Chinese investment in Europe: An analysis of the Belt and Road Initiative.

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DOCTORAL THESIS

Chinese investment in Europe: An analysis of the Belt and Road Initiative

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Abstract

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Doctor of Philosophy

Chinese investment in Europe: An analysis of the Belt and Road Initiative

by Jiandan LI

The Belt and Road Initiative (BRI) is an initiative launched by the Chinese government in 2013 that aims to enhance the global supply chain through large-scale infrastructure investments along a modern "silk road" that connects Asia, Africa, and Europe, where the BRI trade routes end. We observed divergent opinions from various parties regarding BRI's investment in Europe. For instance, while commercial banks and financial institutions in Europe are taking a proactive stance by acting as founding members of BRI financing entities, and numerous European local businesses are embracing the economic opportunities offered by BRI infrastructure projects, it is evident that various European institutions have expressed concerns regarding BRI investment in the EU, which arguably led to the introduction of screening mechanisms for foreign direct investment at the EU level. Despite the mixed views, can Europe benefit from the BRI? This thesis examines the impact of Chinese investment under the BRI on China, Europe, and the rest of the world using mixed methods. We collected secondary data and employed a structural gravity model with general equilibrium analysis to examine the trade and welfare effects of BRI-resulted trade cost reductions on countries at aggregated and sectoral level. We subsequently conducted two simulation exercises using two scenarios under the assumption that all EU member states had signed up to the BRI and additional investments made in three specific EU countries, Spain, Italy, and Greece. Our findings suggest that, overall, the BRI has a positive impact on the EU. On a national level, our results show that a reduction in transport costs for each pair of countries would lead to both trade gains and welfare gains for China and the EU. On a sectoral level, we found that most industries would benefit from a reduction in trade costs. On a micro (or BRI project) level, we found evidence of growth in container traffic and local employment. That said, our study, which includes data collected through semi-structured interviews, also highlighted substantial differences in the workplace regimes on a BRI project level.

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Declaration of Authorship

I, Jiandan LI, declare that this thesis titled, "Chinese investment in Europe: An analysis of the Belt and Road Initiative" and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University. I declare that all the material contained in this thesis is my own work.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

Chapter 1

Introduction

1.1 Background

Chinese state-owned enterprises (SOEs) have been acquiring European assets since 2008 such as ports and railways, through either the foreign direct investment (FDI) channels or the Belt and Road Initiative (BRI). Although many of the BRI infrastructure projects and capital flows are situated in Central and Southeast Asia, there is a growing footprint in Europe, with two-thirds of European Union (EU) member states having BRI membership as well as most Balkan countries. Hamburg, known as the 'gateway to the world', is home to the largest and second largest container port by volume in Germany and the EU. The port recently received massive attention as Berlin decided to give the green light to Chinese SOE shipping giant China Ocean Shipping Company (COSCO)'s investment and acquisition in one of the container terminals. Similarly to Hamburg port acquisition, the most high-profile Chinese investment in Europe is the COSCO operation in Piraeus port in Greece, which has been very successful economically.

This is just part of the bigger story China has to tell/sell as they are only two prominent examples of acquisitions among all other partnerships that COSCO and other Chinese SOEs have been negotiating and working on in the region – Port of Sines in Portugal, Port of Vado Ligure in Italy, Port of Rotterdam in the Netherlands, Ports of Bilbao and Valencia in Spain, Port of Antwerp in Belgium and Ports in the UK. Besides eyeing on European ports, Chinese SOEs investments are also very active in other sectors include energy, transport, metals, utilities, and real estate.

Europe (EU-27 and the UK) has a long history of bilateral trade relations with China through the ancient Silk Road trade networks. This cooperation was enhanced and reached a record high in recent years. One reason for such interaction is the 2008 financial crisis, in which the euro debt crisis impacted EU member states, and therefore China had the opportunity to invest in the field of infrastructure in the region as part of its "Going Out" policy to invest in overseas equity. As a result, Chinese FDI into Europe surged to 35 billion EUR in 2016 compared with only 1.6 billion EUR in 2010. EU-China relations were further strengthened to a new level when President Xi proposed the Belt and Road Initiative (BRI) in 2013. The initiative consists mainly of an international network of infrastructure projects in Asia, Africa, and all trade routes ending in Europe. More importantly, these investments are often backed by Chinese state-owned enterprises (SOEs) with a lower percentage of private companies.

The BRI aims to promote connectivity and enhance the global supply chains in various forms, mainly through large-scale infrastructure investments. And arguably the largest and most ambitious global connectivity initiative plays a central role in China's foreign policy strategy and geopolitical vision. In March 2022, the number of countries that have joined the BRI by signing a Memorandum of Understanding (MoU) with China is 147 according to Center, 2022. MoUs are often used by many BRI economies for specific BRI projects, as well as to lay out principles and areas of cooperation, and these agreements are often confidential. In addition to MoUs, China has signed a large number of bilateral investment treaties (BITs) and multilateral investment treaties (MITs) related to BRI.

The first edition of the BRI was published in 2015 (Development and Commission, 2015), and illustrates the principles and five main goals of the policy, ranging from stimulating economic development to facilitating cross-border trade. It also highlights another important pillar of the BRI – the promotion of unimpeded trade through infrastructural investment along the six corridors. Despite the above, the most notable function of the BRI from an economic point of view is perhaps its ability to channel China's domestic overcapacity overseas (Berger, 2016) by providing the labour and capital needed to develop the infrastructure development projects necessary along the Chinese Silk Road Economic Belt (SREB) and the Maritime Silk Road (MSR).

1.2 Research intuition and objectives

The frequent presence and gradual inflow of Chinese investment in the region raises increasing scepticism, as well as concern, to some extent, for EU countries with and without BRI membership, given the inadequate market access for European investors in China. Moreover, divergent opinion of the member states puts pressure on Brussels to come up with a unified approach to concerns including EU competitiveness and official economic policy, especially when it comes to much more financially vulnerable member states and their strategic public assets.

Despite the fact that all BRI trade routes end in Europe, in the ninth year since its launch in 2013, the EU has still not agreed on a unified approach towards the BRI. It was not until recent years that Europe has been urging immediate actions to restore its regional influence by introducing investments and legal frameworks in response. In the first five years of the BRI, China had many interests in the region, and as to date, Chinese investments continue to go to the top three biggest economies among 27 member states, namely, the UK, Germany and France, none of which have formally joined the BRI. However, Central and Eastern Europe (CEE) and Baltic countries have become the main investing interests in the region for China since 2017. Similarly, China's footprint in Europe also includes acquisition, operation, and investments in electricity, transportation, oil and gas, financial services, insurance, health, real estate, ports, railways, power plants, and energy buildings in Italy, Portugal, Spain, and Hungary (Skala-Kuhmann, 2019).

In addition, since the launch of the initiative almost 10 years ago, half of the EU member states already signed up to the BRI and other EU countries have participated in BRI projects one way or the other (for instance, Germany and the Netherlands). Moreover, Italy was among the first Group of Seven (G7) countries to join the initiative under Europe's general sceptical views of the initiative. Despite all these actions and sentiments from the member states, European institutions as a whole certainly did not respond with a unified approach to China's mega foreign policy and its impact on Eurasia for a long time.

Criticisms that are often associated with the BRI from policymakers are a lack of reciprocal market access for European investors in China or a level playing field for European companies wishing to invest in Chinese markets; jeopardization on EU member states competitiveness; a lack of transparency in BRI projects and related means of financing; failure to meet European environmental social standards; and undermining European rules-based public tenders as the majority of the BRI transport projects are often backed by Chinese state-owned enterprises. And not to mention the lack of detailed information for each BRI project; its financing frameworks and opaque project objectives have always been the main criticisms of the whole initiative. It should be noted that Chinese investments under the route of BRI pose an even bigger threat after COSCO acquired Europe's strategic location - Piraeus port in Greece, as some view this deal as a threat to regional stability given the financial instability the country has been facing.

In 2018, the EU finally came up with their institutional responses, including the EU Investment Plan and extended Trans-European Transport Networks. Furthermore, the European Commission introduced a framework aiming for stronger and stricter FDI screening for each member state. Although the proposal did not mention or target Chinese investment specifically in its language, this can be seen as a unified approach from the EU level on incoming FDI targeting some vulnerable member states, and therefore a more integrated response to Chinese investment in Europe.

The simple fact is that it is not only European ports that play a crucial role in driving domestic and regional growth and trade, but also the role of the port in general and its criticality in international trade and global supply chains. This does not include any additional sustainable developments in promoting port competitiveness, port facilities, handling capacities, port technology and digitisation, inland port connection, and port containerisation. Having said this, for European policymakers, institutions and academic scholars, not only is it important to understand the role and effectiveness of European institutions in the context of BRI infrastructure projects, but also the impact, challenges, risks and opportunities for European member states, companies, industries, and the region as a whole.

One thing that remains unclear is whether these Chinese SOE-backed infrastructure projects mainly via acquisitions bring any significant economic benefits and to what extent in the EU host country and beyond; the subsequent implications for other BRI and non-BRI signatories; and finally what the future holds for Chinese investment in Europe given the EU's new framework. Despite the recent shift of the BRI towards a more digital and green development policy (i.e., Digital Silk Road and Green BRI), this thesis focuses on one of the original contents (the most crucial one) of the BRI: the connectivity and infrastructure developments, hence, improving logistics and transport links to reduce trade barriers and facilitate cross-border trade.

To summarise, Brexit and the US-China trade war have drawn much attention and more importantly academic research on their trade and welfare impacts. For this research, we take equivalently important and also well-known global policy as our starting point to examine the implications at different levels. Hence, this thesis serves as an overdue analysis of the impact of Chinese investment under the BRI on Europe, China, and the rest of the world by using mixed methods. More specifically, we collect secondary data and employ a structural gravity model with general equilibrium analysis to examine the trade and welfare effects of BRI-resulted trade cost reductions on countries at aggregate and sectoral levels. To add to this, we choose the flagship BRI project in Europe as our case study to investigate the on-ground implications of the investment in Piraeus Port in Greece. Through semi-structured interviews with various stakeholders, we tackle important questions around employment and workplace regimes on the state-run and Chinese-run sides of the port in addition to economic impacts.

1.3 Originality and contributions

This thesis makes three important contributions. First, there are only a few BRI studies that use a structural gravity model. Our research adds to the empirical part of the BRI literature by employing a structural gravity model with general equilibrium analysis. Based on Heid, Larch, and Yotov, 2017, De Soyres et al., 2019, and Jackson and Shepotylo, 2021 work, we examine the effects of the BRI on the trade and welfare of China, the EU and the rest of the world using aggregated data. As these BRI transport projects reduce transport costs by port facility expansion and containerisation (and many more), this will lead to an increase in trade volumes and welfare for consumers to both BRI and non-BRI economies. By constructing and obtaining both conditional and full endowment general equilibrium analysis estimates, it allows us to acknowledge the transport cost reduction as a result of the policy change (BRI) on countries along the routes, as well as those that are not. The results take into account the full effects of counterfactual trade policy shocks on trade costs, production, and trade, and this shows the overall economic impact of the BRI. We also propose two scenarios in which we assume that all EU member states sign up to the BRI and also additional investments are made in selected EU countries, namely Spain, Italy, and Greece. We obtain the results and compare them with the BRI scenario.

Second, there has not been any empirical research on the sectoral impact of BRI projects. Therefore we fill an important methodological and empirical gap in the limited BRI literature by applying a structural gravity model with GE analysis to examine the sectoral impact of the BRI on China and the EU, and we then use this as our benchmark estimates and we use the same scenario as we did for aggregate analysis. We take bilateral sectoral-level trade cost reduction data from De Soyres et al., 2019 as our trade cost reduction variable to proxy the sectoral effect of BRI transport projects, which has not been done in any of the existing literature in the context of the BRI. It provides a more detailed analysis of what trade and welfare impacts from the trade cost reductions from the BRI are like for each sector and to what extent they vary under different scenarios. We show that there is a need for such examination and what the results can tell us.

Third, we are among the first cohort of studies to qualitatively assess the impact of BRI on the ground. Most BRI studies are either literature based or empirical papers. There are only a few reports and media coverage of the impact of the BRI on those BRI recipients. In addition, developing a detailed understanding of a broad range of impacts at both micro and macro levels is crucial in this case as there are further planned Chinese investments in Piraeus port as well as other ports around Europe. It is important to understand the effects of Chinese investments in a port and its ripple effect to the greater regional economy. We conclude the case study with policy implications for other Chinese investments in Europe in general.

1.4 Brief summary of findings

Our findings are categorised into three levels. At individual project level, our key findings suggest that, while Chinese shipping giant COSCO and its investment have created much-needed local employment, the adoption of widespread subcontracting of the labour force has segmented workers into very different workplace regimes depending on the side of the port they work at. We also found the new workplace regime introduced by Piraeus Container Terminal (PCT) to have evolved over time since the inception of operations but to have nevertheless retained key elements of a labour control strategy detrimental to workers' agency, that extends to the control of workers' unionisation. In addition, our findings also indicate that there is a positive economic impact as expected as well as trade volume increases in container terminals.

At sector level, we find that sectoral-level analysis captures much more information than the structural gravity model using aggregate data. Moreover, our results also indicate that China and the EU receive positive trade and welfare gains. More specifically, we conclude that a higher percentage of sector share in an economy does not guarantee an equivalent level of trade and welfare effects. It is important to note that the energy sector and mining sector are the top beneficiary industries under all three scenarios. There is also a positive ripple effect, meaning that a trade or welfare gain in one sector would have a positive impact on other sectors.

At country level, our empirical results show that a reduction in transport costs for each country pair would lead to both trade and welfare gains for China and the EU. BRI transport projects resulted in trade cost reduction would increase welfare for consumers in China by 1.78 per cent and in the EU by 0.64 per cent. Furthermore, all EU countries signing up to the BRI would increase welfare by 1.8 and 0.76 per cent for China and the EU respectively. Additional investments made in Spain, Italy and Greece would increase welfare by 1.79 and 0.65 per cent for China and the EU respectively. We find that both the trade and welfare effects of EU countries joining the initiative are greater than the effects of an additional inflow of Chinese investments made in selected EU countries, and it is the case at both sector and country levels.

1.5 Thesis structure

It is worth mentioning that chapters 4, 5 and 6 are stand-alone papers each with their own research objectives and findings. The remainder of this thesis is organised as follows. Chapter 2 provides a theoretical literature review. It starts with a review of infrastructure projects and trade costs. This is followed by a thorough review of the gravity model as well as a brief justification of using the gravity model as our methodology. Chapter 3 reviews contextual BRI literature, and goes into detail of what the policy entails and more. Chapter 4 presents a detailed qualitative analysis of our case study of Chinese investment in Piraeus Port, Greece. Chapters 5 and 6 are our empirical chapters using secondary trade data to perform a structural gravity model with full general equilibrium analysis on the impact of the BRI on China, Europe and the world at both aggregate and disaggregated levels. Finally, chapter 7 outlines the main findings; it also looks at the challenges and opportunities that Chinese investment may face and it concludes with policy implications and research limitations as well as future research suggestions.

Chapter 2

Theoretical Literature Review

2.1 Introduction

Trade volume growth and global supply chain development are often associated with trade barrier reduction, hence, measurements such as improving transport infrastructure, swifter modes of transport connections, faster border checks, and many more are seen as ways to boost export volumes. And the mega global policy BRI is doing exactly that – reducing trade costs via infrastructure by financing countries that are experiencing significant infrastructure gaps, mostly in developing economies and some advanced economies for strategic partnerships. As such, a good understanding of the theoretical and empirical works of trade frictions and how to analyse them is important. It helps a researcher to consolidate a foundation as well as evaluate the findings of the previous research. This chapter also serves to identify the current knowledge gap, which provides the basis for later empirical chapters.

Even though our case study on Piraeus Port in Greece is more of a qualitative research chapter, nonetheless we include the economic implications of the investment in the port and beyond as one of the research questions and incorporate the findings with trade statistics into the discussions. It is therefore safe to say that all three of our empirical studies relate to trade literature, in particular, the role of infrastructure and trade costs reduction. Apart from that, gaining a good level of knowledge about the methodology that this research employs is also crucial. We demonstrate in the second part of this chapter how the gravity model has been at the heart of almost all trade policy-related analyses. The gravity model has often been criticised for a lack of solid foundation; we argue that this is not the case and why it is not.

This chapter is organised as follows. First, a literature review on the impacts of infrastructure projects on trade costs will be covered. Second, the historical development of the gravity model from the original gravity equation to the state-of-the-art specification considering all estimation issues is presented. Third, justifications for using the gravity model in this thesis will be discussed.

2.2 Infrastructure projects and trade costs

"A trade policy without the right accompanying trade-related infrastructure might not deliver on the expected results" (Soobramanien and Zhuawu, 2014)

In recent years, besides traditional key factors which affect international trade such as the level of tariffs and other trade restrictions, the effects of infrastructure on trade have increasingly become a focal point in studies exploring international trade flows and patterns. In other words, it is necessary and crucial under the current international trade environment to examine how other factors can affect trade facilitation, which aims to reduce export and import costs as an alternative to reducing trade costs (Portugal-Perez and Wilson, 2012). These factors can be characterised into two aspects: a "hard" infrastructure related to physical infrastructure such as transport infrastructure, telecommunications infrastructure, and customs efficiency, as well as a "soft" infrastructure dealing with policies, regulatory mechanisms and other institutional dimensions that are intangible (Soobramanien and Zhuawu, 2014).

Both hard and soft infrastructures have a positive impact on bilateral trade flows through the cost channel. It is believed that adequate infrastructure facilitates trade and expedites shipping and transiting times for goods across borders via a reduction in trade costs. As such, transport infrastructure is the variable of interest in this study due to the fact that the BRI aims to reduce transport costs through various transport infrastructure projects.

Aschauer, 1990 stresses the importance of infrastructure by pointing out the great linkages between infrastructure and quality of life, health, and the economy as a whole. A body of literature confirms that improvements in transport infrastructure for a given mode of transport such as rail, road or air via infrastructure projects lead to a decrease in transport costs. Those infrastructure projects are often very expensive. Such improvements include changes in customs efficiency through a reduction of documentary requirements or a shorter inspection time. As a result, traders experience a simplification and harmonisation of border procedures for goods and services using the same routes as before but at a lower cost.

Evidently, Wilson, 2003 calculates that the average time spent waiting at a border might be used to travel 1,600 km over land. Such delays can be due to physical infrastructure deficiencies at ports but can also be procedural. For traders, delivery time is crucial, and it is determined by the distance of two countries as well as infrastructure quality. Poor transport infrastructure and tedious procedures cause delays in goods and services arriving on time. Hummels, 2007 finds that each day saved on journey times is equivalent to an average tariff reduction of approximately 0.4 to 1 per cent for exports and 0.8 to 1.5 per cent for imports. In addition to this, Limao and Venables, 2001 find that poor infrastructure accounts for about 40 per cent of coastal countries' trade costs. Similarly, Clark, Dollar, and Micco, 2004 conclude that port efficiency is the key factor in the cost of maritime freight shipping to and from the USA, and that port quality leads to an increase in shipping costs of 12 per cent.

The empirical literature makes extensive use of the gravity model to explore the impacts of various measures of transport costs as well as other variables influencing trade performance. More details will be discussed in the following sections. Aschauer, 1989 uses econometric methods in estimating the positive impacts of infrastructure projects on trade flows and economic welfare. Bougheas, Demetriades, and Morgenroth, 1999 show that there is a positive relationship between the level of infrastructure and volume of trade for European countries by utilising an augmented gravity model. Limao and Venables, 2001 use a basic gravity model looking at Sub-Saharan African trade with the rest of the world, and they conclude that a) halving transport costs leads to an increase in trade volume by a factor of five, and b) improving infrastructure will increase trade by 50 per cent. Nordås and Piermartini, 2004 use gravity model with transport costs to quantify the impact of transport infrastructure on trade flows.

In recent studies, Shepherd et al., 2011 conclude that a 5 per cent improvement in multimodal transport infrastructure leads to a rise in trade flows of around 2 to 5 per cent for OECD countries. Donaldson and Hornbeck, 2015 investigate the impacts of railroads on the American agriculture sector by employing a general equilibrium trade model, and in their counterfactual simulation scenario, they find that the elimination of all railroads would decrease the agricultural land value by 60 per cent and also bring down consumer welfare. Similarly, Donaldson, 2018 examines the impacts of India's railroad network on welfare and concludes that the development of the railroads decreases trade costs and inter-regional price gaps. This reduction in transport costs leads to an increased income by 16 per cent. Similar studies (Duranton, Morrow, and Turner, 2014 and Alder, 2016) have also analysed the trade effects of infrastructure projects on welfare.

To summarise, existing literature shows us through estimates and evidence that transport infrastructure projects indeed lead to reductions in transport costs. The literature also shows us that transport cost reductions have a significant impact on increasing trade flows and economic welfare for consumers. And the relationship between the two derived from the literature will be shown in our gravity model with a specific parameter later in the chapter.

2.3 The heart of international trade: Gravity model

So often one slogan or concept comes to symbolise an entire political campaign - be it the BRI, Brexit, or Make America Great Again. In international trade, that concept at the heart of all trade policy analysis and beyond is the gravity model. The gravity model has been regarded as the most popular framework in international economics for several reasons. As 2022 marks the 60th anniversary of the gravity equation, it is not surprising to see the gravity model standing out among all other economic models and taking the front page of the Financial Times back in 2016 (Financial Times, 2016). The US-China trade war has also made the headlines in the past few years and therefore trade policy analysis has become even more popular. However, the more popular the gravity equation gets, the more critics it receives. Academics and trade policymakers often view the gravity model as a set of equations without solid foundations and are sceptics over trade theory and policy analysis applied within the computable general equilibrium (CGE) framework.

The first part of this section aims to unpack the story of structural gravity in the following way: tracing back the gravity model's origin; reviewing and deriving the 'new' gravity model; showing that a structural gravity model indeed has a strong theoretical foundation and beyond; and summarising key reasons for the popularity of the gravity equation. The second part of this section explains issues when it comes to gravity estimation and how they should be best solved. Lastly, this section concludes with two sets of equations for aggregate and sectoral structural gravity that take into account all issues related to gravity estimation with general equilibrium trade policy analysis as the main takeaways for future empirical chapter references.

2.3.1 Deriving gravity equation

In attempt to understand the pattern of trade in a globalised setting, Tinbergen, 1962 was among the first to propose that bilateral trade flows between two countries can be approximated by Newton's theory of the derivation of the gravitation equation. Newton's law of universal gravitation states that every particle (i) attracts every other particle (j) with a force (G) that is proportional to the product of their masses (M_i and M_j) and inversely proportional to the square of the distance (D_{ij}^2) between them. It takes the form:

$$F_{ij} = G\frac{(M_i M_j)}{(D_{ij}^2)} \tag{2.1}$$

This gravity equation in physics can also be applied to international trade equivalently as:

$$X_{ij} = G\frac{(Y_i E_j)}{(T_{ij}^{\theta})} \tag{2.2}$$

where X_{ij} represents the value of trade flows between countries i and j; G is the gravitational constant in trade; Y_i,E_j are the value of output in country i and the value of expenditure in country j, respectively; T_{ij} denotes the total bilateral trade costs/restrictions between two countries and θ is the trade elasticity. In other words, trade (equally as the gravitational force) between two countries (two particles) is proportional to the size of the two countries' economy (masses) and inversely proportional to the trade frictions (the square of distance) between them. Assume that in an ideal economic model scenario, this basic model states that economic size or gross domestic product (GDP) attracts countries to trade more with each other while the longer distance between two countries means they tend to trade less with each other.

Ravenstein, 1885 was the first economist to apply gravity on migration and came up with Ravenstein's Laws of migration, which state that economic factors are the main cause of migration, and most migrants tend to move only a short distance. Later Anderson, 1979 carefully built the foundation of a gravity trade theory. It was not until later years that the gravity model was formally recognised due to the work by Eaton and Kortum, 2002 and Anderson and Van Wincoop, 2003.

Eaton and Kortum, 2002 's work is considered as supply-side gravity, whereas Anderson, 1979 and later Anderson and Van Wincoop, 2003 work are seen as demand-side gravity model. In this research, we will employ a theory-consistent demand-side gravity model, although the underlying foundation stays the same for both gravity models. Anderson and Van Wincoop, 2003 build on the work from Anderson, 1979 and derived what is now known as the "structural gravity model".

Derivation of the structural gravity model starts with two assumptions - Armington (Armington, 1969) and the constant elasticity of substitution (CES), or the "Armington-CES" assumptions. Armington, 1969 trade assumption states that products are differentiated by place of origin, and CES is a property of utility functions which consumers face. Because it is a demand-side gravity, we aim to maximise the consumer's optimal utility subject to their budget constraint.

Assume a world that consists of N countries, where each economy produces a variety of goods (i.e., goods are differentiated by place of origin (Armington, 1969)) that are traded with the rest of the world. The supply of each good is fixed to Q_i, and the factory-gate price for each variety is p_i.

Thus, the value of domestic production in a representative economy is defined as $Y_i = p_i Q_i$, where Y_i is also the nominal income in country i. Country i aggregate expenditure is denoted by E_i. Aggregate expenditure can also be expressed in terms of nominal income by $E_i =_i Y_i$, where $_i$ >1 shows that country i runs a trade deficit, while 1> $_i$ > 0 reflects a trade surplus. On the demand side, consumer preferences are assumed to be homothetic, identical across countries, and given by a CES-utility function for country j. If we apply first-order condition and solve it for all the variables, then the solution to our consumers' problems is the following:

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{t_{ij}}{\pi_i P_j}\right)^{1-\delta} \tag{2.3}$$

$$\pi_i^{1-\delta} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\delta} \frac{E_j}{Y} \tag{2.4}$$

$$P_j^{1-\delta} = \sum_i \left(\frac{t_{ij}}{\pi_i}\right)^{1-\delta} \frac{Y_i}{Y} \tag{2.5}$$

$$p_j = \left(\frac{y_j}{Y}\right)^{\frac{1}{1-\delta}} \frac{1}{\alpha_j \pi_j} \tag{2.6}$$

$$E_j = \varphi_j Y_j = \varphi_j p_j Qj \tag{2.7}$$

2.3.2 Understanding the gravity equation

The first equation 2.3 $X_{ij} = \frac{Y_i E_j}{Y}(\frac{t_{ij}}{\pi_i P_j})^{1-\delta}$ is the demand-side structural gravity model under the Armington-CES assumption (Anderson, 1979 and Anderson and Van Wincoop, 2003). The dependent term on the left side X_{ij} represents trade flows from the exporter country to the importer country. Trade flows (X_{ij}) are dependent on two terms - size term $Y_i E_j Y$ and trad cost term $t_{ij}\pi_i P_j$. As the size of two economies, or the equivalent GDP of two countries, increases, the volume of trade between them also increases. The only difference between the structural gravity equation and Newton's equation is the trade cost term $t_{ij}\pi_i P_j)^{1-\delta}$. This is the term that we are interested in because in order to quantify any impact of trade policy changes or shock on trade costs, one must take into account such impact through direct trade costs t_{ij} and general equilibrium (GE) trade cost π_i and P_j. In other words, the total bilateral trade cost equals the direct trade cost and GE trade cost. Direct trade costs (t_{ij}) include free trade agreements (FTA) and tariffs. GE trade costs (π_i and P_j) capture the trade diversion effect due to a trade policy shock and measure the total trade costs changes and effects.

Equations 2.4 and 2.5 π_i and P_j are also called outward and inward multilateral resistance terms (IMR and OMR). Anderson and Van Wincoop, 2003 gave new life to gravity modelling due to the delivery of these two terms. These two terms are the most crucial terms in a gravity equation and they are defined as the remoteness of any two trading countries relevant to the rest of the world. More specifically, the remoteness that is captured by IMR and OMR is when two countries trade more with one another because of the trade policy shock/change (i.e. regional trade agreement or FTA). The resulting effect is that those two countries become more remote from the rest of the world because of their closer trading relationship. Therefore, since they trade more with each other, this will mean that this action of trade destination selection diverges part of trade volumes away from the existing trading partner prior to any trade policy shock or change. This is also called the trade diversion effect which is captured by IMR and OMR terms.

Trade theory allows for changes in any (bilateral or unilateral trade) policy in the world to have an impact on any country. Therefore, when estimating the gravity equation, it is important to take into account this trade diversion effect and remoteness fully. Only factoring in the direct trade cost t_{ij} would lead to severe estimation biases. On the other hand, when estimating a standard gravity equation with total bilateral trade costs - t_{ij} + π_i P_j for any given trade policy, the gravity model can predict well. In short, in an ideal world where there is no friction or barrier (i.e. tariffs and non-tariff barriers (NTB)) to trade, bilateral trade is calculated as the size term $X_{ij} = Y_i E_j Y$. However, this is not the case in the real world and hence we need to take into account total bilateral trade costs (Anderson and Van Wincoop, 2003) which are both direct and GE trade costs (IMR and OMR) - t_{ij}, π_i and P_j, respectively to capture the impact fully and meaningfully.

In combination with market clearing conditions, OMRs can be mapped in the fourth equation 2.6 Factory-gate price ($p_i = (\frac{y_i}{Y})^{\frac{1}{1-\delta}} \frac{1}{\alpha_i \pi_i}$). The factory gate price p_i represents the commodity price that is being set at the factory of production, excluding any separately billed transport or delivery costs in the importer country i. By multiplying how much quantity we want to produce Q, we can also express p_i as $Y_i = \sum_j X_{ij} X_{ii}$, also called the market clearing condition equation. This equation tells us the value of total production which is equal to the value of total sales both domestically and internationally. It is worth mentioning that intra-national trade should always be taken into account in the estimation.

And lastly, once we have production we also need to know expenditure, that is how much we spent on what products. And similar to the consumer's optimisation problem, we are also subject to a constraint, therefore we set our expenditure equal to our production: $E_i = \varphi_i Y_i = \varphi_i p_i Qi$. This equation can be very useful as it allows for any trade policy to have an impact on any country's producers and consumers. The "five-equation" model (Equation 2.3 to 2.7) can also be used to construct many other indexes, such as the terms of trade, welfare statistics, trade bias, and trade openness.

Sectoral gravity model

Structural gravity equation can also be applied at sectoral level given all else constant. On the demand side, consumers are still maximising their utilities subject to their budget constraints. Their preferences or choice of goods are still subject to CES but are also nested in Cobb-Douglas preferences across sectors (k).

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y^k} (\frac{t_{ij}^k}{\pi_i^k P_j^k})^{1-\delta^k} \quad (2.8)$$

$$(\pi_i^k)^{1-\delta^k} = \sum_j (\frac{t_{ij}^k}{P_j^k})^{1-\delta^k} \frac{E_j^k}{Y^k} \quad (2.9)$$

$$(P_j^k)^{1-\delta^k} = \sum_i (\frac{t_{ij}^k}{\pi_i^k})^{1-\delta^k} \frac{Y_i^k}{Y^k} \quad (2.10)$$

$$p_j^k = (\frac{y_j^k}{Y^k})^{\frac{1}{1-\delta^k}} \frac{1}{\alpha_j^k \pi_j^k} \quad (2.11)$$

$$E_j^k = \alpha^k \varphi_j Y_j^k = \alpha^k \varphi_j \sum_k p_j^k Qj^k \quad (2.12)$$

National income Y_j equals the sum of production in all k sectors, with endowment given at sectoral level Q_j^k and factory gate price of k sector p_j^k. In addition to the gravity model application at sectoral level, it can also be applied to firm or product levels (Chaney, 2008) due to the nature of the sectoral gravity model. This sectoral level gravity estimation will come in handy later in the chapter in estimating the impact of the BRI on countries at sector level.

2.3.3 Estimating gravity equation

So far in this section, we have derived the structural gravity model from the very beginning and explained each term in detail. Now it is time to estimate the structural gravity model $X_{ij} = \frac{Y_i E_j}{Y} (\frac{t_{ij}}{\pi_i P_j})^{1-\delta}$ by Log-linearising the gravity equation and adding an error term (ε_{ij}) to account for all the other variables that are not included in this equation but also play a part in influencing trade flows.

$$\ln X_{ij} = \ln Y_i + \ln E_j - \ln Y + (1-\theta)[\ln \tau_{ij} - \ln \pi_i - \ln P_i] + \varepsilon_{ij} \quad (2.13)$$

Where X_{ij} represents the exports indexed of countries i and j, Y_i indicates the gross domestic production (GDP) per capita in current prices for country i, E_j is the expenditure for country j, Y is the world GDP, θ is trade elasticity of substitution, which takes the number of 5 backed by many trade literature, τ_{ij} represents the direct trade costs, π_i is outward multilateral resistance, and P_j is the inward multilateral resistance.

Specification 2.13 is the most popular version of the gravity equation, where it has been used to examine the effects of various determinants of bilateral trade (Silva and Tenreyro, 2006, Baier and Bergstrand, 2009, and Fidrmuc, 2009). For instance, the effects of RTAs, tariffs, immigration, FDI, trade sanctions, and cultural ties. However, many of the gravity estimates suffer from biases and inconsistencies. In order to obtain reliable (trade costs and policy) gravity estimates, one has to address and overcome prominent econometric challenges. The following subsections list some of the key econometric challenges that need to be taken into consideration in order to obtain reliable estimates of structural gravity estimation for any trade policy (Yotov et al., 2016).

Multilateral trade resistance (MTR) terms (IMR and OMR)

Multilateral resistance terms capture trade diversion effects due to remoteness caused by any trade policy change as well as measuring total bilateral trade costs. Not accounting properly for these two terms is considered the "golden mistake" in gravity estimation (Baldwin and Taglioni, 2006). Both inward and outward MTR capture the dependence of imports and outputs into country i (j) on trade costs across all possible suppliers. Anderson and Van Wincoop, 2003's model captures the changes in trade costs on one bilateral route can affect trade flows on all other routes due to the relative price effects.

However, the problem with obtaining MTR terms is that it is quite difficult to observe them directly. Over the years, researchers have come up with solutions to this issue. (Anderson and Van Wincoop, 2003) introduce a programme called the "iterative programme"; (Baier and Bergstrand, 2009)'s suggestion is to construct "remoteness indexes", which is a Taylor-series expansion to account for distribution of both inward and outward MTR without the inclusion of dummy variables. They showed that their model's estimation is almost indistinguishable from those obtained from fixed-effects models; (Rose and Van Wincoop, 2001) and (Feenstra, 2004) introduce exporter and importer fixed effects to fully account for both IMR and OMR terms. (Olivero and Yotov, 2012) introduce exporter-time and importer-time fixed effects for a panel data setting.

These fixed effects are dummy variables taking values 1 or 0. Fixed effects estimation involves the creation of dummy variables for each importer and exporter, which also serve as explanatory variables to the model. (e.g. Harrigan, 1996, Redding and Venables, 2004, and Head and Mayer, 2014). In contrast to the high popularity of fixed effects used in the trade literature, a random effects model is less preferred than the gravity model because the underlying assumption that this model takes is that the MTR is normally distributed, yet the structural gravity model does not say anything on that matter (Egger, 2002 and Carrere, 2006). In summary, an aggregate structural gravity estimation with dummy variables for each exporter and importer will, in theory, take proper account of multilateral resistance, and hence, should produce unbiased estimates.

Endogeneity of trade policy

When using ordinary least square (OLS) estimator, one has to be careful when dealing with endogeneity. It is possible that trade policy may be correlated with unobservable cross-sectional trade costs. In econometrics, endogeneity implies that an explanatory variable is correlated with the error term. This is often the case in the structural gravity model. For example, given that regional trade agreements (RTAs) are likely to be endogenous due to 'natural trading partners hypothesis', which hypothesizes that countries will form RTAs with their existing trading partners. One remedy for this problem is to add instrumental variables (IV) which correlate with the endogenous variable but not with trade and run a two-stage least square (TSLS) test (Baier and Bergstrand, 2004). For fixed effect models, Piermartini and Yotov, 2016 suggest to include intra-national trade to avoid endogeneity. It is a term that multiplies the importer variable by a dummy variable equal to one. Baier and Bergstrand, 2009 use simple averages rather than GDP weights to deal with endogeneity. Another solution to endogeneity problem is to include pair-fixed effect to properly account for all trade cost components (Baier and Bergstrand, 2007).

Pair fixed effects are often used in panel data settings to effectively address the issue of endogeneity of trade policy variables. The pair-fixed effects provide a flexible account of the effects of all time-invariant bilateral trade costs because pair-fixed effects have been shown to carry systematic information about trade costs in addition to the information captured by the standard gravity variables (Agnosteva, Anderson, and Yotov, 2014 and Egger and Nigai, 2015). To do this, a set of fixed effects dummy variables (fe_0) for each country pair would be generated and added to gravity estimation and the number of fixed effects depends on how large the dataset is. The larger the dataset, the more fixed effects dummy variables there will be in a panel data gravity estimation. These country-pair fixed effects address the issues that unobserved country-specific factors might affect bilateral trade and cause bias in estimates. Therefore, incorporating fixed effects in gravity estimation helps alleviate endogeneity issue. However, while this is an acceptable approach according to the literature, it should be noted that it is possible that endogeneity may not be fully addressed.

Zero trade flows

Zero trade flows occur when certain countries do not produce certain products due to natural resources and other factors. Hence, bilateral trade flows take value zero. Apart from the endogeneity issue, Silva and Tenreyro, 2006 also notice that with the OLS method, taking logarithms in the process will drop observations for which the trade value is zero, because the natural logarithm of zero is undefined. The issue is significant empirically as the zeros are quite common in trade values. However, they become less of an issue and almost irrelevant to the analysis and will be dropped when fixed effects are in the estimation equation.

