. The Outline of the 14th FYP (2021−2025) for National Economic and Social Development and the Long-Range Prospects through the year 2035 provides what it will include and how it may affect China's science and technology innovation trajectory. The 14th FYP emphasizes that China would prioritize innovation as a central aspect of its overall modernization efforts. It will also prioritize autonomy and self-development in science and technology (S&T) as a strategic pillar for national development. To achieve China's goal of becoming a leading innovative nation by 2035, the outline specifies four main objectives: enhancing the country's strategic scientific and technological power, improving the technological innovation capacity of businesses, fostering the creative energy of talented individuals, and refining scientific and technological innovation institutions and processes. The upcoming MLP is expected to progress in this manner (Sun and Cao, 2021). The principle of "self-reliance and self-improvement" is emphasized by S&T. The new MLP will prioritize the development of science and technology with a focus on achieving self-sufficiency and continuous progress. "Self-reliance and self-improvement" extend the idea of creating self-sustaining capacities. This concept has evolved from "self-reliance" during the Maoist era to "indigenous innovation" in the MLP (2006-2020) and now to "self-reliance and self-improvement". This evolution is a reaction to the U.S. government's decision after 2018 to restrict U.S. exports of sophisticated components and equipment, particularly semiconductors and machinery used to produce complex electronic gadgets, to China (Sun and Cao, 2021). The Chinese government firmly believes that achieving self-sufficiency and advancement in science and technology is crucial for its long-term development. This will not only support and maintain its industrial growth but also address its national security needs and the well-being of its people. The focus on enhancing "indigenous innovation" and "self-reliance" in the new MLP reflects this priority. The new MLP stresses increasing public R&D investment, particularly in basic research, which will be funded through public and private investments. It aims to increase the share of fundamental research in GERD to 8% during the plan period. Furthermore, the plan encourages greater integration of China into global innovation networks and promotes international cooperation in areas such as global epidemic prevention and control, public health, and climate change.

However, it will also maintain a balance between state control and market forces (Sun and Cao, 2021).

3.2 China and the Green Transition

The substantial potential for continued growth in production and consumption validates China's willingness to invest in renewable energy. Its 13th FYP for energy (2016–2020) was to increase the proportion of non-fossil fuels in overall energy generation from 35 to 39 percent by end 2020. A projection indicates that by 2030, 20% of the nation's electricity consumption will be derived from non-fossil fuel sources (Washington Post, 2016). As to the International Energy Agency, China projected to contribute 36 percent and 40 percent of the global expansion in solar and wind energy throughout the years 2016-2021 (Financial Times, January 2016). Renewable energy implementation is a component of China's broader initiative to establish an "ecological civilization," which represents a cross-industrial strategy to reduce pollution and fossil fuel consumption, address climate change, and enhance energy efficiency (Chiu, 2017). The NEA and the NDRC of China have agreed to allocate about $360 billion towards the advancement of renewable energy and the generation of 13 million employment opportunities in this industry by the year 2020. The number of people in the renewable energy industry in the country greatly exceeds that of the United States, which in 2016 had less than 800,000 employees in this sector. Furthermore, China is in the forefront of investing in an expanding array of global renewable energy initiatives by augmenting its contributions to multilateral organizations. As an illustration, the BRICS New Development Bank, in which China is a member, provided its initial batch of long-term green loans totaling $811 million in April 2017 to finance clean energy initiatives for its partner countries (Chiu, 2017).

Furthermore, it is necessary to address the scenario in two additional key domains: domestic ecological challenges and geopolitical objectives. Beyond domestic factors, there are two additional reasons for the international community to recognize and consider China's leadership in this domain.

Firstly, China's declared ecological goals for the development of renewable energy are generally accepted and undisputed due to the anticipated positive externalities resulting from its investments in technology and implementation. The reason for this is that there is a widespread agreement worldwide on the required reduction of greenhouse gas emissions to alleviate the impacts of climate change.

Pew surveys conducted in 2015 across 40 countries have identified climate change as the foremost worldwide concern (Carle, 2015). In one survey, 79 per cent of respondents expressed the belief that their countries should impose restrictions on greenhouse gas emissions as a component of an international accord (Wike, 2016). The unanimous decision to sign the Paris Agreement in 2015 serves as a formal manifestation of the world community's dedication to addressing the formidable issue of climate change. China, as the top contributor to greenhouse gas emissions globally (Friedrich et al., 2015), must significantly shift towards renewable electricity generation and consumption in order to meet its worldwide goal of reaching peak carbon dioxide emissions by 2030 (Washington Post, March 2016). Another strategic rationale is that by augmenting the share of renewable sources in its energy composition for power consumption, China might alleviate geopolitical tensions by reducing its dependence on volatile regions for energy security. An energy market established on fossil fuels depends on ensuring the security of oil and gas transportation routes to and from countries abundant in fossil fuels, which in turn necessitates the provision of prolonged military protection. For the purpose of safeguarding oil transport choke points, China established its inaugural foreign naval facility in Djibouti in 2016 (Jacobs and Perlez, 2017). Conversely, the resource availability for renewable energy, such as wind and sunshine, greatly surpasses that of fossil fuels and is more uniformly distributed among various countries (Paltsev, 2016). However, a shift has occurred to some extent and will continue to take place, it is from oil and gas holders to those who hold technology, manufacturing and raw materials for the green supply chain. Some scholars believe that global geopolitics will benefit from China's leadership in the expansion of renewable energy in two fundamental ways (Chiu, 2017). Firstly, China will have a reduced justification to increase its military presence in the region in order to ensure energy security, as it increases the proportion of domestically generated renewable energy in its energy portfolio. Furthermore, as China's advancement of the renewable energy industry spreads worldwide as an externality, an increasing number of countries will have the opportunity to become energy producers. This would reduce their reliance on volatile regions like MENA and Russia for traditional fossil fuels. Nevertheless, there remains the issue of a new geopolitical balance with countries lagging behind in technology and also due to production costs and having to rely on China, which gives the Asian power a great deal of power. Hence, it should be noted that the establishment of a renewable-led global electricity market would not eliminate geopolitical issues. Questions regarding the control of power lines, intellectual property rights for technologies like energy storage capacity and grid connection, and the availability of raw materials for building renewable power equipment will continue to exist (Bosman and

Scholten, 2013). Furthermore, China is expected to seek other rationales for boosting its military footprint along maritime trade routes (Chiu, 2017).

To conclude this part and then delve into socio-political dynamics, it is appropriate to give a practical example relating to the automotive industry, particularly electric cars. Indeed, along with other sectors already explained such as solar panels and wind power, China currently holds a strong position in the electric car sector, producing so heavily and selling at consumer-friendly prices that give Beijing a considerable competitive advantage. This has led the European Union to restrict the entry of Chinese cars into the European market as a measure to continue supporting domestic electric vehicle manufacturers.

Former Minister of Science and Technology Wan Gang (1952) is a crucial figure in Chinese science and technology during the 1990s, whose insights would reverberate for the following period and come to the present day with great influence on the electric car, he was the one who realized China had to start producing EVs (Pieranni, 2020). “At this year's Beijing auto show, a retired Chinese bureaucrat bent down to run his hands over the bonnet of a sleek sports coupe announced as the world's fastest battery-powered car, and smiled like a proud father (Bloomberg, 2019)”. Indeed, he is considered the “father of the electric car”. Levi Tillemann, former advisor to the US Department of Energy and author of The Great Race: The Global Quest for the Car of the Future also expressed "he is the father of China's electric vehicle industry. Without Wan Gang, it is unlikely that China would have pushed to overtake the West. This was his big idea".

Wan Gang now heads the Chinese Science and Technology Association after a long career that began with much difficulty. However, he managed to graduate and was given the great opportunity to be admitted to a PhD program in mechanical engineering at the Clausthal University of Technology in Germany. When he graduated in 1991, he was considered a particularly brilliant mind in the field, a person capable of solving all problems and with great visionary ability. Wan Gang chose to go to work for Das auto, Audi. He focuses a lot on his career but does not forget China; in fact, to the Chinese delegates who visit the Ingolstadt factory, the Chinese engineer showed all the organization and working methods. And one of the many Chinese officials who passed through there is the Minister of Science Zhu Lilan. A collaboration begins between the two, with the minister proposing to Wan Gang another Chinese “leap forward”, this time in the field of automobiles. The engineer's speech is simple and practical, the discourse ultimately proves to be successful in convincing the Party leadership. He explains how China is struggling with pollution. Secondly, in the automobile industry China cannot aspire to the achievements of the big Western and Japanese manufacturers, so it is better to think of another way - here the idea of a leapfrog comes back, which is difficult to complete but if it works will shorten the scientific distance - because on traditional vehicles the game is closed (Pieranni, 2020). He argued that Beijing must invest in new technologies to achieve three results: innovate, become a leader in new markets, and reduce dependence on oil. He wanted to create a system in which China can be energy secure and in which there can be a level playing field for local companies, as Bill Russo told “Bloomberg”, a former Chrysler executive who headed the consulting firm Gao Feng Advisory in Beijing. Zhu Lilan places Wan Gang in charge of the electric vehicle project within the 863 program. China's electric revolution started and it is another response to the surprise of finding China at the top of some of the technology sectors driving the economy today. The science minister speaks to Li Langing, a former vice-premier with a career in the industry that began in 1952 at the car manufacturer now known as China FAw Group Corp. From there, Li Langing began to develop the plan to create the EV research program (Pieranni, 2020).

