Erasmus School of Economics

Master Thesis

The effect of Chinese Foreign Direct Investment on Total Factor Productivity and Technology Transfer

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MSc in Economics and Business

Strategy Economics track

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February 6, 2022

The views stated in this thesis are those of the author and not necessarily those of the supervisor, second assessor, Erasmus School of Economics or Erasmus University Rotterdam

ABSTRACT

The ascension of China on the world economy dominance is clear. One important factor is the growing amount invested overseas by Chinese investors. Despite the pandemic, Chinese outward FDI reached $133 billion in 2020, making China the world's largest investor. This master thesis examines the effect of Chinese foreign direct investment (FDI) in the host economy by focusing on the impact on Total Factor Productivity and Technology Transfer. The role of income levels and the Belt & Road Initiative on these effects are also investigated. Using panel data for 153 countries over the period from 2005 to 2020, the FDI effect is ambiguous. Further, empirical results in low and lower income countries for TFP are mixed. The Belt & Road Initiative appears to be ineffective in increasing TFP and technology diffusion. For high income economies, the results partially suggests that belonging to the initiative does not bring a positive externality on TFP.

Keywords: Foreign Firect Investment, China, Belt & Road Initiative, Total Factor Productivity, Technology Transfer, Patents, Income Levels

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1 Introduction

The rise of Foreign Direct Investment (FDI) from China has been remarkable and has attracted substantial scholarly attention in recent years. Since the Chinese economic reform in 1978, China has been an active participant in the global economy and is increasingly integrating itself through FDI and expanded trade flows. In the early 2000s, with the "going global" policy and joining the World Trade Organization (WTO), China took off on a new route of liberalization, and its foreign investment rose sharply. In 2013, the Chinese President Xi Jinping presented the Belt & Road Initiative (BRI), the century's largest infrastructure project. In light of this ambitious major infrastructure initiative, China plans to revive the ancient Silk Roads to gain economic and geopolitical power cross-borders. In 2016, China reached its Outward Foreign Direct Investment (OFDI) peak, with US$196.2bn, becoming the world's second-largest outward investor after the US (Wang and Gao, 2019). After this peak, EY (2019) describes Chinese OFDI as a "trend toward a combination of protectionism and deglobalization." With the Covid-19 pandemic, global FDI flows declined by 35% in 2020 (UNCTAD, 2021). However, China became the world's biggest outward investor reaching $133 billion in 2020, mainly due to the continued growth overseas of the Chinese multinational firms and ongoing BRI projects.

The growing presence of China in every corner of the globe is clear. According to official data retrieved from the Chinese Ministry of Commerce (MOFCOM), Chinese FDI stock in the EU registered an increase above 90-fold between 2003 and 2017 (Knoerich and Miedtank, 2018). In Africa, the stock of Chinese investment grew nearly 100-fold in 17 years, from $490 million in 2003 to $43.4 billion in 2020 (The Diplomat, 2021). In the context of the BRI, Africa places as one of the focus areas of investment and one of the central pillars of the initiative's success. However, the massive and quick expansion of Chinese FDI's has exposed flaws in environmental, social and governance (ESG) issues, and Chinese firms' investment decisions and host-countries' debt structure are also under scrutiny (Wang and Gao, 2019). Some of these concerns also drove the known US-China "trade war." Europe is also increasingly concerned about China's investment in infrastructure and high-tech sectors in the old continent.

These latest developments led to investigate further the economic effects of Chinese foreign direct investment in the host countries. China's growing importance on the global market landscape, in every sense of economic flows, investments, and trade relations, makes this topic extraordinarily relevant to the present and the future of the global economy and public policy. The existing literature on FDI activities proposes that the presence of foreign multinational firms may have a profound impact on the structure of the host economy and the performance of the domestic firms (Blomstrom and Kokko, 2001). FDI is usually assumed to affect TFP in the host country, impacting long-term economic growth. This process happens through introducing new and better technologies, acquiring skills, and spillover effects to domestic firms.

Thus, the focus of this research is twofold. Firstly, the FDI effect on TFP, which is the primary driver of long-run economic growth (Easterly and Levine, 2001). Secondly, to examine whether the introduction of foreign capital in domestic firms plays an essential role of a generalized promoter of technology improvement

and diffusion (Findlay, 1978). Therefore, the research question is the following :

Does Chinese foreign direct investment create total productivity benefits and technology transfer effects in the host country?

The remainder of this thesis is organized as follows. Section 2 reviews relevant literature and presents hypotheses. Section 3 describes and analyses the data. Section 4 details the methodology and presents the empirical findings of this thesis. Finally, section 5 discuss the limitations of this paper and section 6 concludes.

2 Literature Review & Hypotheses

2.1 FDI and its Main Determinants

According to Dunning and Lundan (2008), Foreign Direct Investment (FDI) is especially important because it enhances local and regional economic growth through the transfer and access to knowledge and new technologies, creation of employment, improve overall productivity and boost international competitiveness and entrepreneurship. Because of this generalized belief, policymakers compete strongly for FDI inflows, and the attractiveness of investment of a host country on an international level is an ongoing debate of the last decades. As stated by Dunning (2004), one of the most extraordinary aspects of the golden decade of globalization, the 1990s, was the fast growth of FDI flows across the biggest economies in the world. This upward trend rose the relevance to study the role of FDI in economic development and the figures talk by themselves: in 1985, the share of combined inward and outward FDI stocks for the world as a whole was 14% of the global GDP; in 2019, the same share is around 75% of the GDP (UNCTAD, 2019).

Going back in time to the middle of the 20th century, Solow (1956) presented the renowned neo-classical growth model, whereas the potential impact of FDI on growth was circumscribed to the short run. Afterward, more recent literature on FDI has shown that FDI creates endogenous growth hence generates production increases through externalities and productivity spillovers. This long-run growth possibility through FDI has driven scholars' more significant theoretical and empirical effort. The pioneering work by Melitz (2003); Helpman et al. (2004) predicted that productivity at the firm level drives multinational enterprises' (MNEs) decisions on overseas activities. The authors found a higher propensity to engage in outward FDI in the most productive firms, while less productive firms only produce for the domestic market. This insight helped define firm-level productivity as one of the main drivers of internationalization strategies. In the context of the same activities undertaken mainly by MNEs, FDI is considered the final outcome of their broad globalized strategies and investment decisions. Hence, the determinants of FDI have also been under much debate. Within this context, the eclectic (OLI) paradigm constructed by Dunning (2000) provides the dominant analytical framework to understand the extent, geography, and industrial composition of FDI undertaken by MNEs. A group of three sub-paradigms comprises the OLI paradigm. The first, Ownership (O) specific advantages, i.e., the specific competitive advantages of the firm that wants to engage in FDI. The second, Locational (L) attractions of different countries or regions, i.e., the immobile, natural endowments of a specific location where firms exploit their specific advantages by FDI. The last one, Internalization (I), evaluates how firms are more likely to organize the creation or exploitation of their core advantages, given the locational factors of the different regions.

On a host country level, various factors that determine FDI flows. Dunning (2004) divides into three major groups: a clear policy framework for FDI, stable economic determinants, and good business facilitation. In the first one, economical, political, and social stability is the key to a good and attractive investment policy environment. Furthermore, international agreements on FDI, rules regarding entry and operations, and good

competition policies are crucial for a suitable policy framework for FDI. In the second group, the economic determinants are highly dependent on the type of FDI: the motivation for the FDI, such as natural resource-seeking versus market-seeking. For instance, in a market-seeking FDI, the size of the host economy and the economic growth are vital indicators of a sizeable attractiveness to inward FDI. On the other hand, the availability and quality of skilled labor and abundant natural resources are essential determinants for resource-seeking investments. Finally, in the last group, in the business facilitation scheme, cluster and network promotion, protection of property rights, good infrastructure, and investment promotion schemes are some critical aspects that could lead to higher FDI inflows.

2.2 FDI and its Economic Impact

A substantial amount of scholars have been examining the economic impact of FDI, through macro, cross-country analysis (Alfaro et al., 2004; Borensztein et al., 1998; Osnago et al., 2017), as well as micro, firm-level research (Alfaro and Chen, 2014; Chen and Tang, 2014). Analyzing the relationship between FDI and economic growth, Borensztein et al. (1998) and Alfaro et al. (2004) found evidence that FDI could positively affect economic growth when recipient economies meet certain conditions, such as sufficient human capital stock and substantial financial development. Furthermore, there are arguments in favor of FDI as a conduit for technology transfer. In an influential study, Findlay (1978) suggests that the capital invested in domestic firms plays the role of a generalized promoter of technology improvement. Additionally, Blalock and Gertler (2008), and Liu (2008) found evidence that other domestic firms can learn from firms that received foreign investment by observation or by establishing business relations with the latter or through labor turnover as workers move from foreign to domestic firms.

2.2.1 Effect on Productivity

The effect of FDI on productivity in the host country has extensive literature with ambiguous empirical evidence. In their work, Arnold and Javorcik (2009) use plant-level data from the Indonesian manufacturing industry to show the impact of foreign investment on domestic firms. After the third year under foreign ownership, those plants registered a 13.5% increase in productivity. These upgrades were also felt in increases in machinery equipment, jobs growth, and final output. On the other hand, Wang and Wang (2015) found no evidence of a positive relationship between foreign acquisition and firm productivity after analyzing the post-acquisition performance of foreign and domestic-acquired firms in China.

Additionally to the direct effect on productivity, some scholars focused on examining the spillover effect of FDI on other domestic firms. The literature offers three types of spillover: intra-industry or horizontal spillover, inter-industry spillover through backward linkage, and inter-industry spillover through forward linkage. For the horizontal spillover, literature has failed to find evidence of a productivity spillover in the same industry. Smarzynska Javorcik (2004) and the following studies show no robust evidence of spillovers occurring through the horizontal channel, i.e., that FDI exerts minor or negative effects on the productivity of

domestic firms in the same industry. For the vertical spillover or inter-industry spillover, Smarzynska Javorcik (2004) shows some evidence consistent with positive productivity spillovers from FDI in upstream industries (backward linkage). Using Lithuanian firm-level data, the author found that "a one standard deviation increase in foreign presence in the soucring sectors is associated with a 15% rise in output of each domestic firm in the supplying industry". More studies (Blalock and Gertler, 2008; Javorcik and Spatareanu, 2009) found evidence of positive spillover through backward linkage in Indonesia and the Czech Republic, respectively.

However, the presence and the magnitude of productivity spillover could depend on several mediating factors, such as FDI types, the ownership structure, the absorptive capacity of countries and firms, and national economic policies. For instance, countries with a more robust absorptive capacity such as R&D capacity and substantial human capital would be more likely to witness productivity spillovers than countries with few R&D and human capital resources. In the same work mentioned above, Blalock and Gertler (2008), find that Indonesian firms with more literate workers, more research & development expenses , and minor technology gaps from multinational firms are likely to benefit more from foreign investment. Further, Javorcik and Spatareanu (2008) find support for ownership structure. The authors find that vertical spillovers are more likely to emmerge from projects with shared domestic and foreign ownership but not from wholly foreign-owned firms. Additionally, Farole and Winkler (2014) study finds support for domestic firms' absorptive capacity, investors' spillover potential, and host-country's institutional framework as mediating factors in developing economies.

In addition to firm productivity, the effects of FDI were found on technology transfer and innovation, although these aspects have received less attention from scholars. Scholars like Saggi (2002), Greenaway and Kneller (2007) focused their studies on the macroeconomic effects of FDI, showing that rises on productivity in host economies via FDI inflows primarily lean on technology spillovers from foreign to domestic firms and the capacity of the latter to absorb new and improved knowledge from foreign firms.

2.2.2 Effect on Technology Transfer

As the research above suggests, the positive effects of FDI on productivity cannot be taken for granted. As pioneered in research by Caves (1974), and De Mello Jr (1997), FDI expects to raise productivity in the host country essentially through the transfer of new technologies and knowledge. Another influential study led by Findlay (1978) claimed that the technology gap "must not be too wide" for developing host economies to make use of the technology transfer via FDI inflows. Like productivity improvements, also technology transfer exhibits dependence on several factors to define the existence and the magnitude of the technological spillover in the economy. Durham (2004) shows the prominent role of financial and institutional development as a necessary contingent for the absorptive capacity of host countries to receive new technologies. In another relevant study on FDI and technological diffusion, Xu and Wang (2000) shows that host countries must be enriched with adequate human capital to benefit from FDI as a channel for international technology diffusion.

Further, Sinani and Meyer (2004) show that the magnitude of the technology spillover effect depends on the characteristics of FDI and of the recipient domestic firm. Additionally, the authors used data from Estonian firms and found that spillovers vary with the ownership structure and are affected by the domestic firm's size and trade orientation. Focusing on innovation improvement, Cheung and Ping (2004) found that FDI has increased the number of domestic patent applications in China.

2.2.3 Effect by Income Level

There is little research exploring the effects of FDI diseggregated the analysis by income level. In the previous empirical literature, scholars had preferred to differentiate countries regarding their "development" - developed countries vs. non-developed - instead of differentiating by the income level of the host countries. One example is the study led by De Vita and Kyaw (2009), where the authors found that only developing countries that have reached a minimum threshold of economic development and absorptive capacity are benefiting from the FDI inflows.

Nevertheless, some authors (Blomstrom et al., 1992; Borensztein et al., 1998) tried to some extent to examine whether the role of the FDI inflows differs based on the country's stage of economic development. In their work, Blomstrom et al. (1992) found the role of FDI on growth is under several factors. Comparing results from low and high-income countries, they found a positive effect in the higher income group, suggesting a threshold level of income in which FDI has significant effects on the host economy growth. This finding is consistent with the idea that only countries that have reached a certain level of economic development have absorbed capacities to benefit from new technologies and their diffusion. This absorptive capacity is correlated with each host country's level of human capital. A country with a well-educated population has a greater chance of having more considerable benefits of newly introduced technologies. Beyond this idea, the recognized work from Borensztein et al. (1998), analyzed the role of FDI on growth. Using a panel data set of 69 developing countries during 1970 and 1989, they showed that the interaction of FDI and human capital had an essential impact on growth. Specifically, this effect was just observed when the level of human capital was high enough.