One alternative approach is the Poisson Pseudo-Maximum Likelihood (PPML) estimator. The PPML estimator naturally includes observations which are dropped from the OLS estimation, which could avoid potential sample selection bias. Since the number of observations is greater using the PPML estimator than the OLS, the Poisson model fits the data much better than using the OLS model. There is a strong argument for using the PPML model (Arvis and Shepherd, 2013 and Fally, 2015). An extension of this work is the general equilibrium PPML approach by Anderson, Larch, and Yotov, 2015.

Another approach is the Heckman Sample Selection estimator (Heckman, 1979). The Heckman sample selection model includes zero observations naturally similar to the PPML model. In order to eliminate sample selection bias, Heckman, 1979 used a two-step procedure, which involves estimating the probability of a value in the gravity model using a probit estimator and calculating mill's ratio to solve the omitted variable bias.

The ideal remedy to solve zero trade flows in this research is to estimate the gravity equation in multiplicative form, which is taken using the command "ppml" in statistical software such as Stata (Silva and Tenreyro, 2006).

Heteroskedasticity of trade data

Heteroskedasticity occurs in OLS estimation when the error term or the residuals are not constant, which violates one of the OLS properties, therefore it produces biased estimates. The perfect solution to this is to use a PPML estimator instead of OLS (Silva and Tenreyro, 2006). The PPML estimator has been preferred over the OLS estimator for many reasons. The former solves heteroskedasticity issues; it is also consistent with gravity theory; the former can also deal with zero trade flow issues due to its multiplicative nature that the latter does not have in its form.

Adjustment to trade policy change

Trade policy such as FTA or RTA is usually ratified over a course of time (years); it is therefore important to reflect this adjustment and lag-in-time in our estimation. One can use interval data to adjust any trade policy change. But at the same time, you throw away a large amount of useful data or information that could have been used otherwise. In the empirical chapter later, we will account for the adjustment of BRI policy by using both consecutive year and interval years as our data sets.

Gravity with disaggregated data

Finally, the econometric challenge with gravity estimation is disaggregated data. As mentioned above, the gravity model is separable, which means that we can use it with disaggregated data - sector level, firm level or product level.

Theoretically-consistent structural gravity model

Taking into consideration all the above challenges, and combining the solutions to those issues, theory-consistent estimating structural gravity model is derived as follows (Yotov et al., 2016):

$$X_{ij} = \exp[\pi_i + \chi_j + \mu_{ij} + \eta_1 BTP_{ij} + \eta_2 NES_{iJ} \times INTL_{ij} + \eta_3 NIP_j \times INTL_{ij}] \times \varepsilon_{ij} \tag{2.14}$$

Where the variable X_{ij} denotes the nominal trade flows, π_i is the outward multilateral resistances (OMR), and inward multilateral resistances (IMR) χ_j. And they are often captured by exporter-time and importer-time fixed effects in gravity estimation. μ_{ij} is the country-pair fixed effects. The reason to include this variable is to absorb most of the relationship occurring between endogenous trade policy variables and the error term ε_{ij}. BTP_{ij} indicates the bilateral determinants of trade flows, such as tariffs and FTAs.NES_i denotes any Non-discriminatory Export Support (NES) policies such as export subsidies. $INTL_{ij}$ is the dummy variable taking the value of one for international trade between countries i and j, and zero otherwise. NIP_j represents any Non-discriminatory Import Protection (NIP) policies, such as most favoured nation (MFN) tariffs. The product of NIP_j and dummy variable $INTL_{ij}$ is therefore to identify the effects of any non-discriminatory import protection policies. Lastly, it is worth mentioning that instead of taking natural log of every variable, we use exponential form as expressed in specification 2.14 as exp to represent the multiplicativity.

2.3.4 Structural gravity with general equilibrium (GE) analysis

The following is our standard five-equation structural gravity model:

$$X_{ij} = \frac{Y_i E_j}{Y} (\frac{t_{ij}}{\pi_i P_j})^{1-\delta} \tag{2.15}$$

$$\pi_i^{1-\delta} = \sum_j (\frac{t_{ij}}{P_j})^{1-\delta} \frac{E_j}{Y} \tag{2.16}$$

$$P_j^{1-\delta} = \sum_i (\frac{t_{ij}}{\pi_j})^{1-\delta} \frac{Y_i}{Y} \tag{2.17}$$

$$p_i = (\frac{y_i}{Y})^{\frac{1}{1-\delta}} \frac{1}{\alpha_i \pi_i} \tag{2.18}$$

$$E_i = \varphi_i Y_i = \varphi_i p_i Qi \tag{2.19}$$

Head and Mayer, 2014 establish a structural system that breaks down the effects of trade policy on trade into three different channels: direct or partial equilibrium (PE), conditional general equilibrium (CGE) and full endowment general equilibrium (FEGE). One thing to note is that the structural gravity model is not only part of the CGE model but is more than just a CGE model. It is an estimating CGE model with the standard five-equation model and is able to nest into any other complex gravity models (i.e. Dynamic gravity).

Direct PE refers to the initial effect of trade policy changes on bilateral trade volume, that is the change in bilateral trade costs t_{ij} as a result of trade policy shock leads to a change in bilateral trade volume X_{ij}. The term 'partial' means that only the effect of trade costs on bilateral trade is examined while holding other variables Y_i, E_j, Y, π_i, and P_j constant. Therefore, the effect is only limited to the countries involved with zero effect on the rest of the countries.

Unlike direct effect of partial equilibrium with only estimating the effects of trade cost reduction on countries involved, conditional general equilibrium takes into account the effects of changes in trade policy on the rest of the nations via multilateral resistance terms π_i and p_j. Hence, it is called the general equilibrium, meaning that all other countries also have an impact as a result of this, because it takes into account not only the change in trade costs, but also the general equilibrium effects of consumers and producers in other countries that are triggered by the changes in PE in the first place. Theoretically, conditional GE decomposes the effects of a policy change into two different components: the economic size term $\frac{Y_i E_j}{Y}$, and total bilateral trade cost term $(\frac{t_{ij}}{\pi_i P_j})^{1-\delta}$. This effect is called the conditional GE because it is based on the condition that the economic size term, output (Y_i) and expenditure (E_j) are expected to hold constant.

There are two different CGE effects, namely the first-order GE effects and second-order GE effects. They measure the impacts of bilateral trade changes on countries involved and on the non-member countries via the changes on countries involved in multilateral resistance terms π_i and P_j respectively. For the first-order GE effects, as a decrease in non-tariff barriers, the inward multilateral resistances $_j$ 2.17 will decrease for both countries i and j while holding other variables constant. Similarly, the outward multilateral resistances π_i 2.16 will also decrease as trade liberalisation occurs. On the contrary, the second-order effects measure that the non-member countries' π_n and P_n will increase as countries i and j become more integrated, and the more remote it becomes relative for other countries. It implies that country i is assumed to export more goods to country j, and less to all other countries.

As the name suggests, the full endowment general equilibrium only holds country i's production Q_i constant, and it allows Y_i and E_j to change based on factory-gate price p_i to respond to changes in trade costs t_{ij}. The translation of these changes in p_i will convert into a change in the value of domestic production Y_i for country i and the aggregate expenditure E_j via equation 2.7. According to the first-order CGE mentioned previously, a change in trade costs will lead to a decrease in π_i, based on equation 2.6 for the producer price p_i, a fall in π_i will lead to an increase in p_i. Following that, equation 2.6 shows that if there is a rise in variable p_i, assuming Q_i holds constant, there will be a positive impact on production Y_i, and an increase in E_j eventually. This is because producers in member countries will internalise the favourable change in π_i by increasing their prices. On the contrary, for countries which are not involved, because of higher π_i, producers will decrease their prices.

Additionally, since a trade cost reduction results in a fall in π_i, an increase in p_i, a rise in Y_i, and an increase in E_j, there is a direct GE effect on trade, that is, if we look back at equation 2.3, due to a rise in Y_i, both imports and exports in countries i and j will increase, that is a rise in X_{ij}.

2.4 All roads lead to gravity: model specifications

In a standard gravity equation, the trade policy of interest is modelled through the trade cost term. This is the term that one will tweak to obtain estimates. Hence, proper specification of bilateral trade cost term is important for both partial and general equilibrium trade policy analysis. Anderson and Van Wincoop, 2004 define the term "trade costs" as all costs incurred in obtaining a good to the final user. This implies that trade costs include tariff and non-tariff barriers (NTBs), information costs such as language and colonial history, transport costs such as freight and time costs generated from distance, and local distribution costs.

In the trade literature, trade cost term takes the form of:

$$\tau_{ij} = d_{ij1}^{\delta} - \exp(\delta_2 Cont_{ij} + \delta_3 lang_{ij} + \delta_4 ccol + \delta_5 col_{ij} + \delta_6 landlock_{ij} + \delta_7 RTA_{ij}) \tag{2.20}$$

Where τ_{ij} represents the trade costs, d_{ij} is the bilateral trade distance between country i and j, $cont_{ij}$ is the common border shared. These two variables are the most used and robust proxies for trade costs. $lang_{ij}$ is the common official language, and col_{ij} indicates the common former coloniser, these two are dummy variables taking value one and zero. $landlock_{ij}$ represents landlocked countries, RTA_{ij} (regional trade agreements) is a trade policy variable, as well as the dummy variable of whether there is an FTA between trading partners i and j, taking the value of one, and zero otherwise. δ_n are the parameters to be estimated. These are some of the standard variables that will affect trade costs according to trade economists (Yotov et al., 2016), which we will use to proxy for direct trade cost term t_{ij}. Gravity estimation with only these variables will not predict the level of trade very well because it makes the "golden mistake", which is not taking into account the multilateral resistance terms IMR and OMR.

Besides technology improvements and trade policy liberalisations, trade cost reduction is another factor which affects trade flows. Since the 1970s, trade costs play a crucial role in determining trade flows from a theoretical standpoint. Earlier studies from Anderson, 1979, Krugman, 1980, Bergstrand, 1985; Bergstrand, 1989, Helpman and Krugman, 1985 account for the impacts of trade cost reduction on trade flows fully in their gravity model estimations. The economic rationale for the inclusion of these variables in the trade costs equation above has been highlighted to have a significant impact on trade flows. Therefore, it is reasonable to believe that a high quality of infrastructure, low tariffs, common language and culture shared between country pairs could lead to a trade cost reduction, which in turn is likely to increase trade flows bilaterally. The full measurements of trade costs will be discussed in more detail later in Chapters.

There are some best practices for structural gravity estimation. The first piece of advice is to use panel data whenever data availability allows. It is consistent with theory as well as its reliability property. Not only this, it also improves estimation efficiency significantly. The second advice is to create and use both consecutive and interval years of datasets to adjust for trade policy changes. Thirdly, one should always obtain both intra-national and international trade data in order to capture trade diversion effects fully by IMR and OMR terms. Fourthly, it is ideal to always employ importer-time and exporter-time fixed effects to the unobservable IMR and OMR terms. Fifthly, always employ country-pair fixed effects to avoid endogeneity issues. And lastly, the PPML estimator is preferred. However, PPML has its downside. It is slow when it comes to large data set estimation and also estimates are sometimes nonconvergent, which means that it cannot obtain estimates. In recent years, trade economists (Zylkin et al., 2019) and (Larch et al., 2019) came up with a much faster PPML estimator called the PPML high-dimensional fixed effect ($ppmlhdfe$) or PPML panel structural gravity estimator ($ppml\_panel\_sg$). It solves both issues perfectly - the command runs fast with a large amount of data and also solves non-convergent issue with standard PPML commands.

2.5 Revisiting reasons behind the gravity model's popularity

Every estimation method has its own advantages and disadvantages - it cannot be asserted that any one of them absolutely outperforms the others. Table 2.1 shows a list of the estimation methods used in the trade literature and their advantages and disadvantages (Gómez-Herrera, 2013). Linear methods do not take into account zero trade flows issues, and the revised version's procedures are said to be inefficient and, due to the loss of information, estimation biases may present. For nonlinear estimation methods, apart from the PPML that is mentioned in Table 2.1, other most frequently used methods are Nonlinear Least Square (NLS), Feasible Generalised Least Squares (FGLS), Heckman sample selection and Gamma Pseudo Maximum Likelihood (GPML).

Silva and Tenreyro, 2006 claim that NLS is inefficient because it gives more weight to observations with larger variance and is not robust to heteroskedasticity. Martínez-Zarzoso, 2011 sets out that FGLS are the most appropriate model if the exact form of heteroskedasticity in data is ignored. Martínez-Zarzoso, 2011 computes the performance of GPML, finding it to be adequate in the presence of heteroskedasticity, although it shows less accuracy when zero trade flows are present. Finally, Poisson Pseudo Maximum Likelihood (PPML) is similar to GPML, but assigns the same weight to all observations. PPML notably reduces the magnitude of the coefficients as well as the standard errors (Gómez-Herrera, 2013). Silva and Tenreyro, 2006 point out that this is the most natural procedure without any further information on the pattern of heteroskedasticity.

TABLE 2.1: Summary of estimation methods (Gómez-Herrera, 2013)

Estimation method	**Advantages**	**Disadvantages**
Ordinary Least Square (OLS)	Easy to perform	Zero trade flows and biased coefficients
$OLS(1 + T_{ij})$	Solves zero trade flows issue	Biased coefficients
Tobit model	Solves zero trade flow issue	Lack of theoretical foundation
Panel fixed effect	Controls for unobserved heterogeneity	Sample selection bias
Heckman Two-step	Multicollinearity solved	Identification restriction
PPML	Unbiased estimates	Limited dependent variable bias

Gravity modelling has been popular in trade policy analysis and it is at the heart of international trade for several reasons. First, the gravity specification is very intuitive, and the theoretical foundations are relatively strong as stated in the previous section. Second, one of the main advantages of the structural gravity model is that it delivers a tractable framework for trade policy analysis in a multi-country setting. It simultaneously accommodates multiple countries, multiple sectors, and even firms and products. As such, the gravity framework can be used to capture the possibility that markets (sectors and countries) are linked and that trade policy changes in one market will trigger ripple effects in the rest of the world (countries).

Thirdly, one of the most attractive properties of the structural gravity model is that it is separable. Anderson and Van Wincoop, 2004 show that for a given set of country-level output Y_i and expenditure E_j values, where k is the class of goods or sector, structural gravity equation is able to deliver a sectoral-level specification (Equation 2.8 to 2.12). Lastly, gravity model setting has a very flexible structure that can be integrated within a wide class of broader general equilibrium models in order to study the implications between trade and labour markets, investment and many more.

Moreover, one of the most attractive properties of the gravity model is its predictive power. Empirical gravity equations of trade flows consistently deliver a remarkable fit of between 60 and 90 per cent with aggregate data as well as with sectoral data for both goods and services. Head and Mayer, 2014 offer representative estimates and evidence for the empirical success of gravity with aggregate data. Anderson and Yotov, 2010 present and discuss sectoral gravity estimates with goods trade. Anderson, Larch, and Yotov, 2015 show that gravity works very well with services sectoral data. Finally, Aichele, Felbermayr, and Heiland, 2014 estimate sectoral gravity for agriculture, mining, manufacturing goods and services. Most importantly, structural gravity is more than a CGE model as it can be estimated and nested with many GE superstructures as well as constructing the impact of trade on various economic outcomes while also recovering key structural parameters for CGE analysis.

2.6 Conclusion

This chapter starts with a literature review on the role of infrastructure and trade costs in an international trade setting. Barriers to trade (trade frictions or trade costs) can be reduced via infrastructure projects, and this will further facilitate bilateral trade. The second part of this chapter is a thorough review on the gravity model from its origin, derivation, estimation, issues with estimation, structural gravity model with GE analysis, model specifications, and reasons for such popularity among international trade literature. By the end of this chapter, it is safe to conclude that for the upcoming empirical chapter in which the structural gravity model is employed, we have set up a solid foundation for using the most popular model in our estimation.

Chapter 3

Contextual Literature Review

3.1 Background: Unpacking the BRI

With China deepening its trade integration with the global economy, such substantial economic growth in recent years is seen as the result of its comparative advantages as a manufacturing location (Chen, Yung, and Zhang, 2002 and Rowen, 2003) and various other complementary reform policies set out by the central government. For example, the "Open Door" policy was initiated in 1978 to accumulate global capital through the inflow of Foreign Direct Investment (FDI) and to export Chinese-made commodities to the rest of the world. The policy began its tremendous changes in coastal regions to encourage and welcome foreign trade and investment.

The "Go Global" policy (also referred to as the "Going Out" policy) was initiated in 1999 by the Chinese government to increase Chinese investment abroad. The "Go West" policy was introduced in 2000 aiming to promote economic development of 12 western provincial-level regions. The strategy was expected to benefit those 12 poorest provinces in terms of infrastructural construction support, FDI and environmental protection (Xinhua, 2016), regardless of the mixed results that the policy had (Reuters, 2007). Following from the successful economic reform and recent industrial overcapacity in steels and other sectors, in 2013, President Xi introduced the Belt and Road Initiative (BRI).

In a sense, unlike traditional free trade agreements (FTAs), BRI is seen as the Chinese way of avoiding compliance requirements that a standard treaty normally requires, and it is a less formal arrangement than an FTA but it provides equivalent economic skills and effects (Kennedy and Parker, 2015). More importantly, China's foreign policy is largely concerned with finding new venues for Chinese investments in other countries, especially for the construction of infrastructure, and finding access to raw materials and sources of energy to prevent over-accumulation of capital and domestic saturation (Joshua, 2019). Hence, in line with the "Going Out" policy, the role of the BRI is to support of such policy by creating the appropriate infrastructure to enhance connectivity, especially transportation and communication projects to facilitate the acquisition of raw materials and strategic locations.

3.2 Framework of the Belt and Road Initiative

The BRI was introduced by the Chinese government in 2013 and the official objectives are to stimulate economic development, unimpeded trade, financial support and policy dialogue (Development and Commission, 2015). Policies and regional economic blocs that China has been engaged with laid the groundwork for the BRI policy. Unlike regional trade blocs that were formed, BRI is inclusive in nature and does not exclude any countries or economies. As a result, BRI covers over 149 countries and economies and involves half of the world's population. The complete list of the key 66 BRI countries announced in the original publication of the policy is shown in Table 3.1.

TABLE 3.1: List of key BRI countries (Chin and He, 2016)

Region	Country
East Asia	China
Southeast Asia	Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste and Vietnam
South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka
Central and Western Asia	Armenia, Azerbaijan, Georgia, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan and Uzbekistan
Central and Easter Europe	Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Türkiye (Turkey), Hungary, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia and Ukraine
Middle East and Africa	Bahrain, Egypt, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen

The word 'Belt' refers to the Silk Road Economic Belt (SREB), the overland interconnecting infrastructure corridors linking China to Central and South Asia and onwards to Europe; the word 'Road' refers to the New Maritime Silk Road (MSR), the sea route corridors linking China with Asia and Africa, down to Europe. The initiative, therefore, focuses on maritime routes and land infrastructure that improve the connectivity of both land and sea transportation between Europe and Asia. Ever since the announcement, the initiative has generated immense international interest and enthusiasm as well as some concerns. The inflow of direct investment from China to BRI participating countries is at 1.59 billion USD, and there are 138 newly signed contracts for BRI projects in January 2020 (platform, 2020).

Despite high levels of interest from China's neighbouring countries, concerns have been raised by others regarding BRI's overseas investments. In a report recently published by the World Bank, authors conclude that new infrastructure is often constructed at the expense of rising public debt. In addition, the BRI presents risks common to large infrastructure projects and

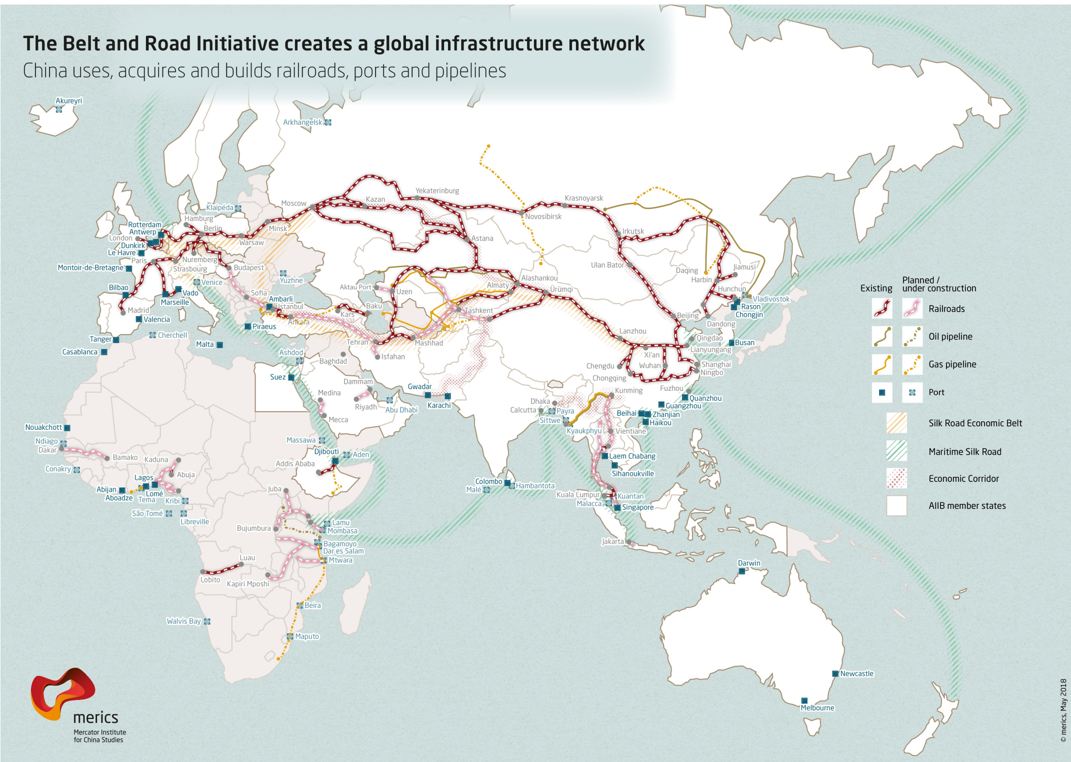


FIGURE 3.1: BRI countries and project type (Merics, 2018)

reasons include the lack of transparency and openness of the policy or the project itself, as well as weak economic foundations and governance of few participating countries (Michele Ruta, 2019).

An important pillar of the BRI is its infrastructural investment projects along the six corridors aiming at lowering transport costs by increasing transport networks connecting regions and countries and also increasing both internal and external trade integration (Huang, 2016). It is also for that reason that the BRI differs from many other international cooperation mechanisms, such as bilateral or regional trade agreements and other trade treaties. Figure 3.1 illustrates countries that are taking part in the policy and infrastructure projects and sectors involved along the route. It is clear that the BRI creates a global infrastructure network by using, acquiring and building railroads, ports and oil and gas pipelines.

According to the Global Infrastructure Hub, despite the demand for infrastructure across the globe is estimated to reach 94 trillion USD by 2040, the infrastructural investment gap still remains as high as 32 to 43 per cent (GIH, 2017). With this in mind, the BRI, being a series of infrastructure projects, helps to build and improve infrastructure in both developing and developed countries. Many beneficiary countries such as Myanmar and Pakistan have seen a substantial under-investment in infrastructure, which often leads to inefficiency in trade with their trading partners.

Former vice chairman of the China Development Bank (CDB) Mr. Zhijie Zheng, at the Boao Forum for Asia (BFA) Annual Conference in March 2019, discussed that there are three main reasons why a fifth of the world's infrastructure investment need is not able to be effectively funded (Qingting Zheng, 2019). First, there is infrastructure spending inefficiency in some countries due to the lack of financial and financing contribution capacity. This results in a significant lag in infrastructure development. Second, market operation inefficiency and difficulty make it harder to attract capital for infrastructure projects which are often large in scale. Lastly, the enormous uncertainty that might occur during project construction often leads to underinvestment in infrastructure planning. In addition, land acquisition and environmental sustainability issues are also common during initial project planning.

OECD and IMF analysis indicates that for every dollar of investment in infrastructure, including motorways, bridges, power plants and grids, communication systems, ports, airports, housing, water, sewers and social infrastructure, there is an x1.6 multiplier in the form of a boost to short-term employment combined with a longer term productivity gain to the economy (Ebrd, 2016). Therefore, the implementation and development of BRI infrastructure projects seemingly fit into the need for infrastructure spending, acting as an alternative to the traditional international financial institutions' aid, which offers long-term and sustainable financial support with assessed levels of risk. So far, there are more than 2,000 projects identified as being linked to China's BRI from both public and private institutions, and those infrastructure projects account for 70 per cent of the total BRI projects. It is estimated that Russia and Central and Eastern Europe are likely to be the biggest recipients of these investment projects (Balhuizen, 2017).

After the reconstruction of the maritime industry in the 1970s, new investment in port facilities and new vessels led to considerable transport cost reduction. For that reason, the sea route has become the most common and cost-effective mode of transport for shipping goods between countries. In the context of China-EU trade, sea freight is the cheapest option among land, air, and sea connections between Europe and China (Hub, 2019). Furthermore, the sea route also provides the option for containers to be further transported by railways (Eurostat, 2019) into neighbouring landlocked countries.

Take Greece as an example, the rail service between Piraeus Port in Greece and inland destinations such as Hungary and Poland enables container ships with transhipment goods at the port to be unloaded into feeder ships or to be transported directly by railroads to their final destinations (Shipping, 2019). Piraeus Port handled 4.9 million Twenty-foot equivalent unit (TEUs) in 2018, an increase of 19.4 per cent compared with 2017 (Glass, 2019). This increase in trade volume is the result of an improved port-rail transport network link, which takes only two days to transit from Piraeus Port to central Europe. It is therefore both cost- and time-saving for firms to choose the Piraeus route compared to the Rotterdam or Hamburg routes (Safety4sea, 2018).

Table 3.2 is a short list of BRI infrastructure projects by category: railways, gas pipelines and ports. Some of these are cross-border infrastructure projects, such as the 800km Sino-Thai High-Speed Railway that carries both passengers and cargo from Kunming, China through Vientiane, Lao, to Bangkok, Thailand. It is Thailand's first high-speed railway spearheaded by China. As mentioned above, infrastructure projects are often expensive and this cross-border railway project is no exception. The estimated cost for this railway is around 500 billion Thai Baht (15.28 million USD). Once the project is completed, it is expected to carry exports from Thailand to Europe in just 12 days (Chen, Eurasia News Online). This is just an example of a costly infrastructure project linked to the BRI that could potentially reduce transport costs between countries. Broadly speaking, there are also other types of BRI projects such as oil pipelines, telecommunications and electricity links taking place in BRI participating countries.

TABLE 3.2: Example of BRI infrastructure projects (Belt Road, 2018)

Type of infrastructure	Project detail
Railways	Sino-Thai 800km high-speed cross-border railway;
	Kuala Lumpur-Singapore cross-border high speed rail;
	Dushanbe-Uzbekistan cross-border road improvement project, Tajikistan
Gas pipelines	Trans-Anatolian natural gas pipeline project, Azerbaijan;
	Central Asia-China cross border gas pipeline
Ports	Dawei port in Myanmar; Gwadar port in Pakistan;
	Piraeus port in Greece; Antwerp port in Belgium

Figure 3.2 illustrates BRI project investment value by both region and sector. It is evident that from the figure, Central and Eastern Europe accounts for most of the BRI project investment value of 31 per cent. The results are certainly not surprising as every BRI route - land and sea - ends in Europe. In addition, railway and road and other transport sectors together account for a total of 44 per cent of project investment value. This can be explained by the fact that the backbone of the BRI is a series of transport infrastructure projects in those mentioned sectors.

BRI creates a global infrastructure network as shown in Figure 3.1 by acquiring and building railroads, ports and pipelines to form six economic corridors. Figure 3.3 is a simplified version of the six corridors shown on the world map. For the following subsections, I will be discussing these six corridors in more detail as they take up the majority of transport projects within

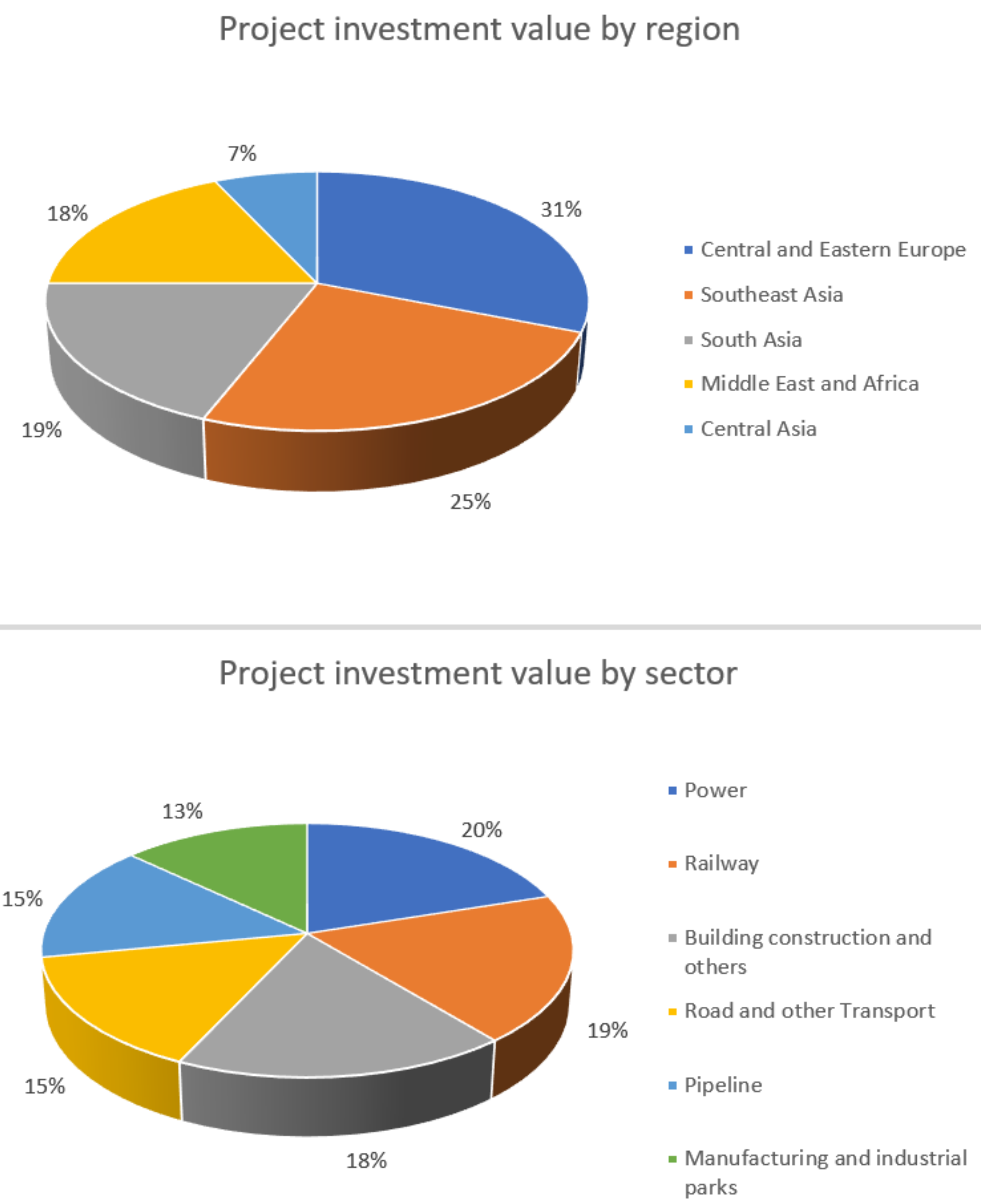


FIGURE 3.2: BRI infrastructure investment value by region and sector (Balhuizen, 2017)

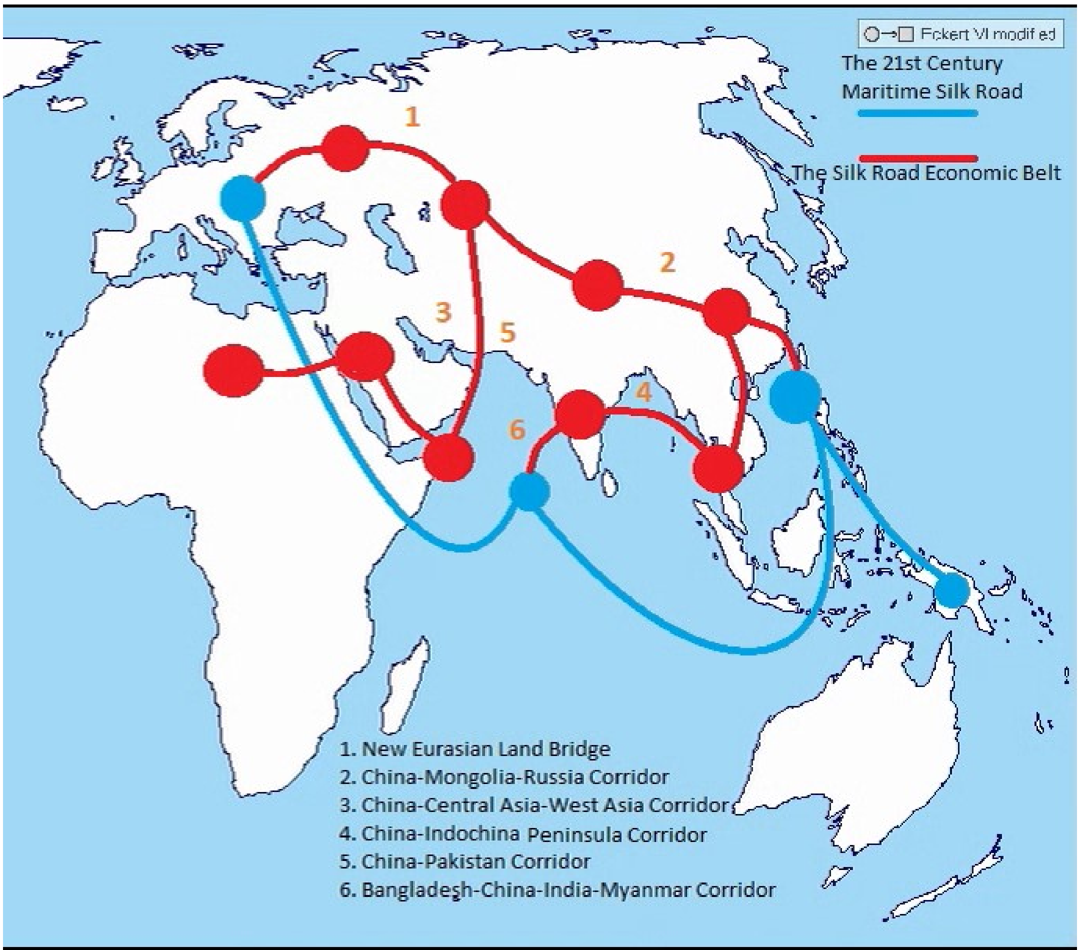


FIGURE 3.3: BRI land and sea routes and six economic corridors (SIIS, 2018), author's adaptation.

BRI. Understanding what each of the corridors entails helps readers to visualise and quantify BRI from an opaque trade policy to empirical terms. Details are summarised based on a report from the China Investment Research with Shanghai Institute For International Studies (SIIS) (SIIS, 2018) with the author's own interpretations.

New Eurasia Land Bridge Economic Corridor (NELBEC)

The catalyst for the New Eurasia Land Bridge Economic Corridor (NELBEC) rail service was that car and electronics companies wish to reduce shipping time and therefore transport costs (Pomfret, 2019). The NELBEC is an international railway line starting from China through Kazakhstan across Azerbaijan, Georgia and onto Turkey and finally ends in the EU, connecting Lianyungang port in China with Rotterdam, the Netherlands. This route is seen as the 'fastest route' taking freight from China to Europe. Furthermore, over 6,300 trains travelled from China overland to Europe in 2018, and it takes just 14 days for goods to arrive in Istanbul, Turkey from Shanghai, China, where the route includes two sea transit segments (Devonshire-Ellis, 2019).

China-Mongolia-Russia Economic Corridor (CMREC)

The China-Mongolia-Russia Economic Corridor (CMREC) is an inland line linking China, Mongolia and Russia via pre-established economic ties and cooperation. The China-Central Asia-West Asia Economic Corridor (CCAWAEC) runs from Xinjiang, China and via Alashankou joins the railway network of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, Turkmenistan) and West Asia (Iran, Türkiye). Together with NELBEC, these two corridors form a two-wing central circle, which stretches across the Eastern Eurasian continent and westward entering into the European economic circle.

The Manzhouli land port is essentially the most important land-sea channel from Bohai Rim Region to Russia and on to Eurasia. The Erenhot railway port is currently the only railway port connecting China and Mongolia and on to Europe. As a result, China-Europe freight trains passing through Erenhot railway port increased by 300 per cent in 2017, while China-Europe inbound/outbound freight trains passing through Manzhouli land port increased by 33 per cent. This could be the result of traders switching their mode of transport goods from maritime to inland freight trains due to cheaper transport costs, quicker shipment time and better transport network linkage.

China-Indochina Peninsula Economic Corridor (CIPEC)

The China-Indochina Peninsula Economic Corridor (CIPEC) mainly covers the Greater Mekong sub-region. There are three routes starting from Kunming, China on to Singapore: a) the Eastern route goes from Kunming, China through Vietnam and terminates at Singapore; b) the Central route departs from Kunming, China through Laos, Thailand and ends in Singapore; and c) the Western route leaves at the same origin city Kunming, passes Myanmar and ends in Singapore.