Later, in 2007, Wan Gang became Minister of Science and Technology, overseeing billions of yuan for research and development. In 2007, a plan posed a challenge to engineers: build a fleet of electric buses for the 2008 Beijing Olympics, put 1,000 battery-powered vehicles on the streets of every major city. Today there are hundreds of Chinese-made electric car models on the market built by giants like Warren Buffett-backed BYD Co. and start-ups like NIO (Bloomberg).

In this narration, two other fundamental aspects related to the shortening of distances in technological progress between China, the West and Japan emerge. Indeed, one aspect is related to academia; Wan Gang went to Germany for his doctorate, where universities provided better training and technical knowledge. Also, the Chinese engineer's attachment to his home country and thus willingness to illustrate all the processes, routines, know-how and knowledge of Audi's Ingolstadt factory.

These factors, added to others that are more technical, economic and scientific in nature, have allowed China to take the lead in the green tech industry.

3.2.1 Socio-political Relevance of Green Issues

Environmental activism in China functions independently, lacking integration within a network of human interactions and established legal or informal regulations among political and social entities. In contrast to situations where activism is merely repressed, the distinctive conditions of entrenchment in China both limit and enable formal environmental organizations. The established ties that effectively reconcile the boundaries between the Party-state and society have allowed environmental activism to assume a progressively vital role in promoting sustainability within industries, government, and consumer practices (Tu and Yang, 2005).

Contemporary China is significantly distinct from the China of the 1980s, a transformation epitomized by the phenomenon known as the "greening of the Chinese state" in the last two decades. This transition is apparent in the implementation of a substantial array of environmental statutes and regulations, as well as the enhancement of the environmental bureaucracy (Ho and Vermeer, 2006).

Despite the fragmented, regional, and non-confrontational nature of environmentalism in China, it would be erroneous to perceive it as a passive or muted movement. Conversely, it signifies a perpetually negotiated and exceptionally effective adjustment to the prevailing political environment, enabling the exertion of considerable political influence. The fundamental success of China's reforms is attributed to a policy of incremental transformation. Since its inception in the Chinese political arena, environmental activism has acquired significant political relevance and cultivated increasing international ties due to its entrenchment (Ho and Edmonds, 2008).

As outlined, the Chinese administration has placed particular emphasis on developing the green industry due to the increasing sensitivity of the Chinese population to issues such as global warming and pollution. The government has recognized the economic advantages of progresses in this sector, as global conditions have driven a definitive shift toward renewable energy, making it a highly lucrative market. Additionally, this focus yields geopolitical benefits, as emerging technologies, including green technologies, are reshaping international power dynamics, as discussed in the section on Techno-Geopolitics and FDI. Finally, promoting the green industry helps mitigate domestic discontent, aligning with China's broader internal control policies.

4. Data and Methodology

4.1 Data Sources

I integrate data from multiple sources for our analysis. Firstly, I utilize the CEPII Gravity Database, which provides information on the political disagreement measure, along with the control variables at the destination-country level used in the models. Patent data is drawn from the BvD ORBIS IP database. Specifically, I collect data on all patents within the green domain that were granted by the China National Intellectual Property Administration" (CNIPA), filed between 2013 and 2020, and that cite at least one foreign patent. To identify green patents, I adopt the standard approach in the academic literature, relying on the OECD's EnvTech classification, which provides a list of relevant International Patent Classification (IPC) and Cooperative Patent Classification (CPC) codes. For each patent, I extract details including the filing date, publication number, applicant identification code from the BvD database, and the country of residence for both the applicant and their Global Ultimate Owner (GUO)—the entity holding at least 50.1% of the firm's shares. This allows us to exclude records of foreign-owned firms. Our final dataset includes 5002 firms actively patenting during our timeline.

Clearly, patents that can be located using these search methods will be just a portion of the "population" of patented innovations with the potential to help reduce negative environmental impacts. It should be highlighted that an aggregate of environment-related technical areas is bound to include developments aimed toward at times opposing environmental policy goals. It is challenging to define technologies with indisputably positive environmental benefits because the utility of "environment-related technologies" can only be assessed by how they are employed and deployed in practice. Unlike the domains of biotech, nanotech, and ICT, which can be described using an "objective" criterion, there is no equivalent objective standard for environmental technology. Indeed, "greenness" is a relatively tricky concept.

To search FDI data, I utilize ORBIS Mergers and Acquisitions, tracking all greenfield and brownfield operations made by firms in our dataset between 2013 and 2020. For each acquisition, we record details such as the deal's completion date, the target company's BvD identification code, and its country of origin. We consult ORBIS IP to obtain the filing dates for all patent applications by the acquired companies, allowing us to pinpoint acquisitions driven by the pursuit of technological knowledge. For each project, we collect data on realization date and business function, thus being able to isolate investments aimed at building new R&D or ITC facilities.

4.2 Methodology

In 1962, Tinbergen applied Newton's universal gravitational law to trade by means of an analogy. The gravity model posits that the volume of trade between two countries is directly proportional to the size of their economies, typically measured by GDP, and inversely proportional to the distance between them, which serves as a proxy for various forms of trade frictions, such as transportation costs, communication barriers, and cultural differences. It assumes that larger economies have a greater capacity to produce and consume goods, while greater distances increase the cost and difficulty of exchanging these goods, thus reducing trade flows. The model's mathematical structure allows for the inclusion of additional variables that capture other potential barriers or facilitators of trade, such as tariffs, common languages, or shared borders, making it highly adaptable for various contexts. Additionally, by incorporating dyadic relationships, the gravity model enables me to analyse the bilateral dynamics between home and host countries. In my case, the extent to which a multinational firm depends on foreign knowledge for innovation is shaped by whether, and to what degree, it has invested in the foreign country, either through (M&A) or greenfield FDI.

Over time, the gravity model has evolved from its initial application in trade studies to being employed in a wide range of fields. Its flexibility in accounting for interactions between economic size and distance has made it useful for studying topics such as migration, foreign direct investment, and even knowledge flows. In migration studies, the model helps explain the movement of people between countries, where population size serves as an analogy for economic size, and geographic distance captures not only physical separation but also cultural and linguistic barriers (Ramos, 2016). Similarly, in studies on FDI, the gravity model can predict the flow of investments between countries, considering factors like market potential and distance-related costs (Kox & Rojas-Romagosa, 2020). Furthermore, the model has proven to be valuable in understanding the transfer of knowledge and innovation across borders, where physical proximity, institutional similarities, and shared languages can significantly influence the diffusion of ideas and technologies (Bello et al., 2023). This versatility underscores the gravity model's robustness in explaining a wide array of international economic phenomena.

Therefore, in my baseline specifications, the gravity model provides a robust framework for capturing the key determinants of a multinational firm’s reliance on foreign knowledge. This reliance is shaped by three primary dimensions: 1) the physical and cultural distance between home and host countries; 2) the degree of foreign investment in the host country, whether through M&A or greenfield FDI, which can grant direct access to local knowledge; and 3) the political relationship between the two countries, with stronger alignment fostering easier and more extensive knowledge flows. The gravity model is, therefore, the ideal tool for addressing my research questions, as it captures the intricate interplay of distance, investment, and political dynamics in shaping the knowledge flows that fuel innovation within MNEs.