2.3 Chinese FDI

A new series of research focused on the emerging Chinese outward FDI is surging. In the beginning, this area of research was mainly descriptive (Cai, 1999; Wu and Chen, 2001; Morck et al., 2008). This group of studies has shown that Chinese FDI has a market-seeking strategy on natural resources and new technologies. Additionally, Chinese firms abroad tried to acquire management expertise, capture more financial capital and expand production lines.

More recently, a new wave of it has been evolving: scholars like (Buckley et al., 2007; Cheung and Qian, 2009; Ramasamy et al., 2012) have taken the examination of the determinants of Chinese FDI to an empirical

and aggregate level. The findings are similar to the ones described above. Chinese FDI seems to be correlated with larger markets, abundant in resources, host-country political instability, and cultural affinity.

While the determinants of Chinese OFDI are well examined, the scholarly attention to the impacts of Chinese OFDI has been relatively low. Some recent literature (Deng et al., 2020; Hertenstein et al., 2017; Zhang et al., 2019) has found some positive effects of Chinese FDI in the host country. However, the massive and quick expansion of Chinese FDI has exposed flaws in environmental, social and governance (ESG) issues, and Chinese firms' investment decisions and host-countries' debt structure are also under scrutiny (Wang and Gao, 2019). Both developing and developed host countries have revealed their worries over national security and some Chinese overseas enterprises (some of them state-owned). In addition to the US, many European countries, including Germany, Italy, France, and the UK, have also expressed their concern over China's investment in infrastructure, energy, and, more recently, in high-tech manufacturing sectors (UNCTAD, 2018).

Looking into the Chinese angle, there are also some research analyzing Chinese outward FDI. You (2015), in its work at a regional level, finds that Chinese local government policies and investment in research & development activities have a positive impact on regional investment. Another characteristic was found by Yao et al. (2016). The authors found evidence that a country's lagged inward FDI stock in China has a positive relationship with China's actual outward FDI. In other words, Chinese outward FDI has been partially generated by countries that have investment stocks in China. Furthermore, using MOFCOM's firm-level data from 1998-2009, Chen and Tang (2014) found that Chinese outward FDI helps firms that engage on foreign activities to obtain higher TFP, employment, export intensity, and larger product innovation.

As mentioned above, the effects of Chinese FDI in the host economy remain unclear. Then, the purpose of this thesis is to empirically investigate whether Chinese foreign direct investment can lead to economic effects in the host country, namely productivity benefits and technology transfer.

Combining the above information and notions about the Chinese foreign direct investment and its economic impact, the following hypotheses are formulated:

Hypothesis 1a: *Chinese FDI improves the total factor productivity of the host country.*

Hypothesis 1b: *Chinese FDI improves the technology of the host country.*

Overall, the existing literature states that Chinese FDI tends to be attracted to sizeable markets and regions (Chen and Lin, 2018). However, Buckley et al. (2007); Ramasamy et al. (2012) stated in their work that Chinese OFDI is positively associated with more risky political environments, and the firms tend to be more risk-averse and adopt a market seeking strategy. These characteristics are found in a more significant proportion in lower income economies than higher ones.

Nevertheless, the work from Borensztein et al. (1998); De Vita and Kyaw (2009); Blomstrom et al. (1992) shows that there is a threshold level of economic development and a level of human capital on which the host

country can capture significant effects on its economy. Therefore, in order to empirically investigate whether Chinese foreign direct investment generates different effects across income groups, the following hypothesis is formulated:

Hypothesis 2: *Chinese FDI generates higher productivity effect and technology transfer in lower income economies than in higher income economies.*

2.4 Chinese FDI in the Belt & Road Initiative (BRI) context

The existing literature focused on the economic impact of the BRI is very short. Some of the available studies are mainly descriptive (Johnson, 2016; Tsui et al., 2017), with a general overview of the Chinese outward investments and assessment of the BRI and its benefits to China. Others focused on the connectivity and transport infrastructure effects of the initiative (World Bank, 2019; Wang et al., 2020). The study led by Chen and Lin (2018) was the one that examined with more broadness the economic effects of foreign direct investment among BRI countries. The authors test how the Chinese and non-Chinese investment influence BRI-countries economic growth, including the growth of GDP, TFP, technology, and trade. The main findings were that FDI positively affects GDP, trade, and employment growth, especially for lower-income countries. Also, in this study, the authors did not find a significant impact on TFP and patents application growth.

Furthermore, studies such (Scissors, 2018; Du and Zhang, 2018) examined China's global investment strategy and diversification under the context of the Belt & Road Initiative, inside and outside of the initiative. The findings show that China is diversifying heavily in non-BRI countries, such as Germany, Britain, and the US. Additionally, in an analysis done by Chen and Lin (2018) on the overall Chinese foreign direct investment, using data from China Global Investment Tracker, the authors show that there has been a significant increase since 2013, the year of creation of BRI. Thus, the possibility of creating the BRI to serve as a "global investment platform" is still under a question mark.

Therefore, in order to empirically investigate the "potential role of the initiative in shaping the patterns and effects" (Chen and Lin, 2018), the following hypothesis is formulated:

Hypothesis 3: *Chinese FDI generates higher productivity and technology effects in the host countries after the BRI creation.*

Additionally, it is wondered what is the potential impact of belonging to BRI and how the BRI impacts across income groups. In the same work conducted by Chen and Lin (2018), the authors show that the volume of investment in non-BRI countries has been rising more rapidly than the volume of investment in BRI participants, almost tripled after three years of the BRI creation. However, many BRI countries belong to the less-developed group. China's strong engagement in greenfield investment and construction projects in these countries could help them to reach a higher level of development, hence bringing to the country a higher technological capacity, know-how, and better access to finance (Chen and Lin, 2018).

Therefore, in order to empirically investigate whether being part of the BRI can lead to higher economic effects, the following hypothesis is formulated:

Hypothesis 4a: *Chinese FDI generates higher productivity and technology effects in BRI countries than in non-BRI countries.*

In the same analysis conducted by Chen and Lin (2018), the authors show Chinese FDI trends and patterns between 2005 and 20016. They studied the evolution of outward FDI between developing and developed countries and also compared between BRI and non-BRI countries. However, the analysis did not present an in-depth evolution combined with income levels regarding BRI and non-BRI countries.

Therefore, in order to empirically investigate whether Chinese foreign direct investment generates significantly different effects across income groups, whether the country is a member of the initiative or not, it is formulated the following hypothesis:

Hypothesis 4b: *Chinese FDI generates significantly different effects across income groups, whether is BRI or a non-BRI country.*

3 Data

This section describes the main source of the Chinese FDI and related economics variables on a country level. Table 1 provides a complete list of the main variables that are used in the empirical analysis.

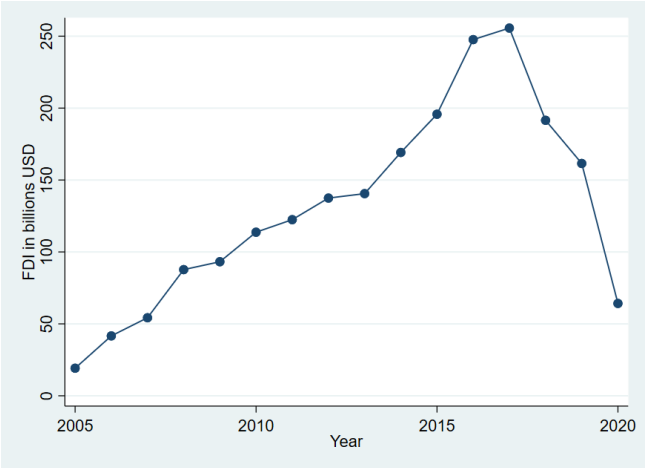
Table 1: Description of the main variables

Abbreviation	Variable	Definition	Source
FDI	Chinese foreign direct investment (FDI)	Annual inflow of Chinese FDI (transactions over $100M)	American Heritage Foundation
Cumulative FDI	Cumulative Chinese FDI	Cumulative Chinese FDI (in $million)	Own calculations
log (Cumulative FDI)	Natural Logarithm of Cumulative FDI	ln Cumulative Chinese FDI (in $million)	Own calculations
FDI/GDP	Cumulative FDI as a share of GDP	Cumulative Chinese FDI (% of GDP)	Own calculations; WDI 2020
PostBRI	Belt & Road Initiative creation	A dummy that takes value 1 if the investment inflow is after the BRI creation, during 2013-2020, and value 0 if it is before BRI creation, during 2005-2012.	Green Belt and Road Initiative Center; American Council of Foreign Relations
PostSign	Participation on Belt & Road Initiative	A dummy variable that takes value 1 if the country had already signed or agreed to belong to the initiative, and value 0 otherwise.	Green Belt and Road Initiative Center; American Council of Foreign Relations
Inc	Level of Income	World Bank's country classifications by income level	World Bank Atlas classification
TFP	Total Factor Productivity	TFP (Cobb-Douglas formula) = (Y/(K^(1-a)*L*a))	Own calculations
Y	GDP	GDP (constant 2010 US$)	World Bank: WDI 2020
K	Capital Stock	Capital stock (constant 2017 national prices)	Penn World Table 10
L	Labor Stock	Labour force (the number of people of working age, defined as being from 15 to 64 years old)	World Bank: WDI 2020
Tech	Tech Transfer	Number of patent applications per 1 million of inhabitants	World Bank: WDI 2020

3.1 Independent Variables

The Chinese FDI data was obtained from China Global Investment Tracker (CGIT), compiled by the American Enterprise Institute and the Heritage Foundation. CGIT includes all the documented Chinese investment transactions (Mergers & Acquisitions or Greenfield) and construction contracts worth 100 million USD or above from 2005 to 2020. The full FDI dataset includes 3524 large transactions in 153 countries across technology, energy, transportation, and other sectors between 2005 and 2020.[1] In this period, these large Chinese FDI transactions totaled 2095.5 billion USD, something like 10% of the actual USA GDP. [2] Using CGIT's aggregate data, Figure 1 plots the evolution of Chinese FDI outflows worldwide. The peak reached in 2017, slightly higher than 2016's value, is consistent with EY (2019).

Figure 1: Trends of Chinese investment transactions and construction contracts



*S*ource: China Global Investment Tracker

[1]The top 10 investments transactions during the analysis' period are reported in the Appendix A
[2]The World Bank (2021)

Table 2: Top 10 Chinese investment destinations since 2005 (cumulative values)

Country	**FDI ($ billion)**	**% of total FDI**
USA	189.28	9,0%
Australia	119.94	5,7%
United Kingdom	98.64	4,7%
Brazil	70.27	3,4%
Switzerland	61.21	2,9%
Pakistan	59.96	2,9%
Canada	57.13	2,7%
Russia	55.97	2,7%
Indonesia	51.57	2,5%
Singapore	48.57	2,3%

Table 3: Top 10 Chinese investment destinations since 2005 (relative values)

Country	**FDI ($ billion)**	**FDI as % of host country GDP**
Sao Tome and Principe	0.95	343%
Laos	27.4	208%
Sierra Leone	5.99	157%
Guinea	11.83	101%
Congo	10.99	94%
Cambodia	16.12	77%
Niger	8.67	66%
Kyrgyzstan	4.73	66%
Antigua and Barbuda	1	66%
Chad	8.28	64%

Table 2 provides the top 10 destination countries for Chinese overseas investment. This selected group totaled 38,8 % of the total FDI analyzed in this sample. A different picture is seen in Table 3: another set of 10 different countries that received large FDI amounts as relative to the host economy. 4 countries exhibited cumulative FDI values higher than their annual GDP in this group.

To divide the sample of countries by income groups, it is used the World Bank Atlas classification (World Bank, 2021)[3]:

1. High income economies, identified with the dummy *hinc*, are those with a GNI per capita of $12.536 or more.

2. Upper middle income economies, identified with the dummy *umidinc*, are those with a GNI per capita between $4.046 and $12.535;

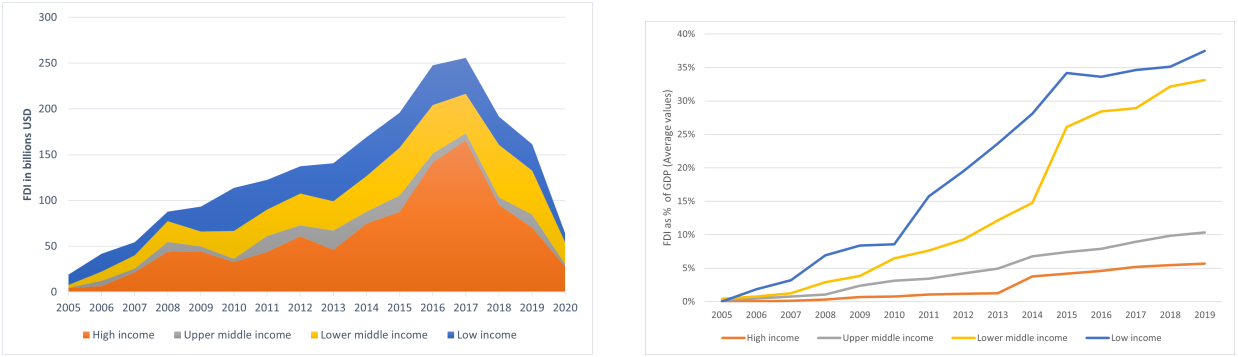
3. Lower middle income economies, identified with the dummy *lmidinc*, are those with a GNI per capita between $1.036 and $4.045;

4. Low income economies, identified with the dummy *linc*, are defined as those with a GNI per capita,, of $1.035 or less;

[3]The list of countries used in the analysis by level of income are shown in Appendix A.