In order to complete the CIPEC, it requires the 800km Sino-Thai High-Speed Railway (HSR) as mentioned above; and the Kuala Lumpur-Singapore HSR with a speed of 350km/h once construction is finished; and also the Indonesia HSR linking Jakarta, Indonesia to Bandung, Indonesia. This corridor is a USD 6 billion project and around 75 per cent of the cost is funded by the Chinese Development Bank (CDB). The short- and long-run impact of infrastructure on export and trade deficit is significant. Research suggests that there is a positive relationship between infrastructure and promoting exports, especially for South Asian economies (Munim and Schramm, 2018).

China-Pakistan Economic Corridor (CPEC)

The China-Pakistan Economic Corridor (CPEC) is an economic corridor running from Kashgar, Xinjiang in China to Pakistan's Gwadar Port. CPEC projects currently include highways, railways, optical fibre and oil pipelines costing a total of USD 62 billion. Pakistan will benefit from the CPEC as it improves its infrastructure, but at the cost of a USD 10 billion debt and the handover of the management of the strategic Gwadar Port in Balochistan province to China. The same happens with the Maldives, which owes China roughly USD 1.5 billion in construction costs (Jha, 2019).

Poor logistics facilitation significantly reduces a country's competitive advantage. Goods trade and logistics performance can limit the potential of developing countries to diversify from time-insensitive goods to value-added goods (Arvis et al., 2016). Not only that, globalised industrial production has increased the importance of seaports in the context of global supply chains. Therefore, port activity does not necessarily refer to just container handling; logistics service provision in an international context has become a core part (Wang and Cullinane, 2015).

China will see a considerable reduction in oil transport costs (USD billion per year) as oil shipping distance is shortened from 13,000 km to 3,000m per barrel of oil imported from the Persian Gulf once the oil pipeline project is finalised. The traditional logistic route from Europe to China is 19,132 miles, whereas the CPEC route is 9,597 miles, an almost 50 per cent reduction in shipping distance. As a result, the translation of the shortening time on distance results in a substantial logistics cost reduction of 41 per cent.

Bangladesh-China-India-Myanmar Economic Corridor (BCIM)

The Bangladesh-China-India-Myanmar Economic Corridor (BCIM) aims to bring the four countries closer through trade integration and connectivity. Similar to the CPEC, BCIM runs from Kunming, China to Kolkata, India, passing through Myanmar and Bangladesh as the name suggests. Projects in Bangladesh include a trade deal between Bangladesh's state-run Ashuganj Power Station (APSCL) and China Energy through a 50/50 joint venture. The project is estimated to cost 2 billion USD with loans from the Export-Import Bank of China (EXIM). In Myanmar, China takes a stake of 85 per cent for 7.3 billion USD in Kyauk Pyu port, a strategically important seaport in the country. Like Gwadar port and all other ports, Kyauk Pyu port is important to China as it is the entry point for a Chinese oil and gas pipeline which provides an alternative route for energy imports from the Middle East to China that avoids the Straits of Malacca, which often experience high traffic and high risk.

As discussed above, the six economic corridors serve as an alternative to the traditional China-Europe trade route. The current maritime shipping route departs from Eastern or Southern ports of China, passing through the Straits of Malacca, the Mediterranean and terminates at Europe. Hence, it is evident that the current China-Europe trade route primarily relies on the Straits of Malacca, which is best known as the 'traffic bottleneck' due to heavy traffic flow and an unstable political environment (Evers and Gerke, 2006). Furthermore, maritime transport is often seen as relatively less reliable due to its long delivery time. Creating more resilient trade routes, not only will significantly reduce transport costs for firms and individuals but also provide long-term growth for a country's economy due to smoother transit of goods.

The development of the BRI and its six economic corridors aims to improve trade efficiency and international logistic networks and reduce transport costs through various transport infrastructure projects. Therefore, these corridors potentially offer an alternative trading route linking China and Europe to ease the heavy use of the current China-Europe shipping route on the Straits of Malacca. Putting positive numbers that BRI projects have brought aside, the BRI is not without its uncertainty.

The most significant example is the unpredictability of the future for infrastructure projects along the economic corridors where construction has just begun. The contracts could potentially be affected for reasons such as the shift of the government from one party to another with a set of different manifestos and agendas when it comes to Chinese investment and BRI, or foreign direct investment as a whole. This could result in the termination of existing working infrastructure projects. The uncertainty of infrastructure projects has turned out to be a high risk for the forthcoming achievement of the BRI. Additionally, the Covid-19 pandemic also halted various BRI projects for almost two years until some of them started working again in 2022.

In transportation and logistics literature research, Wen et al., 2019 look at the full potential of the diverse BRI economic corridors to serve as alternative trade routes between China and Europe. They employ the Route Utility Function method and identify that the New Eurasia Land Bridge Economic Corridor and the China-Mongolia-Russia Economic Corridor are the best alternative routes for the current trading route between China and Europe.

3.3 BRI Financing mechanisms and the SOE-led financial system

Where does the BRI project fund come from? Through which institution, by what form and under what condition? Once we understand what the policy actually implies, which is infrastructure projects, we then need to understand how they are funded and through what channel. The infrastructure development to make these links work requires a substantial amount of capital from a wide range of places. The international community has been providing concessional financing to low-income countries (LICs) in various forms.

For instance, the IMF lending instruments under the Poverty Reduction and Growth Trust (PRGT) (Fund, 2020) is one such example. Despite that, the required financial subsidies and governmental support are limited by domestic laws, which results in most countries not having the bargaining chip to provide concessional financing to external parties on a large scale. This then translates into greater constraints and a lack of sustainability, which is hardly sufficient as BRI's construction projects require a considerable amount of funds over a long period of time. In such cases, it is necessary to establish a stable, sustainable and mutually beneficial BRI investment and financing framework.

Table 3.3 lists each funding channel and major banks or institutions involved. The types of investments that are expected along the countries of the BRI are characterised by large upfront payments and long periods to generate returns on investments. The funding of the BRI can be categorised into five distinct channels: policy banks, emerging multilateral development financial institutions, commercial banks in China with overseas branches and financial services, international financial institutions, and ancillary institutions (City of London, 2018).

TABLE 3.3: BRI funding channels

Funding channels	Institutions
Policy banks	China Development Bank (CDB)
	Export-Import Bank of China (CEXIM)
State-owned banks	Industrial and Commercial Bank of China (ICBC)
	China Construction Bank (CCB)
	Agricultural Bank of China (ABC)
	Bank of China (BOC)
Sovereign wealth funds (SWF)	China Investment Corporation (CIC)
	China Life Insurance Company
	China National Social Security Fund (CNSSF)
	The Silk Road Fund (SRF)
International organisations/ financing institutions	The World Bank Group
	Asian Development Bank (ADB)
	Asian Infrastructure Investment Bank (AIIB)
	New Development Bank (NDB)
Ancillary institutions	Import-export credit insurance companies

3.3.1 Policy banks

The policy banks of China refer to two Chinese state-owned banks, namely the Export-Import Bank of China (CEXIM) and the China Development Bank (CDB). Both banks are under the leadership of the Chinese State Council and are deeply involved in financing BRI's projects. Each of the policy lenders has its unique lending objective. The former supports foreign trade, cross-border investment, the BRI, and international economic cooperation, according to the CEXIM website. There are more than 1,800 BRI projects that have been financially supported by the CEXIM, with loan amounts of more than one trillion Chinese yuan (Xinhua, 2019b). The latter was incorporated in 2008 and focuses on offering mid- to long-term financing of infrastructure, energy and transportation. By the end of 2018, CDB has provided over 190 billion USD in financing for more than 600 BRI projects (Xinhua, 2019a).

Indonesia has joined China's "bullet train club", with the railway project linking Jakarta to Bandung, which was funded by the CDB. The CDB offered 75 per cent commercial loans with a 50-year period plus a grace period at a rate of interest of 2 per cent. The remaining 25 per cent came from Kereta Cepat Indonesia China (KCIC), a Sino-Indonesian joint venture combining Chinese (40 per cent) and Indonesian (60 per cent) state-owned enterprises (SOEs), China Railway and PT Wijaya Karya (Persero) Tbk respectively. KCIC is responsible for the construction and operations of the railway project. This project marks China's first overseas high-speed railway project, and the 150-kilometre-long railway will reduce the journey time between the two countries from three-to-four hours to just 40 minutes (Qiaoyi Li, 2019).

3.3.2 Sovereign wealth funds (SWF)

Emerging multilateral development financial institutions refer to the establishment of multilateral or bilateral funds or investment companies. This allows global investors to have the opportunity to invest in the BRI through the establishment of funds or investment companies. On the other hand, a sovereign wealth fund (SWF) is a state-owned investment fund that invests in financial assets such as stocks, bonds, real estate and precious metals. For instance, the China Investment Corporation (CIC) and the China National Social Security Fund (CNSSF) manage foreign exchange and overseas investment. They are increasingly contributing to the financing and investment of the BRI.

In 2019, the China Life Insurance Company has been granted to invest in foreign real estate. It has been suggested that an increasing amount of funds have been allocated to BRI projects as they are more and more involved in the policy and therefore acted as one of the funding channels (Belt and Road News, 2019). Interestingly, parallel to the launch of the BRI, the Chinese government established the Silk Road Fund (SRF) in late 2014, a brand-new SWF with a specific mandate to finance BRI projects (Silk Road Fund, 2014). The SRF has a total capital of USD 40 billion and RMB 100 billion, which is 15 per cent funded by CIC, 15 per cent funded by CEXIM and 5 per cent funded by CDB. The SRF has made investments in energy and infrastructure including a 9.9 per cent stake in Russia's key new liquefied natural gas (LNG) project (SIBUR, 2015).

3.3.3 State-owned banks

China has multiple state-owned banks, but the big four (Industrial and Commercial Bank of China (ICBC), China Construction Bank (CCB), Agricultural

Bank of China (ABC), and Bank of China (BOC)) are the ones that are primarily involved in financing the BRI as they are tied to China's major SOEs, and provide much of the funding to them. As such, they are the ones delivering most of the financing by issuing overseas bonds and providing loans. These banks have also been specifically tasked with collecting billions to fund investments for BRI projects.

The BOC successfully completed the pricing of USD 3 billion worth of bond issuance overseas in 2017, and the funds raised will be mainly used for BRI-related credit projects. The issuance includes four different types of currency (USD, EUR, AUD and RMB), and six varieties of bonds (Bank of China, 2017). The ICBC, CCB and BOC signed a memorandum of understanding with Investment Enterprise Singapore to support the participation of Singaporean companies in the BRI. This important economic commitment, detached from the related geopolitics, emphasises the potential of BRI projects in generating economic returns (Dini Sejko, 2017).

3.3.4 International financing institutions

Following that, major international multilateral financial institutions that offer financing to the BRI are the Asia Infrastructure Investment Bank (AIIB), Asia Development Bank (ADB) and the World Bank (WB). The World Bank Group consists of five organisations, namely the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Finance Corporation (IFC), the International Centre for Settlement of Investment Disputes (ICSID) and the Multilateral Investment Guarantee Agency (MIGA) (World Bank, 2019). Among the five, the IBRD is the lending institution to the BRI and the BRI takes up approximately 60 per cent of the World Bank's funds in 2016 (City of London, 2018).

The ADB is a Manila-based institution mainly promoting the socioeconomic development of developing countries in the Asia-Pacific region. It supports its 67 members, including 48 from Asia Pacific and 19 others, in areas such as infrastructure, energy, environmental protection, education and public health through loans, joint loan guarantees, technical support and grants. As a regional development bank, the ADB has consequently taken part in projects through the BRI. In its annual report published in 2018, energy and transport are the two largest sectors that have regular ordinary and concessional resources commitments with 24 per cent and 23 per cent, respectively (Bank of China, 2018).

On the other hand, investments made by the AIIB, SRF and domestic policy banks into the BRI regions are largely done in collaboration with the World Bank. The AIIB is a Beijing-based multilateral development bank with the objective to improve social and economic outcomes in the Asia region. The institution currently has 102 approved members worldwide. It invests in sustainable infrastructure and other sectors by granting loans to projects.

To date, there are 70 approved projects in countries such as Egypt, Georgia, India, Indonesia and Oman in areas of energy, transport, financial institution and water sectors between 2016 and 2020 (AIIB). The AIIB is mostly funded by China but with the help of regional and non-regional stakeholders (Das, 2017).

Compared to more established international financial institutions such as the Asian Development Bank (ADB) and the World Bank (WB), the AIIB is more willing to finance infrastructure projects for low-income countries (Lim, 2015). Furthermore, the AIIB will also allow private-sector involvement in its projects with the aim to minimise state borrowers' public debt (Lim, 2015). Other development banks such as the New Development Bank (NDB), established by Brazil, Russia, India, China, and South Africa (BRICS) on July 15, 2014, with an authorised capital of USD 100 billion, also known as the 'BRICS bank', has lent USD 40 billion in green infrastructure projects (Devonshire-Ellis, 2019). Even though AIIB and NDB do not have a specific mandate to support the BRI, and not all AIIB member countries are BRI participants such as Canada, both institutions have developed a portfolio of projects in BRI countries. The AIIB and NDB also attract funding from, and develop collaboration with, other multinational development banks, such as the ADB, WB and European Bank for Reconstruction and Development (EBRD), among others (Galkin, Chen, Ke, et al., 2020).

While Chinese development banks and international institutions are financing BRI projects, Chinese SWFs and SOEs are also directly involved with infrastructure and energy investments. Chinese SOEs are the main participants in this ambitious programme and are playing a leading role in its implementation. According to the State-owned Assets Supervision and Administration Commission of the State Council, more than 80 of the existing 97 state-owned Chinese companies have undertaken 3,100+ BRI projects worldwide (Daily Economic News, 2018). As of October 2018, Chinese SOEs contracted about half of BRI projects by number and more than 70 per cent by project value (Xinwen Zhen, 2019).

The 80+ SOEs have participated in half of the BRI projects in different forms: by establishing joint ventures, making direct investments or becoming shareholders (Dini Sejko, 2017). SOEs have often had the support of the SWFs or the development banks in order to take full advantage of their expertise in specific economic sectors. COSCO Shipping, China Overseas Port Holding Company, and China Merchants Port Holdings have made major acquisitions of port activities: Piraeus, Gwadar, Hambantota, Colombo, and Djibouti. China National Petroleum Corporation and other state-owned companies are involved in the development of oil and gas fields and the construction of pipelines that connect Central Asia to China. State Grid Corporation of China has acquired grids in Italy and Australia and established ultra-high voltage transmission lines between China and Russia, China and Mongolia, and China and Kyrgyzstan. In the same fashion, activities of SOEs have expanded in other sectors such as highways and railways. Successful project implementation has positively affected multinational corporations such as General Electrics, Honeywell, and Caterpillar, which have become suppliers to the SOEs that are implementing the projects.

3.3.5 Financing arrangements

Chinese SOEs involved in infrastructure projects abroad are quietly evolving from contractors responsible for engineering, procurement and construction (EPC) to becoming operators, investors, and owners. CEXIM and CDB support Chinese SOEs' overseas investments by financing them with instruments such as concessional loans. The "EPC plus financing" method has made Chinese SOEs top international contractors (Wendy Leutert, 2019). Besides this method, a number of Chinese SOEs invest in infrastructure projects overseas through the Public Private Partnership (PPP) arrangement.

The PPP model is the most frequently used form for government project operation. Both parties - the government and the private company - will set up an infrastructure construction project and invest in the project in different ratios. Once the project finishes, the state will transfer the project to the company. The project company will operate and maintain the physical infrastructure which includes roads, railways, transportation systems and water and sanitation networks by paying for a lease for an agreed period of time, and later return the control of the infrastructure to the government after the expiry date. The process often involves project bidding and negotiations with the government, and all the PPP projects are reviewed and determined by the state. PPPs are increasingly being used by governments worldwide as it is seen as a way of increasing access to infrastructure services at a reduced cost.

Figure 3.4 illustrates the PPP arrangement from low to high ratio of private sector participation. Most Chinese SOEs take the form of Build-Operate-Transfer (BOT) or Build-Operate-Own (BOO) in BRI projects. In a BOT model, the project company finances and constructs a project and operates it for a fixed period of time before turning it over to the host country's government. The project typically involves design and construction as well as long-term operations. One of the key features of BOT projects is a concession, which is defined by the World Bank as "giving a concessionaire the long-term right to use all utility assets conferred on the concessionaire, including responsibility for operations and some investment" (World Bank, 2022). The duration of the concession often lasts between 25 to 30 years.

A recent example of a BOT infrastructure project is Cambodia's first-ever expressway, a 2 billion USD Chinese-funded project. This 190-km highway slated for completion in 2023 will stretch from the capital Phnom Penh to

Civil words and service contracts → Management and operating agreements → Concessions, Build-Operate-Transfer (BOT), Build Operate Own (BOO) → Full privatization

FIGURE 3.4: The extent of PPP from low to high (World Bank, 2022)

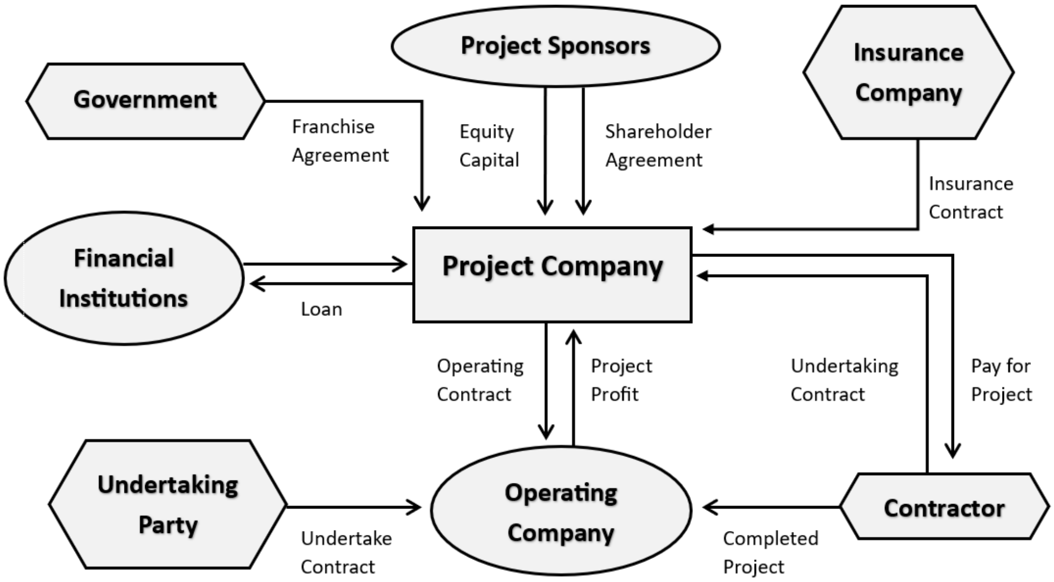


FIGURE 3.5: PPP contractual arrangement (OBOR Invest, 2020)

the southwestern port city of Sihanoukville. Cambodia signed a BOT contract in 2018 with China Road and Bridge Corporation, under which the SOE would foot the project's costs (Asian Review, 2019). Through this approach, the private sector has been playing a significant role in the delivery of public infrastructure and services in many countries. Figures 3.5 and 3.6 illustrate PPP and BOT contractual arrangements in more detail.

In 2008, the state-owned shipping company China COSCO Shipping Group (COSCO) began its investment in the Port of Piraeus in Greece. It obtained a 35-year concession for the operation of Pier II and III of the container terminals at Piraeus for EUR 831.2 million (Lloyd's List, 2008), while the Piraeus Port Authority (PPA) runs Pier I, which is the other side of the port. Later in 2016, the Hellenic Republic Asset Development Fund (HRADF) accepted COSCO's binding offer of EUR 368.5 million in exchange for 67 per cent of PPA's shares, in accordance with the terms of the tender process (China Daily, 2016).

The concession agreement sets out stages in order to acquire the 67 per cent stake: firstly, COSCO has to make a payment of EUR 280.5 million for 51 per cent of the total 67 per cent intended stake acquisition. After five years,

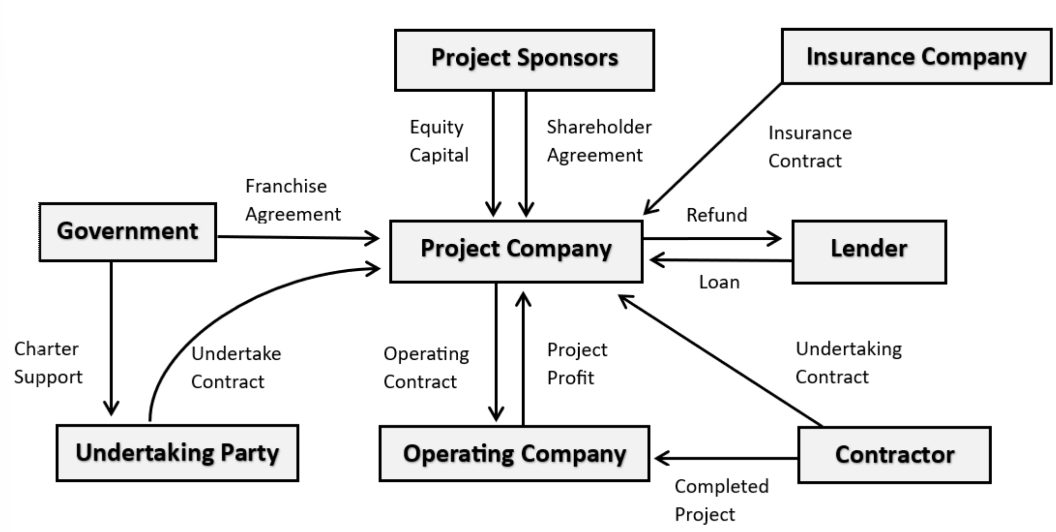


FIGURE 3.6: BOT contractual arrangement (OBOR Invest, 2020)

COSCO is then able to acquire the remaining 16 per cent for EUR 88 million, given that a mandatory investment threshold of EUR 300 million has to be met (HRADF, 2016). The mandatory investment includes investment in a new logistics centre, an additional cruise-ship terminal, four hotels and a shopping mall in the Piraeus region (Nektaria Stamouli, 2019). COSCO's investment in Piraeus has attracted more and more Chinese enterprises to come to Greece and invest in various sectors, including but not limited to, the China Energy Investment Corporation, Air China, and the State Grid Corporation of China (Xiaoli Zou, 2016).

In short, BRI projects have been funded with a mixture of both public and private sector investments. Countries that wish to join the initiative would receive a relatively low interest rate for borrowing from China (Team, 2017). Apart from offering cheap loans, this comparative advantage of financing also allows China's SOEs to offer highly competitive bids for projects against rival companies that are also in the bidding game. However, these cheap loans raise concerns over the potential 'debt trap', a high level of debt that the participant countries may not be able to repay back to China due to a lack of financial means.

Moreover, the massive funding from China leaves beneficiary countries such as Sri Lanka and Pakistan with a high level of public debt. In some cases, BRI countries with relatively low investment ratings might even face a loan default. In addition, there are also concerns about the potential of public debt in beneficiary countries being translated into a degree of dependence and reliance on China as a creditor (Hurley, Morris, and Portelance, 2019). The reason that debt sustainability should not be underestimated is that the more a country borrows does not necessarily result in an increase in economic growth and welfare for domestic consumers.

In summary, breaking down the specific role that Chinese SOEs play in overseas infrastructure projects is the second step to understanding and analysing the BRI. These firms are now becoming operators, investors and owners, thereby taking up long-term commercial and strategic stakes in countries around the world. This shift, while still in its early stages, demands greater attention to the changing nature of Chinese SOEs' business abroad and its implications for governments, economies and communities worldwide.

3.4 European responses to BRI

Almost all BRI routes lead to Europe and its biggest single market. However, even after a decade of existence, the BRI has still not seen a unified approach from geographical Europe or, for that matter, from the EU or even EU member states (Yanyi Yang, 2017). It was not until 2018 that the European Commission came out with an updated version of the FDI screening mechanism which has been seen as a more formal response to the BRI. Meanwhile, some EU and non-EU member states have already become engaged in the BRI in various ways. More than half of EU member states have already signed BRI-related MoUs. In addition to this, many European companies have also taken the opportunity to work with Chinese firms on BRI projects. European financial institutions are also taking part in BRI projects. That being the case, we can categorise European responses towards the BRI into three levels: EU financial institution level, EU corporate level, and EU institutional level (Skala-Kuhmann, 2019).

3.4.1 Institutional and corporate response

China has been steadily increasing its presence in Eastern and Central Europe. In 2012, China launched the "16+1" mechanism, an initiative where President Xi had the chance to meet with 11 EU Member States and 5 Balkan countries, [1] hoping to create deeper cooperation in investments, transport, finance, science, education, and culture between China and the "16+1" countries (The SOUFAN center, 2019). In the framework of the BRI, Beijing has defined three potential priority areas for economic cooperation with the EU: infrastructure, high technologies and green technologies. Currently, there are major BRI infrastructure projects in the EU, which include the Piraeus port in Greece, the Belgrade Bar motorway and the Budapest-Belgrade railway and Port of Trieste in Italy.

Table 3.4 only shows a small number of Chinese investments made in CEE countries through equity and acquisition by country and investment type in Central and Eastern Europe. Countries such as Hungary, Greece, Italy and Luxembourg have already signed a BRI-related memorandum or BRI

[1] Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia.

co-operation instruments (Peter Hirst and Alejandro Garcia, 2019). After the summit in Brussels in 2019, the existing "16+1" became "17+1" as Greece became a full member. Despite the fairly cautious and apprehensive views that the EU has about China's intentions, member states including Greece, Hungary, Italy, and Portugal have endorsed the BRI (ERIK BRATTBERG, 2020).

TABLE 3.4: Sino-CEE investment (SIIS, 2018)

Investment type	Example
Equity investment	Wind farm and solar power company in Poland, Bulgaria and Czech Czech Republic
Acquisition	China State Grid acquired 24 % in ADMIE, Greece's power grid operator

Ever since the announcement of the BRI, international rail services between China and Europe have increased. The Yiwu-London railway line, transporting freight and cargo via the Silk Road railway track is an example. Along with the Yiwu-London line, there are other rail freight lines connecting China with the West: China-Warsaw, China-Hamburg and China-Moscow, which take 12-15, 23-24 and 18 days to arrive, respectively. The China-EU rail freight lines can be seen as an opportunity for companies to take advantage of a shorter trade route due to railway integration. In addition, key benefits of those railways also include 50 per cent less cost compared to air transportation from China, a shortened transit time than sea freight and faster customs clearance at the borders (Brunel Shipping, 2021). As the majority of bilateral trade between China and the EU passes through the Suez Canal, ports such as the Piraeus port in Greece and the Gwadar port in Pakistan are seen as gateways into mainland Europe via a network of railways rather than just ports for the transhipment goods.

However, the BRI infrastructure projects taking place in Europe are not without controversy. The High-Speed Railway (HSR) between Belgrade and Budapest led to Hungary being investigated by the authorities in Brussels for potential breaches of EU transparency requirements in public tenders in relation to the project (Eurasian Business Briefing, 2017). Italy is the first G7 country to sign a BRI memorandum, and the country receives further attention from Chinese investment with its attractive port infrastructure such as the Port of Trieste. In addition, Johnson, 2018 uses an alarming tone when assessing the reasons why China is buying up European ports.

What's more, the negotiation of a comprehensive treaty, also known as the 'Investment Agreement' between China and the EU from 2013, aims to replace the existing bilateral investment treaties (BITs) between China and individual EU member states. The content of the Investment Agreement has not yet been made public, but what is certain is that the Investment Agreement intends to be relatively more comprehensive than the BITs signed between individual EU member states and China (Peter Hirst and Alejandro Garcia, 2019). It is very unlikely that the Investment Agreement will be agreed upon in the near future (Jackson and Shepotylo, 2020). Therefore, this makes the BRI the 'perfect alternative' to the BITs and the Investment Agreement, at least for now.

The investment made by China in key infrastructure projects in Europe also spurred concerns about the political implications for European security. In 2017, Greece vetoed a joint EU statement criticising China's human rights record. In addition, Hungary, another large recipient of Chinese investment, has repeatedly blocked EU statements criticising China's human rights record (Robin Emmott and Angeliki Koutantou, 2017). The U.S. has warned the EU against accepting the Huawei 5G network due to security and intelligence sharing (The SOUFAN center, 2019).

To date, it is agreed that there has not been a unified EU policy towards the BRI despite the growing influence that the BRI has created in the Eurasia region. Several EU countries and cities have been particularly receptive to Chinese investors. Others have been more cautious, seeking guarantees from China that it will follow international standards and not exclusively pursue its geo-strategic interests. The European Commission's vice president Jyrki Katainen made some different points. In his speech in Beijing in 2017, he stated that any scheme connecting Europe and Asia should adhere to a number of principles including market rules and international standards, and should complement existing networks and policies (Jyrki Katainen, 2017).

In response to all the concerns, on April 10, 2019, the Council of the EU established a framework for the screening of FDI into the EU, also known as the "Screening Regulation". According to the publication, security screening is necessary around FDI from China in critical assets, technologies and infrastructure. Under the new rules, FDI in critical sectors including ports, airports, energy and water; critical technologies such as communications, aerospace and data; and media freedom will be scrutinised. Furthermore, if a particular FDI raises concerns that are made by several EU member states, or if an investment affects a project of interest at EU-level, then the EU Commission will have the authority to issue a non-binding opinion on the admission of a specific foreign investment in that member state (European Commission, 2019).

As a result, the Screening Regulation gives substantial powers to EU states and has a possible significant impact on Chinese investment into EU member states such as Italy, Greece and elsewhere in the EU. However, the drawback of the mechanism is that it fails to harmonise the existing national screening legislation measures which around half of EU member states already have in place, and they often differ substantively (ERIK BRATTBERG, 2020). But what is certain is that the volume of Chinese FDI and Chinese investors will be impacted in the region by the screening mechanism.

The outcome of the annual EU-China summit in Brussels, which took place a day before the finalisation of the screening mechanism, was an agreement to finalise an EU-China Comprehensive Agreement on Investment (CAI) by late 2020. The need for a CAI is to facilitate two-way FDI as they remain relatively low. The CAI is also seen as a step closer to a future free trade agreement (FTA) between the EU and China. The agreement will nonetheless fit into the idea of investment agreements that are being negotiated between global key players, such as The Trans-Pacific Partnership (TPP) (Cameron, 2015). Furthermore, the CAI aims to tackle trade imbalances between the EU and China, such as the inadequate level of market access for European investors in China. However, these issues are unlikely to be resolved easily, and thus, as mentioned above, the BRI is likely to remain the best alternative to an EU-China FTA, which allows Chinese investors to invest and operate in Europe under BRI's terms and conditions, rather than the usual compliance requirements that standard trade treaties/agreements normally have (Kennedy and Parker, 2015).

It is undeniable that many European states are in dire need of infrastructure development and fiscal stimulus. Therefore, the BRI infrastructure projects could, in theory, play a vital role in boosting EU states' economies. However, given many factors at play, it is difficult to predict whether there will be more Chinese investment into the wider EU in the long run. "At present, there are more questions than answers, and how these questions are answered may well determine the future of Chinese investment in the EU for years to come" (Peter Hirst and Alejandro Garcia, 2019). Moreover, during the Covid-19 pandemic, vulnerable European business sectors are more likely to be the target of a potential foreign takeover. Under the current EU state aid rules, member states are prohibited to provide domestic businesses with grants or guarantee loans, which in turn, opens avenues for foreign businesses to take over and operate.

Therefore, in 2020, after pressures from member states such as Germany and France, the EU commissioner agreed to relax state aid rules temporarily to prevent a significant takeover by foreign businesses over strategic sectors (Times, 2020). Companies and start-ups can now access the government's liquidity package and state-backed funds, and it helps local firms to avoid being acquired by non-EU investors. In addition, with over 1.9 trillion EUR worth of national schemes approved so far, Germany accounts for 52 per cent of the total value of the emergency coronavirus state aid, with Italy and France each with 17 per cent of the total aid (EURACTIV, 2020). However, member states that only have limited access to the government's liquidity package and state-backed funds, may still be exposed to foreign investors such as Chinese SOEs and many others.

3.4.2 Financial institution response

The proactive attitude of European financial institutions and commercial banks, which has remained steady since the beginning of the BRI should be welcomed despite the general unwillingness of some EU institutions and member states to onboard such policy. The Asian Infrastructure Investment Bank (AIIB) was introduced in early 2016 as a new financial institution with huge significance. With a total of 57 founding members, there are 20 European countries [2] decided to join as AIIB's founding members, including four G7 countries.

Another example of a financial institution response is that Standard Chartered Bank entered into an agreement with the China Export-Import Bank to "...jointly support Chinese companies' overseas expansion" (Standard Chartered, 2008). In accordance with the Agreement, Standard Chartered and China Exim Bank will enhance their commercial collaboration in order to support Chinese businesses that have comparative advantages and wish to invest and grow their operations overseas. Overseas firms and entities will benefit from offered financial products and solutions from the two parties, such as project financing, disbursement and collection services, trade financing, and financial market products. Moreover, in 2017, Germany-based Deutsche Bank signed an MoU with the China Development Bank (CDB) in Berlin, with the aim to support BRI projects worth USD 3 billion (Deutsche Bank, 2017). The two parties also expressed interest in supporting BRI projects through Renminbi's (RMB) internationalisation for China. Germany, as well as other BRI nations, also agreed to establish a joint team in order to further cooperate on projects that promote BRI.

3.5 Assessing the BRI - Literature Review

The BRI policy has become a focal point for geopolitical and economic interests. It is therefore crucial for policymakers to understand the potential impacts of BRI infrastructure projects on promoting economic growth and bilateral trade as well as creating welfare for consumers through a lower commodity price. Some argue that the BRI helps make use of China's massive industrial overcapacity (Kennedy and Parker, 2015), as well as redirecting China's domestic steel surpluses that gigantic infrastructure project investments needed in the countries along the BRI route (Cai, 2017). Other research points out that the BRI could increase shipping and cargo demand as planned infrastructure investments improve ports which previously had difficulties in handling large ship sizes and increasing freight traffic that is caused by depth restrictions and lack of equipment capacity (Orlik and Chen, 2015).

[2] Austria, Denmark, Finland, France, Germany, Italy, Luxembourg, Malta, Netherlands, Poland, Portugal, Spain, Sweden, United Kingdom, Belgium, Hungary, Ireland, Cyprus, Greece and Romania.

The implementation of infrastructure projects related to the BRI could potentially shorten shipping times and therefore trade costs.

Ever since the announcement of the initiative in 2013, there has been a growing body of research in the context of the BRI from research institutes and scholars using different methodologies. This chapter will not go into too much detail introducing every paper that relates to the BRI but will instead focus on a number of key academic literature relevant to the research of this thesis for two reasons. First, most academic literature regarding the BRI is published in Chinese (Lee et al., 2018). Second, existing BRI literature is often descriptive in nature rather than empirical (see Casarini, 2015, Huang, 2016, Cai, 2017, Blanchard and Flint, 2017, and Chaisse and Matsushita, 2018). However, it is worth noting that the World Bank, an active member in providing financial services to BRI projects, has conducted and produced a series of papers, reports and independent analyses around the BRI in relation to trade, investment, debt, procurement, environmental impacts and infrastructure. De Soyres et al., 2018, De Soyres et al., 2019, and De Soyres, Mulabdic, and Ruta, 2020 are the latest research papers examining how much will the BRI reduce trade costs.

What's more, the work of Lee et al., 2018 provides an overview of the BRI with a focus on six main economic corridors that were proposed by the BRI and their relation to trade and transport development, port network and international logistics. Based on that, they lay out four research agendas and one simulation study in the hope of examining the impacts of the BRI on land and sea transport and maritime logistics. There are several key take-away points from their paper. Lee et al., 2018 did a systematic literature review by looking at the number of papers that contain keywords such as the 'BRI', 'SREB' (Silk Road Economic Belt) and 'MSR' (Maritime Silk Road) in the Chinese Social Citation Index from 2012 to 2016 in order to identify key trends and research directions.

The results from their comprehensive literature review indicate that the number of papers gradually increase from 2 papers in 2012 to 498 papers in 2016, almost a 100 per cent increase in the number of BRI papers published. Despite the increase, only 25 of these papers were published in the Thompson index journals. And among these 25 papers, only 8 papers were contributed to BRI with keywords relating to "transport" and/or "logistics". In addition to the limited number of studies in the context of the BRI, they also present methodologies used in those papers, and Table 3.5 is a summary of research methods used in those papers. It is evident that the BRI can be analysed in various different aspects with different methodologies. We will be employing a structural gravity model with general equilibrium analysis to estimate the impact of BRI projects.

Table 3.6 presents a summary of four recent empirical studies using gravity model analysis in the context of the BRI. There are two reasons why we

TABLE 3.5: Research Methods used in BRI papers (Lee et al., 2018)

Quantitative research method	Qualitative research method
Big data analysis	Case study
CGE model	Document review
Gravity model	Interview and survey
Network analysis	Policy research
OLS and Tobit regression	Scenario analysis
Spatial interaction model	Text mining

list these four papers in particular. Firstly, the number of empirical research studies on the impact of infrastructure improvement on trade flow and welfare gains is very limited in BRI literature. Secondly, not only do their studies examine the impact of BRI projects on trade, capital and welfare, but they also perform counterfactual analysis for scenarios including FTA formation. More importantly, the approaches they took to quantify the changes in trade costs as a result of BRI's infrastructure improvements via transport projects are different and robust. In addition to the above four reasons, these four papers are the most relevant research papers within the existing literature that we can use to compare our results with.