This is my baseline specification:

$$backcit^{c}_{i,j,t} = \alpha + \beta 1FDI_{i,j,t} + \beta 2DiploDis_{i,j,t} + C'_{j,t}\beta 8 + D'_{j,t}\beta 9 + X'_{i,t}\beta 10 + E'_{j,t}\beta 11 + F'_{j,t}\beta 11 + G'_{j,t}\beta 11 + \gamma_t + \delta_i + \mu_j + \varepsilon_{i,j,t} \quad (1)$$

$$backcit^{c}_{i,j,t} = \alpha + \beta 1INNO\_FDI_{i,j,t} + \beta 2DiploDis_{i,j,t} + C'_{j,t}\beta 8 + D'_{j,t}\beta 9 + X'_{i,t}\beta 10 + E'_{j,t}\beta 11 + F'_{j,t}\beta 11 + G'_{j,t}\beta 11 + \gamma_t + \delta_i + \mu_j + \varepsilon_{i,j,t} \quad (2)$$

$$backcit^{c}_{i,j,t} = \alpha + B0M\&A_{i,j,t}\beta 1GFDI_{i,j,t} + \beta 2DiploDis_{i,j,t} + C'_{j,t}\beta 8 + D'_{j,t}\beta 9 + X'_{i,t}\beta 10 + E'_{j,t}\beta 11 + F'_{j,t}\beta 11 + G'_{j,t}\beta 11 + \gamma_t + \delta_i + \mu_j + \varepsilon_{i,j,t} \quad (3)$$

$$backcit^{c}_{i,j,t} = \alpha + B0INNO\_M\&A_{i,j,t}\beta 1INNO\_GFDI_{i,j,t} + \beta 2DiploDis_{i,j,t} + C'_{j,t}\beta 8 + D'_{j,t}\beta 9 + X'_{i,t}\beta 10 + E'_{j,t}\beta 11 + F'_{j,t}\beta 11 + G'_{j,t}\beta 11 + \gamma_t + \delta_i + \mu_j + \varepsilon_{i,j,t} \quad (4)$$

Our dependent variable, $backcit^{c}_{i,j,t}$ measures the number of backward citations made by firm i in country j in patent filled during year t. Although patent citations only capture codified knowledge and not tacit forms, they are widely accepted as an effective proxy for knowledge flows in the academic literature. These citations help to trace the dissemination of technological knowledge across both national and organisational borders (Thompson & Fox-Kean, 2005). We assign these citations to countries based on the inventors' nationality rather than that of the applicants, as patents are often strategically assigned to corporate headquarters for internal reasons.

The key explanatory variable is *FDI{i,j,t}*, which captures foreign direct investments. I assign a value of 1 from the year t in which the firm made an outward FDI into country j, and 0 otherwise. As the previous literature, we define knowledge-seeking cross-border mergers and acquisitions (CBM&A) as those where the target company has filed at least one patent in the 20 years prior to the transaction. Knowledge-seeking greenfield FDI, on the other hand, includes investments aimed at establishing new research and development (R&D) centres, data facilities, or ICT infrastructure (Aquaro et al., 2023). In equation (3), we separate greenfield and brownfield FDI by including two dummy variables, GFDI_{i,j,t-s} and M&A_{i,j,t-s}, which are constructed as to FDI_{i,j,t-s}, but exclusively account for greenfield FDI and CBM&A, respectively. We also repeat our estimations by rescaling both variables to include only knowledge-seeking investments, as in equation (2) and (4).

The term DiploDis represents the diplomatic distance between China and country j, quantified using an index that measures political differences based on UN voting data as made in Bailey et al., 2017. This variable captures a country's relative alignment or divergence from the US-led international order. By annually averaging these estimates for each country, we quantify the diplomatic gap between nations as the absolute difference in their average positions.

Another set of variables that influence the phenomenon under the lens are the control variables, below we will give a brief description of them.

Distance (C{j,t}) is measured as the straight-line distance between the most populated cities of the countries involved, and measured in km (Mayer and Zignago, 2011). The idea behind the presence of this variable is that a greater geographical distance between nations can increase logistical costs and challenges, potentially affecting the ease of establishing research and development partnerships and ultimately reducing patent counts. Another important factor is Population (D{j,t}), which reflects the size of the destination country's population, in thousands (World Bank). A larger population can attract FDI by providing a bigger pool of consumers and workers. Moreover, a more populous country often has greater potential for innovation, which could lead to an increase in patent filings. The destination country's GDP (X{i,t}) is also considered, measured in current thousands of US dollars (World Bank), as it captures the economic size and market potential, key elements that influence foreign investment decisions. Additionally, Patents (Ej,t}), representing the stock of patents in the destination country, serve as an indicator of its innovation capabilities. To account for economic relationships, Trade Flow (F{j,t}) is included, measured in thousands of US dollars based on the export data reported by the exporting country (United Nations ComTrade). This variable helps assess the strength of economic ties between countries, which can play a role in attracting FDI. Finally, WTO Membership (G_{j,t}) is a binary variable that assigns a value of 1 if the destination country is a member of the World Trade Organization (WTO), and 0 otherwise. Membership in the WTO can signal openness to trade and economic stability, both of which are factors that may positively influence FDI decisions.

4.3 Descriptive Statistics

Below, you can observe **Table 2**, which contains the main characteristics of our dataset.

Table 2: Summary of variables' values.

Variable	Mean	Sd	Min	Max
FDI	2,08E-04	1,44E-02	0	1
Innovative FDI	4,80E-05	6,95E-03	0	1
Greenfield FDI	1,67E-04	1,29E-02	0	1
Innovative greenfield FDI	4,20E-05	6,49E-03	0	1
M&A	5,00E-05	7,10E-03	0	1
Innovative M&A	7,00E-06	2,65E-03	0	1
Diplomatic Disagreement	9,29E-01	7,17E-01	3,99E-03	3,51E+00
Distance	9,08E+09	4,03E+03	8,67E+02	1,96E+04
Destination country's population	5,18E+04	1,51E+05	2,53E+02	1,38E+06
Destination country's GDP	7,59E+14	2,20E+09	7,42E+05	2,14E+10
Destination country's stock of patents	8,68E+03	3,41E+04	0	2,41E+05
Trade flow	2,16E+07	5,06E+07	6,34E+04	4,80E+08
WTO membership	9,09E-01	2,88E-01	0	1

Source: Author's calculation.

The information given in the dataset offers perspectives on FDI innovation trends and their distribution among countries with various economic and geographical features, alongside diplomatic relations, these are outlined in **Table 2** showcasing essential details.

The dummy variables in the dataset indicate the presence of events or circumstances tied to FDIs and M&As. These dummies typically have values near zero indicating that such occurrences are infrequent within the dataset.

The FDI variable shows if there was a FDI event (labeled as 1) or if there wasn't (labeled as 0). A mean value of 0.000208 indicates that these events are very uncommon in the dataset, manifesting in 0,02 % of the instances. It's evident that FDI occurrences are quite rare and selective, in nature. This suggests that such investments usually target countries or sectors that fulfill certain economic or strategic requirements.

The innovative FDI variable captures instances where FDI is specifically linked to innovation. Innovation driven FDI pertains to investments that aim to boost innovation capabilities, within the host nation by engaging in activities like R&D technology sharing and the creation of products or processes. The primary goal is to drive progress and enhance the host countries edge through meaningful contributions to the innovation landscape.

With a mean of 0,000048, it is clear that innovation-related FDI is even rarer, occurring in just 0.0048% of the cases. This indicates that although foreign direct investment (FDI) is typically not widespread in terms; FDI motivated by innovation is even less common and tends to focus in countries or areas with robust innovation environments or, in industries where technological progress is essential.

The greenfield FDI variable represents the occurrence of greenfield investments, where a parent company starts a new venture in a foreign country by constructing new operational facilities, this variable has a mean of 0.000167. Greenfield investments, much like other forms of FDI, are scarce, occurring in 0.0167% of the data points. These investments demand funding and typically target markets with promising growth prospects or strategic significance which clarifies why they are less common.

The variable greenfield FDI with innovative content is similar to innovative FDI but specifically pertains to greenfield investments that are linked to innovation. The mean value of 0.000042 suggests that such investments are very rare, occurring in only 0.0042% of the cases. This highlights the aspect of new investments in innovation in situations where entering a new market and fostering innovation are in synchrony with each other.

The M&A variable indicates whether an M&A event took place. With a mean of 0.000050, it shows that M&A activities are also quite rare in the dataset, occurring in just 0.005% of observations. Merger and acquisition deals can be intricate processes that typically focus within particular sectors or geographic areas where combining forces, for market growth or forming strategic alliances, is seen as vital.

Innovative M&A variable identifies cases where mergers and acquisitions are motivated by innovation goals. The average value of 0.0007% implies that such occurrences are exceptionally uncommon only appearing in about 0.0007 percent of the instances. This scarcity indicates that, although innovation may influence M&A deals, it plays a role in only a small portion of these transactions—probably within highly specific or technology driven industries.

The descriptive statistics of variables shows that events like foreign direct investment (FDI), innovation centric FDI projects, new greenfield investments and mergers and acquisitions (M&A) are infrequent in the dataset. Indeed, these activities are quite selective, and they tend to concentrate in specific sectors or regions under certain circumstances. Occurrences of innovation focused activities, within FDI or M&A deals, are less common highlighting the specialized nature of these types of investments. The scarcity of occurrences may be attributed to the considerable financial investment and strategic foresight involved in these ventures – making them less frequent yet potentially more impactful when they do take place.

The continuous variables such as distance, destination country's population, destination country's GDP, destination country's stock of patents, and trade flow exhibit significant variation, as suggested by their large standard deviations compared to their means.