As shown in table 27 presented in the Appendix A, the high income group contains the largest number of countries with 48, representing 31% of the used sample. The upper middle income group contains 38 countries, and the lower middle income group contains 41. The lowest number of countries belongs to the lower income group, with only 26, representing 17% of the used sample. Going more in-depth to the top 10 countries identified above in table 2, the majority (60%) of the economies belong to the high income group. Brazil, Pakistan, Indonesia, and Russia are not part of the upper level. In table 3, the picture is taken from the upside-down. Nine out of ten of the economies belong to the lower income groups. Only Chad is a high income economy.

Figure 2(a) plots the FDI patterns by income group. Between 2005 and 2020, the high income economies group was the most significant recipient of the Chinese investment in 13 out of 16 years. The low income economies were particularly strong in 2005, 2006, and 2010. Figure 2(b) presents the FDI patterns as a relative measure to the host economy by income group. The low and lower middle income groups have reached a significant FDI as a percentage of their GDP. In 2019,[4] using average values of each economy, both groups show around a cumulative FDI/GDP of 35%, i.e., on average, the cumulative Chinese FDI reached more than a 1/3 of the annual GDP of the host economies on these two income groups economies. The upper groups do not show the same relative importance of the Chinese FDI. The upper middle income group reaches 10%, and the high income group reaches 5%.



(a) FDI inflows

(b) FDI/GDP

Figure 2: FDI Patterns by income level

The Belt & Road Initiative data and its official list of the countries by year of joining were obtained from the Green Belt and Road Initiative Center and the American Council of Foreign Relations. Table 4 provides the evolution of the Belt & Road Initiative and its participants. Until 2016, the number of officially engaged countries on the global infrastructure initiative was a small share of the sample. After 2016, the number grew 4-fold and reached 114 countries in 2020 (75% of the sample).

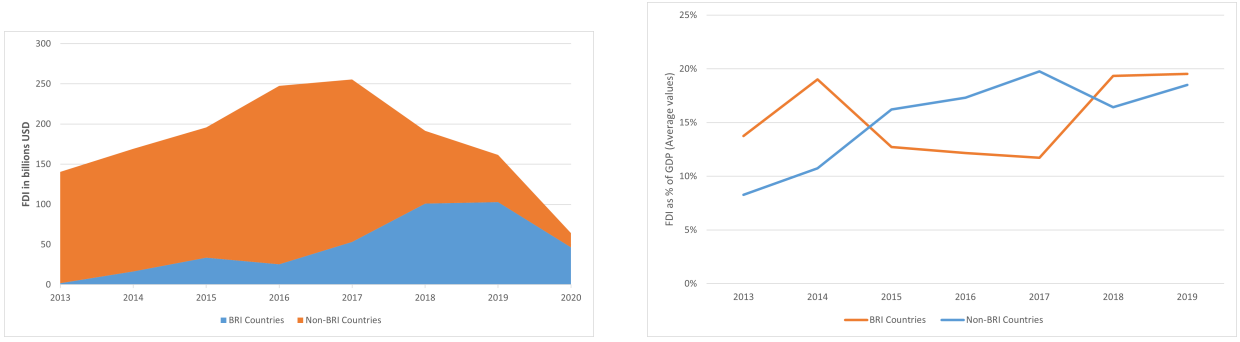
Figure 3(a) provides data about the FDI patterns by BRI and non-BRI countries. FDI inflows in BRI countries grew relative importance after 2016, which resembles the most considerable number of participants. Between 2016 and 2018, the number of participants grew 4-fold, and as well FDI inflows in BRI-Countries

[4]Figures from 2020's GDP were not available at the time of data extraction

Table 4: Belt & Road Initiative: evolution of the number of the participants

Year	Non-participant	Participant
2013	144	9
2014	143	10
2015	129	24
2016	125	28
2017	104	49
2018	54	99
2019	38	115
2020	39	114

also rose 4-fold. FDI inflows in non-BRI countries have fallen after reaching their peak in 2017. FDI inflows in BRI countries are showing greater resistance to the downward trend of Chinese investments than non-BRI countries. Between 2018 and 2020, the BRI Countries outperformed the non-BRI countries. As a result, FDI inflows in non-BRI countries are less than 1/3 of the total Chinese FDI outflows in 2020. Figure 3(b) provides data about the FDI patterns as a relative measure to the host economy by BRI and non-BRI countries. Both BRI countries and non-BRI exhibit a similar FDI level as a percentage of their GDP, reaching almost a cumulative FDI/GDP of 20%. The decomposition of BRI and non-BRI countries by income groups is discussed later in this chapter.



(a) FDI inflows

(b) FDI/GDP

Figure 3: FDI Patterns: BRI vs Non-BRI countries

3.2 Dependent Variables

Since there is no available source for TFP level, the Cobb-Douglas production function is used to construct the variable:

$$\text{TFP} = \frac{Y}{K^{1-\alpha} * L^{\alpha}}, \tag{1}$$

where Y stands for the output, K indicates the capital stock, L represents the labour input, (1-α) is the output elasticity of capital, and α[5] is the output elasticity of labour. Output is measured by real GDP (in 2010 US$) from the World Development Indicators (WDI) 2020 database. The capital stock is measured by Capital stock (in constant 2017 national prices) and is from Penn World Tables (PWT) version 10.0 (Feenstra et al., 2015). The proxy for labor input is the labour force (the number of people of working age, defined as being

[5]Following Ashraf et al. (2016) and common practice in the literature, it is assumed a constant α of 0.6667.

from 15 to 64 years old) retrieved from the WDI 2020 database. Patent applications are used as a proxy for technology transfer. Tech stands for patent applications per 1 million inhabitants and is from the WDI 2020 database.

3.3 Control Variables

The Human capital index, based on years of schooling and returns to education, is retrieved from PWT10 database. The WDI 2020 database is used to retrieve population growth, trade openness, government consumption, and domestic credit data. Both government consumption and domestic credit are measured as a percentage of GDP. The Kaufmann–Kraay–Mastruzzi index measures the political stability and absence of violence, and it is retrieved from the Worldwide Governance Indicators. The property rights data is measured by the property rights index from the Heritage Foundation[6].

Table 5: Description of the Control Variables

Abbreviation	Variable	Definition	Source
Human Capital	Human Capital index	Based on years of schooling and returns to education	PWT10
Population growth	Population growth	Population growth (annual %)	World Bank: WDI 2020
Stability	Stability	Kaufmann–Kraay–Mastruzzi measure of political stability and absence of violence	Worldwide Governance Indicators
Trade	Trade openness	Trade (Sum of exports + imports as a % of GDP)	World Bank: WDI 2020
Gov	Government consumption	General government final consumption expenditure (% of GDP)	World Bank: WDI 2020
Credit	Financial development	Domestic credit to private sector (% of GDP)	World Bank: WDI 2020
Property	Property rights protection	Property rights index, higher values of the index indicate that the country more effectively enforces laws that protect private property	The Heritage Foundation

3.4 Descriptive Statistics

The final and merged dataset yields an unbalanced panel of up to 153 countries with data for the period 2005–2020, in a total of 2448 observations. Table 6 provides summary statistics for the main variables used in the analysis. A relevant set of countries that receive large amounts of Chinese FDI lacks values for the dependent variable TFP. For the Tech variable, a large set of countries, mainly less developed, presents 0 or residual values, which explains the considerable standard deviation value.

Table 6: Summary statistics on the main variables used in the analysis

	Observations	Mean	Sd	Min	Max
FDI	2448	856.00	2440.27	0	53120
Cumulative FDI	2448	5868.92	13809.89	0	189280
log (Cumulative FDI)	1838	7.82	1.61	4.60	12.15
FDI/GDP	2214	0.09	0.25	0	3.87
TFP	2065	7.57	5.66	0.58	50.63
Tech	2448	73.75	303.09	0	3318.62
PostBRI	2448	0.5	0.50	0	1
PostSign	2448	0.18	0.39	0	1
linc	2448	0.17	0.37	0	1
lmidinc	2448	0.27	0.44	0	1
umidinc	2448	0.25	0.43	0	1
hinc	2448	0.31	0.46	0	1
N	2448				

[6]Summary statistics on the control variables used in the analysis are shown in Appendix A

Table 7 provides some descriptive statistics for FDI, TFP, and Tech. This table shows values by income level for the entire sample and four sub-samples. As it is stated, there is considerable change in the four sub-samples. In FDI values, the mean values tend to rise as the level of income rises. As expected, the TFP and Tech mean values also rise as the level of income rises. The opposite happens with FDI/GDP values. The lower income groups have higher FDI/GDP mean values than the higher income groups.

Table 7: Descriptive Statistics by the level of income

	Full Sample	Low	Lower Middle	Upper Middle	High
FDI	856.0 (2440.28)	369.2 (895.99)	775.8 (1514.93)	767.5 (1615.86)	1258.2 (3773.01)
Cumulative FDI	5868.9 (13809.89)	2828.8 (4164.46)	5181.8 (8651.80)	5983.7 (10417.29)	8011.7 (20957.75)
log (Cumulative FDI)	7.8 (1.62)	7.5 (1.34)	7.9 (1.58)	7.9 (1.55)	7.9 (1.82)
FDI/GDP	0.09 (0.25	0.19 (0.28)	0.14 (0.39)	0.05 (0.07)	0.02 (0.08)
TFP	7.6 (5.66)	3.7 (1.45)	3.9 (1.39)	7.4 (6.08)	12.5 (4.95)
Tech	73.75 (303.09)	5.28 (38.93)	6.28 (15.09)	22.37 (42.58)	209.15 (513.55)
N	2448	416	656	608	768

NOTE: This table highlights the mean values and also shows the standard deviation values under parentheses

Table 8 presents descriptive statistics for the same variables again but dividing into three different samples: The 2005-2012 period, i.e., before the BRI creation; and two samples in the period 2013-2020, Non-BRI participant and BRI participant. It shows that FDI mean values before BRI were below than after the creation, whether or not it is part of the initiative. In FDI values, non-BRI countries show a higher mean value than BRI countries. The opposite happens with FDI/GDP, with BRI countries exhibiting a higher mean value than non-BRI countries. The table also shows that the average TFP of a non-BRI participant is higher than that of a BRI participant. The same happens with the average number of patents.

Table 8: Descriptive Statistics by the participation on BRI

	Full Sample	*Before BRI*	*Non-BRI participant*	*BRI participant*
FDI	856.0 (2440.28)	547.1 (1518.82)	1347.1 (3630.67)	849.4 (1659.23)
Cumulative FDI	5868.9 (13809.89)	1883.3 (4535.72)	10060.8 (20905.04)	9497.2 (11951.28)
log (Cumulative FDI)	7.8 (1.62)	7.2 (1.48)	8.1 (1.63)	8.3 (1.49)
FDI/GDP	0.09 (0.25)	0.03	0.14 (0.37)	0.17 (0.26)
TFP	7.6 (5.66)	7.7 (6.07)	8.2 (5.72)	5.7 (2.99)
Tech	73.75 (303.09)	80.40 (307.09)	86.94 (335.41)	32.75 (218.41)
N	2448	1224	776	448

NOTE: This table highlights the mean values and also shows the standard deviation values under parentheses

Table 9 presents the BRI evolution and participants by income group. As said before, the number of participants was residual until 2016. After that, the increased number of countries engaged in the initiative was widespread on every income group. The high income group had four member countries in 2016, increasing almost 5-fold by 2020 to 28 countries. The upper middle income group had one member country in 2016, increasing expressively by 2020 to 20 countries. The low and lower middle income countries were the majority of the initiative members in 2016. Currently, as table 10 shows, they kept the majority but with less

representativeness. The upper income economies represent 42% and the lower income economies 58% of the BRI members. Considering the sample used, the high economies show greater resistance to engaging in the Chinese global infrastructure initiative. In 2020, 42% of the high income economies are not engaged on BRI, while only 21%, 14% and 23% of the upper middle, lower middle and low income economies are not engaged on BRI, respectively. The presence of many high income economies outside of the BRI might help explain the higher FDI, productivity and patents mean values in Non-BRI countries than in BRI countries.

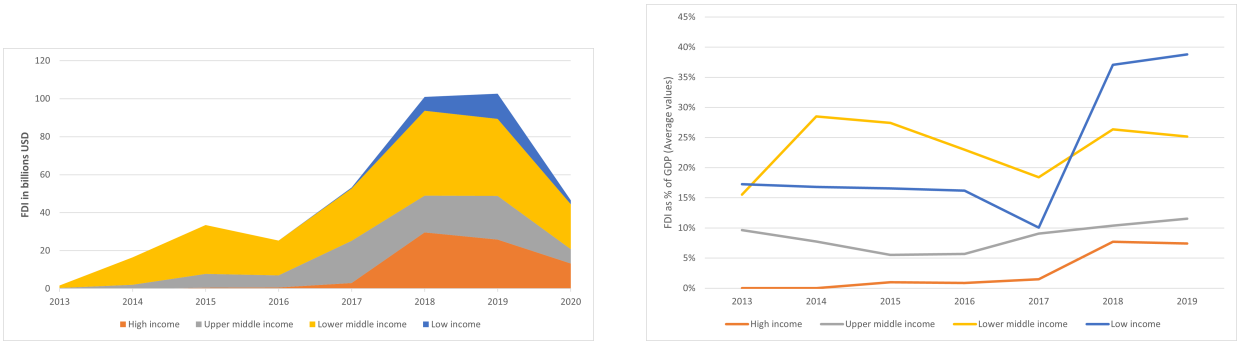
Table 9: BRI: evolution of the number of participants and its decomposition by income level

Level of Income	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
High	0	0	3	4	8	23	28	28
Upper middle	1	1	1	1	4	17	20	20
Lower middle	5	5	8	11	20	32	36	36
Low	3	4	12	12	17	27	31	30
Total	9	10	24	28	49	99	115	114

Table 10: The actual decomposition of BRI and non-BRI countries by income level (2020)

Level of Income	**Participant**	**Non-participant**
High	28	20
Upper-middle	30	8
Lower-middle	36	6
Low	20	6

Figure 4(a) plots the FDI patterns on BRI countries by income group. 2017 was a turning point. Until 2017, the upper and lower middle income groups almost totaled all the FDI inflows. The high income economies started to receive significant investments; however, most of the investments continued to be located in the upper and lower middle income economies. The investment in low income economies was residual in almost the entire period. However, when looking at Figure 4(b), which presents the FDI patterns on BRI countries by income group, the results are the opposite again. Lower income economies tend to have a higher FDI/GDP ratio. Low income economies reached almost 40%, lower middle income economies reached 25%, and the upper income groups were around 10%.