Being at the heart of international trade, gravity modelling has been used for many trade policies in many different settings. But Herrero and Xu, 2017 paper was the first to introduce the gravity model to analyse the impact of the BRI from a trade perspective. Their study looks at 137 countries and examines which countries would expect trade gains as a result of BRI-related transport cost reduction. In addition, they use distance as a proxy to measure trade cost variables. The way they measure transportation cost is to look at three transport modes: sea, air and railway. They do not include road as a mode of transport, as road transport distance is similar to railway distance; if included in the model it might lead to multicollinearity issues. Herrero and Xu, 2017 also look at simulations of FTA creation within the BRI region, and a scenario of where both transport improvement and FTA are implemented. Their results show that a reduction in transportation costs has a statistically significant and positive impact on international trade.

Different from Herrero and Xu, 2017, the World Bank BRI research group (De Soyres et al., 2018) focuses on projects consisting of rail and maritime links only, excluding road and air connectivity due to the fact that the former two modes of transport account for a larger number of international trade in general, and the majority of BRI transport projects are railroads and ports. The novelty of their paper is that they use a new methodology to quantify

TABLE 3.6: Summary of recent BRI empirical studies

Study	Detail
Herrero and Xu, 2017	Trade creation effects as a result of reduction in railway and maritime transportation costs. Using a sample of 16,748 country pairs of 137 countries in 2013. Gravity model with baseline specification based on Baier and Bergstrand, 2009. Findings suggest that a 10% reduction in railway, air and maritime costs increases trade by 2%, 5.5% and 1.1%, respectively. It also points out that Asia region benefits the most under tariff removal scenario, while the EU, especially landlocked countries gain from both scenarios slightly less than Asia.
De Soyres et al., 2018	The impact of BRI projects on shipment times and trade costs. A global database of 1,000 cities in 191 countries and 47 sectors; a regional database for BRI economies of 1,818 cities. Employing network analysis to construct shipment time estimation pre- and post-BRI, then translate shipment times differences into trade costs at country-sector level. Their findings show that BRI reduces shipment times and trade costs significantly, ranging between 1.7 and 3.2%. In addition, Belt and Road economies along the corridors expect the largest trade gains.
Kohl, 2019	The impact of transport improvement and FTA creation on supply-chain trade and welfare. A sample of 64 economies from 1995 to 2011. Structural gravity model based on Anderson, Larch, and Yotov, 2018 with conditional and full general equilibrium analysis. Findings show that infrastructural investments yield asymmetric benefits to China, Russia and the EU. In addition, a distance reduction of 15-50% increases trade by 1-6% for the EU. Also, TPP and RCEP offer less attractive economic prospects.
Jackson, 2021	The impact of changes in trade costs and investment on trade flows and consumer welfare in China, the EU and the rest of the world. Panel data of 162 countries from 1960 to 2014. Structural gravity model from Helpman, Melitz, and Rubinstein, 2008, which captures zero trade flows and models country-level heterogeneity. Findings suggest that a 30% transport cost reduction between China and the EU increases the welfare of a representative consumer in China by 1.51% and the EU by 0.97%. BRI and FTA scenario shows that it increases welfare at a greater extent to 4.9% and 2.94% for China and the EU, respectively. There is a negative effect of the TPP on China, while TTIP has a very small positive effect. Lastly, Chinese investment would increase further welfare for countries involved.

changes in trade costs due to transport projects, which is to use network analysis to estimate shipment times between all city pairs as a benchmark. They then run two separate 'improved' scenarios which account for the planned BRI infrastructure projects, in order to assess the reduction in shipping times resulting from these projects. Their results highlight the impact of transport projects in reducing shipping times. Not surprisingly, the reduction in shipment times in BRI-related transport projects is even greater. Based on these estimates, they then translate the changes in shipment times related to BRI into changes in trade costs at aggregate level based on Hummels and Schaur,

2013. De Soyres et al., 2018 show that countries with the largest investment do not always experience the highest trade cost reduction. For instance, Mongolia is the BRI participant with the highest investment but its trade costs decreased by only 3.22 per cent.

Following this, a paper by Kohl, 2019 estimates the impact of infrastructural improvements and free trade agreements on supply-chain trade and welfare in general equilibrium by employing a structural gravity equation, and they also look at how much the infrastructural improvements compare to other trade agreements such as Regional Comprehensive Economic Partnership (RCEP) and Trans-Pacific Partnership (TPP). Kohl, 2019 explains China's current FTA situation and why RCEP and TPP are of particular interest to China. A third scenario in the paper is the FTA establishment with BRI-related countries as an alternative to infrastructural improvement. The distinctive feature of Kohl, 2019 analysis is that they use data of value-added exports as their dependent variable - International supply-chain trade, which is not common in the trade literature, as often trade studies use gross exports to quantify the dependent variable. In terms of methodology, Kohl, 2019 uses a change in geographic distance as a proxy for infrastructural investments and FTA establishments as an alternative for such improvements. Kohl, 2019 upper bound estimate is inspired by Herrero and Xu, 2017, and Kohl, 2019 findings suggest that a reduction in country pair's distance by 15 per cent would expect greater gains from trade than the alternatives of FTA creation with countries along the trade route.

The most recent paper of examining BRI impacts on trade is by Jackson and Shepotylo, 2021, in which they employ a structural gravity model with general equilibrium analysis. The paper is different to the previous three in several ways. First, they use a range of scenarios such as China-EU FTA. Second, unlike Kohl, 2019 work which only captures partial, conditional and full endowment general equilibrium of the BRI, Jackson and Shepotylo, 2021 take into account a dynamic effect of an FTA and the BRI on trade along with partial, conditional and full endowment general equilibrium analysis. Third, they model Chinese investment as an additional source of welfare gains and estimate the impact of Chinese FDI into key BRI countries and re-evaluate welfare gains based on revised income levels. In terms of quantifying trade costs, Jackson and Shepotylo, 2021 make the assumption that trade costs are proportional to distance as well as depend on transport infrastructure parameter λ_{ij}. Therefore, as transport infrastructure improves, it leads to a decrease in parameter λ_{ij}. Similar to the findings of the previous three studies, Jackson and Shepotylo, 2021 conclude that a 30 per cent reduction in transport costs between China and the EU would increase welfare of a representative consumer in China by 1.51 per cent and in the EU by 0.97 per cent.

However, these studies also have their own research limitations. Herrero and Xu, 2017 only takes into account maritime, air and railway. It would be ideal to take road transport into account as 70 per cent of the EU's internal trade is by railway or road. According to Herrero and Xu, 2017 own calculations despite the multicollinearity issues that might arise, it could have been looked at and dealt with potentially. De Soyres et al., 2018 address that their paper leaves researchers to identify the effect of shipment times and trade costs on individual overland corridors or individual projects. In terms of Kohl, 2019 paper, their dataset only covers 64 economies from 1995 to 2011, which is a relatively small sample size when it comes to estimating the effects of BRI-based transport infrastructure projects on supply-chain trade and welfare, also given that the BRI was introduced in 2013. Therefore, an up-to-date set of data would be ideal.

3.6 Conclusion

This chapter unpacks the story of the decade-old Chinese foreign policy BRI. From key BRI countries to infrastructure network routes, we contextualise what the policy actually entails. We provide details on five Economic corridors, which are the core to trade integration, in different regions and we also look at how BRI infrastructure projects are financed and through what channels. More importantly, this chapter then evaluates European responses to the initiative at institutional, corporate and financial institution levels. We conclude with a systematic BRI literature review.

Chapter 4

Chinese investment in Greece: Analysing the response to a crisis

[1]

4.1 Introduction

The EU investment screening mechanism, which came into effect in October 2020, attempts to address concerns regarding extra-EU investment flows coming into member states by adding EU-level coordination to the process of FDI screening (Jackson, 2021). The Covid-19 pandemic and the ensuing economic downturn further amplified fears of the acquisition of strategic assets with potential ripple effects across the single market. Against this backdrop, this chapter unravels the story behind the Chinese investment under the Belt and Road Initiative (BRI) in Piraeus port, Greece. While scholars have widely debated various dimensions of the BRI (Hillman, 2018; Lairson, 2018; Aminjonov et al., 2019; Hurley, Morris, and Portelance, 2019), there is a relative scarcity of studies looking at BRI acquisitions within Europe. This deficit is more pronounced when it comes to the Chinese investment in Piraeus port; for an exception, see the study of Karlis and Polemis, 2018, focusing on the motivations for the Chinese investment.

Piraeus port is only six miles from the capital of Athens. It is the largest seaport in Greece as well as the second-largest port in the Eastern Mediterranean region. The geographical location of Piraeus is particularly convenient for Chinese goods transported to Europe through the Suez Canal, because it is much closer than the port of Rotterdam, the busiest port in Europe. Therefore, investment in Piraeus port is considered to be one of the most important infrastructure projects in Europe, symbolising the deepening links between Greece and China since 2006. While media coverage of this investment project is more extensive, Lim, 2011 and Neilson, 2019 are among the few to report on the contrasting labour conditions in the pier operated by

[1]This chapter has been submitted to the European Journal of Industrial Relations and received a Revise and Review submission. It is now currently at revising phase. This chapter is the amended version with additional quotations added to some of the sections.

PPA (or OLP) and the entirely Chinese-run PCT side of the port[2]. Hatzopoulos, Kambouri, and Huws, 2014 also refer to Piraeus port as a case study as part of their examination of global supply chains, which finds complex interrelationships between local forces and global players in reshaping work.

While the Belt and Road Initiative (BRI) was launched a decade ago, the best overall guidance on the economic impact of the array of infrastructure projects are only estimates (De Soyres et al., 2019). However, the Chinese investment in Piraeus port is long-standing and has started to deliver measurable results. The story of the BRI in Europe can be meaningfully examined through the lens of what was a rather inefficient but strategically important port in Greece, Piraeus port (Bo, Karpathiotaki, and Changzheng, 2018). Therefore, this case study not only gives a socio-economic perspective of what the impact of a BRI project entails but also analyses how the divergent views from European stakeholders have shaped the port into what it is today – operating as one of the most efficient ports after the Port of Rotterdam. Furthermore, this case study sheds light on the potential impact of Chinese investment in other strategic European ports.

This paper contributes to the small existing academic literature by providing a much-needed assessment of the effect of the Chinese investment in Piraeus port, with a particular focus on labour standards and relations. We address several important questions: (i) What is the impact of COSCO's arrival on the workplace regimes adopted on the PPA side of the port and the PCT piers? (ii) How important are Greek government labour market reforms in shaping workplace organisation in Piraeus port? (iii) How has the presence of unions and unionisation across the port impacted worker rights? (iv) What socio-economic changes have occurred in Piraeus and the wider region since COSCO's 2009 arrival and 2016 takeover? In order to answer these questions, we conducted two phases of fieldwork, where respondents to our semi-structured interviews were selected purposively among dockworkers, managers, business owners, trade union representatives, institutional representatives, policy-makers and analysts who were familiar with the socio-economic and political background of the Piraeus port acquisition.

Our findings suggest a complex picture characterized, on the one hand, by the increases in container traffic, largely in the form of transshipments diverted from other ports. This is due to improvements in port efficiency from investment in soft and hard infrastructure driving down trade costs and complemented by the tax relief from the free zone within which COSCO operates. We also find evidence of vertical spillovers and crowding in, alongside the crowding out of local shipping companies and concerns around the local companies offering ship repairs. On the other hand, against this backdrop, COSCO makes widespread use of subcontracting arrangements in hiring and managing its workforce, such arrangements were enabled by the

[2]Throughout this study we refer to Piraeus Port Authority as PPA but it is also referred to as OLP, PPA-COSCO Shipping or OLP-COSCO Shipping.

broader Greek labour market reforms that took place in response to the bailout programmes, in the aftermath of the 2009 debt crisis. We find substantial differences in the organisation of the PPA and PCT sides of the port, with workplace regimes that differ regarding remuneration, work shifts, employment security, contracts and unionisation. While, on the PPA side, a form of bureaucratic labour control prevails, with a strong and pervasive union presence. However, PCT did not have a Collective Bargaining Agreement (CBA) in place with any union until 2019 and doubts have been cast as to the genuine nature of the union they engage with. We analyse and interpret the consequences of the widespread use of subcontracting and of the unionisation limitations in terms of their labour control implications. More broadly, this case study provides important lessons for policy makers faced with the prospect of new/further Chinese investment, both in the context of Greece and more widely across Europe.

The paper is structured as follows: section 2 provides a discussion of the methodology and data collection process, section 3 introduces the institutional and economic backdrop to the COSCO investment project as well as some considerations on the more strictly economic aspects of its impact. Sections 4 and 5 discuss the employment creation effect and the emergence of differing workplace regimes as a result of subcontracting across the two sides of the port. Finally, section 6 offers policy implications and conclusions.

4.2 Methods and data

Our data collection process consists of two different phases over the period 2019-2021. During the first pilot phase in 2019, we identified our gatekeepers, carried out preliminary interviews and generated our analytical framework abductively. Following an iterative approach, broader categories recurring in two or more respondent interviews in the pilot were initially identified, then the interview guides were updated and deployed during the second full-scale phase of data collection.

The second phase of data collection was disrupted by the unexpected Covid-19 pandemic, therefore we conducted the rest of our interviews online. Respondents were selected purposively, following a snowballing sampling technique, among union representatives, dockworkers, senior managers, local and national institutional representatives, policymakers and analysts, external services providers (ESP), ship forwarders (3rd-party logistics, 3PL), current and former PCT employees who were familiar with the socio-economic and political background of the Piraeus port acquisition. Interviews were semi-structured and lasted on average 50 minutes. Responses were audio-recorded except in those circumstances where participants did not consent to it. Participants were handed consent forms both in English and Greek and two ethical approvals were sought from our academic institution prior to undertaking the research. A translator was available in all instances for those respondents who needed it.

Our final sample includes 25 interviews, with five focus groups and two email responses. To avoid double counting, this number excludes all follow-up interviews which we conducted to triangulate our findings. The primary data was analysed through content analysis (Hsieh and Shannon, 2005; Schreier, 2012) and a series of triangulation strategies were used. Specifically, we triangulated internally by interviewing different categories of respondents on the same themes and carrying out follow-up interviews where needed. In addition, we also triangulated externally by incorporating additional sources of data beyond the interviews. Specifically, we collected trade statistics and conducted several rounds of archival research whereby we incorporated into our analysis newspaper articles as well as business and policy reports.

An important limitation of the dataset we collected is that we could not approach PCT dockworkers within or outside of their work premises. We made the conscious decision not to put any of those workers in danger by further pursuing access through our gatekeepers, as we learnt that the difficulties we were experiencing were due to the fact that the workers, when signing their contracts, were asked to agree to never speak publicly about their employment to the media or any other externals to PCT. Workers would have lost their job if found out and this explains why very few accounts and testimonies from them are publicly available (Lim, 2011; Equal Times, 2022). Triangulation - including through colleagues of the dockworkers employed in different positions such as yard planners or engineers - has therefore been particularly important in replacing the information we could not directly source from PCT dockworkers themselves.

To guarantee anonymity, each interview was labelled as ‘Interview x’, where ‘x’ ranges from number 1 to 25. In order to meet data security legal requirements, iPhone voice memos were used to record the interviews during the pilot, where the equipment is both password and face ID protected. Initially, the data was stored on the mobile application with a 256-bit AES encryption named AESCrypt, which features password protection in the event of equipment loss. Subsequently, the data was transferred to a university secure server, the H Drive. All of the second-phase interviews recorded using Zoom were uploaded to the University’s ‘One Drive’.

In addition, to ensure the quality of the primary data and to avoid bias in their responses due to the fear of being recorded, several measures were taken. Firstly, participants were informed that they would not be identified. We explained to the respondents that we were only there to hear about their experiences regarding the investment project. In other words, there is no right or wrong answer to our questions and we were only interested in getting their perspective.

Furthermore, asking open-ended questions is another standard measure in primary data collection. Prior to every interview, an interview guide with a set of open-ended questions was created, shared, and edited among the interviewers. Open-ended questions encouraged participants to share their understanding of the event in their own words. When needed, we asked follow-up questions to prompt a more elaborate response. Lastly, reviewing primary data is also key to avoiding such biases. All 25 interviews were manually transcribed by the researcher herself; the transcripts were then scrutinised and analysed in depth. During the process, the researcher was able to review the transcripts word-by-word and search for any signs of bias.

4.3 Institutional and economic backdrop

4.3.1 Institutional perspective

Piraeus port was a state-run enterprise until 1999. In 2003 the port was floated on the Athens Stock Exchange, although the state remained the majority stake holder and, therefore, Psaraftis and Pallis, 2012 argue that little changed as a result[3]. In 2006, just three years before the Greek crisis, the government (led by New Democracy) promoted the concept of further port service liberalisation on the grounds of increasing competitiveness and attracting more investment. An interstate agreement between the Chinese state-owned enterprise COSCO, a global shipping company, and the Greek government followed but was determined to be invalid by the European Commission (Kousta, 2010). Therefore, in 2008, Greece launched an international tender for companies to operate Piraeus port's container terminal, upgrade its port facilities, as well as investing in building new piers. During the process various concerns emerged around the riskiness of the proposed investment, leading a number of bidders to withdraw.

COSCO won the bid and they signed a 35-year concession agreement with PPA, a Greek-listed company managing Piraeus port, for an initial period of 30-years (Triantafillidis, 2019). In 2010, while container terminal pier I remained under PPA's management, COSCO started to wholly manage and operate container terminal pier II and later constructed a new pier III as part of the concession agreement under its subsidiary in Greece named PCT. In addition, COSCO had to pay an annual lease to PPA in order to have the right to run container terminal piers II and III (Qianqian and Davarinou, 2019; Gallarias, 2013). In 2016, COSCO bought 67 percent of PPA's shares, ending its role of "tenant" at Piraeus port and becoming a majority shareholder of PPA. Despite this change, the Greek government still has a seat at the board of directors. The share arrangement was divided into two-parts: the initial 51

[3] This process created two separate companies, one managing the port of Piraeus and the other managing the port of Thessaloniki. Creating two companies to manage each port locally was the stated aim of this process, rather than moving away from state control. For further discussion see Psaraftis and Pallis, 2012.

percent acquired in 2016 and the remaining 16 percent received in 2021 under the condition of mandatory investments, or the so called "master plan" (Georgiopoulos, 2016; HRADF, 2016). This arrangement has attracted some criticism, as visible in some of the quotes from respondents who saw the recent development as risky or undesirable:

So COSCO is not an operator, just an operator (...) you can give the land, you can give the facilities, you can give infrastructure, but you cannot give authority. (Interview 12)

[The] first concession was actually a very good deal, it's not a sell-out. It brings jobs and growth. The second deal is more complicated but no comment on this. The deal of acquiring the PPA shares. (Interview 15)

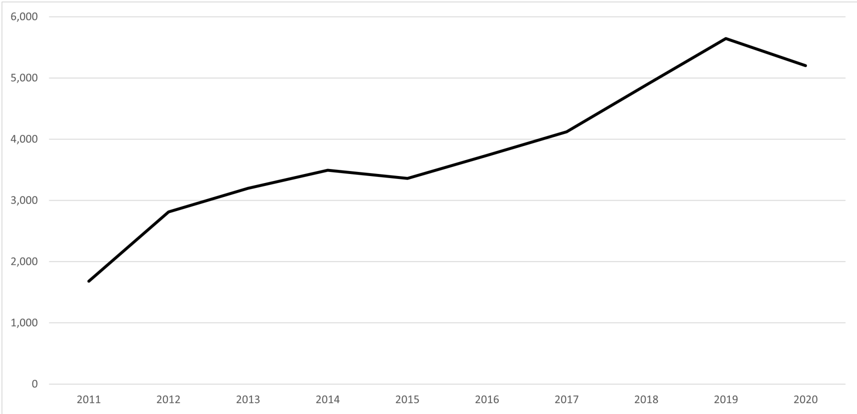
This investment stands out since it is one of the flagship projects of the China-backed BRI in Europe, a strategy that was introduced in 2013 to increase connectivity and promote trade. However, the idea of privatisation received the expected negative reaction from the local trade unions and port workers. The fear of losing their jobs and working for foreign investors instead of the Greek state triggered them to undergo a series of strikes, lasting between 2006-2009, against this decision (Kousta, 2010). We will return on these points in more detail below.

4.3.2 Trade and transshipment

Studies show two potential relationships between FDI and trade: complementary – FDI and trade have a positive relationship; substitutes – FDI and trade have a negative relationship (Africano, Magalhães, et al., 2005). Despite a strong theoretical support for the substitution theory, many of the empirical studies have shown that FDI and trade are complements, especially when considering exports in the host country (Lipsey and Weiss, 1981; Lipsey and Weiss, 1984; Grubert and Mutti, 1991; Blomstrom and Kokko, 1994; Pfaffermayr, 1996; Clausing, 2000). Indeed, our respondents indicate a trade volume increase in Piraeus port after COSCO's arrival and our archival research confirms that there is clear evidence of the economic development of container handling at the port since COSCO's 2009 takeover. Figure 4.1 shows the increase in the volume of containers handled, while figure 4.2 illustrates the growth rate of containers handled in Piraeus, and for comparison the average growth rate of containers handled by the top 20 EU ports (including in the UK).

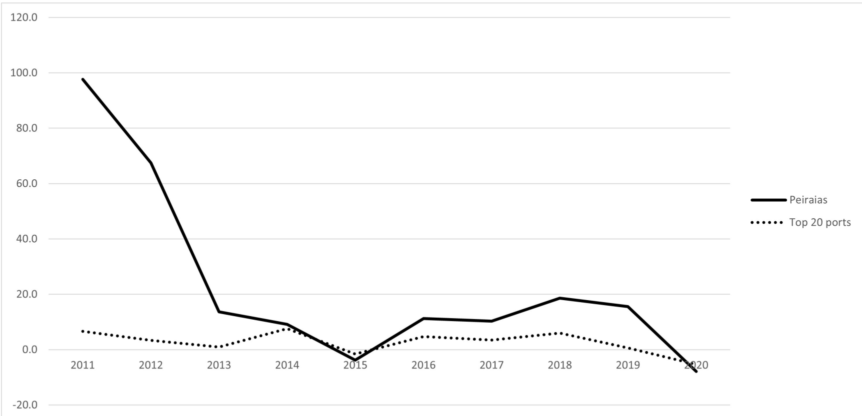
The majority of trade volumes that are coming into Piraeus port are for transshipment, specifically the unloading and loading of goods from one ship into another to complete a journey at its final destination (eurostat, 2021). In fact, Piraeus port has always been a transhipment hub as the demand for

FIGURE 4.1: Volume of containers handled (in thousands of Twenty-foot Equivalent Units (TEUs), total loaded and empty) - Piraeus port



Source: Eurostat

FIGURE 4.2: Growth rate of containers handled on previous period (total loaded and empty)



Source: Eurostat

the local Greek market is small compared to other countries. Our respondents reported that the increased volumes were as the result of a trade diversion from neighbouring competitor ports such as Damietta port in Egypt and Gioia Tauro in Southern Italy. A number of factors account for this trade diversion. One is technology upgrades to which we will return in the next section below, another is the geographical location and the nature of Piraeus port. Similar to the port of Damietta in Egypt, Piraeus port is one of the first few ports situated on many shipping routes just after passing the Suez Canal. The shorter shipping times, compared to ports such as Rotterdam, translates into trade cost reductions for exporters targeting central/eastern European markets. Thirdly, as part of the concession agreement that was published in the official Gazette of the Greek government Law 3755/2009, COSCO's operation also enjoys a VAT exemption. This allowed COSCO to establish a Free Zone warehouse called Piraeus Consolidation and Distribution Centre (PCDC), which is located on the PCT side of the port. This is the only warehouse inside the Piraeus Free Zone Type I area, so it has the advantage of handling containers from elsewhere. Furthermore, Piraeus is a 18-metre deepwater port capable of berthing large ships, which is particularly useful for transshipment hubs where you move goods to smaller feeder ships that can be berthed in regular ports (Dasgupta, 2019). Piraeus also has onward land/railway connections with other cities such as Thessaloniki and then on to other landlocked neighbouring countries [4].

Another issue with Piraeus port under the Greek government administrated PPA period was that the port faced issues with efficiency. As one of our respondents puts it:

Well, the problem was that Piraeus was particularly inefficient...COSCO came along and given the courage to run the port the way that they felt, they get incentives and reduced the cost because they were using old-fashioned equipment which required a lot of manual labour, which was very expensive labour. The modern equipment, automated equipment which brought down the cost tremendously, they diverted a lot of their own ships here. (Interview 20)

Thus, overall, we see a combination of hard infrastructure development such as the construction of pier III, with soft infrastructure and technology upgrades, which led to an increase in productivity, attractiveness, and port operation efficiency. According to some, this is something the previous administration didn't have the incentive to do:

This productivity in COSCO has been amazing, in a way. Because under the previous administration, there is no incentive to improve productivity. (Interview 18)

4.3.3 Technology and Knowledge Transfer

One of the most crucial externalities that FDI can imply is the transfer of technology, such as through the introduction of new processes, managerial skills and know-how, employee training, and productivity gains by operating and managing business in a much more efficient way (Goerg, Greenaway, and Wey, 2003). In our case, technology transfer resulting from the inflow of Chinese FDI into Piraeus port is one of the main factors associated with trade volume increases and one of the reasons as to why there has been a trade diversion from other ports to Piraeus.

For instance, from a worker's point of view, the new vessels that COSCO attracted to the port are much easier to work with. In addition, the process of digitization by implementing a new software called AHPPC for their 3rd party logistics (3PL) company led to decreases in customs processing time

[4] The Athens-Thessaloniki line received recent upgrades such as electrification and changing from single to double tracks.

and financial accuracy that was pointed out by another respondent. Moreover, the most up-to-date terminal operating system (TOS) called DeTOS, was introduced on the PCT-side of the port, while the PPA side of the port is still using the very basic version of the operating system. Other respondents also referred to a new container stacking/storage system:

Storage system they introduced, 5-high containers that can staked up together now before only 2 can be piled up together. So this is something new that they bring in. It's really hard to find space in weekends when vessels come in, so this new storage system helps to improve in that way... (Interview 18)

Such new container stacking/storage system is an ideal solution to space limitations in container yard, where all the containers are offloaded at berthing area from the vessels and then move to the container yard for further sorting out. It is proved in studies that the new system increases efficiency and effectiveness in handling containers, as well as to increase profit margin of the ports as there is less space needed horizontally as the containers are now stacked tripled in height (Rahman, Ismail, and Lun, 2016).

We were also told about automated gates that were introduced by COSCO, which significantly increased port operation efficiency compared to manual gates that PPA used previously. A striking example was that the whole process of coming into the port, loading containers and leaving the port only now takes truck drivers 17 minutes instead of queuing and waiting at the gate for as long as 20.5 hours.

An example of where Chinese made better: the parking of the port. The parking in the port of Piraeus, where people were leaving their cars to go on an island for a day or for a weekend has been upgraded by the Chinese. They put new automatic paying machines, so you don't have to go and wait to pay 1, 10 euros for your tickets. So the technical equipment has been upgraded... (Interview 13)

However, some proposed changes have not proceeded as planned. For example, COSCO initially wanted to create a Hellenic Port Community System (HPCS), a fee-charging unified digital platform providing online services to all Greek ports around the nation, which also gathered all maritime data. Significant criticism was raised around issues of national security and data security, so that eventually COSCO kept the HPCS to itself in Piraeus port, and the Greek state introduced a new state-level platform covering all the ports, while retaining exclusive access to the data.

4.3.4 Spillover Effects

The academic literature is mixed on whether the productivity of domestic firms is linked to the extent of foreign presence in the sector and on the nature of the crowding in/out effects linked to incoming FDI (Bjorvatn, Kind, and Nordås, 2001; Javorcik and Spatareanu, 2005; Farla, De Crombrugghe, and Verspagen, 2016). When looking at vertical spillovers in particular, we find a spillover effect down the supply chain into COSCO's external service providers and 3rd party logistics companies:

We provide some cleaning products from a company that we have a business with [our product suppliers], and they have an increase [of their business] from only our orders of 30 percent...(Interview 8)

We also find that there is a mix of crowding in and out effects in our case. Specifically, the investment attracted shipping line companies, ship supply companies, catering companies and real estate rents:

Yes, certainly we have investors in the city of Piraeus around the port, we had investment of 100 million euros in real estate lately, it was a factory for cigarettes and tobacco industry that has been rebuilt... (Interview 12)

Also, as you know, container terminal is working 24/7, so as funny as it might sound, especially for Greece it is important, there has been an increase in fast food and coffee shops. (Interview 16)

The rents of the area, the last ten years, the last three years have gone up more than 40 percent. Because lots of people they live around the area. (Interview 2)

However, local SME shipping companies were forced out of business due to COSCO's extremely low price strategy:

COSCO had really competitive prices, (. . .) they have created prices that they were like, so low, other companies couldn't unfortunately compete (. . .) and they had to shut down. (Interview 9)

COSCO absorbed companies, absorbed employees, so they seek to [attract] employees from small companies with lower salaries. (Interview 9)

Our findings counter those of the literature, which finds foreign companies' presence to crowd out local companies in developing rather than in developed ones (Caves and Caves, 1996; Blomstrom, Kokko, and Zejan, 2000).

There were also concerns of a crowding out effect on the local shipyard industry, as COSCO aimed to develop their own shipyard, use their own 3rd party logistics companies, instead of collaborating with the local 3PL companies. Finally, at the the local community level respondents particularly pointed to the absence of socio-economic spillovers and significant community engagement as well as to the enclave-like nature of the COSCO investment that failed to spread much beyond the Port area itself:

They operate it like a closed shop. So they will hire the services that they need to hire and that's it. (Interview 17)

They brought some floating bridges from a different country, but they use it for themselves, it's like they are staying isolated. (Interview 11)

In another example, Perama, a municipality nearby Piraeus, where the PCT container terminal is located, was described as suffering from recurrent and severe flooding issues, to which PCT has paid no attention in spite of the fact that the area affected by the issue covers the port itself:

The flood work has to be inside the port itself, because the port has the problem and when (...) it has heavy rain, the water from the port comes to the city. So the real work has to be inside the port. (Interview 5)

4.4 Employment creation and wider local impact

High unemployment levels in Greece have been defined as structural and long-term for a while, standing at 10.5 percent, the second highest EU level, already in 2001 (Seferiades, 2003). This was made worse by the 2009 debt crisis, where the country experienced a further 10 percent decline in formal employment levels (Psychogios et al., 2020). The high rates of unemployment in Greece can be attributed to a multiplicity of co-existing factors such as structural institutional weaknesses or the mismatch between the demand and supply of skilled labour (Katsanevas and Livanos, 2006; Psychogios et al., 2020). While some would also attribute it to the rigidity of the labour market, where high legal protection and non-wage costs are a burden to employers (Katsanevas and Livanos, 2006), others refer to such rigidity as a myth in the context of an already flexibilised Greek labour market (Seferiades, 2003).

Against this background, the Chinese investment in Piraeus port provided a powerful mechanism of unemployment absorption by opening up hundreds of new unskilled, semi-skilled and skilled jobs, as described in the words of one of our respondents:

The number of employees that [PCT] currently has, this is new business, new 1852, new jobs... (Interview 2)

Fears that local workers may be replaced by imported Chinese workers or disposed of, as a result of the port privatisation, did not materialise (Jenkins, 2006), and the creation of direct employment is in line with a large part of the literature on incoming FDI (See Blomstrom, Kokko, and Zejan, 2000; Radosevic, Varblane, and Mickiewicz, 2003; Ernst, 2005; Brincikova and Darmo, 2014). Indirect employment was also created in the broader economy:

This particular business created more than 5,000 jobs for the Greek economy (. . .) because trains come into the port, and you have small companies working a lot with the port because the volumes have increased. (Interview 2)

When [our company started] collaborating with COSCO, they have hired a big amount of people because they needed so in order to go with the international shipping. (Interview 9)

4.5 Workplace regimes in transition: subcontracting, labour control and unionisation

The idea of a 'factory regime' is used by Burawoy and Lukacs, 1985 to analyse the relations between capital, labour and the state. As collisions of interest often occur between these actors (Taylor and Rioux, 2017), the prevailing workplace regimes are shaped by the power relations linking them and, today, also by the governance structures of transnational production dynamics. Strong competitive pressures result in the adoption of flexible labour regimes as a technique to contain costs and lower risks for firms (Standing, 1999; Gereffi and Lee, 2016). In our case, the intersection between different workplace ethics and production mandates generates novel outcomes for workers, whose labour relations are regulated not only by the interaction with their managers – almost often Greek in our case study – but also by new practices introduced by COSCO . These embody in part the production imperatives of fast-paced competitive transnational production networks to which industrial relations and workplace practices have to adapt. In this context, the labour control process, defined as the managerial methods, working conditions, cultural control and teamwork strategies used to convert labour capacity into production processes and outcomes (Nichols et al., 2004; Taylor and Rioux, 2017), acquires particular salience, as we will see below in more detail.

Our findings indicate that, after COSCO's arrival, a new workplace regime started co-existing side by side with the one prevailing under the long-standing PPA administration. This resulted in a segmentation of the workforce in multiple respects (Taylor and Rioux, 2017): first of all, the same workforce is segmented across piers and under different workplace regimes; in addition, the workforce is segmented when it comes to their contractual regimes and to their mobilisation strategies in light of the subcontracting relation that replaces the old direct contractual arrangements for all new workers of piers II and III. It is well-known that having an extensive base of subcontracted firms diversifies the risk away from the lead firm and onto the subcontractors, while it allows to control and limit costs (Peck, Theodore, and Ward, 2005; Barrientos, 2013), as highlighted in the reflections of one of our respondents:

Subcontractors are best for projects that require specific skill sets, while employees are great for on-going, long-term projects. In Piraeus port's and COSCO's case, rapid development in the area of the port owned by the Chinese government needed to be done on a short-term basis with the least cost possible, in terms of personnel wages. Therefore, sub-contracting was a necessary measure. (Interview 14)

Power relations implicit within this set-up, however, lead to an undermining of workers' agency through the spatial discontinuity and disjunction created between workers, the lead firm, and their 'real' employer (Wills, 2009). We have found evidence of these dynamics taking place among the dockworkers of Piraeus port, where COSCO's subsidiary, PCT, hired a local Greek subcontractor company to manage the port and most of all its human resources, leaving only about 200 workers on a direct contract with PCT. PCT is in fact an umbrella company or first level of subcontractor to COSCO, under which two more subcontracting layers exist with six smaller companies coordinated by a middle-tier subcontractor. The subcontracting therefore takes the form of a cascading process whereby lead firms pass duties and costs related to workers' management and social security down through the various subcontracting layers. In our case, the third level subcontractors had the sole responsibility for the hiring and managing of workers as well as for the CBAs negotiations – which, however, were defined as no more than "empty shells" (Papageorgiou, 2020) - and for the settlement of any grievances on their part. Indeed, beyond the risk diversification motive, one respondent also explains that the subcontracting arrangements exist in order to shield COSCO and PCT from workers' mobilisation:

They knew that in Piraeus there were a lot of strikes, a lot of delays, so they didn't want to risk on that. And they thought that this was the way to avoid it. (Interview 12)

Wills, 2009 argues that, in a departure from traditional models of organizations that focus on collective bargaining with the employer, the subcontracted form of employment is becoming more and more widely spread. This is certainly not just the case in the maritime sector but across industries and countries worldwide and it is clearly reflected in the rapid growth of formal temporary staffing agencies globally and the role they have played in facilitating the flexibilization of labour in more liberalised labour markets (Peck, Theodore, and Ward, 2005; Coe, Johns, and Ward, 2009; Barrientos, 2013). As addressed by Papageorgiou, 2020 in his article discussing the "Chineselisation" of the labour relations within the fixed practices of COSCO in Piraeus "even if the Rules of Procedure and the collective bargaining agreements remained untouched, in a short time the downsizing of the regular staff and its replacement by contractors would turn the whole institutional framework into a bare shell". Some foresee that this will eventually result in the extension of subcontracting to pier I (Papageorgiou, 2020).

From a labour control point of view, subcontracting is seen as a device that allows lead firms to free themselves from the exclusive responsibility to enforce labour control by allowing the transfer of competitive pressures down to subcontractors, as is the case with costs (Malesky and Mosley, 2018; Fei, 2020). States have in principle the regulatory capacity to facilitate or impede such outsourcing (Mayer and Phillips, 2017; Alford and Phillips, 2018) by way of national or sectoral legislation. What we see in the case of Greece is that, at a national level, the recent post-2009 crisis legislation has in fact paved the way for labour relations to change in a way that accommodates such new subcontracting dynamics and more generally, a flexibilization of labour mobilisation and labour control processes. Indeed, in 2010, in the context of the structural reforms mandated by the bail-out Memorandum of Understanding (MoU), the Greek government intervened extensively in the labour market legislation in order to improve competitiveness. Among the key reform areas were the collective bargaining reforms (ILO, 2011), with a drive towards increasing the system's flexibility and the decentralization of the bargaining power from national or sectoral to company level. This implies the risk that national level bargaining provisions in place to protect workers from unequal contracts could become no more than a façade under the new proliferation of individual agreements (Katsaroumpas and Koukiadaki, 2019). Thus, in practice, the radical change in workplace regime enacted by PCT and encompassing from workers' contracts and remuneration, to the organization of their work and their unionisation options appears to have been enabled by such national labour market reforms.