The average distance between countries is approximately 9,078 kilometers, ranging from 867 kilometers to nearly 20 000 kilometers. This range highlights the inclusion of both neighboring and significantly distant countries. The strong variation in distances could have an impact on explaining the factors that hinder or promote FDI, as higher distances usually lead to greater transportation expenses and can impact investment choices.

Regarding population, the mean population of destination countries is around 52 million people; however, the standard deviation is quite high at over 150 million which implies that the dataset comprehends countries of varying population sizes, from smaller countries with only a few hundred thousand residents to larger ones with hundreds of millions. This diversity in population sizes indicates that the dataset covers a range of market sizes that could greatly influence how appealing countries are as destinations for FDI.

Related to GDP variable, the mean GDP of destination countries is around 758.8 billion USD, with a standard deviation of over 2.2 trillion USD. This wide range suggests that the dataset includes both developing nations and established global economies giving a detailed insight into the economic landscapes where foreign direct investments occur. Countries with high GDPs are usually seen as having steady and appealing investment markets; however, smaller economies can also offer substantial returns due to their potential for growth.

The variable related to patents has an average patent score of 8,681, but with a large standard deviation of over 34,000. This implies the inclusion of countries with varying innovation capacities– ranging from those with low patent activities to those with substantial intellectual property outcomes. High patent potential may be linked to increased innovation activities, and it could consequently attract a greater amount of FDIs.

To conclude regarding the continuous variable statistic description, the trade flow variable has a mean of approximately 21.6 million USD, with an exceptionally high standard deviation, reflecting a wide range of trade activities. This suggests that some nations participate in trade activities while others experience lower levels of trade which impacts their economic connections and attractiveness for foreign direct investment.

The mean value of the diplomatic disagreement stands at 0.93 with a standard deviation of 0.72, suggesting that disagreements in diplomacy are relatively common and can greatly differ between countries. This variability holds significance as these disputes may impact foreign direct investment flows and countries readiness to participate in patent collaborations or other economic ventures. Increased diplomatic tensions could discourage investments and add complexity to global business connections.

The WTO membership variable indicates that the majority of countries in the dataset are part of the World Trade Organization averaging at 0.91. This significant level of WTO membership is expected to support trade and investment by ensuring a steady trade environment, lowering tariffs and addressing disputes that may otherwise impede global business operations.

The datasets descriptive statistics highlight the variation in economic size of countries and their populations along with political instances, geographical distance, and trade activities across countries observed worldwide. Rare occurrences such as FDI and innovations, combined with notable diplomatic disagreement and widespread WTO memberships depict a multifaceted view of the global investment scenario. These differences can offer perspectives on the aspects that impact decisions on foreign direct investments, the role of innovation and knowledge (patents) in investment's attraction and the effects of diplomatic and institutional elements on global economic links.

Table 3: Extract of backward citations to China by companies from the countries listed below and the median diplomatic disagreements between these countries and China.

Country code	Total citations	Median diplomatic disagreement (UN assembly)
JP	5443	1,16
US	3446	3,12
KR	2362	1,38
DE	1505	1,69
FR	386	1,95
GB	383	2,19
CA	280	1,96
RU	209	0,57
CH	180	1,16
AU	160	1,83
NL	154	1,55
SE	142	1,28
IT	140	1,46

Note: Full descriptive statistics in **Table 1a** in the **Appendix**.
Source: Author’s calculation.

With respect to **Table 3,** it is interesting to observe the top 13 countries that cite China the most and the median of diplomatic disagreement between the various countries and China at the level of the UN assembly - the complete table with all the countries that cite China and the relative median of diplomatic disagreement is within the **Appendix**, **Table 1a**.
These descriptive statistics refer to the green sector and give us a cross-section of China's centrality in terms of technological knowledge.
We can note that the top two countries at the level of backward citations are Japan and the U.S., countries that, as we have been able to observe, are rivals with each other and with China in terms of the race for technological supremacy. The difference that needs to be noted is embodied in the diplomatic disagreement, China, in fact, has non-hostile relations, to claim a friendship would be extreme, with Japan.
On the other hand, the U.S. is often at odds with the PRC and, furthermore, they are competing in the Second Technological War (the first had been between the U.S. and Japan). There are still strategies being adopted by both the Trump and Biden administrations of sanctions to try to block the Beijing superpower.
The third country we see is Korea, which also maintains fairly friendly relations with China.
Continuing in the countries in this excerpt, we come to Germany and France, countries that we have also mentioned in the literature for the change of attitude undertaken in reference to the entry of foreign FDI, especially Chinese, now under detailed scrutiny. It is significant to observe that in this case geopolitical relations are not as positive as in the case of Japan, and this is evidenced by a median of the greater diplomatic disagreement. In addition, these are two countries, particularly Germany, that have seen a substantial increase in Chinese presence and significant technological knowledge transfer operations, as we have also observed in the literature with reference to electric automotive.
Following, there is Great Britain, which has an even more difficult relationship with China but needs its technology, as evidenced by backward citations. The other countries are mostly European, which also explains the European technological dependence on other countries, and in the green sector, the one examined in our study, on China.

Table 4: Extract (US example) of the countries in which Chinese companies invest: the various investment subtypes analyzed in the regression are reported.

Country code	Year	FDI	Innovative FDI	Greenfield FDI	Innovative greenfield FDI	M&A	Innovative M&A
US	2013	4	1	3	1	1	0
US	2014	8	2	5	2	3	0
US	2015	11	4	9	4	3	0
US	2016	13	4	9	4	5	0
US	2017	15	5	11	5	5	0
US	2018	17	5	12	5	6	0
US	2019	18	7	13	7	7	0
US	2020	19	7	13	7	8	0

Note: Full descriptive statistics in **Table 2a** in the **Appendix**.

Source: Author's calculation.

In addition, it is also necessary to highlight the number of investments made by China to other countries. Here you can see reported descriptive statistics referring to the US - this is just a small excerpt, you can consult the full table within the **Appendix**, **Table 2a.**

The U.S. is the country that ranks second in the dataset as an investment receiver, a large amount can be noted in all investment sub-categories, except for innovative M&As, which are however an occurrence under-reported in the dataset as explained in **Table 2**.

The hostile political relationship between the two countries and sanctions policies do not discourage Chinese investors, who still see the U.S. as a great country to invest in. The greenfield FDI categories of FDI is the one that has seen the most growth, but in general a significant amount of investment is detected.

There are two other countries that are worth mentioning as we have also seen to be countries that make extensive use of backward citations, these are Germany and Great Britain. Both countries have seen a surge in investment, Great Britain also sees an amount of innovative M&As, and a large number of innovative FDIs, innovative greenfield FDIs and M&As compared to the other countries in the dataset, this represents a significant statistic. As far as Germany is concerned, this country has received the largest amount of investment in the dataset, with highly significant numbers in all fields, a very large quantity of FDIs and greenfield FDIs can be detected, but also all the other subgroups, with the exception of innovative M&As (still present), the amount of investment received is very notable. This is closely related to the literature outlined above, the new attitude adopted by Germany, and the significant power of outward FDIs as means of knowledge transfer.

In addition, three other countries have received a significant amount of investment, these are India, Brazil and Russia, countries that are members of the BRICS group, thus “friends” of the PRC, as you can also see in **Table 1a** in the **Appendix** (median of the diplomatic disagreement). In India, China invests consistently and purely through FDI and greenfield FDI. Also in the case of Brazil there has been an increase mainly in FDI and greenfield FDI. Finally, in the case of Russia, again there have been significant amounts of FDI and greenfield FDI, but what differentiates Russia from the other countries in the dataset are the amounts of M&As and innovative M&As, this is probably given by the friendship and cooperation between the two countries.

Through the analysis of the descriptive statistics, strongly significant data could be inferred. In particular, China's attitude is to invest in countries that are politically hostile but contain large reservoirs of technological knowledge that they can transfer back home and then be able to develop indigenous innovation. The other strategy is to invest in friendly countries, helping to maintain fruitful ties and strengthening the BRICS bloc as a group of countries that can challenge the West for geopolitical and geoeconomics supremacy.

5. Discussion and results

5.1 Results Presentation and Findings

The results of the statistical elaboration are illustrated in **Table 5** which illustrates the finding of the analysis related to our dependent variable in the green sector. Continuing with the analysis, you will also observe the specific results with reference to innovative FDI, greenfield FDI, innovative greenfield FDI, M&A, and innovative M&A.

Regarding our main research question, i.e. whether the various types of investment help to acquire knowledge, in this case in the green tech sector, we can state that they certainly influence the transfer of technological knowledge, as also highlighted in the academic literature.

The subcategories of FDI, FDI with innovative content, greenfield FDI, greenfield FDI with innovative content significantly influence our dependent variable, backward citations, a proxy for knowledge. Specifically, the dummy variables knowledge seeking FDI and knowledge seeking greenfield FDI are those that most influence our dependent variable. This is because they are investments that aim to innovate; hence, they have a greater impact on patent citations. Nevertheless, the FDI and greenfield FDI variables also show a good degree of significance, in line with the existing literature on the topic.