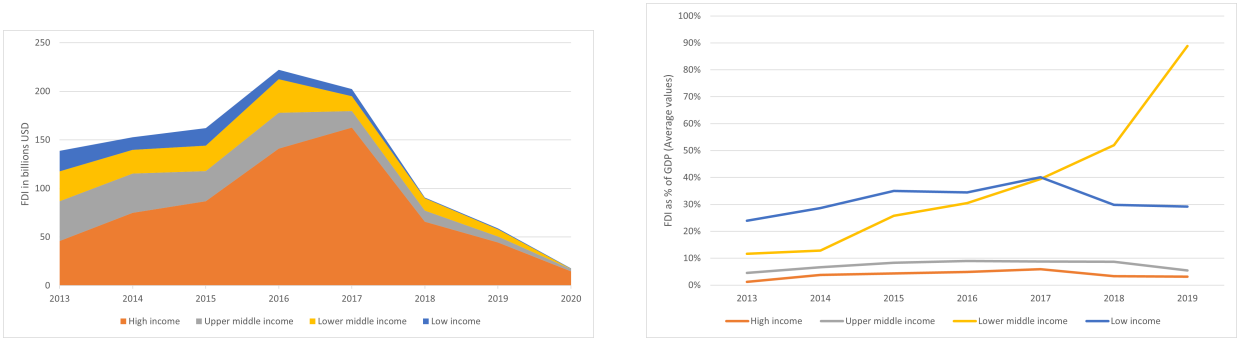


(a) FDI inflows

(b) FDI/GDP

Figure 4: BRI countries: FDI Patterns by income level

Figure 5(a) plots the FDI patterns on non-BRI countries by income group. Non-BRI countries reached their peak of FDI inflows in 2016, mainly due to high income economies (63%). After that, the downward trend has been expressive for all the income groups. Investments in the lower income groups reduced almost to a residual level. The upper income bound also suffered, even though high income economies performed better than upper middle income economies. Figure 5(b) suggests a higher FDI/GDP ratio in the lower income groups again. This time, the lower middle income group reached a ratio of 90%, mainly due to the expressive values of Sao Tome and Principe and Laos.



(a) FDI inflows

(b) FDI/GDP

Figure 5: Non-BRI countries: FDI Patterns by income level

Zooming in on Chinese FDI, table 11 shows the cumulative values by level of income and before and after the BRI creation. When separating the value of FDI by pre-BRI and post-BRI period, i.e., 2005-2012 and 2013-2020, the post-BRI's cumulative FDI value has more than double compared to the pre-BRI period. However, this happened mainly because of large transactions in non-BRI participants, accounting for 73% of the total investment in 2013-2020. In addition, high income and upper middle income groups almost represent 70% of the total Chinese FDI in all the sample (2005-2020). In the post-BRI period, the high income group was the one that attracted more investment. However, looking into BRI countries,the lower middle income group received the most investment.

Final remarks:

1) Different measures for FDI show different interpretations and the size of the host economies matters: When analyzing absolute values for FDI, the upper income group totaled almost 70% of the total FDI; when analyzing relative values for FDI, the lower income group shows FDI/GDP ratios more than 3x higher to the upper income group.

2) After the BRI creation, China has accelerated the investment pace, mainly in non-BRI countries. Non-BRI countries account for 73% of the post-BRI period.

3) BRI Evolution: Until 2017, BRI was mainly composed of low and lower middle income economies. Then, upper income economies also joined the initiative at a larger scale, pushing the combined investment on the initiative upward.

4) BRI took five years to start to have actual investment patterns implications: BRI countries outperformed non-BRI countries between 2018-2020, amongst a global Chinese investment downward trend. 2018 is also the year that BRI countries overtook tnon-BRI countries.

5) BRI countries: lower middle income economies are the main recipient, even after 2017.

6) Non-BRI countries: only high income economies resisted to the downward trend after 2017.

Table 11: Foreign Direct Investment: Cumulative values by Level of income and BRI (in $billion)

	2005-2012	*2005-2012 (%)*	*2013-2020*	*2013-2020 (%)*	*2005-2020*	*%*
Low Income	59.3	8,9%	94.3	6,6%	153.6	7,3%
Lower Middle Income	160.5	24,0%	348.4	24,4%	508.9	24,3%
Upper Middle Income	191.9	28,7%	274.7	19,3%	466.7	22,3%
High Income	257.8	38,5%	708.5	49,7%	966.3	46,1%
Total	669.6		1 425.9		2 095.5	
Non-BRI Countries			1 045.4	73%		
Low Income			71.1	5%		
Lower Middle Income			152.1	11%		
Upper Middle Income			186.3	13%		
High Income			635.9	45%		
BRI Countries			380.5	27%		
Low Income			23.2	2%		
Lower Middle Income			196.3	14%		
Upper Middle Income			88.4	6%		
High Income			72.6	5%		

4 Empirical Analysis

4.1 Methodology

In order to examine how investment inflows influence the host economy's productivity and technology, panel data are better suited to account for the fact that effects take time to diffuse through the economy. Panel data estimation allows controlling for time-invariant country-specific effects, therefore helping to reduce the potential omitted variable bias. The work from Alfaro et al. (2004); Chen and Lin (2018); Ashraf et al. (2016) is combined to construct the baseline analysis. Firstly, Model 1 employs a fixed effects (FE) regression for the total factor productivity effect and secondly, Model 2 also employs a FE regression for the technology transfer effect. With a specification similar to the work mentioned above, the following equations are estimated:

$$TFP_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \quad \text{(Model 1)}$$

$$Tech_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \quad \text{(Model 2)}$$

where t = 2005, 2006,.., 2020, is the time index, and i = 1,2,...,153 is the country index. TFP_{ij} stands for the total factor productivity of capital and labour of the country i at year t in Model 1 and $Tech_{ij}$ stands for the number of patent applications per 1 million of inhabitants of the host country i at year t in Model 2. FDI has two alternative measures: an absolute, $Log(CumulativeFDI)$ and a relative, FDI/GDP. $Log(CumulativeFDI)$ is the natural logarithm of the cumulative value of total investment inflow in year t and country i. FDI/GDP is the cumulative value of total investment flow as a share of GDP in year t and country i. The use of two alternatives measures for FDI strengthens the robustness of the empirical analysis; hence, just using the absolute measure, $Log(CumulativeFDI)$, provides a measure for the overall size of the Chinese FDI in the country without distinguishing between the different size of the host economies. Following Alfaro et al. (2004); Chen and Lin (2018) work, the value of both FDI measures is lagged by one year.

X_{ij} is a vector of the control variables that might affect the economic outcomes of interest. Following Ashraf et al. (2016) work, the baseline model controls for human capital (Human Capital), population growth (Population Growth), and the Kaufmann–Kraay–Mastruzzi measure of political stability and absence of violence (Stability) is added as well. θ_i captures the fixed effect that accounts the individual heterogeneity. ω_t represents a time dummy variable added to capture aggregate macroeconomic shocks that may affect all countries likewise. ϵ_{it} represents the error term. The same work by Ashraf et al. (2016) is used as a guide for further robustness checks. The set of control variables is expanded to incorporate trade openness (Trade), government consumption (Gov), financial development (Credit) and, finally, an index of property rights protection (Property).

Additionally to the baseline models, it is further examined how these effects vary between different income groups. To test hypothesis 2, it is used the interaction terms between FDI and the four dummies referring to the income levels.

$$\begin{aligned} TFP_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * FDI_{-1} \text{ x linc} + \beta_3 * FDI_{-1} \text{ x lmidinc} \\ + \beta_4 * FDI_{-1} \text{ x umidinc} + \beta_5 * FDI_{-1} \text{ x hinc} + \beta_6 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \end{aligned} \quad \text{(Model 3)}$$

$$\begin{aligned} Tech_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * FDI_{-1} \text{ x linc} + \beta_3 * FDI_{-1} \text{ x lmidinc} \\ + \beta_4 * FDI_{-1} \text{ x umidinc} + \beta_5 * FDI_{-1} \text{ x hinc} + \beta_6 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \end{aligned} \quad \text{(Model 4)}$$

where *linc* is a dummy variable that takes value 1 if the country has a low income classification, and value 0 otherwise. *lmidinc* is a dummy variable that takes value 1 if the country has a lower middle income classification, and value 0 otherwise. *umidinc* is a dummy variable that takes value 1 if the country has a upper middle income classification, and value 0 otherwise. *hinc* is a dummy variable that takes value 1 if the country has a high income classification, and value 0 otherwise.

In a second analysis, it is further investigated whether the creation of the BRI impacted Chinese's FDI effects on host economies at a global scale. To test hypotheses 3, it is used the interaction terms between FDI and a dummy referring to the BRI creation. To ensure that the interaction terms do not bring correlation issues, the dummy variable is also included.

$$TFP_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * FDI_{-1} \text{ x PostBRI} + \beta_3 * \text{PostBRI} + \beta_4 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \quad \text{(Model 5)}$$

$$Tech_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * FDI_{-1} \text{ x PostBRI} + \beta_3 * \text{PostBRI} + \beta_4 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \quad \text{(Model 6)}$$

where *PostBRI* is a dummy that takes value 1 if the investment inflow is after the BRI creation, during 2013-2020, and value 0 if it is before BRI creation, during 2005-2012.

In a third analysis, it is examined whether belonging to the B&R Initiative significantly impacts these FDI effects. To test the hypotheses 4a, it is used the interaction terms between FDI and one dummy referring to whether the country is a signatory of the initiative or not. Following the above model specification, is it also included the dummy variable *PostSign*.

$$TFP_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * FDI_{-1} \text{ x PostSign} + \beta_3 * \text{PostSign} + \beta_4 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \quad \text{(Model 7)}$$

$$Tech_{it} = \beta_0 + \beta_1 * FDI_{-1} + \beta_2 * FDI_{-1} \text{ x PostSign} + \beta_3 * \text{PostSign} + \beta_4 * X_{it} + \theta_i + \omega_t + \epsilon_{it}, \quad \text{(Model 8)}$$

where *PostSign* is a dummy variable that takes value 1 if the country had already signed or agreed to belong to the initiative, and value 0 otherwise. Ultimately, to examine whether being part of the B&R Initiative impacts significantly across the same level of income, it is used Model 7 and Model 8 again, but, this time, dividing the full sample in four sub-samples, for each of level of income, using the four dummies referred above - *linc*, *lmidinc*, *umidinc*, *hinc*.

4.2 Estimation results using an absolute FDI measure: Log (Cumulative FDI)

4.2.1 Baseline Results

Total Factor Productivity

Table 12 presents the first baseline results for the effect of FDI on TFP, with the estimation of Model 1 using a fixed effects estimator.

Regressions in Table 12[7] examine the effects of Chinese FDI on Total Factor Productivity (TFP) in 137 countries over the period 2005-2020. The most basic regression estimation results are provided in column (1) of Table 12. In columns (2), (3), and (4), it is added some country development indicators, in (2) the years of schooling and returns to education as a proxy for Human Capital, in (3) the population growth and finally, in (4) the Kaufmann–Kraay–Mastruzzi measure of political stability and absence of violence. Therefore, for robustness check, I add an expanded group of control variables that include trade openness (Trade), government consumption expenditures (Gov), domestic credit to the private sector (Credit), and, finally, an index of property rights protection (Property). These results are seen in column (5).

The coefficients for the main variable of interest, the natural logarithm of cumulative Chinese foreign direct investment, are positive in all of the model specifications but insignificant in columns (1) to (4). However, in column (5) is significant at 10% level. Then, these results partially support hypothesis 1a: Chinese FDI has a positive impact on TFP. Turning to the control variables, Human Capital shows negative and insignificant values in columns (2) to (4). In column (5), the coefficient sign is positive but still insignificant. This is consistent with some previous studies that do not find a significant effect of human capital on TFP (Miller and Upadhyay, 2000; Alfaro et al., 2009; Baltabaev, 2014). Also in Table 12, the results show that population growth and stability are significantly positively related to TFP. Additionally, only property rights are insignificant concerning the additional set of controls. Trade openness, government expenditures and financial development show negative signs and 10%, 10%, and 1% significance levels, respectively.

[7]The explanation for the reduced, when compared to the summary statistics, and decreasing number of observations as the set of variables extends is threefold:(1) A relevant set of countries that receive large amounts of Chinese FDI is lacking values for the dependent variable TFP. (2) The set of control variables used are not completely available for the entire sample of countries. (3) FDI is lagged by one year, what excludes 2005 and 2020 observations out from the regressions.