4.5.1 Contracts, shifts and remuneration

Looking specifically at the working conditions prevailing on site, we found that no traditional (when compared to pier I arrangements) continuity in work patterns and shifts existed for the workers hired under subcontracting, as in the words of a Pier I dockworker and a former PCT employee:

Here in pier I, it's more, let's say, organized, and I know most of my schedules. I know that, on Wednesday, I have a day off. For the other workers, in pier II and III, this is not the case: you may have the day off, you may receive a text the last night and you have to come, it's not compulsory officially, but it is in real term it is compulsory, you have to go. [Also on pier I], you are not expecting to receive a call in your day off, and saying to you: 'oh, can you please come to work?' (Interview 3)

And to be secured. I mean that, you know that you have a monthly salary, you have an employment contract. Whereas the subcontracted employee, it's waiting to receive the SMS, of whether he will come on duty or not (...) Everything is better (in PPA), there is no comparison. The company employees have a fixed salary, the outsourced employee does not necessarily have the fixed salary of the company employee. (Interview 16)

The local press repeatedly highlighted the challenges and demands of working as a subcontracted worker on pier II and III, denouncing 12 hour shifts or the practice of what is called "back-to-back shifts", when a worker works two full shifts with just eight hours rest in-between (ekathimerini, 2021b). One of the managers among our respondents also explained that subcontracted workers are convenient insofar as they are seen as easily replaceable and re-deployable:

Fixed term contracts without considerable health benefits and insurance in most cases, mean that workers under the COSCO side of the port are more expendable and subject to any shifts in work schedule, nature of work etc. (Interview 14)

On the other hand, the opposing view was that many of the workers were willing and happy to take on more work and longer hours as these were remunerated accordingly. In other words, the perception was that there was no lack of employment and that many were happy to take advantage of the new opportunities; in spite of the fact that employment certainty and stability was much higher on the PPA managed side of the port, with long-established and negotiated practices protected by high levels of unionization. Thus, two contrasting narratives emerge, compounded by the fact that working conditions did not remain static and rather evolved since the inception of COSCO's operations in 2009.

Specifically, the uncertainty and flexibility in contracts was said to only really have occurred during port downtime periods. Therefore, while turmoil was caused by excessive flexibility being demanded of workers around the beginning of COSCO's operations in Piraeus port, this was no longer the case at the time of our interviews, when all shifts were fully booked and scheduled daily due to the huge increase in trade volumes. In other words, the idea was that the losses in working welfare experienced in the past were a transitory phase towards the new operative regime of the port, where the productivity is such that work contracts and shifts are equally as stable as on pier I thanks to the productivity gains[5].

However, the discourse around such productivity increases was not uncontroversial. A glaring example was the animosity surrounding gang numbers. Specifically, a longstanding union-backed and agreed provision required that a gang of nine people worked at a gantry crane at all times on

[5] A former PCT dockworker gave a media interview in 2011 (Lim, 2011), after being fired, where he explained that there were instances where pier II and III workers went through 8-hour shifts without a meal or toilet break while receiving half the salary of pier I workers. Furthermore, he declared that no extra pay for working night shifts or weekends was offered and that he himself had been on 24/7 call for nine months. While we have no way of assessing the validity of such claims at the time, our evidence suggests that working conditions have evolved with respect to the beginning of operations; however, the lack of testimonies from PCT workers and the ban on approaching them raises doubts on the extent of such change, and further research is certainly needed which takes into account their perspectives too.

pier I; COSCO reformed this practice and used a crew of just four or at times a maximum of five dockworkers. While some stressed that four to five workers are more than enough for most tasks, others – and especially dockworkers and union respondents from pier I – strongly disagreed and saw the change as reflecting very different views of the trade-off between productivity and workers' safety and well-being at work.

In addition, a former PCT employee also added that PPA workers operating cranes normally undertook 4-hour shifts, in line with many other European ports' standards, but for PCT crane workers, shifts were extended to eight hours. We also found that, more recently, as part of the Greek national post-pandemic recovery plan, new labour reforms allow employees to request work shifts of up to 10 hours per day. Though the weekly maximum is still capped at 40 hours (Mercer, 2021), many have seen such reforms as irresponsible and favouring business (Guardian, 2021).

It was hard to compare monthly salaries across the two parts of the ports due to the way subcontracted salaries are calculated on a 22-day basis. Our respondents, however, indicated that the average negotiated salary for PPA dockworkers was in the region of 1500-1600 euros per month, while contrasting information emerged for PCT dockworkers, with some of our respondents indicating 1150 euros per month in 2019 and Equal Times, 2022 reporting 1300 euros. More importantly, however, what emerged from some of our interviews was that PPA salaries were mostly fixed, while changes in shifts lengths, overtime hours worked, and in general the flexibility we described above allowed workers to earn substantially more than their basic salary. While this is at odds with the protracted strikes that PCT dockworkers carried out in Feb 2022 (Equal Times, 2022); it was reported to reflect work organisation arrangements across the two piers, by some of our respondents. More specifically, on pier I dockworkers were assigned to a broader range of tasks on a daily basis but none of these affected the contractual (and CBA agreed) pay to a large extent. In piers II and III, workers' remuneration is instead much more connected to their speciality level and sector:

The higher the speciality that somebody can work, the higher the salary they get. Even if I use him as a driver, I pay him as a quay crane driver. (Interview 2)

Benefits and allowances are received by workers on both sides of the port and we found that the PCT subcontracted workers' benefit package included private health insurance, lunch on site, and free driving lessons. PCT also engaged in other CSR initiatives such as partnerships with local organizations to help children in need by setting up a blood bank within the company and aiming to become the first company to provide a bone marrow transplant.

4.5.2 Labour control through workers' unionisation

When COSCO started operations in 2010, workers did not have any access to or coverage by any union for several years. The media reported on the issue as one of worker rights violation, but PCT issued a statement in which workers were identified as the only ones responsible for unionising, thus attempting to clear PCT/COSCO of any responsibility (Vamvakidis, 2013). No mention was made of the power dynamics that made more or less favourable the creation of unions. Thereafter, the first CBA was not signed until 2019. Our findings indicate that labour control in the case of PCT workers is exerted as much through the segmentation resulting from subcontracting as through the limitations imposed on the unionisation of workers.

According to Edwards, 1982 there are three ideal types of labour control: firstly, there is simple control, as with the direct supervision of managers on the workplace and the introduction of fines for failures to meet work targets. In the second type of control, the technical control, technology drives the character and pace of work. The last type of control, the bureaucratic control, relies on an agreement between the employer and a union as a representative of the employees with regulations that govern the workplace and offer structured pay rises and rewards for good performance and opportunities for personal advancement. Workplaces are often structured by combinations of two or three types of labour control.

Unionisation levels differ across piers in Piraeus port, with pier I workers falling under at least three large established unions, namely the Federation of Port Workers of Greece (OMYLE), the Association of Dockworkers of PPA, and the Union of Supervisors and Foreman (OFE). We identified a trend towards the merging of many small unions into bigger ones and consistently very high levels of unionisation across all port employees. Thus, the bureaucratic labour control strategy can be understood as the prevailing one in Pier I, with CBAs forming the backbone of the representation strategy and three CBAs signed from 2017 and 2022 by OMYLE and OFE.

The PCT piers host two main unions: namely the Union of Piraeus Port Dock Container Workers (ENEDEP) created in 2014 and the Union of employees of firms that are operating on piers II and III (SYNEDEP), formalized in 2018. The first union, a left-wing politically militant union, wasn't formally recognised by the company until a fatal accident that led to one of ENEDEP members' death at pier II after his shift in October 2021 (ekathimerini, 2021a). As a result of the accident, strikes were held by PCT workers and ENEDEP demanded the setting-up of a Health and Safety Committee at PCT, the termination of back-to-back shifts and 12-hour shifts for dockworkers, and more importantly, the signing of the new rounds of CBAs. Most requests were accepted given the circumstances and it was decided that the number of gang members on shift would be increased back from four to five (ekathimerini, 2021b; thenationalherald, 2021). PCT's subsidiaries and ENEDEP had for long interacted over the issue of CBAs but the union failed to secure a deal in

2018 (Pamehellas, 2018); a three month strike achieved little success (ekathimerini, 2018) and it took a major on-site accident for some of ENEDEP's demands to be taken into account.

SYNEDEP, on the other hand, was the union with the largest representation base at the time of our interviews. Some of our respondents associated it to a far-right Greek political party and explained that every PCT dockworker was automatically signed up to be a member of SYNEDEP, upon signing their contract. As, by law, the CBA was to be signed with the union that has the largest representation of the workers, many believe that the forced sign-up was no more than a strategy to fictitiously attribute the largest representation base to a company-managed-union (Rizospastis, 2013; Equal Times, 2022); in other words 'the employer set up its own syndicate, so that it could negotiate with itself' (Katiousa, 2018). Our field evidence, therefore, points towards the unionisation process being used in this case as a mechanism of labour control in pier II and III alongside other forms of simple control and the control derived from the fragmented and precarious nature of subcontracted work.

4.6 Policy implications and conclusions

Our approach in conducting this study has been to focus on better understanding the employment effects and segmented workplace regimes that have developed on the PPA and PCT operated sides of the port. At the same time, we have been keen to explore some of the broader socio-economic impacts, such that the changes to labour relations and working conditions are put into context. We also acknowledge that we have not discussed a number of important aspects, such as the serious environmental implications of the COSCO investment project, and we leave these areas for future research.

Our findings point to positive employment effects, where local workers were recruited during a time of exceptionally high unemployment in Greece, following the 2009 debt crisis. However, in spite of substantial productivity increases, the gains in terms of trade volumes and business activities have not translated into improved working conditions. Specifically, we found employment patterns characterized by inbuilt flexibility and precariousness due to the subcontracting taking place across the board. We argue that the adoption of such workplace regime results in the disjunction between the lead firm COSCO and all remuneration and representation matters related to the workforce at piers II and III. It also implies the deployment of labour control strategies that extend to the unionisation on site, which appears to be management-controlled. We further argue that the national legislative reforms started in 2010, in response to and under the pressures of the bail out programs, facilitate such outsourcing with a view to achieving a liberalization and flexibilization of the labour market. Without these reforms and the flexible working practices that they allowed COSCO to adopt, the investment in Piraeus may have been deemed too risky.

A crucial question for the future is whether there is any reasonable chance that the port could be operated by a company other than COSCO - and specifically a Greek-owned company - after the concession agreement ends. Whether the labour relations we described in this study could be reversible or set to stay following any such change is unclear, especially given they are backed and enabled by national reforms. This delineates a potential role for the EU-level policy-making aiming to screen these types of investments prior to implementation and to support governments in crisis to maintain minimum labour standards. However, the EU FDI screening mechanism focuses on investments where the impact may permeate beyond the host country. Instead, where there are limited ripple effects and individual member states are facing serious economic issues, the screening mechanism is not currently designed to result in policy recommendations and intervention. More importantly, labour relations are not currently given enough prominence and space in the policy tool, in spite of the clear potential for spillovers they may have when practices consolidated through investment in one country and likely to be applied elsewhere. This is particularly the case when the national labour regulatory framework intersects with company-level agreements and practices to determine workplace outcomes. At the present time, there is no requirement for member states to introduce a screening mechanism. In the specific case of Piraeus port and COSCO, there is therefore a tangible risk that a labour relation model that got consolidated in that setting may be de facto exported to a similar investment country/sector destination without raising any formal scrutiny or concern. Thus, through the case examined in this paper, we shed light on the shortcomings of the current screening mechanism and the need to consider its reform in order to protect workers in states facing serious economic challenges. Further research should concentrate on this avenue and on cross-country comparisons that can help us shed light on similar proposed or existing investment projects across Europe.

Chapter 5

Selling European strategic assets: An examination of the trade effects

5.1 Introduction

Trade protectionism has been on the rise, especially with The European Union (EU) framework for investment screening being introduced in 2020. Trade protective measures and guidance have been introduced in many countries since the 2008 global financial crisis, which triggered a surge in economic nationalism. This trend was then further intensified by the Covid-19 pandemic. Many governments introduced measures to protect national strategic assets and avoid predatory buying behaviours from foreign actors.

The U.S. has continued to carefully monitor and screen Chinese investment under the Biden administration given the prolonged US-China trade war and its implications on global trade and supply chain networks. Whereas India, one of the world's most protectionist countries in bilateral trade, is the only exception where it reversed its protectionist trade policy of the telecommunications services industry and welcomed foreign investors. Taking on a similar stance to the U.S., the EU and the UK are both introducing tougher measures to expand their investment screening powers.

Investment screening mechanisms often serve two purposes. One refers to national security considerations in key strategic industries such as defence manufacturing and energy in India as well as mineral lease rights and agricultural land in the U.S. The second one takes into account more integrated issues and often relates to the net benefit of foreign investment. There is a growing consensus that not all FDI, whether mergers and acquisitions (MAs) or other forms, is equally beneficial to both host and home countries.

A recent example of FDI screening is the EU's new investment screening framework at EU-level, which came into effect in October 2020 to oversee foreign investments made into member states, and there are currently 16 member states that have adapted FDI rules to EU regulation (European Commission, 2020), while 8 countries are in the process of adapting the new FDI regimes. The screening mechanism aims to prevent opportunistic foreign acquisitions of European companies that are currently trading/operating at a discount as a result of collapsing share prices. This will mean that many ongoing and future projects under the Belt and Road (BRI) may now be subject to the new screening competence of the Commission.

China, the EU's strategic competitor, has been investing in the region via both direct and indirect investment channels. There are reportedly four airports and six maritime ports in Europe now owned mainly by Chinese state-owned enterprises (SOEs) (Iain Marlow, 2018). With China acquiring more and more European strategic assets – infrastructure, in particular, due to member states' sell-off of their critical assets partially due to the 2008 financial crisis – it is essential to examine the trade implications of this. Furthermore, there will be additional planned investments made in selected member states.

Therefore, with screening frameworks becoming a reality and more Chinese investments flooding into the region, this chapter seeks to provide a better understanding of the trade impacts of those existing investments made via the BRI route on Europe and the rest of the world. By employing a structural gravity model with general equilibrium analysis, we aim to examine and acknowledge the role of those infrastructure projects in reducing trade barriers, promoting better logistics and increasing connectivity and cross-border trade of goods. In addition, we also perform counterfactual analysis with scenarios from EU member states signed up to the BRI and additional investments made in selected EU member states to further examine the implication.

In this chapter, we contribute to the growing BRI literature by exploring the trade and welfare effects of BRI projects on EU member states, China and the rest of the world. The number of BRI studies has been growing; while some research papers revealed the motivations behind the BRI as well as opportunities and challenges (Wong, Booker, and Barthe-Dejean, 2017 and Wijeratne et al., 2017), other studies examined how much the BRI will reduce trade costs in the context of Europe (Grieger, 2016, Zuokui, 2016, Herrero and Xu, 2017, De Soyres et al., 2018, and Jackson and Shepotylo, 2021). It is worth mentioning that the most recent work looking at the BRI comes from World Bank studies, and in particular, De Soyres et al., 2018 create and translate shipping times into a trade cost reduction in percentage pre- and post-BRI projects, which will be used in this paper as our BRI-related trade cost reduction.

Having said this, this chapter aims to answer the following two questions:
1. What are the trade impacts of the BRI on the EU, China and the rest of the world, and if so, to what extent?
2. What will be the ripple effects across the single market from the increased investment in one or more member states e.g. Italy, Spain and Greece?

The rest of this chapter is divided into five sections. Given that we have introduced and explained the origins of gravity modelling and its popularity in international trade empirical analysis in Chapter 2, therefore in this chapter, we will use Section 2 to explain our model specification - econometric estimation of gravity equations with a short introduction to the gravity model as a recap, as well as outlining general equilibrium analysis without going into too much detail of theoretical justifications of using structural gravity model. In addition, Section 2 sets a foundation for our estimation and counterfactual analysis. Section 3 introduces our data and explains how we quantify BRI transport projects in our model. It also provides a detailed step-by-step process on how to perform a full general equilibrium analysis, and a complete data summary and description. Section 4 explains how we come up with our three scenarios. Section 5 provides empirical results for each of the three scenarios. Section 6 summarises this chapter and discusses the policy implications of our findings.

5.2 Model and methodology

5.2.1 Structural gravity model

The gravity model of international trade is a model that originally predicts bilateral trade flows based on the economic sizes and distance between two units.[1] It was introduced by Tinbergen, 1962 and has been used as a workhorse for international trade econometric analysis. However, the gravity equations were criticised for not having sufficient theoretical foundations (Leamer and Levinsohn, 1995). In recent years, it is becoming increasingly clear that the gravity model is only justifiable once it is theoretically grounded as much as possible. Anderson, 1979 carefully built the foundation of a gravity trade theory by introducing demand-side (The Armington, 1969 assumption) gravity specifications. But the model was not receiving a lot of attention among researchers until 2003, when Anderson and Van Wincoop, 2003 further derived a complete gravity equation based on Armington, 1969 work. It gave a new life to the structural gravity model and it was then that the gravity model became popular and has since been used in international trade literature. It is worth mentioning that the Eaton-Kortum model (Eaton and Kortum, 2002) consists of the same derived gravity equations; the only difference with Anderson and Van Wincoop, 2003 model is that they capture supply-side shocks rather than demand side.

Since then, the gravity model has been used extensively within the trade literature when evaluating a trade policy shock. However, there is a very limited number of studies when it comes to employing the structural gravity model to estimate the impacts of BRI as a trade policy. Transport projects under the BRI will improve cross-border logistics, and port terminal handling productivity, as well as reduce trade frictions including customs procedure

[1] Chapter 2 offers a more detailed size of literature, theoretical justifications and empirical research on the gravity model.

times, and hence, it will improve trade conditions between countries and increase bilateral trade volumes. Herrero and Xu, 2017 were the first to use a structural gravity model with counterfactual analysis to estimate trade creation as a consequence of BRI infrastructure projects for Europe. Their results suggest that a 10 per cent reduction in railway and maritime costs leads to an increase in trade volume by 2 per cent and 1.1 per cent, respectively. They further extend the model by considering a potential FTA within the BRI signatories.

Similarly, De Soyres et al., 2018 estimate how much the BRI will reduce trade costs by employing Geographic Information System analysis to estimate shipment times and then translate them into trade costs. Their results find that for the BRI economies, aggregate trade costs fall between 1.5 to 2.8 per cent. Lastly, the most recent work by Jackson and Shepotylo, 2020 also employs the structural gravity model with full general equilibrium analysis to evaluate the impact of the BRI on the EU. They conclude that a 15 per cent reduction in transport costs between China and the EU would increase the welfare of a representative consumer in the EU by 0.5 per cent. For counterfactual analysis, they look at potential EU-China FTA and US-China trade war scenarios. In summary, transportation costs are found to be statistically and economically significant in improving trade facilitation.

To properly account for BRI-related transport cost reduction and its trade effects, we proxy improvements in trade volume due to trade cost reduction using parameter λ_{ij}. λ_{ij} represents a percentage decrease in trade costs due to BRI infrastructure projects. This is based on the work done by Jackson and Shepotylo, 2021. Their work is the most recent work in the BRI literature using the gravity model to examine the trade effects of BRI projects. Their research is also the closest work that we could use to compare our results with. Their results were further tested using a robustness check, and their model specification is theory-consistent. Therefore, in our econometric model of gravity specification, we will use λ_{ij} to indicate our trade policy shock.

Factoring in issues including zero trade flows, endogeneity of trade policy, and multilateral trade resistance (Anderson and Van Wincoop, 2003), the structural gravity model takes the following form:

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{\tau_{ij}}{\Pi_i P_j}\right)^{1-\delta} \tag{5.1}$$

where X_{ij} is the export from country i to country j, Y_i is the total income in country i, E_j is the total expenditure in country j, and Y is the world gross output, and it is equivalent of Gross Domestic Product (GDP).

The middle term in Equation 5.1 $\frac{Y_i E_j}{Y}$ is the economic size term when $\tau_{ij} = 1$. This indicates that there is a positive relationship between the term Y_i and X_{ij}, meaning that the larger the size of the producers, the more they will export goods to the rest of the countries. Similar interpretation for the term E_j and X_{ij}, the bigger the market size, the more the country will import from other countries.

One of the key distinguishing features of the structural gravity equation is that it includes variables which capture how the third country - the rest of the economy, which is not affected directly by the trade policy shock, is being affected. $(\frac{\tau_{ij}}{\Pi_i P_j})^{1-\delta}$ is the trade cost term, where τ_{ij} is the bilateral trade cost between country i and country j measured by geographic and trade policy variables, δ is elasticity of substitution ($\delta > 1$), outward multilateral resistance term (OMR)

$$\Pi_i^{1-\delta} = \sum_j (\frac{\tau_{ij}}{P_j})^{1-\delta} \frac{E_j}{Y} \tag{5.2}$$

and inward multilateral resistance term (IMR)

$$P_j^{1-\delta} = \sum_i (\frac{\tau_{ij}}{\Pi_j})^{1-\delta} \frac{Y_i}{Y} \tag{5.3}$$

Both OMR and IMR capture differences in market thickness across host and home countries. Anderson's (Anderson and Van Wincoop, 2003) model captures how changes in trade costs on one bilateral route, can affect trade flows on all other routes due to the relative price effects.

Finally, together with factory-gate price in country i

$$p_i = (\frac{y_i}{Y})^{\frac{1}{1-\delta}} \frac{1}{\alpha_i \Pi_i} \tag{5.4}$$

the equilibrium income is given by

$$E_i = \varphi_i Y_i = \varphi_i p_i Q i \tag{5.5}$$

5.2.2 General equilibrium analysis

The complete structural gravity model system is as follows:

$$X_{ij} = \frac{Y_i E_j}{Y} (\frac{\tau_{ij}}{\Pi_i P_j})^{1-\delta} \tag{5.6}$$

$$\Pi_i^{1-\delta} = \sum_j (\frac{\tau_{ij}}{P_j})^{1-\delta} \frac{E_j}{Y} \tag{5.7}$$

$$P_j^{1-\delta} = \sum_i (\frac{\tau_{ij}}{\Pi_j})^{1-\delta} \frac{Y_i}{Y} \tag{5.8}$$

$$p_i = (\frac{y_i}{Y})^{\frac{1}{1-\delta}} \frac{1}{\alpha_i \Pi_i} \tag{5.9}$$

$$E_i = \varphi_i Y_i = \varphi_i p_i Q i \tag{5.10}$$

We can then run the structural gravity model estimation and assess the general equilibrium effects of trade policy. Head and Mayer, 2014 break down the effects of trade policy on trade into three different channels:

$$\begin{cases} \text{Direct partial equilibrium (PE): equation 5.6} \\ \text{Conditional general equilibrium (GE): equation 5.6, 5.7 and 5.8} \\ \text{Full endowment GE equation: equation 5.6, 5.7, 5.8, 5.9 and 5.10} \end{cases} \tag{5.11}$$

Direct effect of PE is a decrease in bilateral trade costs between country i and country j, it is also the initial and strongest effect of trade policy changes on bilateral trade. However, the effect is limited to trade-involving countries (countries i and j) only. In other words, τ_{ij} is the only variable that changes in equation 5.6 while all other variables remain unchanged.

Unlike PE effects, conditional GE allows the effect of trade policy changes to ripple through the rest of the world via OMR and IMR terms (Π_i and P_i) while holding output (Y_i) and expenditure (E_j) constant. There are first-order GE effects which measure the impact of trade policy changes on member countries. And the second-order GE effects capture the impacts on non-member countries as a result of changes in member countries' MR. A change in t_{ij} due to trade policy changes leads to a change in OMR and IMR accordingly, together they result in a change in X_{ij}. Therefore, conditional GE captures the total bilateral trade cost indexes, or the trade cost term $(\frac{t_{ij}}{\Pi_i P_j})^{1-\delta}$.

The full GE effects capture the impacts of a trade policy change among all economies in the world. This accounts for the value changes of the economic size term Y_i and E_j based on factory gate prices p_i in response to changes in trade cost τ_{ij} and associated ripple effects in MR through equation 5.9. And then it translates these changes in factory gate price into a change in the value of Y_i and aggregate expenditure E_j using equation 5.10. In full GE effect, only production Q_i is constant.

5.3 Empirical strategy and data

5.3.1 Trade costs

Given the limited number of studies using the gravity model in the BRI literature, we will use trade cost reduction percentages from De Soyres et al., 2018 for each country pair, and we use parameter λ_{ij} (Jackson, 2021) to represent this as our trade policy shock. Hence, trade costs term τ_{ij} is defined as follows:

$$\tau_{ij}^{(1-\delta)} = exp(\beta_{dist} \ln(\lambda_{ij} \times dist_{ij})) + \beta_T T_{ij}) + u_{ij} \tag{5.12}$$

where λ_{ij} represents the percentage decrease in trade costs as a result of BRI infrastructure projects calculated by De Soyres et al., 2018. T_{ij} represents other factors which affect trade costs, such as common border, cultural determinants, language barriers and a colonial past. $dist_{ij}$ is the distance between country i and j. u_{ij} is the error term that is unbiased and captures the rest of the factors that might have an effect on the dependent variable but are not explained or included in the equation.

In order to examine the trade effect - that is, how much trade creation or trade diversion has been created due to BRI transport projects, we need to figure out trade cost reductions aroused from those projects first. To do this, we employ trade cost reduction calculated by De Soyres et al., 2019. It is the only trade cost reduction by country pair data that is available in the literature produced by the World Bank. Table 5.1 is an average trade cost reduction in percentage terms across different regions based on De Soyres et al., 2018 data set calculated by the author. It shows that on average, BRI transport projects lead to a 7.43 per cent trade cost reduction for South Asia, and 3.78 per cent for the EU. It suggests that trade cost reduction in percentage term do vary slightly, but roughly stay within the range of 2.67 to 7.43 on average. We will apply these sets of trade cost reductions by region to our country pair.

TABLE 5.1: Trade cost reductions, by region

Region	**Trade costs reduction (%)**
Central Europe and the Baltics	4.18
East Asia Pacific	5.00
Europe Central Asia	5.90
European Union	3.78
Latin America Caribbean	2.67
Middle East North Africa	5.40
North America	3.19
South Asia	7.43
Sub-Saharan Africa	4.01

Once we obtain trade policy shock (λ_{ij}) data, our gravity equation for estimation is defined as follows:

$$X_{ij} = exp(\beta_{dist} \ln(\lambda_{ij} \times dist_{ij}) + \beta_{FTA} FTA_{ij} + \beta_T T_{ij} + \pi_i + \chi_j) + \varepsilon_{ij} \quad (5.13)$$

where π_i and χ_j are exporter-time and importer-time fixed effects, respectively. The error term ε_{ij} is a stochastic term that is assumed to carry any variables that might affect the dependent variable X_{ij} other than trade costs.

Before estimating Equation 5.13 using general equilibrium analysis, Equation 5.13 will be estimated with both importer- and exporter-time fixed effects by Ordinary Least Square (OLS) and Poisson Pseudo Maximum Likelihood (PPML) methods using panel data (both intra-national and international data), with five-year intervals (four-year intervals for the last time period) and full consecutive year. Both methods are common in the literature (Head and Mayer, 2014) and they solve issues including the unobservable variables OMR and IMR; zero trade flows; and heteroscedasticity of trade data. We estimate our gravity equation using OLS, PPML and later, we will use $PPMLHDFE$, a Stata command for estimation of Poisson regression models with multiple high-dimensional fixed effects (HDFE).

Gravity model theory suggests employing interval years to account for trade policy adjustments which take full effect in later years. In addition to this, we also run regressions to show that while taking consecutive years in estimation solves trade policy adjustment issues, it is missing out, or giving up quite a lot of useful yet estimable and valuable data that could have been included and estimated otherwise in the regression, it would give us a different set of results. Similarly, we run regression both with and without domestic trade flow data, as often, it is not wrong to not include intra-national trade data in regression, however, the results do show that by taking into account domestic trade data, which is a big part of trade flow data for any given country (especially a small-sized country with where the majority of their trade is domestic-focused, or their imports are a very small share of the world market), the results are more robust and significant. By incorporating domestic trade data, estimates that we obtain from the regression will also explain to what extent small-size economies will benefit from the BRI due to trade liberalisation.

For general equilibrium analysis with the gravity model of trade, we will be using ppmlhdfe - it is a Stata package that implements Poisson Pseudo Maximum Likelihood regressions (PPML) with multiple high-dimensional fixed effects (HDFE) (Correia, Guimarães, and Zylkin, 2019b, Correia, Guimarães, and Zylkin, 2019a and Correia, Guimarães, and Zylkin, 2020). According to Correia, Guimarães, and Zylkin, 2020, the estimator employed is robust as its statistical separation property which solves convergence issues, given that such issues are seen quite often in OLS and PPML regression.

5.3.2 The general equilibrium analysis of trade policy

Often a policy change in an economic system will have repercussions far beyond the sector in which the change occurs, and the partial equilibrium model can only capture the change that takes place in that particular sector. General equilibrium models are designed to help us understand those repercussions. Thinking in general equilibrium terms helps us to see the full consequences of policy changes. For instance, in having a large inflow of Chinese investment in infrastructure sectors, what is the effect of an increased port efficiency on exports and imports volumes?

The general equilibrium analysis of trade policy consists of conditional general equilibrium and full general equilibrium analysis. Through changes in household budget sets (due to changes in wages, prices or firm profits), and changes in consumers' behaviours that enter directly into their own utility (due to externalities), general equilibrium analysis of trade policy together with $PPMLHDFE$ can not only apply real data to models but also simulate the effects of policy changes inside the models to capture the trade and welfare effects of any trade policy.

For conditional general equilibrium analysis (Head and Mayer, 2014), 'conditional' refers to output (Y_i) and expenditure E_j variables which under assumption, are to hold constant and unchanged. Trade cost reductions happen when there is a trade policy shock τ to $\tau\prime$, in this case, the trade policy shock is implementing BRI transport projects which improve transport infrastructure and logistics performance and therefore lead to economic and trade growth due to trade cost reductions. We then evaluate OMR and IMR terms before and after trade policy shock by applying the PPML estimator with general equilibrium analysis in our regression model (Anderson, Larch, and Yotov, 2018). Once a counterfactual scenario is defined, trade cost variable λ_{ij} will be modified to reflect policy shock and re-estimate the model. Any adjustments to the trade policy variables will result in a new matrix of counterfactual (CFL) bilateral trade costs $((\hat{t_{ij,t}})^{1-\delta})^{CFL}$. The only difference between the baseline and counterfactual trade costs is the error term, where this shock will translate into changes in the key economic indicators. Finally, indexes are computed by solving OMR and IMR terms to obtain new values.

Counterfactual trade policy changes capture the changes in factory gate prices p_i, resulting from changes in π_i which lead to changes in output Y_i and expenditure E_j, which then in turn impact directly on trade and indirectly on MR term:

$$[\hat{\Pi_{i,t}}^{1-\delta}]^{CFL}_{FULL} = \frac{Y^{FULL}_{i,t}}{exp(\hat{\pi_{i,t}}^{FULL})} * E^{FULL}_{R,t} \tag{5.14}$$

$$[\hat{P_{j,t}}^{1-\delta}]^{CFL}_{FULL} = \frac{E^{FULL}_{j,t}}{exp(\hat{\chi_{j,t}}^{FULL})} * \frac{1}{E^{FULL}_{R,t}} \tag{5.15}$$

Where FULL denotes "full endowment", $\hat{\pi_{j,t}}^{FULL}$ and $\hat{\chi_{j,t}}^{FULL}$ are the latest PPML estimates of exporter-time and importer-time fixed effects of the structural gravity model, which are obtained by applying the iterative procedure. $Y^{FULL}_{i,t}$ and $E^{FULL}_{j,t}$ are output and expenditure values. $E_{R,t}$ denotes expenditure of the reference country R in year t.

Stata MP 16.1 version is used for all regressions. Steps to perform a general equilibrium analysis of trade policy with PPML are as follows:

1. Solve the baseline gravity model. Use the PPML estimator to estimate gravity with exporter and importer fixed effects.
2. Construct baseline gravity indexes of interest - inward and outward multilateral resistance terms (IMR and OMR) and welfare indices, using $[\tau_{ij}^{(1-\delta)}]^{BLN}$.
3. Define a counterfactual scenario by changing trade policy variables while keeping everything else constant.
4. Estimate the same gravity specification using PPML estimator with new estimates obtained in baseline gravity.
5. Solve the counterfactual model in two steps by estimating separately and sequentially of conditional general equilibrium and full endowment effect.
6. Recover counterfactual inward and outward multilateral resistance terms and compute new welfare indices and trade flows.
7. Compare the baseline and counterfactual variables. The general equilibrium effects indexes are expressed in terms of percentage changes with respect to the baseline model.

Welfare effect estimation

The welfare impact of a counterfactual scenario relative to the baseline is computed according to

$$\Delta GDP_{FULL} = \frac{GDP_{FULL} - GDP_{BLN}}{GDP_{BLN}} \times 100 \tag{5.16}$$

We also compute the full general equilibrium (GE) effect of each scenario, following the algorithm suggested by Anderson, Larch, and Yotov, 2018.

5.3.3 Data

Table 5.2 reports three sets of panel data. Panel A contains data ranges from 1960 to 2019 for 199 countries, similarly, panel B covers countries from 1960 to 2019 but with five-year intervals (four years for the last year of observations) to account for trade policy adjustment that was raised in 2, and finally a cross-section data from 2018 for counterfactual analysis. Dependent variable X_{ij}, aggregate bilateral exports measured in millions of current US dollars is taken from the Direction of Trade Statistics (DOTS) provided by the International Monetary Fund (IMF). Dummy variable FTA equals 1 if the country pair has an active FTA in place and 0 otherwise, and data are collected from the Centre D'Ètudes Prospectives et D'Informations Internationales (CEPII) Gravity dataset. Similarly, data for $dist_{ij}$ variable distance are also taken from the CEPII. Colonial past and contiguity dummy variables are used to control for pair-specific trade costs that are indirectly related to distance. The ability to speak the same language and have the same religion are captured by dummy variables to cover the effects of cultural similarities on trade (Lameli et al., 2015).

TABLE 5.2: Summary statistics

Variables	N	Mean	St.Dev	Min	Max
Panel A: 1960 - 2019 sample					
Export, million USD	2,520,000	186.2	3,272	0	480,689
Common border, Yes = 1	2,520,000	0.015	0.122	0	1
Common language, Yes = 1	2,520,000	0.159	0.366	0	1
Colonial past, Yes = 1	2,520,000	0.011	0.103	0	1
FTA, Yes = 1	1,909,000	0.029	0.169	0	1
Common religion, Yes = 1	2,468,000	0.168	0.243	0	0.997
Common legal = 1	2,520,000	0.105	0.307	0	1
Ln Distance	2,494,000	8.784	0.756	4.546	9.890
Panel B: 1960 - 2019 sample (5-year interval)					
Export, million USD	778,176	277.7	4,262	0	418,584
Common border, Yes = 1	778,176	0.015	0.122	0	1
Common language, Yes = 1	778,176	0.159	0.366	0	1
Colonial past, Yes = 1	778,176	0.011	0.103	0	1
FTA, Yes = 1	217,636	0.027	0.162	0	1
Common religion, Yes = 1	762,090	0.168	0.243	0	0.997
Common legal = 1	778,176	0.105	0.307	0	1
Ln Distance	770,112	8.784	0.756	4.546	9.890
Panel C: 2018					
Export, million USD	37,056	491.7	6,088	0	480,689
Common border, Yes = 1	37,056	0.015	0.122	0	1
Common language, Yes = 1	37,056	0.159	0.366	0	1
Colonial past, Yes = 1	37,056	0.011	0.103	0	1
FTA, Yes = 1	28,725	0.086	0.28	0	1
Common religion, Yes = 1	36,290	0.168	0.243	0	0.997
Common legal = 1	37,056	0.105	0.307	0	1
Ln Distance	36,672	8.784	0.756	4.546	9.890

In addition to distance, which is the first variable in the physics version of the gravity equation to be correlated with "mass" or trade flow, we also include a number of other trade cost observables as control variables. Specifically, we include a dummy variable equal to 1 for countries that share a common religion (*comrelig*), a dummy variable equal to 1 for countries that share a common legal system (*comleg*), a dummy variable equal to 1 for countries that share a common border (Contiguity, or *contig* for short), another dummy variable equal to 1 for those countries that share a common language ($comlang\_off$), a dummy variable equal to 1 for those country pairs that were ever in a colonial relationship (*colony*), and finally a dummy variable equal to 1 for those countries that were formerly colonised by the same power (*comcol*). We also include an FTA dummy variable if the country pair has an FTA (fta) in effect. There is evidence from the gravity model literature that all these factors can have a significant impact on trade flows, primarily because these variables increase or decrease the costs of moving goods internationally.

5.4 Building the scenarios

The gravity model can obtain estimates of the sensitivity of trade with respect to changes in particular policy factors through parameters, it can also present results of counterfactual simulations (Shepherd, 2008). Counterfactual analysis of the effects of various trade policies using the gravity model has been the object of a series of recent studies (Egger, 2002, Herrero and Xu, 2017, De Soyres et al., 2018, Jackson and Shepotylo, 2020), and it has been part of the standard literature of gravity modelling. To do this, we take baseline estimates and estimated elasticities and use them to create a "policy shock" to independent variables onto project trade effects. It is important to note that counterfactual experiments should be policy-relevant, and we take regional averages of trade cost reductions from De Soyres et al., 2019 as this can represent a reasonable policy shock value and thus, make counterfactual results meaningful. However, it is important to acknowledge that we make a series of assumptions in the construction of these scenarios. The gravity model of counterfactual simulations only gives us estimated values, which are illustrative. In other words, the results of our scenario are indicative only, they serve the purpose to show readers the implications of a potentially relevant policy factor that may be in effect.