As far as M&As and knowledge seeking M&As are concerned, here in the analysis of our dataset we are in contrast to the literature, which sees these two factors as very important for knowledge transfer.

Specifically, regarding the subcategories of investment, the positive effect of FDI highlights how crucial it is to establish an environment that attracts international investments; these are closely tied to progress and advancement within the host country. The result of this variable is in line with expectations. China, thanks to a major economic boom, has had an exponential growth of local companies, which has led not only to benefits but also to negative aspects for the economy. Indeed, the Chinese domestic market is rather saturated and, until a few years ago, lacked all the key technologies it now possesses. In fact, our analysis is in line with Luo and Tung's (2007) study which states that when firms face institutional and market constraints, they turn abroad, through the use of FDI, to quickly acquire crucial assets and resources from advanced MNEs to compensate for a global competitive fragility. In the case of Chinese MNEs, the strategy of outward FDIs and landing in a foreign market is also driven by the aforementioned domestic limitations and a necessity to go global (Deng, 2009; Aresu, 2022).

The higher coefficient of innovative FDI, compared to FDI, implies that investments involving innovation bring even greater advantages. It is possibly because of introducing novel technologies and methods that could drive additional economic progress. This outcome underscores how promoting innovation, alongside investments, is crucial as it could result in more significant and enduring economic expansion. Related to the impact of this variable, this corroborates the reasoning related to “classic” FDI and underlines the even greater strategic importance of innovative FDI in the acquisition of technological knowledge.

Similarly, the greenfield FDI variable displays a positive impact. Greenfield investments involve establishing facilities or infrastructure and have a significant influence by generating employment opportunities and enhancing technical capabilities.

The innovative greenfield FDI variable demonstrates an even more pronounced positive effect. This indicates that when greenfield investments are linked with creativity and originality, the influence is amplified. The high level of significance highlights how crucial such investments are in influencing an economy by bringing in cutting-edge technologies and the creation of high-value industries. The beneficial impact on innovation and on the economy of greenfield investments in China's domestic market has been widely studied, companies such as Hyundai, BMW or Volkswagen have extensively invested in China's automotive sector, this has made China the largest car market (Davies, 2012). Liu and Zou (2008) also showed the favorable impact of inward greenfield investments on Chinese innovation (Wang et al., 2016). However, in our study, which deals with outward FDIs, the impact of greenfield investments, and in particular of innovative greenfield investments, on our dependent variable is markedly positive and highly significant. This shows a centrality of both inward and outward greenfield investments in influencing green technological innovation.

We can observe, also by recalling descriptive statistics, that Chinese MNEs invest all over the world, adopting little distinction related to the political orientation of the countries receiving the various sub-categories of investment. Specifically, observing the variable of diplomatic disagreement at the level of the United Nations assembly, we can find that the result is in line with the outlined descriptive statistics. In fact, we could find that the country receiving the most investment is Germany, which is not on friendly terms with China. This is the even more extreme case of the US, which is in a struggle with China in the second technology war, but still represents the second largest investment target country for Chinese MNEs.

The coefficient shown below highlights that diplomatic disagreement negatively influences backward citations, however, it has little significance. This result can be explained by stating that China does not take political orientations into account when it comes to taking investment initiatives in order to acquire technological knowledge.

Table 5: Dependent Variable: Backward Citations, Green sector

Variable	(1)	(2)	(3)	(4)	(5)	(6)
FDI (dummy)	1,09E-02 *					
	3,06E-01					
Knowledge-seeking FDI (dummy)		2,00E-03 **				
		4,44E-01				
greenfield FDI (dummy)			1,02E-02 *			
			3,42E-01			
Knowledge-seeking greenfield FDI (dummy)				1,90E-03 **		
				4,73E-01		
M&A (dummy)					2,E-01	
					3,02E-01	
Knowledge-seeking M&A (dummy)						4,82E-01
						[3,93E-01]
Dilpomatic disagreement	6,96E-01	6,92E-01	7,02E-01	6,93E-01	6,92E-01	7,00E-01
	[- 6,74E-02]	[- 6,87E-02]	[- 6,61E-02]	[- 6,86E-02]	[- 6,76E-02]	[- 6,58E-02]
Distance	2,20E-05 ***	2,20E-05 ***	2,20E-05 ***	2,20E-05 ***	2,30E-05 ***	2,60E-05 ***
	[2,50E-03]	[2,48E-03]	[2,48E-03]	[2,48E-03]	[2,48E-03]	[2,47E-03]
Destination country's population	4,90E-05 ***	4,60E-05 ***	5,00E-05 ***	4,60E-05 ***	4,30E-05 ***	4,42E-05 ***
	[1,40E-05]	[1,40E-05]	[1,40E-05]	[1,40E-05]	[1,40E-05]	[1,40E-05]
Destination country's GDP	2,36E-01	2,23E-01	2,42E-01	2,21E-01	1,81E-01	1,72E-01
	[1,00E-11]	[1,00E-11]	[1,00E-11]	[1,00E-11]	[1,00E-11]	[1,00E-11]
Destination country's patent stock	9,74E-02 .	1,02E-01	9,57E-02 .	1,01E-01 .	1,13E-01	1,10E-01
	[3,00E-06]	[4,00E-06]	[3,00E-06]	[4,00E-06]	[3,00E-06]	[3,00E-06]
Trade flow	5,00E-06 ***	5,00E-06 ***	6,00E-06 ***	5,00E-06 ***	5,00E-06 ***	4,00E-06 ***
	[- 2,00E-09]	[- 2,00E-09]	[- 2,00E-09]	[- 2,00E-09]	[- 2,00E-09]	[- 2,00E-09]
WTO membership	2,00E-07 ***	1,00E-07 ***	2,00E-14 ***	1,00E-14 ***	2,00E-14 ***	1,42E-13 ***
	[7,20]	[7,20]	[7,20]	[7,20]	[7,19]	[7,19]
Fixed effects	Year: 8, Firm: 5002, country code: 75	Year: 8, Firm: 5002, country code: 75	Year: 8, Firm: 5002, country code: 75	Year: 8, Firm: 5002, country code: 75	Year: 8, Firm: 5002, country code: 75	Year: 8, Firm: 5002, country code: 75
Adj, Pseudo R²	4,40E-01	4,40E-01	4,40E-01	4,40E-01	4,40E-01	4,40E-01
Number of Observations	2,96E+06	2,96E+06	2,96E+06	2,96E+06	2,96E+06	2,96E+06

Standard error clustered “year”.

Source: Author’s calculation.

This implies that while conflicts in diplomacy may have implications, in this case they may not directly influence the dependent variable in the dataset. It suggests that MNEs might not consider diplomatic tensions when making knowledge-transfer-oriented investments. However, this is a relevant finding for our purpose. The constant but non-significant negative coefficients might suggest that diplomatic disputes could prevent global collaboration or investment opportunities, however, their impact is either too minimal or too unpredictable to be identified with confidence in this study.

With reference to the study by Damioli and Gregori (2023) and Li et al. (2018) and related to M&As and diplomatic disagreement, our analysis suggests a diversity in the findings; indeed, M&As have little significant influence on our dependent variable. The interaction of M&As with the variable of diplomatic disagreement at the UN assembly and the other control covariates suggests that geopolitical ties also have little significant influence.

Furthermore, some control variables also showed significant results. Among them, it is worth mentioning trade flow and WTO membership. In fact, we can see that both present extremely significant coefficients. Examining them in detail, we can note a coefficient that is close to 0 but negative for trade. This could signal a saturation effect due to increased competition that mitigates the benefits of trade in specific scenarios and diminishes the positive impact of backward citations.

As regards WTO membership, it is a factor that consistently shows a strong positive impact on the dependent variable. This suggests that WTO membership is strongly associated with an increase in the value of backward citations, as WTO membership provides benefits such as access to global markets and streamlined trade regulations that facilitate trade and investment. The result of the WTO covariate is particularly significant, as it can be seen that China's accession to the WTO in 2001 brought great benefits. Moreover, the People's Republic adopted the ‘Go-Global Strategy’ (Deng, 2009), which came at the most appropriate time, i.e. when the institutional environment was ready. The impact of this variable is always positive with high levels of significance on our dependent variable, which highlights the success of the strategy whereby a technologically backward country, in order to fill the gap (Wesson, 2004), must undertake large investment policies by pushing FDI both in private enterprises - leaving them freer and with incentives of a fiscal nature, as we have seen in the literature chapter - and in SOEs to acquire technologies that are fundamental for the country's development. This has allowed China to change pace, transforming itself from a technology imitator country to a producer of indigenous technological innovation. Historically, China's accession to the WTO was a process that started much earlier due to an institutional framework that allowed the Chinese economy to open up to international trade, a path inaugurated by Deng Xiaoping.