Table 12: The Effects of Chinese FDI on TFP (1)

	(1)	(2)	(3)	(4)	(5)
ln (Cumulative FDI)	0.09	0.03	0.03	0.04	0.06*
	[0.05]	[0.05]	[0.04]	[0.04]	[0.03]
Human Capital		-0.79	-0.24	-0.21	0.48
		[0.99]	[0.79]	[0.78]	[0.48]
Population Growth			0.22**	0.22**	0.30***
			[0.08]	[0.08]	[0.05]
Stability				0.20*	0.25***
				[0.10]	[0.07]
Trade					-0.00*
					[0.00]
Gov					-0.06*
					[0.03]
Credit					-0.01***
					[0.00]
Property					0.00
					[0.00]
Constant	7.48***	9.70***	7.92***	7.87***	7.33***
	[0.32]	[2.54]	[2.06]	[2.02]	[1.16]
Observations	1,406	1,258	1,258	1,258	1,093
R-squared	0.035	0.025	0.134	0.141	0.362
Number of Countries	137	121	121	121	117
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes

*l*n (Cumulative FDI) is lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Technology Transfer

Table 13 presents the first baseline results for the effect of FDI on technology transfer, with the estimation of the Model 2 using a fixed effects estimator.

Regressions in table 13[8] examine the effects of Chinese FDI on Technology Transfer in 153 countries over the period 2005-2020. The estimation results of the most basic regression are provided in column (1) of Table 13. Columns (2) to (5) follow the same model specifications as mentioned above for 12. The coefficients for the main variable of interest, the natural logarithm of cumulative Chinese foreign direct investment, have all a negative sign. In column (1), FDI is significant at 10% level, but as it is included control variables in columns (2) to (5), the coefficient becomes insignificant. Surprisingly, higher levels of cumulative Chinese FDI are associated with lower levels of patents applications per capita. Then, the results do not show evidence that supports hypothesis 1b.

Turning to the control variables, Human Capital, as largely expected, shows positive and significant values in all of the model specifications. These results are in line with the research that shows that host countries must be endowed with sufficient human capital to benefit from FDI as a channel for international technology diffusion (Xu and Wang, 2000). Financial development shows a positive sign on a 10% significance level, acting as a necessary contingent for the absorptive capacity of host countries to receive new technologies (Durham, 2004). On the opposite side, Trade openness shows a negative association with patents applications on the host countries on a 5% significance level. Finally, population growth and stability show insignificant values in all of the model specifications.

[8]The explanation for the reduced and decreasing number of observations is the same mentioned above, less the one related to TFP.

Table 13: The Effects of Chinese FDI on Technology Transfer (1)

	(1)	(2)	(3)	(4)	(5)
ln (Cumulative FDI)	-12.19*	-3.75	-3.74	-3.75	-3.08
	[7.22]	[3.24]	[3.24]	[3.24]	[3.05]
Human Capital		78.62***	77.31***	77.06***	69.08***
		[27.61]	[27.34]	[27.67]	[25.48]
Population growth			-0.49	-0.37	0.30
			[0.99]	[1.03]	[0.92]
Stability				-2.16	-7.24
				[4.40]	[6.46]
Trade					-0.41**
					[0.17]
Gov					-0.73
					[0.63]
Credit					0.16*
					[0.09]
Property					-0.21
					[0.29]
Constant	139.67***	-78.53	-74.27	-74.16	0.10
	[37.15]	[61.33]	[60.99]	[62.05]	[51.59]
Observations	1,685	1,287	1,287	1,287	1,095
R-squared	0.059	0.050	0.050	0.051	0.070
Number of Countries	153	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes

*l*n (Cumulative FDI) is lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.2.2 Differences between income groups

As indicated by hypothesis 2, it is expected that Chinese FDI could generate a higher economic effect in lower income economies than in higher income economies. To examine that, it is created four interaction terms - FDI x linc, FDI x lmidinc, FDI x umidinc, FDI x hinc - to test whether Chinese FDI impacts more in lower income economies comparing to the highest level. Table 14 presents the results for both TFP and Technology Transfer in columns (1) to (5) and (6) to (10), respectively. The robustness checks are stated in columns (5) and (10), respectively.

Total Factor Productivity

For TFP, the coefficients of the interaction terms show no evidence to support hypothesis 2, with all the coefficients being insignificant in all of the model specifications in columns (1) to (5). Following the results of the baseline analysis, only Population growth and Stability are significantly positively related to TFP. In the robustness check, the coefficient on the natural logarithm of cumulative Chinese foreign direct investment remains insignificant, which does not resemble previous results of table 12. All of the additional controls have resembles results with previous results of the baseline analysis.

Technology Transfer

For Technology Transfer, the interaction terms show significant values without controls. However, as the control set is enlarged, the interaction terms lose their significance. Human Capital exhibits a positive and significant coefficient in all the model specifications. Compared to the baseline analysis on table 13, the main difference is related to the financial development coefficient. Credit maintains its positive sign but loses its

Table 14: The Effects of Chinese FDI and its Economic Impact: Income level analysis (1)

	TFP					Technology Transfer				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln (Cumulative FDI)	0.01	-0.02	0.02	0.02	0.07	-26.81**	-7.46	-7.65	-7.63	-6.50
	[0.07]	[0.06]	[0.05]	[0.05]	[0.04]	[12.95]	[6.59]	[6.74]	[6.75]	[7.34]
FDI x linc	0.12	0.10	0.03	0.04	-0.01	29.71**	7.42	7.64	7.43	7.19
	[0.12]	[0.13]	[0.11]	[0.10]	[0.08]	[12.81]	[7.33]	[7.52]	[7.58]	[8.70]
FDI x lmidinc	0.17	0.12	0.04	0.03	0.01	27.83**	7.93	8.40	8.43	7.10
	[0.11]	[0.10]	[0.08]	[0.08]	[0.06]	[12.51]	[7.46]	[7.85]	[7.85]	[9.45]
FDI x umidinc	0.07	0.10	0.01	0.01	-0.08	25.34**	5.18	5.65	5.72	4.49
	[0.13]	[0.13]	[0.09]	[0.09]	[0.06]	[12.55]	[7.39]	[7.78]	[7.78]	[8.95]
Human Capital		-0.79	-0.24	-0.20	0.56		79.93***	76.34**	76.04**	70.42**
		[1.05]	[0.83]	[0.81]	[0.45]		[30.40]	[30.15]	[30.52]	[27.04]
Population Growth			0.22**	0.21**	0.31***			-1.30	-1.21	-0.67
			[0.08]	[0.08]	[0.04]			[1.46]	[1.50]	[1.79]
Stability				0.20*	0.26***				-1.76	-6.39
				[0.11]	[0.08]				[4.69]	[6.72]
Trade					-0.00*					-0.39**
					[0.00]					[0.18]
Gov					-0.06*					-0.67
					[0.03]					[0.66]
Credit					-0.01***					0.11
					[0.00]					[0.10]
Property					0.00					-0.31
					[0.00]					[0.39]
Constant	7.43***	9.60***	7.91***	7.85***	7.17***	110.61***	-86.62	-75.44	-75.12	-2.59
	[0.29]	[2.59]	[2.11]	[2.07]	[1.06]	[22.14]	[70.10]	[70.29]	[71.23]	[56.53]
Observations	1,406	1,258	1,258	1,258	1,093	1,685	1,287	1,287	1,287	1,095
R-squared	0.050	0.035	0.135	0.142	0.367	0.078	0.067	0.068	0.068	0.080
Number of Countries	137	121	121	121	117	153	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

significance. Overall, for both cases, the results show no evidence that supports hypothesis 2.

4.2.3 Belt & Road Initiative as an "Investment platform"

As indicated by hypothesis 3, it is expected that Chinese FDI could generate a higher economic effect in the host countries after the BRI creation. These expectations come along with the fact that the Chinese FDI has expanded widely between 2013-2020 period, compared to 2005-2013. To examine that, it is included PostBRI, a dummy that takes value 1 if the investment inflow is after the BRI creation, and the interaction term between the main variable of interest and PostBRI, FDI x PostBRI. Table 15 presents the results for both TFP and Technology Transfer in columns (1) to (5) and (6) to (10), respectively. The robustness checks are stated in columns (5) and (10), respectively.

Total Factor Productivity

Regarding TFP, the interaction term FDI x PostBRI and PostBRI show significant values without controls. However, as it is added a larger control set, both the interaction term and the initiative dummy lose their significance, maintaining the same sign. Population growth, stability, government consumption and financial development maintain their significant results. Overall, there is no evidence that Chinese FDI generated a higher TFP impact after the BRI creation.

Table 15: The Effects of Chinese FDI and its Economic Impact: BRI as an "investment platform" (1)

	TFP					Technology Transfer				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln (Cumulative FDI)	0.03	-0.00	-0.00	0.00	0.05	-12.68	-5.44	-5.44	-5.45	-5.11
	[0.06]	[0.05]	[0.05]	[0.05]	[0.04]	[8.58]	[4.24]	[4.24]	[4.23]	[4.28]
FDI x PostBRI	0.12**	0.08	0.08	0.07	0.02	0.95	3.74	3.74	3.77	3.97
	[0.06]	[0.05]	[0.05]	[0.05]	[0.04]	[3.09]	[3.14]	[3.14]	[3.15]	[3.70]
PostBRI	-1.64***	-0.73	-0.72	-0.72	-0.26	-37.57*	-37.15*	-37.25*	-37.58*	-38.40*
	[0.63]	[0.56]	[0.55]	[0.55]	[0.33]	[22.26]	[19.30]	[19.32]	[19.57]	[20.10]
Human Capital		-0.81	-0.26	-0.23	0.46		77.47***	76.14***	75.85***	66.34***
		[0.97]	[0.77]	[0.75]	[0.48]		[26.58]	[26.33]	[26.69]	[24.74]
Population Growth			0.22***	0.22**	0.30***			-0.50	-0.36	0.08
			[0.08]	[0.08]	[0.05]			[0.94]	[0.98]	[1.03]
Stability				0.19*	0.25***				-2.43	-7.47
				[0.10]	[0.07]				[4.44]	[6.48]
Trade					-0.00					-0.38**
					[0.00]					[0.17]
Gov					-0.06*					-0.72
					[0.03]					[0.60]
Credit					-0.01***					0.14
					[0.00]					[0.11]
Property					0.00					-0.21
					[0.00]					[0.28]
Constant	7.85***	9.98***	8.20***	8.14***	7.41***	142.82***	-64.53	-60.16	-59.93	18.81
	[0.34]	[2.49]	[2.00]	[1.97]	[1.21]	[45.94]	[59.09]	[59.05]	[60.19]	[57.93]
Observations	1,406	1,258	1,258	1,258	1,093	1,685	1,287	1,287	1,287	1,095
R-squared	0.051	0.033	0.142	0.148	0.362	0.059	0.057	0.057	0.058	0.077
Number of Countries	137	121	121	121	117	153	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Technology Transfer

Concerning Technology Transfer now, the results show a negative and significant (at a 10% level) association between the creation of the Belt & Road Initiative and the number of patents application per capita, regardless of whether the controls are included or not. However, the interaction term FDI x PostBRI shows a positive but not significant coefficient, implying that the BRI creation does not play a significant role in technology transfer via Chinese FDI. Overall, there is no evidence that supports hypothesis 3 from neither the TFP nor Technology transfer effect.

4.2.4 BRI countries vs non-BRI countries

As indicated by hypothesis 4a, it is expected that Chinese FDI could generate a higher economic effect on BRI participant countries than on non-participant BRI countries. These expectations come along with the strengthening of political ties between China and the BRI participant countries and the economic involvement within the countries inside of the initiative. To examine that, it is included PostSign, a dummy variable that takes value 1 if the country belongs to the Belt & Road Initiative, and the interaction term between the main variable of interest and PostSign, FDI x PostSign. Table 16 presents the results for both TFP and Technology Transfer in columns (1) to (5) and (6) to (10), respectively. The robustness checks are stated in columns (5) and (10), respectively.

Table 16: The Effects of Chinese FDI and its Economic Impact: BRI vs Non-BRI countries(1)

	TFP					Technology Transfer				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln (Cumulative FDI)	0.08	0.04	0.03	0.04	0.06*	-11.91*	-3.74	-3.73	-3.73	-3.15
	[0.05]	[0.05]	[0.04]	[0.04]	[0.03]	[7.10]	[3.19]	[3.19]	[3.19]	[3.06]
FDI x PostSign	0.02	-0.01	-0.00	-0.01	-0.04	0.64	2.01	1.99	2.04	1.58
	[0.06]	[0.05]	[0.05]	[0.05]	[0.03]	[4.38]	[1.55]	[1.54]	[1.58]	[1.60]
PostSign	-0.15	0.14	0.02	0.05	0.38*	14.91	-8.85	-8.54	-8.87	-4.85
	[0.48]	[0.39]	[0.38]	[0.39]	[0.22]	[26.36]	[11.31]	[11.25]	[11.51]	[11.87]
Human Capital		-0.79	-0.24	-0.21	0.49		77.91***	76.40***	76.09***	66.28***
		[1.00]	[0.80]	[0.78]	[0.49]		[26.67]	[26.33]	[26.72]	[23.87]
Population Growth			0.22**	0.22**	0.30***			-0.56	-0.42	-0.02
			[0.09]	[0.08]	[0.05]			[0.96]	[1.00]	[0.93]
Stability				0.20*	0.25***				-2.53	-7.31
				[0.10]	[0.07]				[4.47]	[6.53]
Trade					-0.00*					-0.42**
					[0.00]					[0.17]
Gov					-0.06*					-0.61
					[0.03]					[0.62]
Credit					-0.01***					0.14
					[0.00]					[0.09]
Property					0.00					-0.28
					[0.00]					[0.32]
Constant	7.49***	9.70***	7.91***	7.86***	7.27***	138.61***	-76.28	-71.36	-71.18	10.88
	[0.31]	[2.55]	[2.06]	[2.03]	[1.18]	[37.22]	[59.10]	[58.65]	[59.87]	[49.25]
Observations	1,406	1,258	1,258	1,258	1,093	1,685	1,287	1,287	1,287	1,095
R-squared	0.036	0.025	0.134	0.141	0.364	0.062	0.056	0.056	0.057	0.075
Number of Countries	137	121	121	121	117	153	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Total Factor Productivity

Regarding TFP, the interaction term FDI x PostSign exhibits insignificant results in all the model specifications. PostSign and FDI are only significant in column (5). These results imply that there is no distinction between the Chinese FDI effect on TFP on BRI countries compared to non-BRI countries.