5.4.1 BRI scenario

Besides Europe's forced reckoning with China's BRI by introducing the Global Gateway, a new EU strategy to boost the competitiveness and security of global supply chains, the EU has also introduced a screening mechanism proposed by the European Commission in 2017, and approved by the European Parliament in 2019, to oversee foreign investments made in member states, especially Chinese investments targeting EU member states' strategic public assets. It is a screening mechanism in parallel to member states' national measurements of foreign investments.

This EU-level screening mechanism is mostly aimed at filtering and scrutinising investment coming from China to ensure that the EU's strategic infrastructure such as ports, railways and energy sectors are not predatorily targeted by foreign investors (Grieger, 2019). The screening mechanism has been effective in tackling foreign investment, in particular, it has led to a 40 per cent drop in Chinese investments in the EU in 2018, compared with 2017, to approximately EUR 17.3 billion (PortStrategy, 2020).

Our BRI scenario builds on De Soyres et al., 2018's study. Their study estimates shipment times before and after the BRI and uses sectoral estimates of "value of time" to transform changes in shipment times into changes in ad valorem trade costs. The results suggest that the BRI will significantly reduce shipment times and trade costs, especially with countries located along the corridors, as they encounter the largest trade gains. However, there are limitations to their methodology. First, for the mode of transport selection, they only focus on rail and maritime links for the simplification of the network analysis.

Nevertheless, railroads and air links are also important, as they are two types of BRI infrastructure projects in facilitating regional trade. Second, the database of planned BRI road, rail and port investment that De Soyres et al., 2018 use does not include railroad and air elements. This is also another factor which might have an impact on the effects of trade and welfare in the slightest way. Despite all limitations, De Soyres et al., 2018's work is the closest and the most recent work which is relevant and related to this thesis and, for this chapter's research, that we can use to proxy our BRI trade cost reductions.

We take trade cost reduction estimates from De Soyres et al., 2018, which is the upper-bound percentage change in trade costs ranging from 0 to 65.16 per cent with a mean of 2.81 per cent. The results might be underestimated due to insufficient modes of transport included. In addition, the database of the BRI projects comes from Reed and Trubetskoy, 2019, and their database only includes BRI projects until 2018, but there are additional infrastructure projects that have been taking place since 2018, that are not included in their database.

Therefore, we will be proposing a third scenario further investments (FI) of BRI with additional investments made in selected EU member states, by including projects constructed after 2018 in three EU countries. But for our first scenario BRI, we will only be considering trade and welfare effects pre and post-BRI for all countries. We show trade policy shock by computing values for parameter λ_{ij}, and we apply trade cost reductions for each country pair in our dataset and run both conditional and full general equilibrium analysis.

5.4.2 All 27 EU member states were to sign up to the BRI (EU)

As of March 2022, there are 18 [2] EU countries that have joined the BRI by signing a Memorandum of Understanding (MoU) with China across different years. However, it is worth mentioning that there are also many other strategic infrastructures in non-BRI EU member states, such as the port of Rotterdam in the Netherlands, the largest and busiest seaport in Europe. But there has not been an actual signing of a China-Netherlands MoU specifically related to the BRI. If this were the case, the Netherlands could play a bigger part with substantial trade and welfare effects (Times, 2019b).

Similarly, German business circles have shown growing enthusiasm towards the BRI despite the German government still debating this infrastructure-building initiative. A business-government MoU which was signed between Germany's Siemens and China's Belt and Road Construction Promotion Centre shows that business players from non-BRI countries are engaging with but not endorsing the BRI (Italy's, 2019 and Times, 2019a). With all these actions, they signal that member states have intentions to join the BRI, or are at least doing business/welcoming Chinese investments to certain degrees, it is therefore reasonable to make an assumption and propose a scenario (EU) in counterfactual analysis, in which the rest of the 10 EU member states sign MoUs with China [3].

Furthermore, trade policy shock parameters will be changed this time. In order to find a valid trade cost reduction percentage for this scenario, we compute the percentage trade cost reduction difference between Central Europe and the Baltics and the EU region from De Soyres et al., 2018 dataset as our λ_{ij} (see Table 5.1), and apply this only to EU country pairs. That is, our λ_{ij} will be computed as

$$\lambda_{ij} = 1 - ((upper/100) + ((upper/100) * 0.10582)) \text{ if } eu_o == 1 \mid eu_d == 1$$

where $upper$ is the upper bound trade cost reduction for all country pairs, 0.10582 is the computed percentage difference that aims to reflect if all EU member states were to sign up to the BRI.

5.4.3 Further investments made only in EU member states - Italy, Spain and Greece (FI)

In the third scenario (FI) we propose additional investments which will be coming into EU member states – Italy, Spain and Greece. As discussed in Chapter 4, the hard infrastructure – the completion of the construction of Pier

[2] Austria (2018), Bulgaria (2015), Croatia (2017), Cyprus (2018), Czech Republic (2015), Estonia (2017), Greece (2018), Hungary (2015), Italy (2019), Latvia (2016), Lithuania (2017), Luxembourg (2019), Malta (2018), Poland (2015), Portugal (2018), Romania (2015), Slovakia(2015), Slovenia (2017) (Based on author's research).

[3] As defined in earlier Chapter 1, we consider "Europe" as "EU-27 and the United Kingdom (UK)".

III – has brought a lot of economic growth and improved port services and container handling. For instance, if firms decide to take the Piraeus route for goods coming into the central European market, they can do so by docking at Pier II and III since Piraeus port capacity has expanded due to investments. In addition, the Piraeus port route also reduces shipping times by 7-11 days compared with using alternative European ports. The increased infrastructure and shortened shipping time have resulted in a reduction in trade costs for exporters.

In order for COSCO to acquire the remaining 16 per cent of PPA shares, an additional mandatory investment of a EUR 610 million master plan has been submitted for approval, and most of it has been approved. Along with the master plan, the committee is still in discussion over COSCO's new application – an expansion of a new fourth pier (pier IV) at the container terminal, proposed to build to the east of Pier I. The expansion is expected to increase port traffic by 1.8 per cent compared to 2019, as well as having an annual capacity of 2.8 million TEUs. The 2.8 million TEUs, added to the existing port handling capacity, make the overall port capacity reach 10 million TEUs per year. Therefore, if the Greek government approved the construction of this new pier IV, despite environmental concerns, the potential trade volume increase will be substantial, meaning that Piraeus port can now handle more vessels and container ships, and port transhipment volumes will also increase. A container port's performance is a critical factor in determining transport costs and trade competitiveness. Thus, we assume a trade cost reduction of 10 per cent with the proposed construction of Pier IV at the container terminal.

In addition, COSCO has also made changes to the soft infrastructure in the port area to improve port efficiency, such as digitalisation of the port. Prior to PPA's proposal, no parties had come up with any online platform to modernise the port logistic system. Against this backdrop, PPA had the idea of creating a digital platform to increase its technology efficiency and innovation. The digital system is called the Hellenic Port Community System (HPCS) and has been developed in collaboration with Eurobank and the Hellenic Customs Administration. The system is from INFORM Vehicle logistics, where customers, suppliers, 3PL and customs authorities will be able to track the real-time location and status of a car, for example for the car terminal (INFORM, 2020). What's more, the algorithms of HPCS provide optimising operational processes through advanced planning of the container ports and spaces. Automated work order generation while optimising them in real time helps PPA to increase its port capacity and its services much more efficiently. Despite much opposition to this potential data sharing across the entire port, the digital transformation of Piraeus is expected to reduce customs processing time by cutting the number of documents required for various port activities. In particular, the HPCS and its digital services are said to reduce processing time for container handling from 6 hours to just 20 minutes (ekathimerini, 2020). This, in turn, will ultimately translate into trade cost reductions.

Beyond Piraeus port, COSCO also has interests in other European ports, such as Italy and Spain. The new Vado Gateway terminal, situated in Vado Ligure, Italy, is the first-ever semi-automated terminal in Italy, which is jointly owned by APM terminals (50.1 per cent), COSCO Shipping Ports (40 per cent) and Qingdao Port International Development (9.9 per cent). The initial stage of the terminal started operation in December 2019, according to News, 2020. With a total of EUR 450 million, the new terminal is equipped with a fully-automated gate and stacking yard, which will significantly increase port efficiency and competitiveness. Further investments will be made as the second stage of the terminal is now under construction and was expected to be completed in the first half of 2021 (Strategy, 2021). What's more, not only will there be additional investments made to increase physical port facilities, but a new shuttle service between the container terminal at the Port of Vado Ligure, Italy, and the COSCO-owned Port of Piraeus will also be launched subsequently, connecting the Far and Middle East, India, Oceania and the Eastern Mediterranean to Southern Europe. What's key about this new route connection is the "transit-time speed", so that trans-shipment goods will be able to travel through the route and, along with the railway connections at both port terminals, arrive in central and northern Europe (Technology, 2020).

Not only that, COSCO has also committed to investing in its operation terminals in Spain, as well as a rail freight line. More than EUR 62 million will be invested in Valencia port, Spain until 2022 in order to increase the capacity of the port of Valencia by 30 per cent to 5 million TEUs (Europe, 2020). Additionally, COSCO has also improved rail connectivity between Spanish terminals by opening a new rail freight line, not only to increase its logistical development but also to create better connectivity for Trans-European networks (Papatolios, 2021). Both terminal and rail development significantly reduces transit time for trans-shipment goods and also translates to a reduction in trade costs for exporters.

Overall, the identified additional investments which COSCO is expected to pour into countries Greece, Italy and Spain, lead to our third and final scenario, further investment (FI), where we propose further investments made by COSCO in these three EU countries and consider the trade and welfare effects. For comparison purposes, we employ the same percentage for trade cost parameter 10.582 per cent that is used for EU scenario as the trade cost reduction for FI scenario, but this time, we apply the trade policy shock only for Italy, Spain and Greece, and their trading partners. Our λ_{ij} will be computed as

λ_{ij} = 1 - (($upper/100$) + (($upper/100$) * 0.10582)) if $grc_o == 1 \mid grc_d == 1 \mid ita_o == 1 \mid ita_d == 1 \mid esp_o == 1 \mid esp_d == 1$

where *upper* is the upper bound trade cost reduction for all country pairs, 0.10582 is the computed percentage difference that aims to reflect if further investments were made only in Greece.

The scenarios for counterfactual analysis are summarised in Table 5.3.

TABLE 5.3: Counterfactual scenarios

Scenario	Description
BRI	Trade cost reduction (%) due to BRI transport projects
EU	All 28 EU member states signing up to the BRI
FI	Further investments made in Italy, Spain and Greece

5.5 Empirical results

5.5.1 Estimating trade elasticities

Trade policies take time to adjust and implement, it is, therefore, crucial to take into account these adjustments in regression, for this reason, we create three sets of data to estimate trade elasticities: 2018 sample, 1960-2019 sample, and 1960-2019 with five-year intervals sample. Dropping five-year intervals worth of data is not ideal in obtaining full effects compared to using a full data sample to run regression, in addition to 1960-2019 with five-year intervals panel data sample, we also run regression using full sample data of 1960-2019.

Tables 5.4 and 5.5 present estimations of export elasticities with respect to trade policy variables. We employ PPML and fixed effect methods, both of which are common in the trade literature (Head and Mayer, 2014). The PPML method has been used throughout the trade literature. Because the PPML estimator is expressed in a multiplicative form, it accounts for heteroscedasticity (Silva and Tenreyro, 2006). The estimator also solves issues of zero trade flows. The inclusion of fixed effects (exporter-time and importer-time fixed effects) in a gravity model is to capture both market-size effects and multilateral-resistance indexes.

There are 12 models that are divided into two categories. The first category is shown in Table 5.4 and consists of models (1)-(6), in which we estimate them without intra-national trade. Models (7)-(12), shown in Table 5.5, fall into the second category, in which we estimate models with intra-national trade. It was suggested by Heid, Larch, and Yotov, 2017 as one of the solutions in the gravity model literature to be able to estimate the impact of non-discriminatory trade policy in a gravity model setting. Traditional solutions, such as calculating the remoteness indexes and employing a two-stage estimation, often create biased gravity estimates, therefore the effects

TABLE 5.4: Estimation of trade elasticities (1-6)

	(1)	(2)	(3)	(4)	(5)	(6)
Method	**PPML**	**PPML**	**PPML**	**FE**	**PPML**	**FE**
			No internal trade			
Dependent variable	Exp_{ij}	Exp_{ij}	Exp_{ij}	$LnExp_{ij}$	Exp_{ij}	$LnExp_{ij}$
FTA	0.598**	0.485**	0.091**	0.484**	0.08**	0.471**
	(0.081)	(0.032)	(0.014)	(0.033)	(0.007)	(0.014)
$LnDist_{ij}$	-0.715**	-0.771**				
	(0.039)	(0.016)				
Colonial past	0.235**	0.122**				
	(0.093)	(0.043)				
Common language	0.094	0.214**				
	(0.074)	(0.031)				
Common religion	0.168	0.057				
	(0.093)	(0.043)				
Common legal	-0.035	0.0002				
	(0.097)	(0.054)				
Common border	0.45**	0.488**				
	(0.072)	(0.033)				
Fixed effects:						
Exporter-year	Yes	Yes	Yes	Yes	Yes	Yes
Importer-year	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair	No	No	Yes	Yes	Yes	Yes
Sample	2018	1960-2019	1960-2019	1960-2019	1960-2019	1960-2019
Observations	28,139	195,852	177,146	122648	960,711	639,668

** Significant at 1 % level. * Significant at 5% level.

Notes: Estimation sample is DOTS IMF, for 199 countries. Time frame is 2018 for models (1), 1960-2019 with 5-year intervals (4-year interval for the last time period) for models (2)-(4).

In all regressions, the standard errors presented in brackets are clustered at country-pair level.

of trade policy could also be changed (Anderson and Van Wincoop, 2003). The inclusion of intra-national trade means that non-discriminatory variables can be identified and estimated. Another advantage of adding intra-national trade is that the estimates of non-discriminatory trade policies in the structural gravity model are less likely to suffer from endogeneity issues. In addition, it is also crucial to acknowledge that smaller trading economies with lower percentages of export volumes in their trade data, including domestic trade numbers can better capture trade impacts due to policy shock.

Time selection for these 12 models is also different. Models (1) and (7) use the sample of 199 countries in 2018 with no country-pair fixed effects. We have chosen the 2018 data sample rather than 2019 because the former consists of much more complete and detailed trade data that could potentially result in better estimates than the latter. Models (2)-(4) and (8)-(10) use panel data from 1960-2019 with five-year intervals (four-year intervals for the last period of time) to account for trade policy adjustment. Lastly, a full

TABLE 5.5: Estimation of trade elasticities (7-12)

	(7)	(8)	(9)	(10)	(11)	(12)
Method	**PPML**	**PPML**	**PPML**	**FE**	**PPML**	**FE**
			Internal trade included			
Dependent variable	Exp_{ij}	Exp_{ij}	Exp_{ij}	$LnExp_{ij}$	Exp_{ij}	$LnExp_{ij}$
FTA	0.595**	0.486**	0.085**	0.446**	0.073**	0.437**
	(0.081)	(0.033)	(0.014)	(0.033)	(0.007)	(0.014)
$LnDist_{ij}$	-0.715**	-0.769**				
	(0.039)	(0.016)				
Colonial past	0.232*	0.12**				
	(0.094)	(0.043)				
Common language	0.094	0.213**				
	(0.074)	(0.031)				
Common religion	0.17	0.063				
	(0.094)	(0.043)				
Common legal	-0.031	0.00004				
	(0.097)	(0.054)				
Common border	0.452**	0.49**				
	(0.071)	(0.033)				
Fixed effects:						
Exporter-year	Yes	Yes	Yes	Yes	Yes	Yes
Importer-year	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair	No	No	Yes	Yes	Yes	Yes
Sample	2018	1960-2019	1960-2019	1960-2019	1960-2019	1960-2019
Observations	26,696	183,490	165,353	117,630	896,588	613,975

** Significant at 1 % level. * Significant at 5% level.

Notes: Estimation sample is DOTS IMF, for 199 countries. Time frame is 2018 for models (7),
1960-2019 with 5-year intervals (4-year interval for the last time period) for models (8)-(10).
In all regressions, the standard errors presented in brackets are clustered at country-pair level.

panel data sample in the same time period, 1960-2019 without intervals, is used for models (5)-(6) and (11)-(12). In all regressions, the standard errors are clustered at the country-pair level. In addition, besides exporter-time and importer-time fixed effects, we also include country-pair fixed effects for models (3)-(6) and (9)-(12). The inclusion of country-pair fixed effects is to capture the unobserved bilateral factors (Parsons, 2012).

We use Stata **ppmlhdfe** command for models where they employ PPML as their methods, and **reghdfe** command for models in which fixed effects (FE) are used. It requires the installation of the latest version of *reghdfe* and *ppmlhdfe* in Stata software to run regression. Exp_{ij} denotes the dependent variable used along with a full set of bilateral, exporter-time, importer-time or country-pair fixed effects. Fast Poisson Estimation with High Dimensional Fixed Effects (PPMLHDFE) is a Poisson Pseudo Likelihood regression with multiple levels of fixed effects (Correia, Guimarães, and Zylkin, 2019a). *ppmlhdfe* has the same flexibility as *reghdfe* allowing for multiple fixed effects and interactions, but the former has a number of advantages. First, the estimator employed is robust to statistical separation and convergence issues (Correia, Guimarães, and Zylkin, 2019b). It also includes several algorithmic shortcuts which it can be used to deal with very large datasets. Furthermore, ordinary least square (OLS) regression outcome variables in the form of the natural log of the dependent variable (e.g. *ln(exports)*) are likely to create inconsistent estimates when there is heteroscedasticity, whereas *ppmlhdfe* moderate zero trade flow issues and *ppmlhdfe* use dependent variable (e.g. exports) instead of the natural log of the dependent variable as zero values can now be included in the regression.

Our trade elasticities result using goods data are consistent with the panel data econometrics literature. Table 5.6 presents a list of average estimates obtained from 159 papers of typical gravity variables compiled by Head and Mayer, 2014. We would expect to see a negative sign for distance variable and a positive relation between trade flows and the rest of the independent variables X. Our estimates, as expected, are in line with previous research: we find that FTA, colonial past, common language, common religion, common legal system and common border (contiguity) are all positively correlated with trade. That is, a 1 per cent increase in control variables leads to an increase in goods trade, and this positive effect is statistically significant at one per cent significance level. Estimates for distance, however, as expected, are negatively associated with trade at one per cent significance level, meaning that a 1 per cent increase in distance between the trading country pair leads to a reduction in goods trade of 0.7 per cent. And this coefficient is consistent with the mean of typical gravity variables of 159 papers, which is from -0.93 to -1.1 per cent. The relatively strong negative correlation between trade and distance, as trading partners further away from each other tend to trade less, is also in line with the basic intuition of the gravity model as explained in Chapter 2.

TABLE 5.6: Estimates of typical gravity variables

Estimates	**All Gravity**	**Structural Gravity**
	Mean	Mean
Distance	-0.93	-1.1
Contiguity	0.53	0.66
Common language	0.54	0.39
Colonial link	0.92	0.75
RTA/FTA	0.59	0.36

Notes: The number of estimates is 2508, obtained from 159 papers (Head and Mayer, 2014).

5.5.2 Trade and welfare effects

In this section, we consider all three scenarios which have been proposed earlier in this chapter. BRI scenario (Table 5.7 Panel A) reduces transport costs between China and BRI countries based on De Soyres et al., 2019 estimates due to infrastructure projects that are taking place in BRI economies and BRI economic corridors - railroads, logistic networks and shipping routes. EU scenario (Table 5.7 Panel B) considers the effects of all EU member states signing up to the BRI. Finally, FI scenario (Table 5.7 Panel C) considers further planned investments that will be made in selected EU member states. Table 5.7 reports the general equilibrium (GE) gravity analysis with *ppmlhdfe* (Zylkin et al., 2019 and Larch et al., 2019) results. It presents both trade and welfare effects relative to the status quo in 2018 across different regions. We employ $\sigma = 5.13$ to compute welfare gains, which is consistent in the structural gravity models (Head and Mayer, 2014).

BRI scenario

Firstly, the "conditional general equilibrium" (CGE) effects on trade are relatively small for all scenarios, but CGE effects on trade further increased in the "full general equilibrium" (FGE) setting, in which the effects vary between 0.27 and 3.43 per cent as compared to CGE effects on trade. The results of the BRI scenario on trade effects suggest a strong positive correlation between hard infrastructure and country size, as measured by the value of output. More specifically, this positive relationship is illustrated by South Asia - the biggest trade recipient region with a 3.43 per cent increase in trade volume given all else equal. This finding is revealed by the fact that as of January 2021, most of the BRI infrastructure projects do take place largely in Asia, Europe and Africa, as these regions are the locations for most BRI transport projects.

Table 5.8 below lists the number of BRI countries by region based on IIGF - Green Belt and Road Initiative Centre (IIGF, 2021). It is no surprise to see that the Sub-Saharan Africa region has 40 BRI participants, the highest number of countries joining the BRI; followed by Europe & Central Asia with 34 BRI economies; and Latin America Caribbean region and East Asia Pacific region with 19 and 17 BRI economies, respectively.

While Southeast Asia only has six countries that sign up to the BRI according to IIGF, 2021, but Center, 2022 counts them differently and Center, 2022 reports that there are 11 key BRI economies in the Southeast Asia region. Despite the number difference, the Southeast Asia region remains the biggest trade and welfare gain recipient for all three scenarios. This is partly due to economic cooperation between China and Southeast Asia (Association of Southeast Asian Nations (ASEAN)), which started long before the BRI. ASEAN is a list of 11 neighbouring countries that aims to promote regional integration. With all 11 ASEAN members [4] as members of BRI, as categorised by Center, 2022, it is no surprise that they receive some of the

[4]Brunei, Burma (Myanmar), Cambodia, Timor-Leste, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam.

TABLE 5.7: Trade and welfare effects of BRI, EU, and FI by region, %

A. BRI: Mean trade and welfare effects by region, %

	Trade effects		Welfare effects
Region	**CGE**	**Full GE**	**Full GE**
China	0.76	1.58	2.07
Central Europe & the Baltics	0.04	0.38	1.14
East Asia Pacific	0.27	2.17	4.36
Europe & Central Asia	0.03	1.38	3.32
European Union	0.04	0.27	0.84
Latin America & Caribbean	0.01	0.39	0.95
Middle East & North Africa	0.13	2.56	5.41
North America	0.36	0.63	1.14
South Asia	-0.08	3.43	7.94
Sub-Saharan Africa	0.02	1.67	3.80
All	0.07	1.59	3.56

B. EU: Mean trade and welfare effects by region, %

	Trade effects		Welfare effects
Region	**CGE**	**Full GE**	**Full GE**
China	0.76	1.58	2.09
Central Europe & the Baltics	0.05	0.45	1.36
East Asia Pacific	0.27	2.19	4.43
Europe & Central Asia	0.04	1.44	3.48
European Union	0.05	0.32	1.00
Latin America & Caribbean	0.01	0.41	1.00
Middle East & North Africa	0.14	2.65	5.61
North America	0.35	0.61	1.13
South Asia	-0.08	3.49	8.09
Sub-Saharan Africa	0.02	1.70	3.90
All	0.07	1.63	3.68

C. FI: Mean trade and welfare effects by region, %

	Trade effects		Welfare effects
Region	**CGE**	**Full GE**	**Full GE**
China	0.76	1.59	2.08
Central Europe & the Baltics	0.04	0.38	1.14
East Asia Pacific	0.27	2.18	4.37
Europe & Central Asia	0.03	1.39	3.34
European Union	0.04	0.27	0.85
Latin America & Caribbean	0.01	0.40	0.96
Middle East & North Africa	0.13	2.57	5.43
North America	0.36	0.63	1.14
South Asia	-0.08	3.44	7.96
Sub-Saharan Africa	0.02	1.67	3.82
All	0.07	1.60	3.58

Notes: This table presents trade and welfare gains computed for conditional and full general equilibrium. We take transport cost reduction between China and EU, China and BRI countries from De Soyres et al., 2018. Elasticity of substitution is 5.13.

biggest trade and welfare gains based on our results.

TABLE 5.8: BRI countries by region (IIGF, 2021)

Region	BRI countries
Europe & Central Asia	34
East Asia pacific	24
Middle East & North Africa	17
Latin America & Caribbean	19
South East Asia	6
Sub-Saharan Africa	40

In addition, with relatively shorter distances to China compared to EU countries, ASEAN holds the comparative advantage of a much shorter supply chain and lower labour costs. This is then further added with improved transport infrastructure and logistic networks in the region, which therefore doubles the welfare effect to 7.94 per cent for consumers in the region. Welfare effects are represented by the changes in real GDP associated with the transport cost reductions and decompose these changes into effects on the consumers (via the inward multilateral resistances defined as -1 × $P_{j,t}$) and on the producers (via the factory-gate prices) for each of the countries in our data. Another crucial factor which can also explain our results is the China-ASEAN FTA protocol, which took full effect in October 2019. With more than 90 per cent of goods between China and ASEAN now subject to zero tariffs, an increase in infrastructure investment via the BRI channel further reduces trade barriers between China and ASEAN nations, benefiting both sides' consumers.

Table 5.9 reports the top 12 recipients of trade and welfare by country and region for the BRI scenario. Our results suggest that across all three scenarios, countries in Central Asia, Eastern Europe and East Africa experience and receive the largest trade and welfare gains. When trade costs between China and all other BRI economies are reduced between 20-25 per cent, there are estimated increases in trade of 9 per cent to 14.3 per cent for Kyrgyzstan, Nepal, Rwanda and Mongolia. In addition, countries in Central Asia see trade creation due to infrastructure improvement. This can be explained by the existing trade route between China and neighbouring countries being high-cost due to a lack of proper infrastructure including railways, roads and ports. The much-needed BRI infrastructure projects funded by AIIB and other financial institutions help bring down trade costs as well as improve trade networks and thereby increase trade volumes (exports in particular).

Furthermore, almost all countries in Table 5.9 pass through at least one BRI economic corridor that was explained earlier in Chapter 3 – China-Mongolia-Russia, The New Eurasia Land Bridge Economic Corridor, China-Central Asia-West Asia Economic Corridor, and China-Indochina Peninsula Economic Corridor, in which most infrastructure projects take place. Not only can neighbouring countries of China benefit from better logistics within the supply chain network, but landlocked countries in East Africa also benefit from

TABLE 5.9: Top recipients of trade and welfare by countries, BRI scenario, %

Country	Region	Trade	Welfare
Kyrgyzstan	Central Asia	14.37	35.12
Nepal	South Asia	10.37	22.61
Rwanda	East Africa	9.36	21.25
Mongolia	East Asia	9.00	20.62
Kazakhstan	Central Asia	7.52	17.04
Laos	Asia	7.27	15.72
Tajikistan	Central Asia	7.00	15.51
Bahrain	Middle East	6.22	12.83
Uganda	East Africa	5.47	12.20
Ethiopia	East Africa	5.40	11.78
Armenia	Asia	5.28	10.96
Kuwait	Middle East	5.30	10.48

the Maritime Silk Road route which passes through Kenya. Landlocked countries including Rwanda, Ethiopia and Uganda benefit considerably due to transport cost reductions in the region. We encounter similar findings from Herrero and Xu, 2017 where the EU, especially landlocked countries, benefit in particular compared to other regions.

A similar notion applies to Middle East & North Africa (MENA) and East Asia Pacific - the second and third largest trade and welfare recipients, with each receiving 2.56 per cent and 2.17 per cent trade increases and 5.41 per cent and 4.36 per cent welfare gains. While helping MENA nations meet their infrastructure and development needs, as well as offering many new opportunities for regional businesses and investors, many MENA countries have shown enthusiasm towards the BRI. This can be seen in the significant number of Chinese investments poured into railroads, ports, power plants and energy sectors. MENA is a crucial trade route for China, with the Gulf, in particular, serving as a major crossroad, and its oil and Liquefied Natural Gas (LNG) continue to be essential for meeting China's huge energy needs. Chinese involvement in MENA projects includes port and railway developments, oil and gas, Artificial Intelligence (AI), 5G network and space technology in Algeria, Bahrain, Egypt, Iran, Iraq, Morocco, Qatar and Saudi Arabia.

Moreover, our results show that not only do reductions in transport costs due to BRI have a positive impact on trade volume and consumer welfare, but also for non-BRI country pairs which are not expected to experience any BRI-related trade cost reductions. In other words, there is a trade and welfare gain which is spilled far beyond BRI participants to other countries. It implies that all else equal, with a certain percentage of trade cost reductions for BRI country-pairs, BRI projects increase trade and welfare for non-BRI member countries by 0.63 per cent and 1.14 per cent, [5] respectively. The transport cost reductions and cross-border infrastructure improvement will affect trade flow to trading nations differently. This implies that a country that is not part of the BRI network may benefit from being able to access a shorter and cheaper route (from air to rail) to the final destination market; it could also be the case that countries experience better port operations and more efficient customs clearing processes. Subsequently, trade and welfare gains are realised from improvements in infrastructure in BRI countries.

Equally important, China and EU countries both receive trade and welfare gains under all three scenarios, while China receives significantly higher gains than EU countries. This can be explained by the simple fact that China is exporting more than the EU's exports to China (Jackson and Shepotylo, 2021). More specifically, our trade and welfare results for China and the EU both fall under 20-25 per cent trade cost reductions proposed by Jackson and Shepotylo, 2021, indicating that with a 20-25 per cent trade cost reduction between China and the EU, there is 1.58 per cent and 0.27 per cent increase in trade volumes, and 2.07 per cent and 0.84 per cent increase in consumer welfare in China and the EU, respectively.

Correspondingly, while all countries see their export volume to China increase, the EU also experiences trade and welfare increases. Some EU countries benefit from BRI projects significantly while others lose out. For all three scenarios, Sweden, Bulgaria, Latvia, Cyprus and Lithuania are the top 5 biggest trade and welfare recipients out of the 27 EU member states, as shown in Table 5.10. Bulgaria receives the highest welfare effect of 1.86 per cent and this can be explained by a number of factors. Bulgaria holds a strategic location as it sits between the Balkan countries and Turkey. It is also a member of the "16+1" Cooperation, therefore making it an ideal investing location for Chinese and Asian investors. There has been a boost of investment from Chinese private and state-owned investors to Bulgarian energy sectors, infrastructure development in railway and port sectors, 5G network building as well as the signing of financing agreements between the two nations' financial institutions to fund BRI projects in Bulgaria.

Moreover, as Bulgaria is one of the key countries in the New Eurasia Land Bridge Economic Corridor – the railway development between China and Europe through Kazakhstan and Russia (Chen and Yang, 2019) – transport cost reductions will therefore have a positive and significant impact on Bulgaria both in terms of trade and welfare. In the same way, Cyprus connects the Indian Ocean and the Mediterranean Sea through the Gulf of Suez for China's energy projects in the Middle East as well as in Eastern Europe. Therefore, Cyprus's geographical location, EU membership, and importance as a trans-shipment hub are seen as the next stop of the BRI (Mordechai Chaziza, 2021) and explain why the island receives trade and welfare gains.

[5] Here the results are taken from North America region as an example.

TABLE 5.10: Trade and welfare effects by EU countries, BRI scenario, %

Trade effect	%	Welfare effect	%
Sweden	0.65	Bulgaria	1.86
Bulgaria	0.61	Latvia	1.69
Latvia	0.58	Sweden	1.63
Cyprus	0.55	Lithuania	1.58
Lithuania	0.55	Cyprus	1.42

Moreover, as Bulgaria is one of the key countries in the New Eurasia Land Bridge Economic Corridor – the railway development between China and Europe through Kazakhstan and Russia (Chen and Yang, 2019) – transport cost reductions will therefore have a positive and significant impact on Bulgaria both in terms of trade and welfare. In the same way, Cyprus connects the Indian Ocean and the Mediterranean Sea through the Gulf of Suez for China's energy projects in the Middle East as well as in Eastern Europe. Therefore, Cyprus's geographical location, EU membership, and importance as a trans-shipment hub are seen as the next stop of the BRI (Mordechai Chaziza, 2021) and explain why the island receives trade and welfare gains.

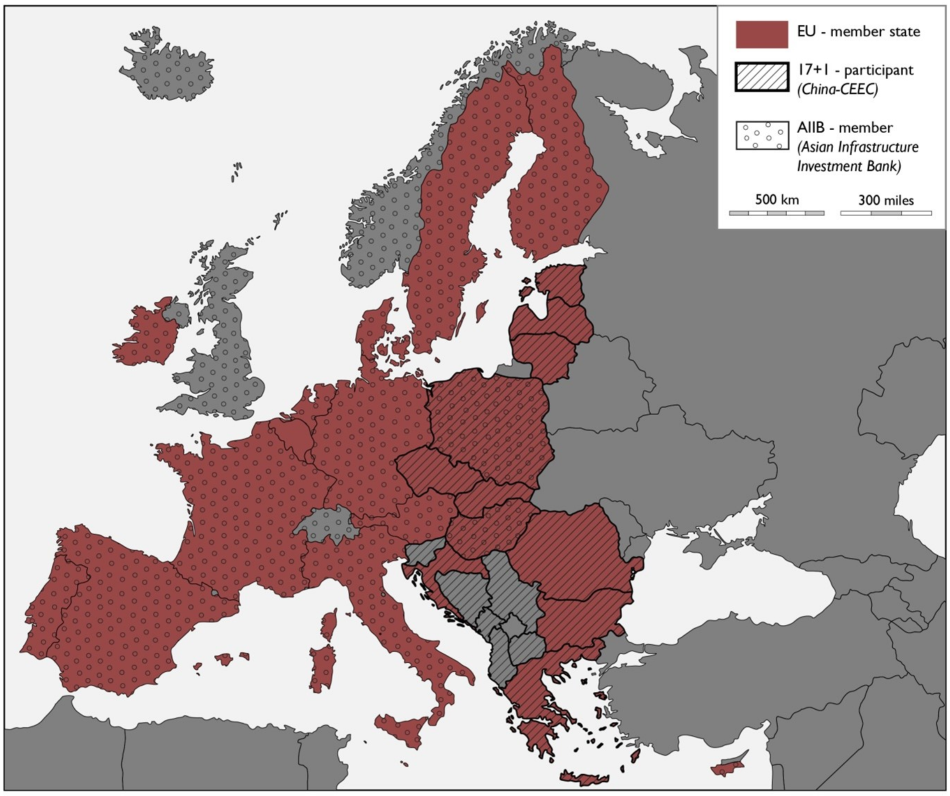
Similarly, Sweden and its neighbouring countries - Latvia and Lithuania - also receive positive trade and welfare gains. This finding continues to hold for scenario EU and FI with higher percentages of trade and welfare gains for each member state. Even though the effects for EU countries are not as high as for those countries in Central Asia or countries that share borders with China, they still account for a large impact since all BRI routes end in Europe. Latvia signed an MoU in November 2016 with China, the first country in the Baltic Sea area to welcome BRI. For Latvia, transport cost reductions from infrastructure improvement in BRI countries lead to a 1.69 per cent increase in consumer welfare. This is explained by a high percentage of intra-EU trade between Latvia and Lithuania and other nearby countries of 67 per cent for exports and 75 per cent for imports (Xinhua Silk Road, 2020).

Both Latvia and Lithuania (despite its recent dropout of China's "17+1" bloc in Eastern Europe in May 2021 and worsened Sino-Lithuanian relations) trade with each other as neighbouring countries, as well as both seeing an increase in exports volumes from, for example, Poland, due to freight railway construction built under BRI projects. Sweden, however, despite being a founding member of the AIIB, does not engage in infrastructure projects nor MoUs signing. Unlike the German business sector's enthusiasm towards new opportunities in BRI projects, Swedish trade and business sectors are rather calm in response to the BRI. Our results suggest that infrastructure improvement in BRI countries leads to an increase in trade of 0.65 per cent and welfare of 1.63 per cent in the Swedish economy. This would then imply that the public and private sector's coordination would only benefit the Swedish economy as a whole rather than the other way around.

EU scenario

Secondly, assuming all EU countries sign up to the BRI, it would lead to a 2.09 per cent welfare increase for China and a 1 per cent welfare improvement for the EU. More specifically, all EU countries expect to see an increase in their trade as well as welfare compared to the BRI scenario. In addition, significant trade and welfare gains for the Balkan countries should not be surprising given that 8 [6] out of the 17 Central and Eastern European (CEE) countries are the "17+1" (the 17 CEE countries and China) member states, which receive higher welfare gains under our EU scenario. Figure 5.1 illustrates the institutional frameworks and membership of the Eurasia region. It is worth noting that for top trade and welfare recipients like Sweden, despite the country not having a BRI membership, the fact that the country is a founding member of AIIB from a financial perspective also explains the additional improvements in trade and welfare, that is, the active role Sweden has played in deciding with respect to financing BRI projects in addition to our assumption of Sweden's BRI membership attainment.