The study emphasizes the benefits of different types of foreign direct investments, especially innovative investments. Moreover, as opposed to literature, the research suggests that M&As lack of a significant influence. Although diplomatic disagreement is linked to negative outcomes, its effect is not statistically significant; yet the findings offer valuable insights for our analysis and the control covariates offer additional information on the overall economic and geographical elements impacting our dependent variable.

To conclude this section, it is appropriate to share some thoughts about the model we have looked at. Overall, the outcomes highlight how foreign investments, especially those focused on innovation, play a crucial role in facilitating the exchange of knowledge. Greenfield investments and innovative FDI are identified as key factors in spreading knowledge, probably because of their dynamic and inventive nature.

On the other hand, M&As effectiveness, although they have the potential to contribute positively to knowledge transfer outcomes, show less significant results. It may depend on a variety of elements involved in the process, both contextual and company specific. The diplomatic disagreement at the UN assembly consistently showed a trend across the various models being never statistically significant.

This suggests that in the context studied here it seems that diplomatic disagreements do not consistently affect the knowledge flows for green technology or perhaps the impact is too weak to be clearly seen in the data. Nevertheless, there are chances that in specific scenarios or sectors diplomatic disagreements could still prevent the transfer of technology and global partnerships.

Specifically, in our research the fact that Chinese multinationals (our unit of analysis) do not take into account political relations when making investment choices or seeking technological knowledge. This is also in line with the history of China's overflowing economic and technological evolution illustrated in the previous chapters. Chinese leaders have always reasoned, from Deng onwards, according to Chinese power and the advancement of its people.

5.2 Discussion

This study can join the part of the literature that seeks to study instruments such as FDI, but also greenfield investments and M&A transactions, and their interaction with knowledge flows, a primary asset in today's globalised world.

In the analysis, an attempt was made to add a political/geopolitical element- represented by the variable related to the diplomatic disagreement at the UN assembly- to the interrelation between investments and patents.

Some relevant findings for our study are a confirmation of the importance of FDI, especially innovative FDI. In fact, our results are in line with the academic literature that sees FDI as a means of technology transfer. We were able to observe a significant interaction between FDI and patent backward citations. These tools of investment are widely used by MNEs; in the Chinese case, there has been a substantial increase since 2001 that has greatly benefited China's economic and technological advancement. As far as greenfield ventures are concerned, particularly those of an innovative nature, an even greater impact on our dependent variable was observed, probably given precisely by the already innovative nature of this type of investment. This result is significant insofar as the benefit of inward greenfield investments is well established in the existing literature - see, for example, the automotive sector in general and the electrical sector in particular - but in our case the impact of this type of venture made by China in outward greenfield investments was taken into account.

As for the study of M&As practices, these have been shown not to interact substantially with backward citations, however, there may be a bias caused by the round-tripping practice explained in Chapter 2.

The study of the diplomatic disagreement variable also led to a significant reflection, Chinese MNEs do not consider geopolitical ties, of the nature explained in the variable we reported, when making investment decisions for the acquisition of technological knowledge.

Regarding the other covariates, the interesting impact of the WTO variable should be highlighted. Indeed, this result demonstrates the success of Chinese openness to global trade. This nod to Chinese economic history allows a reminder of the strategies adopted by the People's Republic. The various Chinese governments of the historical periods reported in this study were patient and all contributed to the construction of a China that could be an industrial and technological champion. The establishment of the various medium/long-term industrial plans served to have continuity of purpose and an adoption of a strategy of an extremely programmatic nature, certainly this was enabled by the nature of Chinese institutions that allow for greater continuity and more fluid decision-making.

6. Conclusion

6.1 Contribution

The present study contributes to the literature studying the interaction between FDI and geopolitics and its impact on technological knowledge acquisition.

Through empirical analysis, we observed that China and domestic companies do not respond to a paradigm of investments made in geopolitically friendly countries. In fact, they decide to invest beyond this factor even in countries that are in strong diplomatic disagreement. Rather, the investment decisions are aimed at acquiring strategic knowledge assets.

Moreover, we pointed out that FDIs, and, in particular, the subcategories of FDIs with innovative content and greenfield FDIs with innovative content play a primary role. However, "classic" FDIs and greenfield FDIs also have significant contribution on green technological knowledge acquisition. On the other hand, M&As and M&As with innovative content have little significance in our case, which puts us at odds with part of the literature.

The result regarding the interaction of diplomatic disagreement with FDIs in influencing our dependent variable, the number of backward citations, is of particular significance because it explains the attitudes of Chinese firms and the Chinese administration. Indeed, geopolitical ties of friendship are split from investment decisions that lead to the economic benefits brought to the PRC. Nevertheless, this has an implication in geopolitics itself, as investment policies to acquire technological knowledge have brought major rewards to the Chinese state and companies, allowing the nation itself to gain greater prominence internationally and become a global superpower. China's new positioning on the international chessboard and its technological dominance in certain sectors, such as green, was what led to the Second Technological War that is still ongoing- this time between China and the United States.

6.2 Limitations of the Study and Recommendations

Our analysis presents limitations as the results outlined are to be considered relevant only with reference to the data analyzed, the model adopted, our choice of variables and their interaction. This is a topic that needs further development. Two different directions could be pursued, at the micro level and at the macro level. With regard to the former, a study of bilateral ties could be significant, specifically noting the interactions between China and a specific country, such as the U.S. or Germany. In this case, it would be appropriate to include different variables or integrate additional variables relevant with the two countries studied. As for the macro level, it might be interesting to broaden the spectrum of analysis with additional geopolitical variables. In addition, an analysis could be conducted regarding the relation between BRICS bloc with the US-led bloc.

Finally, an additional avenue of research might be to consider another country that has been experiencing significant growth in recent decades, and even more so in recent years: India. Again, both a micro-level and macro-level analysis could be contemplated.

6.3 Implications for Management Practices and Public Policies

The present study also leads to implications regarding managerial practices and public policies. With reference to the former, both inward and outward FDIs practices should be considered with extreme caution. As far as inward FDIs are concerned, companies should note that they can benefit from foreign economic and knowledge input; we have seen in the literature chapters how inward FDIs have also been a driving force for innovation and the Chinese economy. However, if proper attention is not devoted, FDIs can also facilitate knowledge transfer to the detriment of the country and firm receiving the ventures.

On the public policy side, it is crucial for countries to consider policies of economic openness; we could see how China has benefited to a large extent. Policies of closure can lead to isolation, which can be a significantly negative aspect for countries. On the other hand, it is also necessary to adopt meticulous scrutiny of inward FDIs as these can bring about technology transfer that could harm a competitive advantage of the interested country and its companies. In addition, it is recommended to facilitate outbound investment practices to seek precisely the missing technological knowledge for innovation development and fill this gap. Then, initiate development plans for indigenous innovation production, as China has done.

Finally, Chinese example has shown that investment decisions need not be influenced by diplomatic friendship, as economic advantage can still be gained. Certainly, friendly geopolitical and diplomatic relations can facilitate acceptance of FDIs and an easier passage to inbound scrutiny by receiving countries, as demonstrated by the beginning of China's history of economic and political openness and rapprochement with the U.S. in a “tacit alliance” (Kissinger, 1972).

Appendix

Table 1a: Backward citations to China by companies from the countries below and median diplomatic disagreements between these countries and China.

Country code	Total citations	Median diplomatic disagreement (UN assembly)
JP	5443	1,160523057
US	3446	3,116850376
KR	2362	1,380710542
DE	1505	1,688885748
FR	386	1,94791472
GB	383	2,185391307
CA	280	1,957646251
RU	209	0,566930026
CH	180	1,158898056
AU	160	1,834789336
NL	154	1,545774698
SE	142	1,27808392
IT	140	1,459796429
FI	121	1,403532028
AT	92	1,223461568
ES	89	1,487656176
BE	74	1,56262666
IN	64	0,1425111
DK	59	1,588103771
IL	52	2,980819345
MY	48	0,252956055
SG	43	0,161034949
BR	40	0,248428449
NO	31	1,422748625
SA	25	0,243982196
HU	22	1,663286269
PL	18	1,575764298
IE	17	1,213016808
LU	14	1,485963821
MX	14	0,413023889
TR	14	1,076135159
GR	13	1,389750242
KW	13	0,432160914
CZ	12	1,715305209
UA	12	1,577268541
NZ	11	1,177530289
TH	11	0,16138225
ZA	11	0,09313295

RO	10	1,522521138
CO	9	0,403846368
BG	8	1,499316812
CL	8	0,249160051
PT	7	1,421117365
IR	6	1,255641818
AR	5	0,349924698
PH	5	0,200491145
EE	4	1,587934732
ID	4	0,567957044
SI	4	1,499248028
SK	4	1,577691257
AE	3	0,279148944
BO	3	0,963571668
CY	3	1,113887906
EG	3	0,769322157
HR	3	1,549679756
TM	3	0,404514611
AL	2	1,506325543
UZ	2	0,1144545
VU	2	0,392022386
AZ	1	0,315160692
BB	1	0,132439446
BS	1	0,188704848
BY	1	0,175374553
EC	1	0,463034362
GY	1	0,212563552
JM	1	0,116970748
KZ	1	0,137452699
LB	1	0,618006796
LV	1	1,602744222
MA	1	0,193405002
PG	1	0,616607308
QA	1	0,324114352
TZ	1	0,34269245
UY	1	0,119184252
VN	1	0,54624936

Note: Citations made by companies belonging to the above-mentioned countries.