Technology Transfer

Turning to the technology transfer effect, both interaction term FDI x PostSign and dummy PostSign show insignificant coefficients in all the model specifications. FDI has a negative and significant relationship with patents applications in the first model specification. However, after controlling for the participation on the BRI and remaining control variables, the coefficients remain negative but become insignificant. Overall, both results do not support hypothesis 4a.

4.2.5 BRI countries vs non-BRI countries: Differences between income groups

As indicated by hypothesis 4b, it is expected different effects across different income levels, whether the country belongs to the BRI or not. To examine that, the entire sample is divided into four sub-samples as seen in Table 17 and Table 18. As done above, it is also included the interaction term FDI x PostSign and the dummy PostSign. The first column of each sample includes the first set of controls and the second column checks the robustness with an extended control set.

Table 17: The Effects of Chinese FDI on TFP by Income level: BRI vs Non-BRI countries (1)

	Full Sample		**Low income**		**Lower middle income**		**Upper middle income**		**High income**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln (Cumulative FDI)	0.04	0.06*	0.08	0.02	-0.08	-0.04	-0.02	-0.03	0.16*	0.14**
	[0.04]	[0.03]	[0.10]	[0.06]	[0.05]	[0.04]	[0.06]	[0.06]	[0.09]	[0.06]
FDI x PostSign	-0.01	-0.04	-0.04	-0.07	0.07	0.07	-0.03	-0.03	-0.18	-0.19***
	[0.05]	[0.03]	[0.07]	[0.06]	[0.05]	[0.06]	[0.04]	[0.03]	[0.13]	[0.05]
PostSign	0.05	0.38*	0.07	0.54	-0.41	-0.36	0.43	0.43	0.91	1.23***
	[0.39]	[0.22]	[0.56]	[0.47]	[0.36]	[0.49]	[0.27]	[0.26]	[1.00]	[0.36]
Human Capital	-0.21	0.49	-1.35	0.52	1.72*	1.97*	-2.13**	-0.87*	0.53	0.12
	[0.78]	[0.49]	[1.40]	[1.00]	[0.90]	[1.11]	[0.98]	[0.47]	[1.52]	[0.83]
Population Growth	0.22**	0.30***	0.30	0.17	0.10	0.11	0.18**	0.09	0.19*	0.24***
	[0.08]	[0.05]	[0.25]	[0.18]	[0.25]	[0.25]	[0.09]	[0.09]	[0.10]	[0.05]
Stability	0.20*	0.25***	0.44**	0.26**	0.21*	0.29**	0.04	0.08	0.25	0.45
	[0.10]	[0.07]	[0.17]	[0.09]	[0.11]	[0.12]	[0.21]	[0.14]	[0.68]	[0.28]
Trade		-0.00*		-0.01***		-0.00		0.00		-0.01**
		[0.00]		[0.00]		[0.00]		[0.00]		[0.00]
Gov		-0.06*		0.02		-0.03		0.00		-0.19***
		[0.03]		[0.03]		[0.02]		[0.03]		[0.06]
Credit		-0.01***		-0.01		-0.01***		0.01***		-0.00
		[0.00]		[0.01]		[0.00]		[0.00]		[0.00]
Property		0.00		0.00		-0.01		0.01***		0.01
		[0.00]		[0.01]		[0.01]		[0.00]		[0.01]
Constant	7.86***	7.27***	4.62	2.58	0.67	0.50	12.70***	8.19***	10.88**	16.33***
	[2.03]	[1.18]	[2.71]	[1.87]	[1.90]	[2.13]	[2.47]	[1.16]	[4.85]	[2.91]
Observations	1,258	1,093	189	150	350	295	303	275	416	373
R-squared	0.141	0.364	0.365	0.450	0.163	0.365	0.240	0.311	0.224	0.601
Number of Countries	121	117	18	16	33	32	27	27	43	42
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Total Factor Productivity

Table 17 presents the results for the effects of Chinese FDI on TFP by income level, whether the host country is a BRI participant or not. The results vary by level of income. Analyzing the high income sample, both FDI, Post Sign, and interaction term FDI x PostSign show significant values in column (10). However, the interaction term is the only one with a negative sign, which implies that a high income economy does not have TFP benefits via Chinese FDI to join the BRI. Analyzing the upper middle income sample, the interaction term shows a negative but insignificant result. Surprisingly, human capital exhibits a significant negative sign. The lower middle and low income sample show insignificant coefficients for the interaction term. The lower middle income group, the one that receives the most BRI investment in the period analyzed, is the only one exhibiting positive sign but insignificant. Ultimately, both low and lower middle income sample exhibits a positive and significant role of stability on TFP performance. This outcome finds partial evidence to support hypothesis 4b for TFP impact, namely for high income economies.

Technology Transfer

Table 18 presents the results for the effects of Chinese FDI on Technology Transfer by income level, whether the host country is a BRI participant or not. Both interaction terms and the BRI dummy are insignificant in all the income groups, so it is not possible to find evidence of differences in technology diffusion between BRI countries and non-BRI countries across income groups.

Table 18: The Effects of Chinese FDI on Technology Transfer by Income level: BRI vs Non-BRI countries (1)

	Full Sample		**Low income**		**Lower middle income**		**Upper middle income**		**High income**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln (Cumulative FDI)	-3.73	-3.15	-0.18	0.02	-0.36	-0.56	2.02	1.87	-7.24	-7.65
	[3.19]	[3.06]	[0.17]	[0.04]	[0.44]	[0.36]	[2.43]	[2.39]	[5.48]	[4.86]
FDI x PostSign	2.04	1.58	-0.01	0.00	0.13	-0.55	-1.88	-1.13	6.23	5.85
	[1.58]	[1.60]	[0.08]	[0.06]	[0.87]	[0.98]	[1.48]	[1.85]	[4.96]	[6.98]
PostSign	-8.87	-4.85	-0.65	0.09	1.14	7.12	16.73	12.50	-31.24	-25.92
	[11.51]	[11.87]	[0.97]	[0.41]	[9.40]	[10.54]	[11.63]	[14.25]	[35.02]	[48.96]
Human Capital	76.09***	66.28***	3.07	1.17	-0.95	-1.44	44.71	-7.73	136.47***	81.04
	[26.72]	[23.87]	[2.37]	[1.18]	[4.41]	[5.13]	[33.84]	[21.00]	[39.05]	[55.60]
Population Growth	-0.42	-0.02	0.01	-0.14	3.40*	5.47*	2.32	2.07	0.29	-2.02
	[1.00]	[0.93]	[0.15]	[0.11]	[1.93]	[2.72]	[1.92]	[1.74]	[2.74]	[3.71]
Stability	-2.53	-7.31	-0.78	-0.12	1.12	1.01	-0.84	-7.74	-63.26	-78.85*
	[4.47]	[6.53]	[0.53]	[0.07]	[1.09]	[1.01]	[8.87]	[6.15]	[39.75]	[44.79]
Trade		-0.42**		0.00		-0.04		0.09		-1.26*
		[0.17]		[0.00]		[0.05]		[0.10]		[0.70]
Gov		-0.61		-0.01		0.20		0.04		-2.58
		[0.62]		[0.01]		[0.14]		[1.02]		[2.73]
Credit		0.14		-0.00		0.04		0.46*		-0.28
		[0.09]		[0.01]		[0.05]		[0.24]		[0.27]
Property		-0.28		-0.00		0.03		-0.21*		-1.26
		[0.32]		[0.00]		[0.09]		[0.12]		[1.23]
Constant	-71.18	10.88	0.95	-2.00	4.84	5.69	-110.43	-0.09	-67.13	444.48
	[59.87]	[49.25]	[3.64]	[1.93]	[10.29]	[12.05]	[84.85]	[45.83]	[93.23]	[308.84]
Observations	1,287	1,095	203	152	350	295	318	275	416	373
R-squared	0.057	0.075	0.275	0.863	0.114	0.172	0.093	0.101	0.133	0.181
Number of Countries	123	118	19	17	33	32	28	27	43	42
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

4.3 Estimation results using a relative FDI measure: Cumulative FDI as a share of GDP

4.3.1 Baseline Results

Total Factor Productivity

Table 19 presents the second baseline results for the effect of FDI on TFP, with the estimation of the Model 1 using a fixed effects estimator.

Regressions in Table 19[9] examine the effects of Chinese FDI on Total Factor Productivity (TFP) in 138 countries over the period 2005-2020. The estimation results of the most basic regression are provided in column (1) of Table 19. In columns (2) to (5), it is added some country development indicators with the same structure described at the beginning of this section. This time, the coefficient for FDI/GDP is negative in almost any model specifications and insignificant in all of them. Once again, there is no evidence to support that FDI has a growth benefit on TFP. However, the population growth and stability results are similar, exhibiting a positive and significant coefficient.

Technology Transfer

Table 20 presents the first of the baseline results for the effect of FDI on technology transfer, with the estimation of the Model 2 using a fixed effects estimator.

[9]The explanation for the reduced, when compared to the summary statistics, and decreasing number of observations as the set of variables extends are the same explained in the first analysis

Table 19: The Effects of Chinese FDI on TFP (2)

	(1)	(2)	(3)	(4)	(5)
FDI/GDP	0.04	-0.17	-0.23	-0.25	-0.13
	[0.12]	[0.25]	[0.24]	[0.24]	[0.25]
Human Capital		-0.34	-0.06	-0.06	0.58
		[0.67]	[0.60]	[0.59]	[0.46]
Population Growth			0.22***	0.22***	0.28***
			[0.07]	[0.07]	[0.04]
Stability				0.19*	0.24***
				[0.10]	[0.08]
Trade					0.00
					[0.00]
Gov					-0.06*
					[0.03]
Credit					-0.01***
					[0.00]
Property					0.00
					[0.00]
Constant	7.73***	8.73***	7.65***	7.68***	7.48***
	[0.09]	[1.63]	[1.50]	[1.47]	[1.05]
Observations	1,926	1,703	1,703	1,703	1,461
R-squared	0.032	0.028	0.107	0.113	0.299
Number of Countries	138	122	122	122	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes

*F*DI/GDP is lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Regressions in table 20 examine the effects of Chinese FDI on Technology Transfer in 150 countries over the period 2005-2020. The estimation results of the most basic regression are provided in column (1) of Table 20. Once again, some country development indicators are added in columns (2) to (5). The coefficient for FDI/GDP is positive (in contrast to the results of 13) in all the model specifications, but loses its significance after controlling for Human Capital. Once again, the schooling index has a robust and positive effect on patents applications. Overall, there is no evidence to support that FDI has a growth benefit on technology diffusion.

4.3.2 Differences between income groups

Table 21 presents the estimation results for the effects of Chinese FDI on both TFP and Technology Transfer and its differences between income groups, following the same model specifications of table 14.

Total Factor Productivity

The coefficients of the interaction terms between FDI and both lower income groups, FDI/GDP x linc and FDI/GDP x lmidinc, show positive and significant values but fail in the robustness check in column (5). On top of that, the coefficient for FDI/GDP is significantly negative. These results imply that, compared to upper levels of income, both low and lower middle income economies receive larger TFP benefit via Chinese FDI than upper middle and high income economies. Nevertheless, the evidence is not robust and partially supports hypothesis 2 since the coefficient of FDI/GDP is negative at a large scale. In other words, the net TFP benefit via Chinese FDI is negative in the lower income economies, but still greater than upper income economies.

Table 20: The Effects of Chinese FDI on Technology Transfer (2)

	(1)	(2)	(3)	(4)	(5)
FDI/GDP	19.72*	8.07	8.30	9.37	3.74
	[11.06]	[13.27]	[13.40]	[12.63]	[19.85]
Human Capital		74.04**	73.09**	73.03**	88.20**
		[29.16]	[29.33]	[29.78]	[34.05]
Population Growth			-0.73	-0.41	1.52
			[1.19]	[1.31]	[2.18]
Stability				-11.92	-14.78
				[12.39]	[16.13]
Trade					-0.08
					[0.18]
Gov					-0.51
					[0.70]
Credit					0.23*
					[0.12]
Property					-0.32
					[0.41]
Constant	81.15***	-85.63	-82.03	-83.86	-100.90
	[5.01]	[71.70]	[72.65]	[74.85]	[98.78]
Observations	2,214	1,718	1,718	1,718	1,461
R-squared	0.055	0.023	0.024	0.030	0.042
Number of Countries	150	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes

*F*DI/GDP is lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Technology Transfer

The interaction terms between FDI and income level show insignificant values in almost any column. Therefore, there is no evidence supporting for hypothesis 2, regarding technology diffusion. The existence of a higher human capital index remains a robust pillar to benefit from FDI as a channel for technology diffusion.

4.3.3 Belt & Road Initiative as an "Investment platform"

Table 22 presents the estimation results for the impact of BRI creation on the effects of Chinese FDI on both TFP and Technology Transfer, following the same model specifications of table 15.

Total Factor Productivity

The interaction term between FDI and BRI creation shows negative values in all columns, in contrast with the results from table 15. However, none of the coefficients are significant. Then, there is no evidence to support or reject hypothesis 3.

Technology Transfer

The interaction term between FDI and BRI creation shows positive values in all columns but loses significance after controlling for human capital. Overall, there is no evidence supporting the hypothesis for both TFP and technology diffusion impact.