FIGURE 5.1: Institutional Frameworks and Membership in international cooperation. March 2020. Sielker and Kaufmann, 2020

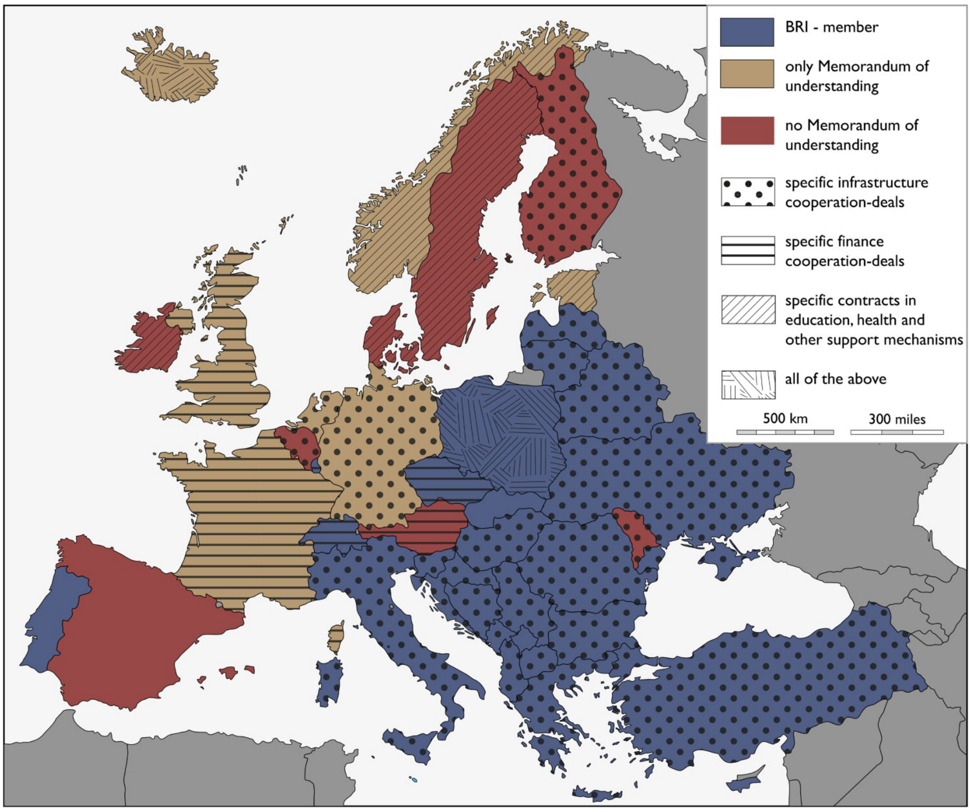


It is also the case for Central and Eastern European Countries (CEEC), namely Bulgaria, Latvia and Lithuania. Figure 5.2 shows the contractual

[6]Bulgaria, Croatia, Estonia, Greece, Hungary, Poland and Slovenia.

arrangements and other informal/formal arrangements that the EU countries have with China ((Sielker and Kaufmann, 2020)). We can see that, apart from Sweden and Denmark, most of CEEC and the Balkan countries hold BRI memberships (blue colour) and most of them have specific infrastructure cooperation deals in place already (black dots). This explains why the Balkan countries also experience higher trade increases and welfare improvements. Similarly, if we explore our findings from the trade routes perspective shown in Figure 5.3, countries including Latvia, Lithuania and Estonia have strategic corridors already built or in construction (dotted lines). For Bulgaria, there is a strategic corridor planned and investment assured. This also tells us that with the maritime routes and strategic corridors that are either already built or planned, we can conclude that these infrastructure projects will bring down trade costs and ultimately increase welfare for consumers in host countries.

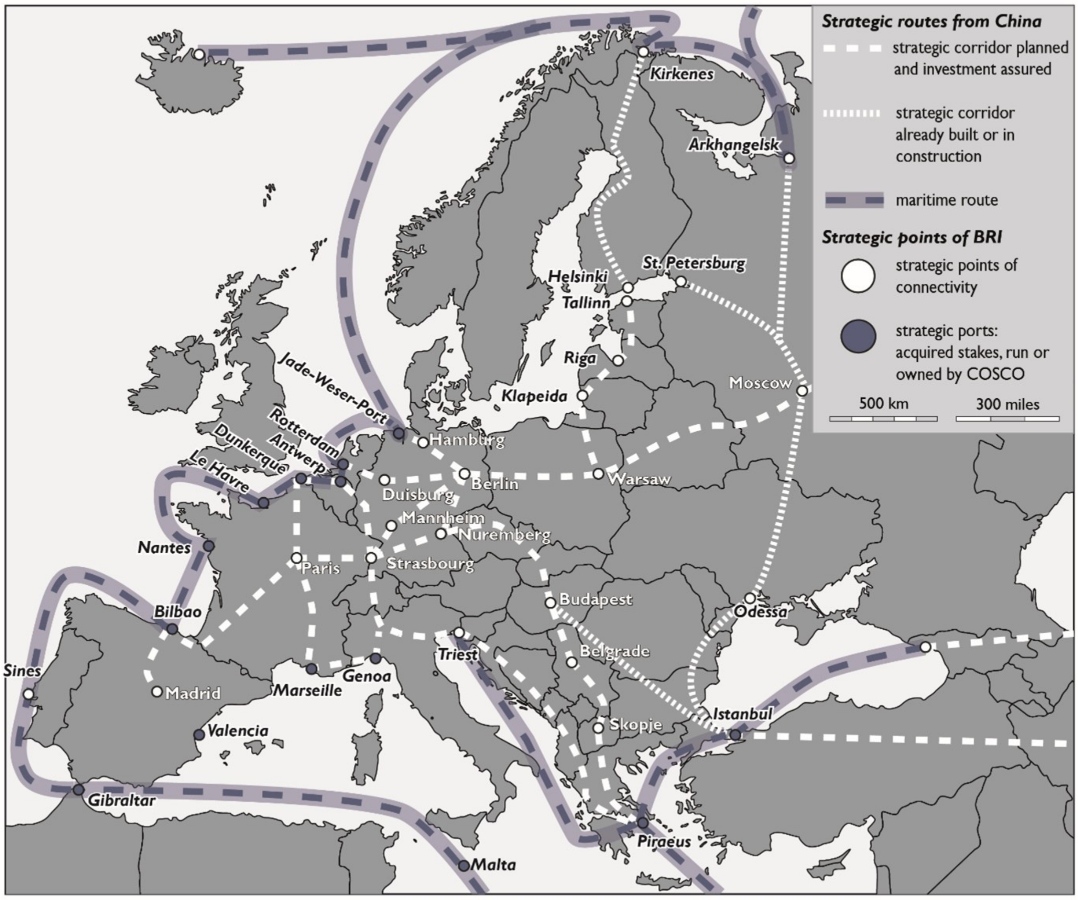
FIGURE 5.2: Contractual arrangements and other informal or formal agreements, March 2020. Sielker and Kaufmann, 2020



FI scenario

Thirdly, additional investments made in Italy, Spain and Greece would generate welfare of 2.08 per cent for China and 0.85 per cent for the EU. Unlike the EU scenario, where we apply trade cost reduction changes to all 27 EU member states and its trading partners as trade policy shock, here in the FI scenario, we only apply changes to three identified EU member states in

FIGURE 5.3: Entry points and roads to Europe from China. March 2020. Sielker and Kaufmann, 2020



which they are expected to receive additional investments towards BRI infrastructure projects. As a result, understandably the trade and welfare effects are not as significant as in the EU scenario. In fact, both trade and welfare effects under the FI scenario are smaller than estimates found in the EU scenario if both are compared with the BRI scenario as the benchmark. Despite the overall small impact compared to the EU scenario, trade and welfare effects for Italy, Spain and Greece increase substantially. For Spain, welfare effects increase from 0.01 per cent to 0.12 per cent, similarly, Greece would experience a rise in export volumes from 0.25 per cent to 0.35 per cent. Those additional investments identified will not only benefit freight services but also improve labour supply and technical advancement.

5.6 Conclusion

This chapter examines the trade and welfare effects of the Belt and Road Initiative for both non-BRI and BRI countries. The analysis employs a structural gravity model with general equilibrium analysis to quantify the impacts of BRI infrastructure projects on trade volumes and welfare improvements.

Several key findings stand out. BRI infrastructure project-related trade cost reductions can substantially increase trade and welfare for countries with and without BRI membership. While most countries benefit from BRI, only a small number of economies experience a trade diversion effect.

In addition, China receives 1.58 and 2.07 per cent increase in trade and welfare respectively. The EU also experiences trade volume increase and welfare improvement of 0.27 and 0.84 per cent. More importantly, our results suggest that the EU, especially the Balkan states, experience a higher trade increase as well as welfare improvement. Similarly, we also see a ripple effect across the single market with member states Italy, Spain and Greece receiving further investments. Having the EU signed up to the BRI would generate the region with a 1 per cent welfare increase, and additional investments made in selected EU countries would mean an average of a 0.85 per cent welfare increase for the EU. Our results in this chapter do not include data from Belgium, Romania and Luxembourg due to data dropout in a simulation exercise.

Despite the BRI being introduced a decade ago, and already seeing many infrastructure projects in various key strategic sectors taking place, the future for the BRI in Europe, or even in other regions, is not without its challenges. First, many Western countries group have come up with a number of BRI-alternative policies, which specifically counter China's BRI projects. These policies aim to target and challenge BRI-related issues such as a lack of transparency, and potential debt trap for low-income countries. For instance, Europe's "Global Gateway", which is the EU's version to tackle China's BRI, although it is still in its initial phase, and we do not know much of its detail, once it is implemented we do not know what impact it will have on the existing and upcoming BRI projects in Europe.

Furthermore, the EU-wide FDI screening mechanism adds further obstacles to those planned BRI infrastructure projects in EU member states as well as future incoming Chinese investment. This indeed complicates the fate of those projects in Europe. Secondly, the very recent Build Back Better World (B3W), introduced by G7 countries, is another alternative to the BRI (Hunnicutt, 2021). We might see greater welfare and trade gains for BRI member countries if these new initiatives materialise, but for now, they still remain in their very first stages and are yet far from happening.

Another issue which was mentioned by Sacks, 2021 was whether countries that are both in the Global Gateway and the B3W will have the resources to put into both initiatives, or whether they will just focus their resources on one initiative if they aim to provide a "meaningful" alternative to the BRI. "Unless B3W and Global Gateway coordinate their approaches, neither will meet its full potential" (Sacks, 2021). Last but not least, what we do know is the substantial economic opportunities within the BRI - from a trade perspective for many countries and consumers, especially for the EU. Our results for

25 EU countries should be very motivating and encouraging for the EU as it gives an insight as to where trade creation and diversion are headed.

Chapter 6

Mapping China's investment in Europe: a sectoral level analysis

6.1 Introduction

Europe has always been one of the favourite destinations for Chinese investment – from the flagship port project in Piraeus, Greece, to solar projects in Spain. There are many more projects across different sectors in Europe and many of them are within the framework of the Belt and Road Initiative (BRI), an infrastructure development policy aiming at reducing transport costs and facilitating cross-border trade through Chinese state-owned enterprises. The rise and resilience of Chinese investment flows are causing both enthusiasm and anxiety in Europe, yet there is too little debate on what these deep interests in the region mean in real terms: do European industries expect trade gains from Chinese investment under the umbrella of the BRI?

Empirical studies (Europe: Herrero and Xu, 2017; a series of work by the World Bank: De Soyres et al., 2019; De Soyres, Mulabdic, and Ruta, 2020; Baniya, Rocha, and Ruta, 2020; and also work by Jackson and Shepotylo, 2021) have shown positive effects of BRI transport projects at the country level while ignoring sectoral level differences for each country and therefore the impacts that they might receive from the projects. Moreover, the literature is even more limited when it comes to consideration of the potential trade effects of greater transport cost reductions from new infrastructure projects beyond those already planned, and any trade diverting effects from further investments targeted at selected countries.

Our paper is the first few studies to model trade effects of the BRI at the sectoral level with BRI-related simulations. Previous studies include De Soyres et al., 2019 collect and calculate BRI advalorem trade cost reductions at sectoral level that is translated from shipping times decrease resulting from the BRI, but they fail to examine the sectoral level impact of BRI infrastructure projects. Properly adjusting sectoral level differences in empirical analysis is necessary and needed, as often sector weightings are distinct from one economy to another. To do this, we create a two-phase method with the objective of both validating the approach and computing sectoral-level results.

We use a structural gravity model to perform a full general equilibrium analysis examining the potential trade and welfare effects of the BRI on China, EU member states and the rest of the world, in 64 countries across 22 industries over the period of 1960–2019.

We conduct a number of simulations (see Chapter 5 for a detailed scenario development): (a) planned investment projects lead to trade cost reductions, (b) all remaining EU member states sign up to the BRI and realise trade cost reductions equal to those of the Balkan states, and (c) additional new investments take place in Greece, Italy and Spain. We apply a two-phase method to all three scenarios and these experiments allow us to answer the following questions: Which industries are expected to gain the most from the BRI? Do sectoral-level results differ from those found in studies using aggregate analysis? Which industries might expect further trade gains/losses if additional trade cost reductions were realised in selected countries e.g., Greece, Italy and Spain?

We argue that the trade effect of the BRI varies at sectoral level and our paper makes both empirical and methodological contributions to the growing BRI literature in the following ways. First, we develop a two-phase method to examine the trade effects of BRI at sectoral level. With this method, not only can we assess the fitness of the structural gravity model when analysing sectoral trade effects of BRI, but also identify any potential issues and produce more robust results compared to existing country-level empirical BRI studies. Second, we complement existing BRI studies with sectoral-level results. In addition, we go a step further than previous research by modelling two more scenarios to showcase the impacts of BRI if all EU member states sign up to the BRI and additional investment plans take place in Greece, Spain and Italy. Sectoral level results from this chapter will help provide early warnings of any issues from Chinese investment through the BRI channel for European policymakers.

The rest of this chapter is organised as follows. Section 2 provides a detailed BRI literature and section 3 explains and discusses our empirical strategy of how to approach sectoral-level gravity analysis and the potential challenges in doing so, as well as our methodology and data. Section 4 presents the empirical results, while Section 5 discusses the results of the analysis. Section 7 concludes with policy implications.

6.2 Literature Review

It is often the case that the concept of the BRI has been referred to by some as "fluid" and "uncertain"– with only broad overarching goals of coordination, connectivity, trade facilitation, financial integration, and people-to-people bonds (Haggai, 2016), but lacking an official recognition of the entities and mechanisms; an official list of BRI projects; and transparent investment volumes and financial risks. It, therefore, leaves room for scholars to interpret the policy from various perspectives. Over time, research and academic institutions began to follow and gather every little piece of information related to the BRI and put them all together, some of them from a trade perspective. For instance, Ibold, 2019 published a list of 118 projects related to the BRI with the aim to facilitate the debate and foster knowledge about the BRI. Similarly, Center, 2022, a Shanghai-based think tank, also dedicates much of its research to Green BRI, as well as regularly updating the list of countries (146) that have joined the BRI.

In addition to that, there are also peer-reviewed BRI research papers examining the BRI from different angles since its announcement in 2013, but it was not until very recently that Panibratov et al., 2022 carried out an initial attempt to systematically categorise the BRI literature into five themes using a guided delimitation approach. The five themes are 1). Bilateral relations and international trade; 2). Chinese OFDI and the impact on BRI projects and vice versa the BRI's influence on Chinese OFDI; 3). Global value chains and the industrial dimension of the BRI (inclusion of the impact on particular industries); 4). Regional and urban development under the BRI; and 5). A broader topic of challenges and opportunities in BRI implementation.

The impact of the BRI on international trade dynamics falls under the umbrella of bilateral relations and international trade, where empirical studies examine the effect of the BRI on infrastructure, trade and transportation at either country or regional level. Herrero and Xu, 2017, are among the first researchers to estimate the trade creation effect as a result of trade cost reductions from BRI infrastructure projects in Europe. Their findings suggest that not only Southeast Asia, but landlocked European countries also benefit considerably. As well as that, Jiang and Fu, 2018 measure the benefits of the Maritime Silk Road for China and neighbouring countries in Southeast Asia, and they draw the conclusion that the new Silk Road as part of the BRI route promotes trade for China and Singapore in a significant way; India and Malaysia have only benefited from the BRI to a certain extent; and the effect from the BRI for the Philippines and Indonesia is relatively weak and insignificant. Similarly, recent studies by Chin, Ong, and Kon, 2019 provide an empirical analysis showing that there would be income convergence in selected Southeast Asian Nations (ASEAN) countries if trade facilitation through the implementation of the BRI was assumed. Moreover, Chen, Chen, and Yao, 2020 analyse the effect of trade competitiveness and complementarity at country level and their study finds that trade complementarity along with other factors promotes trade development between China and BRI economies, whereas geopolitical distance and trade competitiveness block bilateral trade.

Under the industrial dimension theme of the BRI literature, Chen and Yang, 2018 suggest that based on their empirical analysis, port cluster growth via BRI-related ports in Asia will benefit both the manufacturing industry and social welfare. In addition, a similar study taking the port of Colombo in

Sri Lanka as a case study suggests that investments made in container ports in the New Silk Road of the BRI route will boost trade volumes of 31.31 billion USD of annual products if there were eight new built container berths and port charges were 111 USD per TEU (Chen and Yang, 2019). Le, Tran, and Nguyen Duc, 2019 conduct desk reviews and in-depth interviews to identify potential impacts of the BRI on the Vietnam textile and garment industry. Their findings suggest that the respondents agreed that the initiative could foster textile export and the development of infrastructure. From the global supply chain point of view, the BRI reduces time distance independent of geographical distance by diverting supply chain flows from existing routes to new routes via far less accessible regions (Thürer et al., 2020). (Chen et al., 2021) look at the whole tourism sector and argue that the bilateral relationship between economic growth and international tourism revenue along the BRI is mainly positive.

Although existing BRI literature, theoretical arguments and empirical results generally confirm a strong positive link between the implementation of BRI infrastructure projects and bilateral trade between China and BRI economies, a clear consensus regarding examining the impact of BRI infrastructure projects at broad sectoral level for all countries has not yet been reached. In other words, the examination of the trade effect of the BRI policy on both BRI and non-BRI countries has been addressed to a very limited extent. This lack of industrial-level analysis in the realm of BRI research signals the need for further studies such as this one to understand the trade impact of the initiative at industrial level for all countries.

Methodological approaches in the realm of BRI research are generally twofold – qualitative and quantitative research. Structured interviews, desk reviews and other qualitative methods have been used to address the impact of BRI as a foreign policy. Alongside that, there are several commonly used methods among quantitative papers evaluating the impact of the BRI on various economics and business perspectives, namely, difference-in-difference estimation, network analysis and gravity model of trade (Panibratov et al., 2022). Gravity modelling stands out as a prevailing economic modelling tool for examining empirical analysis of BRI impacts. For example, empirical studies of the impacts of BRI dated back to 2017, where Herrero and Xu, 2017 estimate trade creation effect among BRI countries as a result of the transportation cost reductions using a gravity model empirical specification, and they find that landlocked European countries experience considerably more trade gains.

Furthermore, a more recent study published by the World Bank (De Soyres et al., 2019) provides us with a more comprehensive dataset of the changes in ad valorem trade costs before and after BRI implementation at country-sector level. The findings show that the BRI will reduce trade costs significantly – a range of 1.5 to 2.8 per cent trade cost reductions for BRI economies. On a similar note, Jackson and Shepotylo, 2021 explore the impact of the BRI on trade and consumer welfare using general equilibrium structural gravity approach, as well as conducting a counterfactual analysis. Their findings suggest that China and Europe expect to make substantial gains from the BRI due to transportation cost reductions. Counterfactual analysis estimates indicate that a deep EU-China Free Trade Agreement (FTA) is comparable to 15 to 20 per cent transport cost reductions. There are also other BRI studies employing the gravity model of trade when assessing the impact of the BRI on trade and other strands (Shahriar, Kea, and Qian, 2019; Baniya, Rocha, and Ruta, 2020; and Liu, Lu, and Wang, 2020). Gravity modelling as a research method in the BRI literature is being criticised by some for lacking a theoretical foundation as well as “a systematic application”. There are more recent methodological developments in the field of the gravity model of trade that prove the gravity model of trade provides unbiased and robust estimates.

6.3 Methodology and data

6.3.1 Methodology

The sectoral composition of a country’s trade matters. Trade volumes increase in a particular sector due to technology improvements, additional investment flows, or subsequent economic growth, and those changes may be more easily identified and picked up at sectoral level. There are a few cautionary notes on dealing with the gravity model with disaggregated data. First, database construction and estimation for sectoral trade flows should be related to sectoral-related variables. That is to use gross production and final demand for exporter and importer countries’ gross domestic product (GDP) metrics, as the usual GDPs are not good proxies for demand and supply at the sectoral level. Second, the issue of zero trade is more likely to occur in sectoral trade flow data than in aggregate trade data, as often some countries do not produce/trade certain products with other nations. Therefore, similar to how aggregate data treats zero trade issues, our sectoral gravity model automatically drops no-trade country pairs once detected in any sector from the sample without any information loss. Additional measures include replacing all missing values in all of our variables to further ensure the credibility of the results and minimise measurement errors.

To run the gravity model with disaggregated data, we develop a more appropriate method to ensure that our results are not as biased as they might be, and it consists of two steps. In the first step, we run sectoral full general equilibrium analysis, then we employ an input-output table to calculate the percentage share of the economic sector in GDP for sector diversification, that is to divide value added at basic prices of the sector by GDP of an economy. In this chapter, we refer to "GDP of an economy" as the sum of all 22 industries of interest (see Table 6.1 for a list of all 22 industries) rather than the actual aggregate GDP per capita, as this is a better representation of the economy that we are interested in. Finally, the adjusted aggregate real GDP change equals the product of the sectoral real GDP change that we computed and the percentage share of the economic sector in an economy.

TABLE 6.1: List of 22 industries (ISIC Rev.4)

D01T02	Agriculture, hunting, forestry
D03	Fishing and aquaculture
D05T06	Mining and quarrying, energy producing products
D07T08	Mining and quarrying, non-energy producing products
D09	Mining support services activities
D10T12	Food products, beverages and tobacco
D13T15	Textiles, textile products, leather and footwear
D16	Wood and products of wood and cork
D17T18	Paper products and printing
D19	Coke and refined petroleum products
D20	Chemical and chemical products
D21	Pharmaceuticals, medicinal chemical and botanical products
D22	Rubber and plastics products
D23	Other non-metallic mineral products
D24	Basic metals
D25	Fabricated metal products
D26	Computer, electronic and optical equipment
D27	Electrical equipment
D28	Machinery and equipment, nec
D29	Motor vehicles, trailers and semi-trailers
D30	Other transport equipment
D31T33	Manufacturing nec; repair and installation of machinery and equipment

Consider a sectoral level real GDP change for country i as g_{ik} measured in percentage, value added of sector k in country i is V_{ik}. It can be found in the input-output table of a country i at the bottom of the table. The GDP of country i is $GDP_i = \sum_k V_{ik}$. The aggregate real GDP change is calculated as

$$g_i = \sum_k \times \frac{V_{ik}}{GDP_i} \tag{6.1}$$

This value g_i is compared with the aggregate values that are calculated in the previous chapter for one sector economy.

In order to validate the approach, we sum up all sectoral level real GDP change in each country and compare the weighted aggregate results with estimates that we had obtained in the previous chapter, given everything else is constant. The whole purpose of this first step is to ensure that there is a need for sectoral level analysis of the trade effects of the BRI, and we do so by comparing aggregate results with weighted aggregate results to see if there is any difference. The second step is to apply De Soyres et al., 2019 sectoral trade cost reductions and run a new full general equilibrium analysis sector-by-sector using 2018 year of data as our benchmark. It is crucial to note that we use gross exports (by industry and by partner) - the value of goods traded and recorded by sector as our trade flow of exports, different to those aggregate analysis studies that often use global trade flows as their dependent variable.

6.3.2 Model

We use structural gravity modelling to measure the trade and welfare gains of the BRI policy on China, the EU and the rest of the world. Structural gravity modelling has been used in previous BRI research examining trade impacts of the policy at aggregate level. Our model and specification are consistent with other trade models; they are also similar to aggregate-level BRI analysis but with the addition of variable value-added sector k.

Our gravity model takes the following form

$$X_{ij,t}^{k} = \exp[\beta_{dist}^{k} \ln(\lambda_{ij} * dist_{ij}) + \beta_{T}^{k} T_{ij} + \pi_{i}^{k} + \chi_{j}^{k}] + \varepsilon_{ij,t}^{k} \tag{6.2}$$

where k represents each of the 22 goods sectors; the subscripts i and j are exporter and importer countries; $X_{ij,t}^{k}$ is the dependent variable gross exports of country i to j in time t for value-added sector k; T_{ij} represents all other factors including common language, religion, colonial ties, and others; π_{i}^{k} and $^{k}_{j}$ are exporter-time and importer-time fixed effects, respectively; and $\varepsilon_{ij,t}^{k}$ is the error term which captures everything that might not be included in this regression and is uncorrelated with any variables in this model.

We parameterise trade costs as follows

$$\tau_{ij}^{k} = trade\_costs = \exp[\beta_{dist}^{k} \ln(\lambda_{ij} * dist_{ij}) + \beta_{T}^{k} T_{ij}] \tag{6.3}$$

Trade costs change with respect to distance, and they are also affected by transport infrastructure. We introduce $_{ij}$ to represent the transport infrastructure. In our scenarios, we model infrastructure projects related improvements as a percentage reduction in λ. Other factors affecting trade costs including common border, common language and colonial past, are all part of T_{ij}.

The typical trade policy simulation procedure consists of four steps:

- 1. Choose a theoretical model that is appropriate to predict the effects of the policy under consideration.
- 2. Collect the corresponding trade (including import and export flows as well as tariffs) and production data for the specific sector(s) before the policy change.
- 3. Select values for the model's key parameters (elasticities).

- 4. Change the value of the policy variables of interest and recalculate the prices and trade volume for comparison with the baseline one.

Trade economists often need to decide whether to use a partial equilibrium (PE) or general equilibrium (GE) model. The choice involves a trade-off: on the one hand, a GE approach takes into account inter-market linkages which a PE approach cannot; on the other hand, a GE model will typically be set up at an aggregate level, whereas a PE model can be done at disaggregated level. Whether to choose disaggregation or proper treatment of inter-market linkages depends on the nature of the policy experiment conducted and on the specific concerns of the policymaker. In this case, we will perform both FE and GE analysis to compute the results.

6.3.3 Data

Sectoral level trade cost reductions are estimated using data from De Soyres et al., 2019. All data obtained for this chapter is publicly available for view and download online, as shown in Table 6.2. Dependent variable gross exports measured in billions of US dollars by industry and by partner country are taken from the OECD Trade in Value-Added (TiVA) 2021 edition indicators (EXGR 4.4), for 66 countries and 22 goods industries for the period of 2010-2018. Similarly, production capacity and final demand, which are the equivalent of GDP for exporters and importers, respectively in aggregate analysis are also taken from TiVA. The Trade in Value Added (TiVA) database is a collection of measures that can provide insights into global production networks and supply chains beyond what is possible with conventional trade statistics. In addition, this edition covers 66 economies (including all OECD, EU and G20 countries and most East and Southeast Asian economies) as well as region aggregates. Indicators are available for 45 industries within a hierarchy based on ISIC Rev.4. It has a selection of principal indicators that track the origins of value added in exports, imports and final demand for the years 1995-2018.

TABLE 6.2: Data summary

Variables	**Sources**
Exports	OECD TiVA 2021 - varaible EXGR 4.4
Input-output table 2018	OECD's Inter-Country Input-Output (ICIO) Database 2021 version
GDP	CEPII (V202102)
Population	CEPII (V202102)
Distance	CEPII (V202102)
Contiguity	CEPII (V202102)
Common language	CEPII (V202102)

Dummy variables such as common language and contiguity are taken from the Centre D'Ètudes Prospectives et D'Informations Internationales (CEPII)

Gravity dataset. As it is a sectoral level analysis, we select 22 industries (excluding service sectors) based on ISIC Rev. 4 from the OECD data website in accordance with all other variables in this dataset as shown in table 6.1. For the first exercise, the 22 sectors are aggregated into one sector, in other words, they are summed up together as in one sector in order to compare the results with aggregated results from the previous chapter. For the second step, which is the actual sectoral full general equilibrium analysis, we obtain results for each sector and explain the findings sectorally.

6.4 Empirical results

6.4.1 Step 1 Results

The whole purpose of the first experiment is to test whether sectoral full general equilibrium analysis is necessary and appropriate in solving our research questions. We compare aggregated sectoral-level results with aggregate results from the previous chapter. More specifically, we construct aggregated sectoral level results by first performing a general equilibrium analysis sector by sector; we then multiply these welfare change results with the percentage share of each sector in each country's economy. It is worth mentioning that we calculate each country's economy as the sum of all 22 industries to proportionally reflect the weight of each sector. The product of the two is the aggregated sectoral level results.

Having said that, in this first experiment, we do not anticipate utilising any of the figures as the actual results to explain the implication of the BRI. As these numbers are only for referencing purposes, the actual simulation analysis takes place in the second step. We intend to compare both results to see 1). if doing a sectoral full general equilibrium analysis is necessary; 2). if there is any difference in both aggregated results, and if yes, to what extent; and 3). which industry, country, or region might experience any underrepresentation of the trade effects compared to aggregate analysis results.

There are several important findings from this exercise. First, there is an average of 70.42 per cent welfare effect difference found with respect to aggregate analysis method. Out of 58 countries, there are 36 countries that prove to have failed to capture a full trade effect in aggregate analysis. A range from 950 per cent to 3.59 per cent of welfare differences has been logged and this trend applies to all three scenarios, while the results for the remaining countries are much more in line with aggregate results we obtained from the previous chapter.

Moreover, if we take a closer look at the EU as shown in Table 6.3, we find that 9[1] out of 25 EU members are significantly underrepresented in their trade effects due to BRI with a range of 950 per cent to 4.053 per cent, while

[1]Bulgaria, Cyprus, Germany, Spain, Estonia, Finland, Greece, Lithuania, and Sweden.

the results for other member states are very close to the results using an aggregate method. There is an average of 16.95 per cent welfare gains across all three scenarios that have not been captured comparatively to previous chapter results. The reason for this pattern of not capturing trade effects is that different economies have different sector weightings.

TABLE 6.3: Experiment 1: Comparison of EU results

EU country	S1 (6)	S1 (5)	S2 (6)	S2 (5)	S3 (6)	S3 (5)
Spain	0.14	0.01	0.22	0.08	0.27	0.12
Estonia	2.18	1.14	2.59	1.37	2.17	1.13
Greece	1.63	0.93	1.92	1.12	2.00	1.18
Bulgaria	3.09	1.86	3.56	2.16	3.07	1.85
Lithuania	1.83	1.58	2.16	1.86	1.85	1.58
Sweden	1.82	1.63	2.11	1.89	1.82	1.62
Finland	0.61	0.56	0.77	0.70	0.61	0.55
Cyprus	1.56	1.42	1.84	1.70	1.54	1.41
Germany	0.57	0.54	0.67	0.64	0.56	0.54
Latvia	1.63	1.69	1.95	2.02	1.62	1.68
Denmark	1.30	1.40	1.51	1.62	1.30	1.40
Britain	0.41	0.47	0.55	0.59	0.41	0.46
Croatia	0.78	0.92	0.94	1.09	0.77	0.91
Poland	0.56	0.70	0.72	0.85	0.56	0.70
Hungary	0.93	1.16	1.10	1.37	0.92	1.15
Slovakia	0.81	1.02	0.96	1.20	0.80	1.02
Czech Republic	0.51	0.66	0.61	0.78	0.50	0.65
Italy	0.33	0.46	0.43	0.57	0.48	0.62
France	0.15	0.21	0.20	0.28	0.13	0.20
Slovenia	0.49	0.71	0.59	0.88	0.47	0.69
Malta	0.39	0.59	0.52	0.74	0.39	0.58
Austria	0.14	0.22	0.20	0.28	0.13	0.21
Netherlands	0.18	0.32	0.26	0.40	0.18	0.31
Ireland	0.13	0.38	0.18	0.47	0.12	0.37
Portugal	0.22	-0.03	0.31	0.04	0.19	-0.04
Luxembourg	0.21		0.27		0.21	
Belgium	-0.01		0.00		-0.01	
Roumania	1.42		1.69		1.41	

Notes: S1, S2 and S3 denote scenarios 1 (BRI), 2 (EU) and 3 (FI), while the number inside brackets represents types of data. S1 (6) indicates results for scenario 1 (BRI) in Chapter 6 or using disaggregated data and S1 (5) represents the results for scenario 1 (BRI) in Chapter 5 or using aggregate data.

Take China as an example, the agriculture sector accounts for around 17 per cent of the whole 22-sector economy (shown in Figure 6.1), while for Germany, the largest industry among the 22-industry economy is motor vehicles, trailers and semi-trailers and machinery and equipment, nec industry. Similarly, food products, beverages and tobacco, and agriculture, hunting, and forestry account for more than half (51.4 per cent) of the economy for Greece (shown in Figure 6.2) but only 33.7 per cent for Spain. The difference in sector weighting in an economy implies that it will play a crucial role in the results of any trade policy shock impact, therefore taking into account sector diversification as a factor in full general equilibrium is needed.

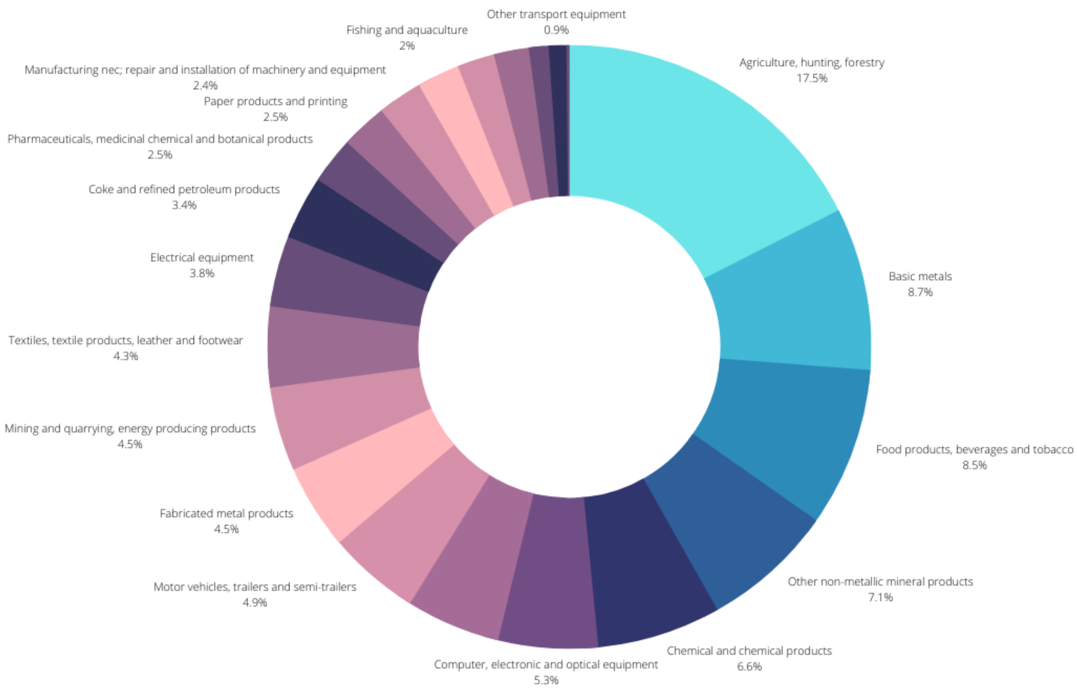


FIGURE 6.1: Sector weighting in an economy: China

Regionally speaking, as the results show in Table 6.4, we also discover a relatively consistent pattern across our comparisons and that is - FGE using disaggregated data explains more trade policy changes than using aggregated data. For Central Europe and the Baltics, an average of 13.1 per cent more trade values have been captured by sectoral level analysis. For South Asia, the results are very close for both datasets. Interestingly, for North America, the difference in results is almost 50 per cent. We see consistencies across some regions but we also see there are divergences in results using two very different sets of data.