Source: Author’s calculation.

Table 2a: Countries in which Chinese companies invest: the various sub-types of investment analyzed in the regression are reported.

Country code	Year	FDI	Innovative FDI	Greenfield FDI	Innovative greenfield FDI	M&A	Innovative M&A
AE	2013	1	0	1	0	0	0
AE	2014	1	0	1	0	0	0
AE	2015	2	0	2	0	0	0
AE	2016	2	0	2	0	0	0
AE	2017	4	1	3	1	1	0
AE	2018	4	1	3	1	1	0
AE	2019	5	1	5	1	1	0
AE	2020	5	1	5	1	1	0
AR	2013	1	0	1	0	0	0
AR	2014	1	0	1	0	0	0
AR	2015	1	0	1	0	0	0
AR	2016	1	0	1	0	0	0
AR	2017	1	0	1	0	0	0
AR	2018	2	0	1	0	1	0
AR	2019	2	0	1	0	1	0
AR	2020	2	0	1	0	1	0
AT	2014	1	0	0	0	1	0
AT	2015	1	0	0	0	1	0
AT	2016	1	0	0	0	1	0
AT	2017	2	1	1	1	1	0
AT	2018	5	3	3	2	2	1
AT	2019	6	4	4	3	2	1
AT	2020	6	4	4	3	2	1
AU	2013	3	0	1	0	2	0
AU	2014	3	0	1	0	2	0
AU	2015	4	0	2	0	2	0
AU	2016	4	0	2	0	2	0
AU	2017	4	0	2	0	2	0
AU	2018	5	1	4	1	2	0
AU	2019	5	1	4	1	2	0
AU	2020	5	1	4	1	2	0
BE	2013	1	0	0	0	1	0
BE	2014	2	0	1	0	1	0
BE	2015	2	1	2	1	1	0
BE	2016	2	1	2	1	1	0
BE	2017	2	1	2	1	1	0
BE	2018	2	1	2	1	1	0
BE	2019	3	1	3	1	1	0
BE	2020	3	1	3	1	1	0
BO	2017	1	0	1	0	0	0

BO	2018	1	0	1	0	0	0
BO	2019	1	0	1	0	0	0
BO	2020	1	0	1	0	0	0
BR	2013	3	0	3	0	0	0
BR	2014	3	1	3	1	0	0
BR	2015	4	1	4	1	0	0
BR	2016	5	1	5	1	0	0
BR	2017	7	1	7	1	0	0
BR	2018	7	1	7	1	0	0
BR	2019	7	1	7	1	0	0
BR	2020	7	2	7	2	0	0
BY	2013	1	0	1	0	0	0
BY	2014	1	0	1	0	0	0
BY	2015	1	0	1	0	0	0
BY	2016	1	0	1	0	0	0
BY	2017	2	0	2	0	0	0
BY	2018	2	0	2	0	0	0
BY	2019	3	0	3	0	0	0
BY	2020	3	0	3	0	0	0
CA	2013	2	0	1	0	1	0
CA	2014	2	0	1	0	1	0
CA	2015	3	0	2	0	1	0
CA	2016	3	0	2	0	1	0
CA	2017	4	1	3	1	1	0
CA	2018	5	1	4	1	1	0
CA	2019	6	1	5	1	1	0
CA	2020	7	1	5	1	2	0
CH	2016	1	0	0	0	1	0
CH	2017	1	0	0	0	1	0
CH	2018	2	1	1	1	1	0
CH	2019	3	1	2	1	1	0
CH	2020	3	1	2	1	1	0
CL	2016	1	0	1	0	0	0
CL	2017	1	0	1	0	0	0
CL	2018	2	0	1	0	1	0
CL	2019	4	1	3	1	1	0
CL	2020	4	1	3	1	1	0
CO	2014	1	0	1	0	0	0
CO	2015	1	0	1	0	0	0
CO	2016	1	0	1	0	0	0
CO	2017	1	0	1	0	0	0
CO	2018	2	1	2	1	0	0
CO	2019	2	1	2	1	0	0
CO	2020	2	1	2	1	0	0
CZ	2017	3	0	3	0	0	0
CZ	2018	3	0	3	0	0	0

CZ	2019	3	0	3	0	0	0
CZ	2020	3	0	3	0	0	0
DE	2013	1	0	0	0	1	0
DE	2014	4	2	3	2	1	0
DE	2015	4	2	3	2	1	0
DE	2016	9	3	6	2	4	1
DE	2017	14	4	12	3	5	1
DE	2018	17	6	14	5	6	1
DE	2019	19	9	17	8	6	1
DE	2020	20	9	17	8	7	1
DK	2013	1	1	1	1	0	0
DK	2014	3	1	2	1	1	0
DK	2015	3	1	3	1	1	0
DK	2016	3	1	3	1	1	0
DK	2017	3	1	3	1	1	0
DK	2018	3	1	3	1	1	0
DK	2019	3	1	3	1	1	0
DK	2020	3	1	3	1	1	0
EE	2017	1	0	1	0	0	0
EE	2018	1	0	1	0	0	0
EE	2019	1	0	1	0	0	0
EE	2020	1	0	1	0	0	0
EG	2017	2	1	2	1	0	0
EG	2018	2	1	2	1	0	0
EG	2019	2	1	2	1	0	0
EG	2020	2	1	2	1	0	0
ES	2015	1	0	1	0	0	0
ES	2016	1	0	1	0	0	0
ES	2017	2	0	2	0	0	0
ES	2018	3	0	2	0	1	0
ES	2019	5	0	4	0	1	0
ES	2020	6	0	4	0	2	0
FI	2016	1	1	1	1	0	0
FI	2017	1	1	1	1	0	0
FI	2018	1	1	1	1	0	0
FI	2019	1	1	1	1	0	0
FI	2020	1	1	1	1	0	0
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FR	2014	2	0	1	0	1	0
FR	2015	3	1	2	1	1	0
FR	2016	3	1	2	1	1	0
FR	2017	3	1	2	1	1	0
FR	2018	5	1	4	1	1	0
FR	2019	6	1	5	1	1	0
FR	2020	8	2	7	2	1	0
GB	2013	1	1	1	1	0	0

GB	2014	3	3	3	3	1	1
GB	2015	6	3	6	3	1	1
GB	2016	8	3	7	3	3	1
GB	2017	10	3	9	3	3	1
GB	2018	12	4	10	3	4	2
GB	2019	12	4	10	3	4	2
GB	2020	12	4	10	3	4	2
GR	2013	1	0	1	0	0	0
GR	2014	1	0	1	0	0	0
GR	2015	1	0	1	0	0	0
GR	2016	1	0	1	0	0	0
GR	2017	2	0	2	0	0	0
GR	2018	2	0	2	0	0	0
GR	2019	2	0	2	0	0	0
GR	2020	2	0	2	0	0	0
HU	2014	1	1	1	1	0	0
HU	2015	1	1	1	1	0	0
HU	2016	1	1	1	1	0	0
HU	2017	2	1	2	1	0	0
HU	2018	2	1	2	1	0	0
HU	2019	2	1	2	1	0	0
HU	2020	2	1	2	1	0	0
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ID	2016	4	0	4	0	0	0
ID	2017	6	0	6	0	0	0
ID	2018	7	0	7	0	0	0
ID	2019	7	0	7	0	0	0
ID	2020	8	0	8	0	1	0
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IE	2019	1	1	1	1	0	0
IE	2020	1	1	1	1	0	0
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IL	2015	1	0	0	0	1	0
IL	2016	1	0	0	0	1	0
IL	2017	2	0	0	0	2	0
IL	2018	3	0	1	0	3	0
IL	2019	6	2	4	2	3	0
IL	2020	6	2	4	2	3	0
IN	2013	1	1	1	1	0	0
IN	2014	3	2	3	2	0	0
IN	2015	6	2	6	2	0	0