Table 21: The Effects of Chinese FDI and its Economic Impact: Income level analysis (2)

	TFP					Technology Transfer				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI/GDP	-9.57**	-9.19**	-8.24**	-8.37**	-2.85	45.28*	91.69	89.16	95.75	54.78
	[3.88]	[3.69]	[3.36]	[3.38]	[3.11]	[24.89]	[63.41]	[62.51]	[61.07]	[105.62]
FDI/GDP x linc	9.46**	9.14**	8.16**	8.33**	2.87	-14.17	-83.10	-80.48	-89.21	-49.31
	[3.93]	[3.76]	[3.42]	[3.44]	[3.18]	[20.41]	[56.60]	[55.99]	[54.68]	[99.80]
FDI/GDP x lmidinc	9.65**	8.98**	7.94**	8.00**	2.39	-29.64	-83.88	-81.10	-83.97	-55.63
	[3.90]	[3.77]	[3.44]	[3.46]	[3.17]	[22.19]	[55.71]	[55.20]	[55.42]	[95.44]
FDI/GDP x umidinc	5.01	6.99	5.74	5.47	0.35	61.59	-108.20*	-104.76	-91.27	-57.46
	[5.27]	[4.26]	[3.91]	[3.96]	[3.25]	[41.31]	[63.13]	[64.46]	[65.69]	[102.20]
Human Capital		-0.22	0.05	0.07	0.64		74.22**	73.48**	72.74**	87.29**
		[0.72]	[0.64]	[0.63]	[0.48]		[28.55]	[28.86]	[29.03]	[33.73]
Population Growth			0.21***	0.20***	0.27***			-0.56	-0.25	1.61
			[0.07]	[0.07]	[0.04]			[1.20]	[1.31]	[2.16]
Stability				0.23**	0.25***				-12.06	-14.74
				[0.10]	[0.08]				[12.34]	[15.90]
Trade					-0.00					-0.08
					[0.00]					[0.19]
Gov					-0.06*					-0.55
					[0.03]					[0.67]
Credit					-0.01***					0.24*
					[0.00]					[0.12]
Property					0.00					-0.30
					[0.00]					[0.41]
Constant	7.74***	8.44***	7.41***	7.41***	7.44***	81.10***	-86.06	-83.28	-83.43	-99.18
	[0.08]	[1.77]	[1.59]	[1.55]	[1.03]	[4.98]	[70.42]	[71.80]	[73.30]	[97.90]
Observations	1,926	1,703	1,703	1,703	1,461	2,214	1,718	1,718	1,718	1,461
R-squared	0.087	0.076	0.145	0.154	0.306	0.056	0.025	0.025	0.031	0.042
Number of Countries	138	122	122	122	118	150	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

4.3.4 BRI countries vs non-BRI countries

Table 23 presents the estimation results for the impact of BRI participation on the economic effects of Chinese FDI studied, namely TFP and Technology Transfer, following the same model specifications of table 16.

Total Factor Productivity

The interaction term between FDI and BRI participation shows a negative sign and insignificant value in column (1) but changes its sign after controlling human capital. The coefficient remains insignificant with more controls added. Overall, the coefficient sign is in contrast with the results from table 16, but there is no robust evidence to support or reject hypothesis 4a regarding TFP impact.

Technology Transfer

The interaction term between FDI and BRI participation shows a positive sign and significant value in column (1) but changes its sign after controlling human capital. Once again, the coefficient remains insignificant with more controls added. Once again, the coefficient sign is in contrast with the results from table 16. Overall, there is no robust evidence to support or reject hypothesis 4a regarding TFP and technology transfer.

Table 22: The Effects of Chinese FDI and its Economic Impact: BRI as an "investment platform" (2)

	TFP					Technology Transfer				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI/GDP	0.24	0.09	0.00	0.03	-0.07	-15.00	-2.24	-1.95	-3.49	-3.98
	[0.23]	[0.19]	[0.18]	[0.18]	[0.15]	[11.53]	[6.21]	[6.24]	[6.68]	[10.63]
FDI/GDP x PostBRI	-0.21	-0.26	-0.24	-0.29	-0.07	35.14***	10.53	10.47	13.15	8.21
	[0.27]	[0.27]	[0.26]	[0.26]	[0.27]	[13.04]	[11.16]	[11.12]	[9.35]	[14.44]
PostBRI	-0.24	-0.00	0.01	0.02	0.12	-87.10***	-26.21*	-26.25*	-26.45*	-21.82*
	[0.17]	[0.25]	[0.24]	[0.24]	[0.18]	[28.27]	[13.83]	[13.83]	[13.90]	[12.32]
Human Capital		-0.35	-0.06	-0.07	0.57		74.36**	73.41**	73.43**	88.53**
		[0.67]	[0.60]	[0.59]	[0.46]		[29.11]	[29.28]	[29.78]	[33.97]
Population Growth			0.22***	0.22***	0.28***			-0.73	-0.40	1.52
			[0.07]	[0.07]	[0.04]			[1.19]	[1.31]	[2.18]
Stability				0.20*	0.24***				-12.02	-14.81
				[0.10]	[0.08]				[12.36]	[16.10]
Trade					0.00					-0.07
					[0.00]					[0.18]
Gov					-0.06*					-0.52
					[0.03]					[0.71]
Credit					-0.01***					0.23*
					[0.00]					[0.12]
Property					0.00					-0.32
					[0.00]					[0.41]
Constant	7.73***	8.75***	7.67***	7.71***	7.49***	81.22***	-86.38	-82.80	-84.84	-101.50
	[0.09]	[1.64]	[1.50]	[1.48]	[1.04]	[5.03]	[71.55]	[72.48]	[74.80]	[98.46]
Observations	1,926	1,703	1,703	1,703	1,461	2,214	1,718	1,718	1,718	1,461
R-squared	0.032	0.029	0.107	0.114	0.299	0.055	0.024	0.024	0.030	0.042
Number of Countries	138	122	122	122	118	150	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

4.3.5 BRI countries vs non-BRI countries: Differences between income groups

Table 24 and 25 presents the results for the economic effects of Chinese FDI studied, namely TFP and Technology Transfer by income level, whether the host country is a BRI participant or not.

Total Factor Productivity

The estimation results vary by level of income. Starting the low income sample first, the interaction term between FDI and BRI shows an insignificant value but an ambiguous sign. The Role of stability remains significant on TFP performance. In the lower middle income group, the interaction term between FDI and BRI shows a positive sign but ambiguous significance. Higher levels of schooling and political stability have significant and positive values on TFP benefits. The interaction term coefficient is insignificant in the upper middle income and shows an ambiguous sign. In the latter group, both interaction terms coefficients are negative but only column (10) shows significant results. Population growth maintains its significant role on TFP performance in high income economies. Overall, there is no evidence to support hypothesis 4b for TFP impact.

Table 23: The Effects of Chinese FDI and its Economic Impact: BRI vs Non-BRI countries (2)

	TFP					**Technology Transfer**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI/GDP	0.06	-0.22	-0.28	-0.28	-0.15	12.27	9.52	9.75	10.15	8.74
	[0.12]	[0.32]	[0.31]	[0.31]	[0.33]	[8.48]	[15.11]	[15.24]	[14.93]	[21.00]
FDI/GDP x PostSign	-0.10	0.09	0.08	0.06	0.04	36.33*	-4.02	-4.00	-2.71	-13.32
	[0.17]	[0.23]	[0.21]	[0.21]	[0.30]	[21.94]	[9.22]	[9.20]	[9.09]	[13.12]
PostSign	0.06	0.02	-0.03	-0.03	0.02	15.62	6.14	6.31	6.56	8.86
	[0.12]	[0.11]	[0.11]	[0.11]	[0.09]	[17.01]	[7.26]	[7.27]	[7.25]	[6.54]
Human Capital		-0.35	-0.06	-0.05	0.57		73.21**	72.11**	71.94**	87.00**
		[0.67]	[0.60]	[0.60]	[0.46]		[29.07]	[29.21]	[29.64]	[33.77]
Population Growth			0.22***	0.22***	0.28***			-0.83	-0.51	1.30
			[0.07]	[0.07]	[0.04]			[1.18]	[1.30]	[2.23]
Stability				0.19*	0.24***				-12.06	-14.80
				[0.10]	[0.08]				[12.42]	[16.17]
Trade					0.00					-0.08
					[0.00]					[0.19]
Gov					-0.06*					-0.48
					[0.03]					[0.68]
Credit					-0.01***					0.23*
					[0.00]					[0.13]
Property					0.00					-0.36
					[0.00]					[0.43]
Constant	7.73***	8.75***	7.65***	7.68***	7.50***	81.18***	-83.59	-79.47	-81.05	-95.02
	[0.08]	[1.64]	[1.50]	[1.48]	[1.04]	[4.99]	[71.61]	[72.46]	[74.58]	[99.11]
Observations	1,926	1,703	1,703	1,703	1,461	2,214	1,718	1,718	1,718	1,461
R-squared	0.032	0.028	0.107	0.114	0.299	0.060	0.025	0.025	0.032	0.044
Number of Countries	138	122	122	122	118	150	123	123	123	118
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*All FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Technology Transfer

The interaction terms show insignificant values in all the income groups, exhibiting positive signs in the lower groups and negative ones in the upper groups. Human capital plays a significant role in low and high income economies. Once again, there is no evidence to support hypothesis 4b for technology diffusion impact.

Table 24: The Effects of Chinese FDI on TFP by Income level: BRI vs Non-BRI countries (2)

	Full Sample		**Low income**		**Lower middle income**		**Upper middle income**		**High income**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI/GDP	-0.28	-0.15	0.01	0.09	-0.88	-2.22***	-2.69*	-1.75	-6.37***	0.38
	[0.31]	[0.33]	[0.13]	[0.19]	[0.63]	[0.75]	[1.34]	[1.15]	[2.07]	[2.68]
FDI/GDP x PostSign	0.06	0.04	0.13	-0.07	0.52	1.81**	1.46	-0.18	-6.25	-4.94**
	[0.21]	[0.30]	[0.13]	[0.13]	[0.47]	[0.67]	[1.66]	[1.21]	[4.81]	[1.94]
PostSign	-0.03	0.02	-0.41*	-0.00	0.12	-0.04	0.15	0.22*	-0.20	-0.12
	[0.11]	[0.09]	[0.22]	[0.14]	[0.08]	[0.06]	[0.13]	[0.13]	[0.28]	[0.20]
Human Capital	-0.05	0.57	-1.37	-0.80	1.09**	0.83**	-1.92**	-0.35	0.94	0.85
	[0.60]	[0.46]	[1.03]	[1.32]	[0.50]	[0.31]	[0.79]	[0.45]	[1.20]	[0.84]
Population Growth	0.22***	0.28***	0.36*	0.15	-0.02	-0.02	-0.01	0.01	0.22**	0.24***
	[0.07]	[0.04]	[0.20]	[0.13]	[0.18]	[0.14]	[0.12]	[0.08]	[0.10]	[0.05]
Stability	0.19*	0.24***	0.40***	0.37***	0.21***	0.22***	0.17	0.18	0.13	-0.00
	[0.10]	[0.08]	[0.10]	[0.10]	[0.07]	[0.05]	[0.21]	[0.12]	[0.55]	[0.29]
Trade		0.00		-0.01		-0.00		-0.00		0.00
		[0.00]		[0.00]		[0.00]		[0.00]		[0.00]
Gov		-0.06*		0.04		-0.01		0.03		-0.25***
		[0.03]		[0.03]		[0.01]		[0.02]		[0.09]
Credit		-0.01***		-0.01		-0.01***		0.01***		-0.01
		[0.00]		[0.01]		[0.00]		[0.00]		[0.00]
Property		0.00		0.00		0.00		0.01***		0.01
		[0.00]		[0.01]		[0.00]		[0.00]		[0.01]
Constant	7.68***	7.50***	4.97**	4.53*	1.70	2.51***	12.39***	7.17***	9.73***	14.15***
	[1.48]	[1.04]	[1.98]	[2.45]	[1.02]	[0.66]	[1.85]	[1.16]	[3.54]	[2.68]
Observations	1,703	1,461	252	199	462	388	373	331	616	543
R-squared	0.114	0.299	0.328	0.341	0.221	0.474	0.245	0.273	0.236	0.502
Number of Countries	122	118	18	16	33	32	27	27	44	43
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*A*ll FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 25: The Effects of Chinese FDI on Technology Transfer by Income level: BRI vs Non-BRI countries (2)

	Full Sample		**Low income**		**Lower middle income**		**Upper middle income**		**High income**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI/GDP	10.15	8.74	-0.01	-0.04	-1.71	-6.97	8.21	21.13	195.12	8.42
	[14.93]	[21.00]	[0.07]	[0.06]	[2.35]	[5.03]	[16.55]	[24.13]	[162.65]	[236.44]
FDI/GDP x PostSign	-2.71	-13.32	0.10	0.16	3.14	1.48	-51.73	-40.31	-13.29	-35.77
	[9.09]	[13.12]	[0.10]	[0.11]	[3.52]	[7.38]	[51.80]	[46.93]	[162.89]	[182.98]
PostSign	6.56	8.86	0.04	0.04	-2.61	0.86	2.53	4.03	20.92	24.65
	[7.25]	[6.54]	[0.15]	[0.10]	[4.23]	[2.10]	[5.71]	[5.84]	[22.29]	[20.34]
Human Capital	71.94**	87.00**	1.48*	1.09*	-12.11	1.08	25.93	2.19	201.94**	242.54**
	[29.64]	[33.77]	[0.83]	[0.58]	[14.72]	[4.41]	[23.39]	[10.41]	[79.05]	[103.56]
Population Growth	-0.51	1.30	-0.15	-0.11	3.94	0.52	1.12	1.85	2.90	6.33
	[1.30]	[2.23]	[0.09]	[0.08]	[3.17]	[1.37]	[1.77]	[1.36]	[4.13]	[6.51]
Stability	-12.06	-14.80	-0.11	-0.05	1.62	0.95	-1.77	-7.23	-105.11	-108.37
	[12.42]	[16.17]	[0.11]	[0.07]	[1.86]	[0.78]	[8.35]	[5.19]	[70.30]	[83.83]
Trade		-0.08		0.00		-0.01		-0.00		-0.11
		[0.19]		[0.00]		[0.04]		[0.06]		[0.50]
Gov		-0.48		-0.00		0.10		-0.42		-0.47
		[0.68]		[0.01]		[0.15]		[0.64]		[3.02]
Credit		0.23*		0.00		0.05		0.38**		-0.01
		[0.13]		[0.00]		[0.04]		[0.18]		[0.26]
Property		-0.36		-0.00		-0.01		-0.07		-1.18
		[0.43]		[0.00]		[0.05]		[0.10]		[1.08]
Constant	-81.05	-95.02	-1.77	-1.51*	27.16	0.58	-43.03	4.45	-295.79	-299.14
	[74.58]	[99.11]	[1.04]	[0.81]	[28.05]	[8.43]	[55.58]	[30.49]	[204.84]	[313.76]
Observations	1,718	1,461	252	199	462	388	388	331	616	543
R-squared	0.032	0.044	0.108	0.100	0.065	0.076	0.059	0.079	0.131	0.144
Number of Countries	123	118	18	16	33	32	28	27	44	43
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yearly Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*A*ll FDI variables are lagged by one year. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5 Limitations

As stated above, there is little literature on the research topic, which unable this work to have a proper comparison with previous work, but brings no harm to the empirical findings.

Regarding the data selection and construction, some limitations can be pointed out. Believing that the host economies can be impacted more from a large transaction or investment than smaller ones, it was decided to use data from CGIT instead of official data from MOFCOM or UNCTAD. Choosing CGIT, total FDI inflows were not considered, but only large transactions, above 100$ million. Additionally, FDI was not diseggregated by type and mode of entry, into M&A and Greenfield investments as other works did (Ashraf et al., 2016; Wang and Sunny Wong, 2009). Furthermore, some countries that were recipients of Chinese outward FDI did not have data regarding GDP, patents applications, and other economic indicators, which unable this study to use those countries in the regression models. Further, studying outward Chinese FDI and its patterns and effects could lead to selection bias. Especially with BRI, China is investing in countries that are being invited to invest. In some of those countries, China is replacing the US and Europe as main investment and goods providers. The use of country fixed effects in the regressions can solve this bias to some extent but not entirely.

Regarding the main dependent variables, some issues that can be discussed. Using the Cobb-Douglas production function to calculate TFP, which is essentially a measure of productive efficiency based on a ratio between GDP and production inputs, brings some limitations. For example, TFP cannot be disentangled into different types of efficiencies, such as technical progress, and efficiency development. Also, Temple (2006) argues that the absence of cross effects between labour and capital may lead to specious results.

Another caveat of this work is related to the measure of technology transfer. To measure innovation by patents is a challenge. On the one hand, there is some knowledge and innovations that are not patented but transmitted to local firms based on informal contacts, worker's mobility and collaboration, managerial experience (Jaffe et al., 1993). For example, a large set of African and South American countries, mainly from the lower income bound income, might benefit from having Chinese investment in their firms, bringing new processes and innovation to its production and business. However, these countries do not have enough human capital and proper access to financing to engage in patents applications and production. On the other hand, patents applications are a slow process. The patents development and creation process takes years to be finalized. Some patents are granted decades after its first R&D action. Therefore, even with a 1-year log in the FDI variable, it might not be enough to impact patents applications.

To future research, it is proposed a sectoral analysis, which was not undertaken due to dataset construction constraints. While some analysis is being done, for example, in the energy sector (Liedtke, 2017; Pareja-Alcaraz, 2017), would be very important to further research the impact by industries, hence Chinese FDI are becoming even more "high-tech" and "high-quality".

6 Conclusion

The uprising of China's economy and the analysis of its global consequences is fundamental for a better understanding of the actual economic flows and bilateral relations on a global scale as China is becoming the major global economic force. In one of the most recent forecast, presented by the English think-thank Centre for Economics and Business Research in December 2020, said that "China will overtake the United States to become the world's biggest economy in 2028, 5 years earlier than previously estimated due to the contrasting recoveries of the two countries from the COVID-19 pandemic" (The Guardian, 2020). This even deserves more special attention after China surpassed the US as the major trade partner of the EU. In addition to this context, due to the covid-19 pandemic, globalization and global flows are clearly in a downward trend, with global foreign direct investment falling by 35% in 2020 (UNCTAD, 2021). As mentioned above in the report, neither Chinese FDI nor BRI impacts were clearly studied and explored. Table 26 shows an overview of the empirical findings of this study. The main takeaways are interesting and sobering for some host countries.

Table 26: Empirical analysis overview

	Hypothesis	Dep. Variable	Expected outcome	Empirical analysis	Relevant Controls
1			*(FDI / FDI:GDP)*	(FDI / FDI:GDP)	
	Chinese FDI improves the TFP of the host country	TFP	(+/+)	(+/-)	(+) Population Growth ** (+) Stability *
	Chinese FDI improves the technology of the host country	Patents	(+/+)	(-/+)	(+) Human Capital ** (+) Credit*
2	Chinese FDI generates higher productivity effect and technology transfer in lower income economies than in higher income economies		*(FDI x inc / FDI:GDP x inc)*	*(FDI x inc / FDI:GDP x inc)*	
		TFP	Low income (+,+)	Low income (+,+** but FDI(-)**)	(+) Population Growth ** (+) Stability *
			Lower middle income (+,+)	Lower middle income (+,+** but FDI(-)**)	
		Patents	Low income (+,+)	Low income (+,-)	(+) Human Capital **
			Lower middle income (+,+)	Lower middle income (+,-)	
3	Chinese FDI generates higher productivity and technology effects in the host countries after the BRI creation		*(FDI x PostBRI / FDI:GDP x PostBRI)*	*(FDI x PostBRI / FDI:GDP x PostBRI)*	
		TFP	(+/+)	(+/-)	(+) Population Growth ** (+) Stability *
		Patents	(+/+)	(+/+)	(+) Human Capital **
	Chinese FDI generates higher productivity and technology effects in BRI participant countries than in non-participant BRI countries		*(FDI x PostSign / FDI:GDP x PostSign)*	*(FDI x PostSign / FDI:GDP x PostSign)*	
		TFP	(+/+)	(-/+)	(+) Population Growth ** (+) Stability *
		Patents	(+/+)	(+/-)	(+) Human Capital **
4					
	Chinese FDI generates significantly different effects across income groups, whether is a BRI or a non-BRI country	TFP	low income (?,?)	low income (-,?)	(+) Stability **
			lower middle income (?,?)	lower middle income (+,+)	(+) Stability * (+) Human Capital*
			upper middle income (?,?)	upper middle income (-,?)	(-) Human Capital*
			high income (?,?)	high income (- but FDI (+*),-)	(+) Population Growth*
		Patents	low income (?,?)	low income (?,+)	
			lower middle income (?,?)	lower middle income (?,+)	
			upper middle income (?,?)	upper middle income (-,-)	
			high income (?,?)	high income (+,-)	

*** p<0.01, ** p<0.05, * p<0.1

Regarding TFP, the results were inconclusive for both FDI measures. However, they present ambiguous signs. Similar results were found by Chen and Lin (2018) but studying outward FDI in BRI countries and not just outward Chinese FDI. Being population one of the main inputs of the economics, population growth and TFP are positively associated as expected. Further, political stability holds an essential role in TFP growth. In addition, the results are partially significant when examining the FDI effect magnitude on TFP. Using FDI relative to the size of the host economy, low and lower middle income have a greater TFP effect than the upper bound. Still, the net benefit is below 0. Further, FDI fails again: the Belt & Road Initiative

proves to be ineffective in having positive externalities on TFP, whether due to its creation or participation. Ultimately, the results also suggest, but also partially, that high income economies do not have additional benefits to join the initiative.

On technology transfer, the results were also inconclusive. No matter the measure, the positive association between Chinese FDI and a higher level of patent applications is insignificant across all the empirical analyses. There is also no evidence to support that the Belt & Road Initiative can bring positive externalities to technological progress in host countries. At least, regarding to patents production. The transmittable knowledge and competences that might be absorbed by local firms via Chinese FDI inflows are scope for further research. Nevertheless, as expected by literature, Human Capital plays a huge role in technology diffusion.

The scope and results of this research brings greater relevance to the further discussion about the effects of Chinese FDI on the host economies. Chinese FDI suggests different effects on both TFP and technology diffusion, whether it is measured by absolute FDI values or by relative FDI to the size of the economy. Even with a global downward trend, Chinese FDI is gaining its front-runner position in some economies, and it is not yet clear whether it brings benefits of growth or economic development. Chinese investments have been under scrutiny since the beginning of the decade due to its geopolitical and economic power motivations underlined, no matter whether the recipient is a developed or a developing country.

These developments hold implications to present and future policymakers. On the one hand, the political ties undertaken by China in the BRI are growing and becoming more "tech-savvy". This is especially concerning since China is signing some major R&D partnerships with many OECD countries, including the EU countries and the US. Thus, the growth of R&D partnerships with Chinese entities and the associated challenges must be discussed in future research. On the other hand, countries should pursue active and structured policies on strengthening their principal economic determinants such as technological and managerial knowledge, physical infrastructure (ports, roads, power, telecommunications), and innovative entrepreneurial environment (Dunning, 2003), in order to have a greater chance to benefit from inward FDI at a larger scale.

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Appendix A Main Statistics

Table 27: Countries in the analysis, 2005-2020

Low Income	Lower Middle Income	Upper Middle Income	High Income
Afghanistan	Angola	Algeria	Antigua and Barbuda
Chad	Bangladesh	Argentina	Australia
Dem. Rep. of the Congo	Benin	Azerbaijan	Austria
Eritrea	Bolivia	Belarus	Bahamas
Ethiopia	Cambodia	Bosnia and Herzegovina	Bahrain
Guinea	Cameroon	Botswana	Barbados
Guinea-Bissau	Cape Verde	Brazil	Belgium
Liberia	Congo	Bulgaria	Brunei
Madagascar	Djibouti	Colombia	Canada
Malawi	Egypt	Costa Rica	Chile
Mali	Georgia	Cuba	Croatia
Mozambique	Ghana	Ecuador	Cyprus
Nepal	Honduras	Equatorial Guinea	Czech Republic
Niger	India	Fiji	Denmark
North Korea	Indonesia	Gabon	Finland
Rwanda	Ivory Coast	Guatemala	France
Senegal	Kenya	Guyana	Germany
Sierra Leone	Kyrgyzstan	Iran	Greece
South Sudan	Laos	Iraq	Hungary
Syria	Lesotho	Jamaica	Ireland
Tajikistan	Mauritania	Jordan	Israel
Tanzania	Moldova	Kazakhstan	Italy
Togo	Mongolia	Libya	Japan
Uganda	Morocco	Macedonia	Kuwait
Yemen	Myanmar	Malaysia	Latvia
Zimbabwe	Namibia	Maldives	Luxembourg
	Nicaragua	Mexico	Malta
	Nigeria	Montenegro	Mauritius
	Pakistan	Peru	Netherlands
	Papua New Guinea	Romania	New Zealand
	Philippines	Russia	Norway
	Sao Tome and Principe	Samoa	Oman
	Solomon Islands	Serbia	Panama
	Sri Lanka	South Africa	Poland
	Sudan	Thailand	Portugal
	Timor-Leste	Turkey	Qatar
	Tunisia	Turkmenistan	Saudi Arabia
	Ukraine	Venezuela	Singapore
	Uzbekistan		Slovenia
	Vietnam		South Korea
	Zambia		Spain
			Sweden
			Switzerland
			Taiwan
			Trinidad-Tobago
			UAE
			United Kingdom
			USA

Table 28: China's top 10 investment transactions since 2005

Year	Investor	Transaction Partner	Country	Sector	Subsector	Value (billion USD)
2017	China Reform Holdings, ChemChina	Syngenta	Switzerland	Agriculture		43.060
2012	CNOOC	Nexen	Canada	Energy		15.100
2017	CIC	Logicor	Britain	Logistics		13.790
2008	Chinalco	Rio Tinto	Australia	Metals	Aluminum	12.800
2017	HNA	CIT Group	USA	Transport	Aviation	10.380
2017	Ping An	HSBC	Britain	Finance	Banking	9.660
2017	Vanke, Hopu, Hillhouse, Bank of China	Global Logistics Property	Singapore	Logistics		9.060
2018	Geely Auto	Daimler	Germany	Transport	Autos	9.030
2019	China General Nuclear	Hinkley Point C	Britain	Energy		8.860
2016	Tencent	Supercell	Finland	Entertainment		8.600

Table 29: Summary statistics on the control variables used in the analysis

	Observations	Mean	Sd	Min	Max
HumanCap	1860	2.56	0.68	1.14	4.35
Pop	2272	1.56	1.60	-4.54	17.51
Stability	2288	-0.17	0.96	-2.99	1.62
Trade	2097	89.37	53.21	0.17	437.33
Gov	2048	16.24	7.77	2.05	115.93
Credit	1986	52.17	45.31	0.50	255.31
Property	2310	46.33	23.70	0	98.4
N	2445				

Table 30: Correlation matrix among selected variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. ln (Cumulative FDI)	1								
2. FDI/GDP	0.06	1							
3. TFP	0.16	-0.26	1						
4. Tech	0.12	-0.10	0.29	1					
5. BRI	0.06	0.02	-0.22	-0.08	1				
6. linc	-0.11	0.22	-0.31	-0.11	-0.07	1			
7. lmidinc	0.04	0.20	-0.40	-0.14	0.12	-0.26	1		
8. umidinc	0.01	-0.13	-0.06	-0.10	0.12	-0.25	-0.35	1	
9. hinc	0.03	-0.24	0.68	0.32	-0.16	-0.30	-0.42	0.40	1