IN	2016	7	3	7	3	1	0
IN	2017	7	3	7	3	1	0
IN	2018	8	3	8	3	1	0
IN	2019	9	3	9	3	1	0
IN	2020	10	3	10	3	1	0
IR	2018	1	1	1	1	0	0
IR	2019	2	1	2	1	0	0
IR	2020	2	1	2	1	0	0
IT	2013	1	0	0	0	1	0
IT	2014	2	0	0	0	2	0
IT	2015	2	0	0	0	2	0
IT	2016	3	0	0	0	3	0
IT	2017	3	0	0	0	3	0
IT	2018	6	0	2	0	4	0
IT	2019	8	1	3	1	5	0
IT	2020	8	1	3	1	5	0
JP	2013	1	1	1	1	0	0
JP	2014	1	1	1	1	0	0
JP	2015	1	1	1	1	0	0
JP	2016	2	2	2	2	0	0
JP	2017	2	2	2	2	0	0
JP	2018	3	3	3	3	0	0
JP	2019	3	3	3	3	0	0
JP	2020	3	3	3	3	0	0
KR	2014	2	1	2	1	0	0
KR	2015	2	1	2	1	0	0
KR	2016	2	1	2	1	0	0
KR	2017	2	1	2	1	0	0
KR	2018	3	2	3	2	0	0
KR	2019	3	2	3	2	0	0
KR	2020	3	2	3	2	0	0
KW	2014	1	1	1	1	0	0
KW	2015	1	1	1	1	0	0
KW	2017	1	1	1	1	0	0
KW	2018	1	1	1	1	0	0
KW	2019	1	1	1	1	0	0
KW	2020	1	1	1	1	0	0
KZ	2015	1	0	1	0	0	0
KZ	2016	1	0	1	0	0	0
KZ	2017	1	0	1	0	0	0
KZ	2018	1	0	1	0	0	0
KZ	2019	1	0	1	0	0	0
KZ	2020	1	0	1	0	0	0
LB	2015	1	0	1	0	0	0
LB	2016	1	0	1	0	0	0
LB	2017	2	0	2	0	0	0

LB	2018	2	0	2	0	0	0
LB	2019	2	0	2	0	0	0
LB	2020	2	0	2	0	0	0
LV	2017	1	0	1	0	0	0
LV	2018	1	0	1	0	0	0
LV	2019	1	0	1	0	0	0
LV	2020	1	0	1	0	0	0
MA	2014	1	0	1	0	0	0
MA	2015	2	0	2	0	0	0
MA	2016	2	0	2	0	0	0
MA	2017	2	0	2	0	0	0
MA	2018	2	0	2	0	0	0
MA	2019	3	0	3	0	0	0
MA	2020	4	0	4	0	0	0
MX	2013	1	0	1	0	0	0
MX	2014	2	1	2	1	0	0
MX	2015	2	1	2	1	0	0
MX	2016	2	1	2	1	0	0
MX	2017	4	1	4	1	0	0
MX	2018	5	1	5	1	0	0
MX	2019	5	1	5	1	0	0
MX	2020	5	1	5	1	0	0
MY	2013	2	0	2	0	0	0
MY	2014	2	0	2	0	0	0
MY	2015	2	1	2	1	0	0
MY	2016	3	1	3	1	1	0
MY	2017	5	1	4	1	2	0
MY	2018	6	1	5	1	2	0
MY	2019	6	1	5	1	2	0
MY	2020	6	1	5	1	2	0
NL	2013	1	0	0	0	1	0
NL	2014	4	1	2	1	2	0
NL	2015	5	1	2	1	3	0
NL	2016	6	1	3	1	3	0
NL	2017	7	2	4	2	3	0
NL	2018	7	2	4	2	3	0
NL	2019	8	2	5	2	3	0
NL	2020	8	2	5	2	3	0
NO	2013	1	0	1	0	0	0
NO	2014	1	0	1	0	0	0
NO	2015	1	0	1	0	0	0
NO	2016	1	0	1	0	0	0
NO	2017	1	0	1	0	0	0
NO	2018	1	0	1	0	0	0
NO	2019	1	0	1	0	0	0
NO	2020	1	0	1	0	0	0

NZ	2014	1	0	1	0	0	0
NZ	2015	1	0	1	0	0	0
NZ	2016	1	0	1	0	0	0
NZ	2017	2	1	2	1	0	0
NZ	2018	2	1	2	1	0	0
NZ	2019	2	1	2	1	0	0
NZ	2020	2	1	2	1	0	0
PG	2017	1	0	0	0	1	0
PG	2018	1	0	0	0	1	0
PG	2019	1	0	0	0	1	0
PG	2020	1	0	0	0	1	0
PH	2014	1	0	1	0	0	0
PH	2015	1	0	1	0	0	0
PH	2016	1	0	1	0	0	0
PH	2017	1	0	1	0	0	0
PH	2018	2	0	2	0	0	0
PH	2019	2	0	2	0	0	0
PH	2020	2	0	2	0	0	0
PL	2015	1	0	1	0	0	0
PL	2016	1	0	1	0	0	0
PL	2017	2	0	2	0	0	0
PL	2018	2	0	2	0	0	0
PL	2019	2	0	2	0	0	0
PL	2020	2	0	2	0	0	0
PT	2018	2	0	1	0	1	0
PT	2019	4	0	3	0	1	0
PT	2020	4	0	3	0	1	0
QA	2018	1	0	1	0	0	0
QA	2019	1	1	1	1	0	0
QA	2020	1	1	1	1	0	0
RO	2017	1	0	1	0	0	0
RO	2018	1	0	1	0	0	0
RO	2019	2	0	2	0	0	0
RO	2020	2	0	2	0	0	0
RU	2013	1	0	1	0	0	0
RU	2014	5	0	5	0	1	0
RU	2015	7	3	5	1	3	2
RU	2016	7	3	5	1	3	2
RU	2017	8	3	6	1	3	2
RU	2018	8	3	6	1	3	2
RU	2019	8	3	6	1	3	2
RU	2020	8	3	6	1	3	2
SA	2014	1	0	1	0	0	0
SA	2015	2	1	2	1	0	0
SA	2016	3	1	3	1	0	0
SA	2017	3	1	3	1	0	0

SA	2018	3	1	3	1	0	0
SA	2019	3	1	3	1	0	0
SA	2020	3	1	3	1	0	0
SE	2018	1	0	0	0	1	0
SE	2019	3	0	2	0	1	0
SE	2020	4	1	3	1	1	0
SG	2013	1	0	1	0	0	0
SG	2014	2	0	2	0	0	0
SG	2015	2	0	2	0	0	0
SG	2016	3	0	3	0	0	0
SG	2017	3	1	3	1	0	0
SG	2018	3	1	3	1	0	0
SG	2019	4	2	4	2	0	0
SG	2020	4	2	4	2	0	0
SK	2014	1	0	1	0	0	0
SK	2015	1	0	1	0	0	0
SK	2016	1	0	1	0	0	0
SK	2017	2	0	2	0	0	0
SK	2018	2	0	2	0	0	0
SK	2019	2	0	2	0	0	0
SK	2020	2	0	2	0	0	0
TH	2013	1	0	1	0	0	0
TH	2014	2	0	2	0	0	0
TH	2015	2	0	2	0	0	0
TH	2016	2	0	2	0	0	0
TH	2017	4	1	4	1	0	0
TH	2018	5	1	5	1	0	0
TH	2019	5	1	5	1	0	0
TH	2020	5	1	5	1	0	0
TR	2018	3	1	2	1	1	0
TR	2019	3	1	2	1	1	0
TR	2020	3	1	2	1	1	0
UA	2017	1	0	1	0	0	0
UA	2018	1	0	1	0	0	0
UA	2019	1	0	1	0	0	0
UA	2020	1	0	1	0	0	0
US	2013	4	1	3	1	1	0
US	2014	8	2	5	2	3	0
US	2015	11	4	9	4	3	0
US	2016	13	4	9	4	5	0
US	2017	15	5	11	5	5	0
US	2018	17	5	12	5	6	0
US	2019	18	7	13	7	7	0
US	2020	19	7	13	7	8	0
UY	2014	1	0	1	0	0	0
UY	2015	1	0	1	0	0	0

UY	2016	1	0	1	0	0	0
UY	2017	1	0	1	0	0	0
UY	2018	1	0	1	0	0	0
UY	2019	1	0	1	0	0	0
UY	2020	1	0	1	0	0	0
UZ	2020	2	0	2	0	0	0
VN	2017	1	0	1	0	0	0
VN	2018	1	0	1	0	0	0
VN	2019	1	0	1	0	0	0
VN	2020	1	0	1	0	0	0
ZA	2013	1	0	1	0	0	0
ZA	2014	2	0	2	0	0	0
ZA	2015	3	0	3	0	0	0
ZA	2016	3	0	3	0	0	0
ZA	2017	3	0	3	0	0	0
ZA	2018	4	0	4	0	0	0
ZA	2019	4	1	4	1	0	0
ZA	2020	4	1	4	1	0	0

Source: Author’s calculation.

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