Experiment 1 serves the purpose of providing us with a clear comparison between the two sets of "aggregated" results using disaggregated and aggregated data. We take into account sector weighting in our model for each country and estimate using full general equilibrium analysis. Comparisons between the results we obtained in this chapter and aggregated results tell us three things. One, despite almost all previous BRI empirical studies with aggregated data, there is room for further estimation at sectoral level based

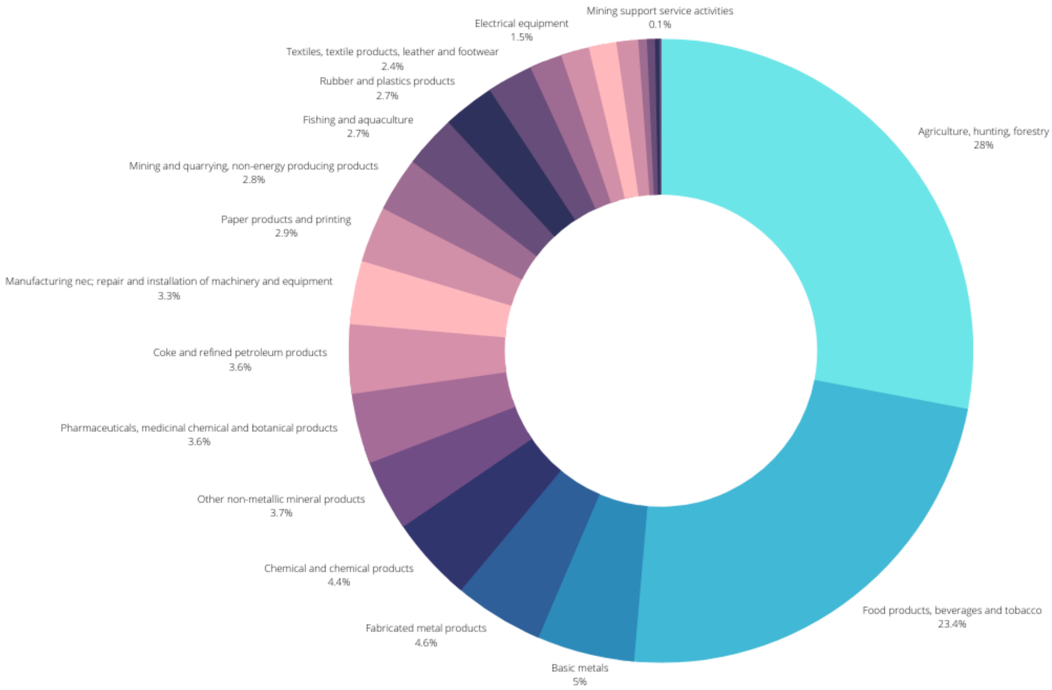


FIGURE 6.2: Sector weighting in an economy: Greece

TABLE 6.4: Welfare effects percentage difference between two methods, by region

Region	**S1(6)**	**S1(5)**	**S2(6)**	**S2(5)**	**S3(6)**	**S3(5)**
Central Europe & the Baltics	1.29	1.14	1.53	1.36	1.29	1.14
East Asia & Pacific	4.46	4.36	4.48	4.43	4.46	4.37
Europe & Central Asia	2.65	3.32	2.81	3.48	2.66	3.35
European Union	0.87	0.84	1.05	1.00	0.89	0.85
Latin America & Caribbean	1.04	0.95	1.09	1.01	1.06	0.96
Middle East & North Africa	2.50	5.41	2.64	5.61	2.51	5.43
North America	1.67	1.14	1.66	1.13	1.66	1.14
South Asia	7.86	7.94	7.94	8.09	7.86	7.96
Sub-Saharan Africa	3.54	3.80	3.56	3.90	3.56	3.82

on our step 1 results and comparisons. Second, we see sectoral level analysis captures more trade volume changes after trade policy shock across regions, trade blocs and scenarios, while results for some regions do not differ much, meaning that there is some stability in the methodology that we employed. Third, for European countries, Spain, Greece, Portugal and Estonia are among the top four countries that have the highest percentage difference in their results across three scenarios. Regions including North America and Central Europe and the Baltics are among the top welfare effects difference in percentage terms. Having step 1 results as our basis, we then conduct both partial and full general equilibrium analysis with structural gravity models.

6.4.2 Step 2 Results

After experiment 1 laid out the foundation for a sectoral level gravity modelling analysis, we performed general equilibrium analysis for 22 industries and results are presented into three different categories - percentage change in exports (%ΔX), percentage change in welfare gains (%ΔW) and percentage change in aggregated welfare gains(%ΔA). For the last pair of results %ΔA, we multiply sectoral level welfare gain results by the percentage share of each sector in each economy and add the results up for each country. In doing so, we have the option to explain some of the sectoral results after sector weightings. In this section, the results of both changes in exports and welfare are reported for all three scenarios. It is also worth noting that unlike OLS studies where results are being explained either as "statistically significant" or "insignificant", we will explain our results differently cross-sector.

Similar to Chapter 5, we take regional averages as the policy shock value, and gravity counterfactual results are still valid because they are captured fully by obtaining both direct effects (through the trade cost functions in the main gravity model) and indirect effects through the Multilateral resistance (MR) terms. However, it is important to acknowledge that we make a series of assumptions in the construction of these scenarios. In addition, it is also crucial to mention that the gravity model of counterfactual simulations only gives us estimated values, which are illustrative. In other words, the results of our scenario are indicative only, they serve the purpose to show readers the implications of a potentially relevant policy factor that may be in effect.

Scenario 1: BRI - exports and welfare changes

Scenario 1 (BRI) is our baseline scenario where we would be using results as benchmark for the two counterfactual simulations. We incorporated the World Bank dataset (De Soyres et al., 2019), which is the only data set that is available to date for BRI trade cost reductions country pairs by sector. De Soyres et al., 2019, make the very first attempt to quantify how much the BRI will impact trade costs. They first compute pre- and post-BRI reduction in shipping times using the current network of railways and ports across the world and estimate the current shipping times between every pair of cities. In other words, they quantify the changes in shipping times induced by the new and improved transport infrastructure projects. Secondly, they employ the concept of "value of time" to translate those changes in shipping time into a reduction in trade costs. We use their sectoral trade cost reduction dataset to incorporate sector weightings in each economy, as sectors have country-specific weightings, which can be further aggregated to quantify changes in trade costs by country (%ΔA). Therefore, calculating those different "value of time" for each pair of countries and each sector is necessary (De Soyres et al., 2019).

Results from sectoral partial and full general equilibrium analysis with structural gravity models are threefold - percentage change in exports/trade volumes (%ΔX); percentage change in country's consumers' welfare gains (%ΔW); and percentage change welfare gains sector weighting aggregation by country (%ΔA). To have a better understanding of the results/impact of the BRI, we aggregate the results across pairs of regions. Table 6.5 reports scenario 1 results and it provides an average percentage change in trade volumes by region and industry. Looking at the figures in these tables, we see several interesting and important patterns. First, as expected, South Asia region experiences the largest increase in trade volumes (represented as %ΔX) vis-a-vis all the other regions (second last column in Table 6.5). Looking more closely, trade volume increases for the South Asia region range from -0.57 per cent (pharmaceuticals, medicinal chemical and botanical products) to 10.17 per cent (mining and quarrying, energy producing products). Five industries [2] are among the 22 sectors to receive the largest trade volume increase.

Whereas for other industries such as other transport equipment and pharmaceuticals, medicinal chemical and botanical products, there are negative trade volume impacts due to BRI projects. Our results are not surprising as the BRI spans from Europe to Africa, but its major infrastructure projects are taking place in South Asia. There are six countries from the region that have joined the initiative,[3] and five out of those six countries are in fact low or low-middle income countries, which also explains the huge increase in trade volume due to BRI as our results suggest. The lack of infrastructure facilities and transport logistics in the region has always been an issue and the BRI proves to be a perfect short-term solution for it. Moreover, with a foothold in South Asia via transport infrastructure connectivity, China could reduce its dependency on the vulnerable Straits of Malacca by constructing alternative overland routes to ensure its access to other continents.

While for the EU and Central Europe and the Baltics, the increase in trade volume is not as strong as in the South Asia region, but the percentage change in exports still ranges positively between 0.03 (mining support service activities) to 1.53 (mining and quarrying, non-energy producing products). At a more disaggregated level, China experiences an increase in trade volumes between -0.69 (mining and quarrying, non-energy producing products) and 2.76 (agriculture, hunting, forestry), where for the former, we see a rise in export changes for other regions including South Asia (9.11), North America (6.12), and Middle East North Africa (5.55). The latter can be explained by the fact that agriculture, hunting and forestry is the biggest industry in terms

[2] Agriculture, hunting, forestry; Basic metals; Coke and refined petroleum products; Food products, beverages and tobacco; Mining and quarrying, non-energy producing products; and Paper products and printing.

[3] Afghanistan (Low income), Sri Lanka (Lower middle income), Pakistan (Lower middle income), Nepal(Low income), Maldives (upper middle income) and Bangladesh(Lower middle income) (Center, 2022).

TABLE 6.5: Scenario 1 BRI: Results by region, percentage change in exports and welfare

A. Trade effect

Region	D01T02	D24	D20	D19	D26	D27	D25	D03	D10T12	D28	D31T33
China	2.76	1.80	1.83	0.74	0.64	1.11	1.33	1.18	2.18	0.92	0.55
Central Europe & the Baltics	0.95	0.75	0.63	0.19	0.26	0.40	0.37	0.22	0.72	0.36	0.15
East Asia & Pacific	1.62	1.44	1.21	1.10	0.47	0.87	1.09	0.94	1.68	0.68	0.57
Europe & Central Asia	1.21	0.96	0.80	0.48	0.32	0.53	0.56	0.31	0.96	0.45	0.24
European Union	0.91	0.69	0.53	0.06	0.23	0.34	0.33	0.14	0.62	0.30	0.13
Latin America & Caribbean	0.89	0.72	0.54	0.13	0.23	0.45	0.54	0.40	0.84	0.31	0.22
Middle East & North Africa	2.72	2.16	1.72	0.20	0.66	1.14	1.33	1.04	2.20	0.89	0.57
North America	1.56	1.31	1.07	0.67	0.59	0.77	0.58	0.86	1.33	0.58	0.53
South Asia	4.59	4.13	3.97	4.58	1.08	2.27	2.41	2.14	4.08	2.01	1.17
Sub-Saharan Africa	1.95	1.60	1.85	2.01	0.65	1.12	1.32	1.36	1.74	0.86	0.64

	D05T06	D07T08	D09	D29	D23	D30	D17T18	D21	D22	D13T15	D16
China	2.64	-0.69	0.23	1.53	1.87	-0.23	2.45	-0.49	2.00	0.74	1.77
Central Europe & the Baltics	-0.27	1.53	0.03	0.26	0.72	-0.05	0.62	-0.07	0.69	0.18	0.57
East Asia & Pacific	1.42	1.31	0.30	1.08	1.60	-0.14	1.38	-0.34	1.56	0.82	1.47
Europe & Central Asia	-0.25	2.01	0.12	0.48	0.93	-0.07	0.86	-0.11	0.88	0.32	0.93
European Union	-0.86	1.44	0.03	0.24	0.64	-0.04	0.57	-0.05	0.56	0.12	0.47
Latin America & Caribbean	0.08	0.01	0.14	0.56	0.85	-0.04	0.80	-0.14	0.92	0.35	0.67
Middle East & North Africa	3.36	5.55	0.50	1.24	1.78	-0.19	1.78	-0.33	1.63	0.92	1.94
North America	1.56	6.12	0.23	0.37	1.03	-0.12	1.01	-0.25	0.86	0.47	1.05
South Asia	10.17	9.11	0.62	2.41	3.64	-0.36	4.11	-0.57	4.34	1.63	3.97
Sub-Saharan Africa	2.60	2.35	0.32	1.55	2.57	-0.14	1.90	-0.41	1.98	1.06	1.63

B. Welfare effect

Region	D01T02	D24	D20	D19	D26	D27	D25	D03	D10T12	D28	D31T33
China	1.76	1.66	1.79	3.20	0.46	1.02	1.34	1.23	2.33	0.97	0.92
Central Europe & the Baltics	1.04	1.16	1.20	1.66	0.45	0.63	0.63	0.63	0.98	0.49	0.41
East Asia & Pacific	2.21	1.93	2.00	2.51	0.62	1.23	1.54	1.43	2.19	1.13	0.87
Europe & Central Asia	1.51	1.58	1.54	2.38	0.56	0.92	1.04	0.94	1.43	0.74	0.55
European Union	0.85	0.92	0.91	1.16	0.38	0.54	0.55	0.46	0.69	0.42	0.31
Latin America & Caribbean	0.83	0.73	0.84	0.97	0.15	0.56	0.84	0.68	1.03	0.54	0.36
Middle East & North Africa	3.83	3.71	3.62	4.56	1.31	2.34	3.18	2.02	3.89	1.99	1.39
North America	1.23	1.36	1.42	1.27	0.87	1.32	1.14	0.61	1.61	0.88	0.69
South Asia	6.11	5.34	5.23	7.34	2.13	3.32	3.99	3.92	5.08	2.84	1.97
Sub-Saharan Africa	3.92	2.92	3.13	3.68	1.31	1.94	2.35	2.31	2.97	1.48	1.26

	D05T06	D07T08	D09	D29	D23	D30	D17T18	D21	D22	D13T15	D16
China	2.84	0.95	0.70	1.71	1.61	-0.32	2.07	-0.77	2.06	0.77	1.96
Central Europe & the Baltics	4.70	3.25	0.17	0.39	0.93	-0.09	0.73	-0.14	0.94	0.83	1.01
East Asia & Pacific	2.46	2.24	0.75	1.84	1.88	-0.30	2.12	-0.72	2.06	1.08	1.99
Europe & Central Asia	3.95	3.56	0.34	0.98	1.40	-0.13	1.38	-0.22	1.47	1.03	1.73
European Union	2.68	2.40	0.12	0.40	0.79	-0.07	0.61	-0.09	0.75	0.67	0.76
Latin America & Caribbean	0.44	0.52	0.44	0.94	0.92	-0.10	1.04	-0.27	1.19	0.37	1.04
Middle East & North Africa	-2.55	7.18	1.00	2.92	4.23	-0.34	3.79	-0.76	3.95	1.99	4.21
North America	1.11	4.57	0.41	0.93	1.50	-0.18	1.04	-0.36	1.55	1.29	1.22
South Asia	6.26	9.39	1.56	4.13	5.49	-0.57	5.68	-1.15	4.87	3.05	6.81
Sub-Saharan Africa	2.10	2.69	0.66	2.26	3.42	-0.35	3.10	-0.91	3.00	1.67	3.08

Notes: This table presents sectoral trade effects (Panel A) and welfare gains (Panel B) computed for conditional general equilibrium in BRI scenario and results are presented by region and sector. We apply different sets of transport cost reductions between China and EU, China and BRI countries. Elasticity of substitution is 5.13. 22 industries are represented by their industrial classification based on ISIC Rev.4 in Table 6.1.

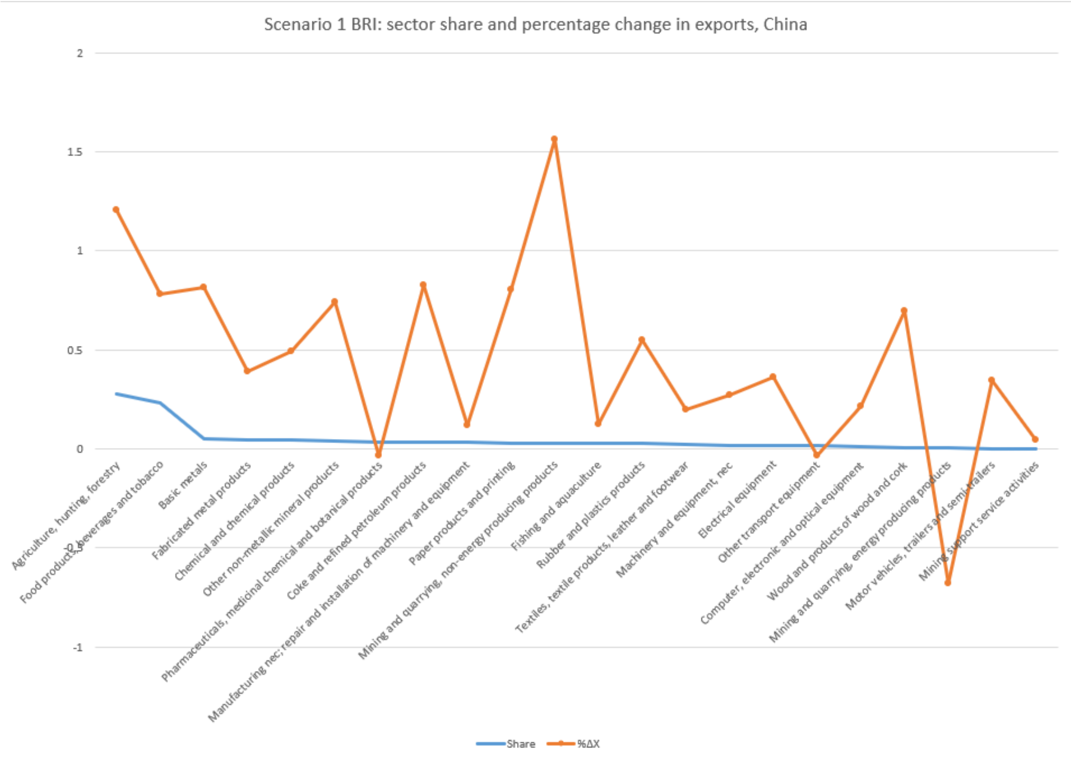


FIGURE 6.3: Scenario 1 BRI: sector share and percentage change in exports, China

of share of China's economy, therefore we see the biggest increase in trade volume for the same industry. On a similar note, in order to see trade impact by size, we create three categories to group sectors together by their trade impacts. We find that China receives a relatively large trade effect based on our definition - 13 sectors with a trade volume increase that is greater than 1 per cent; 7 sectors with a trade volume increase between 0 and 1 per cent; and only 2 sectors with a negative trade effect.

Secondly, if we compare the percentage sector share (%share) with change in exports (%ΔX) figures, we find that the two do not relate to each other in a significant way. This means that even though a sector has a high share percentage in an economy, it does not mean that the sector will experience the same trade impact proportionally/equally. This is the case for China, Greece and other countries. As an example, Figures 6.3 and 6.4 illustrate the relationship between the two indicators. The blue line is the percentage share for sectors and they add up to 1 or 100 per cent. The sectors are in descending order horizontally. The orange dotted line is the percentage change in exports from our analysis. One would expect a higher percentage share of a sector would lead to a higher trade volume impact. This is certainly not the case, as for Greece, agriculture, hunting and forestry take almost 18 per cent of the economy, yet the highest impact due to the BRI is for coke and refined petroleum products with a 3.2 per cent trade volume increase.

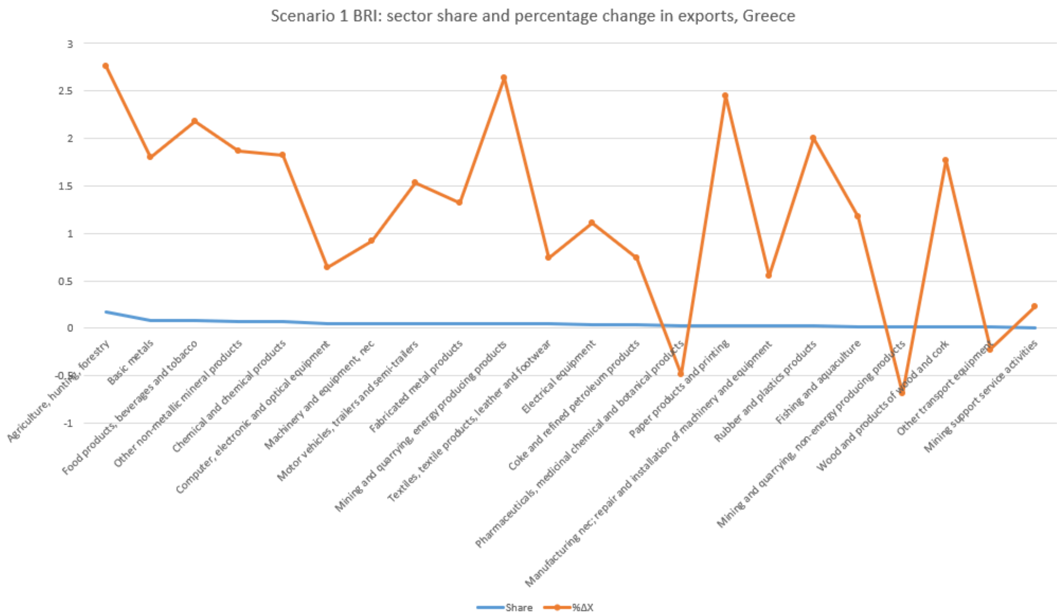


FIGURE 6.4: Scenario 1 BRI: sector share and percentage change in exports, Greece

In terms of the percentage change in welfare, a huge benefit of performing full general equilibrium analysis with the structural model is to be able to see the full-scale impact of any trade policy shock, and we also notice some patterns. For China, there is a similar welfare gain as to trade impact, meaning that both conditional and full GE scenarios do not vary with the exception of the coke and refined petroleum products industry, where there is a substantial increase from 0.74 per cent (trade effects) to 3.2 per cent (welfare effects). As a net oil importer, China's strong economic performance has increased its dependence on oil demand (Huang and Han, 2022). Even though the Gulf does not count as a formal region on the BRI map, the construction of energy infrastructure in the region as well as building facilities outside the region in order to facilitate the flow of oil and gas resources from the region to China has been taking place. And those projects are expected to facilitate Chinese energy firms to deliver even larger volumes of energy resources from the region.

The deep-water port and pipeline projects in Kyakphyui, on Myanmar's western coast, would allow for energy resources from the Gulf to be transported via a 771-km pipeline from the Bay of Bengal into Yunnan Province in China, bypassing the often dangerous Straits of Malacca. Similarly, the operation of the port of Gwadar in Pakistan grants Chinese state-owned enterprise China Overseas Port Holding Company (COPHC) to connect Kashgar in Xinjiang with Gwadar, not coincidentally serving as the shortest route for energy transports from the Gulf to the western part of China (Rakhmat, n.d.). That being said, our welfare effect results are in line with the descriptions from the observers and indicate substantial gains from the BRI for China's energy industry where a certain reduction in transportation costs between

China and the BRI economies would increase the welfare of a representative Chinese consumer in the domestic energy market by 3.2 per cent.

Overall, our benchmark results highlight the systematic impact of the BRI projects on trade volumes and consumer welfare. While some sectors are not seeing positive changes in volumes and welfare, positive impacts resulting from Chinese investments in these projects will spread far beyond the BRI countries to non-BRI economies and regions. Our results further prove this general finding in the BRI literature - that trade cost reductions for BRI countries will have a positive spillover effect on both BRI and non-BRI economies. Our research captures a more diverse image by showing those impacts down to each sector.

Scenario 2: EU - exports and welfare change

Besides the BRI scenario, we also propose two counterfactual simulations using the structural gravity model to perform general equilibrium analysis. The EU scenario considers the effects of all EU member states joining the initiative. And the FI scenario considers the effects of additional flow of Chinese capital into Greece, Spain and Italy. The gravity model not only obtains estimates of the sensitivity of trade to changes in particular geographical or policy factors but also performs a "trade shock" to independent variables onto projected trade effects. For both simulations, we compare counterfactual results with our benchmark results from scenario 1 (BRI) to explain the results more meaningful.

Once we have a policy simulation in mind, we then create a new trade cost variable which represents the counterfactual value of trade costs that we are interested in. In this case, as we did for gravity modelling with aggregated data in Chapter 5, we apply the same trade costs 0.10582 - the difference between Central Europe and the Baltics and the EU region from De Soyres et al., 2018 as our λ_{ij}, and apply this only to EU country pairs in our dataset. Therefore, our λ_{ij} will be computed as:

$$\begin{aligned}\lambda_{ij} = 1 - ((&Change\_Cost\_Upper\_bdred/100) \\ &+ ((Change\_Cost\_Upper\_bdred/100) * 0.10582)) \\ &\qquad\qquad if eu_o == 1 | eu_d == 1\end{aligned}$$

where *Change_Cost_Upper_bdred* is the upper bound trade cost reduction for all country pairs taken from De Soyres et al., 2018, 0.10582 is the computed percentage difference that aims to reflect the situation if all EU member states were to sign up to the BRI. The reason we do this calculation is that we believe this is the more appropriate way to represent an actual trade cost reduction due to the BRI in the context of all EU states joining the initiative. This is also something that existing literature has not yet produced.

Following from that, we replace the initial λ value to the newly computed λ, and then we generate our counterfactual trade cost variable tij_CFL as:

$$tij\_CFL = exp(b[lndist] * (lndist * \lambda) + b[contig] * contig + b[comlang\_off] * comlang\_off)$$

And lastly, we calculate the percentage change in the transformed trade cost variable (counterfactual relative to baseline), then map the percentage change to trade using the estimated elasticity. As usual, we aggregate figures to region level and they are shown in Table 6.6.

Table 6.6 report EU scenario results. It would be meaningless to just explain counterfactual results without comparing them to benchmark results. That is what we have done here; we calculate the percentage trade effect difference between two scenarios and we now present the key results of the impact of BRI-related transport projects on trade costs based on the assumption that all 27 EU member states join the initiative. First, we find that there is an average of 0.8 per cent trade volume increase for China, while five industries have negative trade impacts[4]. Similarly, Latin America & Caribbean, South Asia and East Asia & Pacific regions also experience an average of 0.8 per cent increase in trade volumes across 22 industries, meaning that if we were to assume that all EU countries join the BRI, then we would expect to see little impact or increase in trade volumes for China, Latin America & Caribbean, South Asia and East Asia & Pacific regions.

Second, there is a negative trade impact on Sub-Saharan Africa (-0.28 per cent) and North America regions (-1.7 per cent). This could result from the fact that joining the initiative for the EU leads to more capital flows into member countries, which further increases trade facilitation in the continent, therefore as all BRI trade routes end in Europe, it reduces some of the trade volumes for Sub-Saharan Africa and North America regions. Third, Central Europe & Baltics experience the highest trade volume increases with 9.62 per cent on average across all sectors, while the EU receives a similar trade volume impact of 9.14 per cent. Following the top 2 trade impact receiving regions, Europe Central Asia and Middle East & North Africa receive 6.01 per cent and 3.44 per cent trade volume increase, respectively.

There have been calls in the Baltic states for improvements to physical and digital infrastructure, as well as attracting much-needed resources for infrastructure in the transport, energy and digital sectors in the region. Moreover,

[4]Agriculture, hunting, forestry; Coke and refined petroleum products; Mining and quarrying, energy producing products; Mining and quarrying, non-energy producing products; and Textiles, wearing apparel, leather and related products.

TABLE 6.6: Scenario 2 EU: Results by region, percentage change in exports and welfare

A. Trade effect

Region	D01T02	D24	D20	D19	D26	D27	D25	D03	D10T12	D28	D31T33
China	1.91	1.82	1.84	0.72	0.65	1.12	1.34	1.20	2.21	0.92	0.55
Central Europe & the Baltics	1.03	0.83	0.71	0.27	0.28	0.44	0.41	0.26	0.79	0.40	0.17
East Asia & Pacific	1.65	1.45	1.21	1.11	0.47	0.88	1.10	0.96	1.71	0.68	0.57
Europe & Central Asia	1.28	1.02	0.86	0.54	0.33	0.56	0.59	0.34	1.02	0.48	0.25
European Union	0.99	0.76	0.59	0.12	0.25	0.37	0.36	0.17	0.68	0.34	0.14
Latin America & Caribbean	0.92	0.73	0.54	0.12	0.23	0.45	0.55	0.42	0.86	0.31	0.22
Middle East & North Africa	2.82	2.22	1.77	0.29	0.67	1.17	1.38	1.08	2.30	0.92	0.58
North America	1.56	1.30	1.05	0.64	0.59	0.76	0.57	0.85	1.32	0.57	0.51
South Asia	4.61	4.15	3.99	4.62	1.09	2.29	2.44	2.16	4.14	2.02	1.18
Sub-Saharan Africa	1.96	1.59	1.85	2.00	0.64	1.12	1.32	1.36	1.75	0.85	0.64

	D05T06	D07T08	D09	D29	D23	D30	D17T18	D21	D22	D13T15	D16
China	2.55	-0.68	0.24	1.55	1.88	-0.23	2.48	-0.50	2.01	0.74	1.79
Central Europe & the Baltics	-0.27	1.76	0.04	0.29	0.77	-0.05	0.67	-0.08	0.75	0.19	0.62
East Asia & Pacific	1.43	1.32	0.31	1.09	1.62	-0.14	1.39	-0.35	1.58	0.82	1.49
Europe & Central Asia	-0.33	2.20	0.13	0.51	0.98	-0.07	0.91	-0.11	0.92	0.33	0.96
European Union	-0.93	1.65	0.04	0.27	0.68	-0.04	0.61	-0.05	0.60	0.13	0.51
Latin America & Caribbean	0.03	0.02	0.15	0.56	0.85	-0.04	0.81	-0.14	0.94	0.34	0.68
Middle East & North Africa	3.35	5.59	0.53	1.31	1.86	-0.20	1.86	-0.34	1.72	0.95	2.03
North America	1.47	6.11	0.23	0.35	1.02	-0.12	0.99	-0.25	0.84	0.44	1.03
South Asia	10.29	9.13	0.65	2.42	3.67	-0.36	4.13	-0.58	4.40	1.64	3.99
Sub-Saharan Africa	2.55	2.35	0.32	1.55	2.56	-0.14	1.90	-0.40	1.98	1.04	1.62

B. Welfare effect

Region	D01T02	D24	D20	D19	D26	D27	D25	D03	D10T12	D28	D31T33
China	1.80	1.68	1.82	3.21	0.46	1.04	1.37	1.25	2.37	0.99	0.94
Central Europe & the Baltics	1.22	1.37	1.40	2.00	0.53	0.75	0.74	0.73	1.15	0.57	0.49
East Asia & Pacific	2.25	1.96	2.04	2.54	0.62	1.25	1.58	1.46	2.25	1.16	0.89
Europe & Central Asia	1.65	1.73	1.69	2.61	0.62	1.02	1.14	1.02	1.56	0.80	0.61
European Union	1.00	1.09	1.07	1.40	0.45	0.64	0.65	0.55	0.82	0.49	0.38
Latin America & Caribbean	0.87	0.77	0.88	1.01	0.16	0.60	0.90	0.71	1.08	0.57	0.38
Middle East & North Africa	4.00	3.85	3.78	4.74	1.33	2.44	3.33	2.11	4.13	2.07	1.45
North America	1.23	1.36	1.42	1.26	0.87	1.31	1.14	0.61	1.61	0.87	0.69
South Asia	6.18	5.39	5.32	7.43	2.14	3.36	4.06	3.97	5.21	2.89	2.01
Sub-Saharan Africa	3.97	2.93	3.17	3.72	1.31	1.95	2.38	2.33	3.02	1.48	1.27

	D05T06	D07T08	D09	D29	D23	D30	D17T18	D21	D22	D13T15	D16
China	2.77	0.95	0.72	1.76	1.65	-0.33	2.11	-0.80	2.10	0.77	2.00
Central Europe & the Baltics	5.88	3.89	0.20	0.46	1.09	-0.11	0.85	-0.16	1.11	0.98	1.17
East Asia & Pacific	2.42	2.25	0.78	1.90	1.92	-0.31	2.17	-0.75	2.11	1.09	2.03
Europe & Central Asia	4.57	3.99	0.36	1.06	1.54	-0.14	1.50	-0.24	1.62	1.14	1.86
European Union	3.48	2.91	0.15	0.47	0.93	-0.08	0.71	-0.11	0.90	0.80	0.89
Latin America & Caribbean	0.41	0.53	0.46	0.99	0.99	-0.11	1.10	-0.28	1.28	0.39	1.10
Middle East & North Africa	-2.70	7.26	1.06	3.10	4.43	-0.35	4.02	-0.80	4.18	2.05	4.46
North America	1.08	4.57	0.42	0.93	1.50	-0.18	1.04	-0.37	1.55	1.28	1.21
South Asia	6.30	9.43	1.61	4.22	5.56	-0.58	5.80	-1.19	4.97	3.07	6.97
Sub-Saharan Africa	2.02	2.70	0.67	2.30	3.46	-0.35	3.13	-0.94	3.04	1.68	3.12

Notes: This table presents sectoral trade effects (Panel A) and welfare gains (Panel B) computed for conditional general equilibrium in EU scenario and results are presented by region and sector. We apply different sets of transport cost reductions between China and EU, China and BRI countries. Elasticity of substitution is 5.13. 22 industries are represented by their industrial classification based on ISIC Rev.4 in Table 6.1.

Estonia, Latvia and Lithuania have been experiencing gaps in transportation, energy and digitisation for a long period of time. Therefore, investments from Chinese projects such as port construction in Lithuania, a massive underwater corridor between Estonia and Finland, and the omnipresent Huawei 5G option close the gap in those sectors (jela, 2022). This explains why we see that there is a 9.62 per cent trade volume increase due to infrastructure improvements. Just like the infrastructure gap in some Asian countries, which also receive BRI investments, the Baltic states will see a substantial trade increase once the infrastructure gaps have been improved.

Similarly, for the EU, we see the second largest trade volume increase of 9.14 per cent compared to BRI scenario. Table 6.7 illustrates a more detailed trade impact for the EU region. The left-hand side column are industries and the right-hand side column represents the results of the difference between BRI scenario and EU scenario in percentage terms. It is obvious that energy sector sees the biggest trade increase under both scenarios, in fact, having all EU countries sign up to the BRI will see a trade volume increase of 95.6 per cent (from BRI scenario's 0.06 per cent to EU scenario's 0.12 per cent). Many of the energy projects are still taking place in Central Asia, but assuming EU countries are more active and join the initiative, the European energy sector benefits substantially with a trade effect of 0.12 per cent. As mining countries in Central Asia and Africa are the most likely recipients of Chinese investment, rich deposits of cobalt, copper, gold and uranium will attract investors as commodity prices improve. As trade connectivity improves, trade volumes will also increase at 0.04 per cent with trade routes finally arriving in Europe. Similar evaluations apply to transport and other related sectors where BRI infrastructure projects are heavily invested.

TABLE 6.7: Scenario 2 EU: Top 8 industries with respect to increase in trade effects, %

Industry	Percentage increase in trade effects
Coke and refined petroleum products	95.6
Mining support service activities	28.7
Fishing and aquaculture	18.9
Other transport equipment	17.5
Mining and quarrying, non-energy producing products	15.0
Pharmaceuticals, medicinal chemical and botanical products	14.8
Chemical and chemical products	11.9
Machinery and equipment, n.e.c	11.1

Moreover, Table 6.6 also reports welfare effects by region for the EU scenario. We see that all regions and sectors are experiencing relatively positive welfare effects apart from for other transport equipment and pharmaceuticals, medicinal chemical and botanical products industries. Compared to the benchmark scenario, there is only an average of 1 per cent increase for consumers in China, with 1.39 per cent welfare gains. Other regions also see very little change compared to the benchmark results. For example, there is an average of 1.53 per cent welfare gains in the East Asia region, which is only 0.2 per cent increase from the BRI scenario. However, for the EU and Central Europe and the Baltics we find a much more substantial welfare impact. Consumers in both regions see an increase in their welfare of 0.89 per cent and 1.2 per cent, respectively. The numbers are 20 per cent more compared to BRI scenario which only considers BRI transport project-related trade cost reductions. In other words, having both trade cost reductions from the BRI projects and the onboarding of all EU countries leads to a welfare increase of 20 per cent compared to only having the former.

Scenario 3: FI - exports and welfare change

Beyond COSCO's investments in Greece and Italy, COSCO has also committed to invest in its operation terminals in Spain, as well as a rail freight line. More than EUR 62 million will be invested in Valencia port, Spain until 2022 in order to increase the capacity of the port of Valencia by 30 per cent to 5 million TEUs (Europe, 2020). Additionally, COSCO has also improved rail connectivity between Spanish terminals by opening a new rail freight line, which not only increases its logistical development but also provides better connectivity with Trans-European networks (Papatolios, 2021). Both terminal and rail development significantly reduces transit time for trans-shipment goods, and it also translates to a reduction in trade costs. Therefore, for comparison purposes, we also employ the 10.58 per cent that was used for scenario 2 as the trade cost reduction for this scenario, but only for Italy, Spain and Greece and their trading partners. Our λ_{ij} will be computed as

$$\begin{aligned}\lambda_{ij} = 1 - ((&Change\_Cost\_Upper\_bdred/100) \\ &+ ((Change\_Cost\_Upper\_bdred/100) * 0.10582)) \\ &if grc_o == 1|grc_d == 1|ita_o == 1|ita_d == 1|esp_o == 1|esp_d == 1\end{aligned}$$

Where *Change_Cost_Upper_bdred* is the upper bound trade cost reduction for all country pairs, 0.10582 is the computed percentage difference that aims to reflect if further investments were made only in Greece.

Table 6.8 presents both trade and welfare effect results for Further Investment (FI) made in Spain, Italy and Greece in addition to BRI transport cost reductions. First, the EU scenario results in a higher trade and welfare impact compared to FI scenario. As we only model new trade cost variables for Spain, Italy and Greece country pairs, therefore we would expect to see a relatively small impact. Table 6.9 is an overview of both effects by region in average terms, and we find that at an aggregate level, FI scenario results do not vary much with the BRI scenario. Both trade volumes and welfare gains for consumers remain almost the same as in BRI Scenario. It is worth noting that for the latter two scenarios, both welfare impacts are greater than trade impacts. China and the EU would see welfare improvements of 1.38 per cent and 0.75 per cent, respectively. Second, we propose the scenario based on the assumptions of potential additional Chinese investments that would come into three selected EU countries in the transport sector. Although our aggregate results do not seem to vary as of the benchmark results, our sector-by-sector results indicate investments made in one sector would have a positive spillover effect down to other sectors quite evenly, on a smaller scale.

6.5 Conclusion

Trade cost reductions related to the BRI projects have translated into improvements in trade volumes and welfare gains, as the initiative has been in place for 10 years, and our empirical findings are consistent with the existing empirical BRI studies. Our findings also further demonstrate China's devotion to the initiative through financing and capital flows. This chapter aims to explore sectoral trade and welfare impacts of the BRI transport projects by employing structural gravity modelling and carrying out full general equilibrium analysis to capture both impacts. The two-phase method allows us to first evaluate whether a sectoral gravity modelling analysis is necessary, and we conclude that BRI empirical analysis using aggregate data leads to an under-representation of some of the trade and welfare impacts. We then perform a full general equilibrium analysis with two further scenarios in addition to BRI trade cost reductions.

The scenarios presented here lead to a number of key conclusions. First, our results suggest that most industries gain from the BRI under all three scenarios. The positive spillover effect from BRI infrastructure projects in railways, ports, energy, power plants and other sectors leads to a positive spillover effect down to other sectors. At the same time, the spillover effect also creates trade diversion for some industries. Second, there is a very weak relationship between the sector shares in an economy and the BRI impacts it may experience. Large sector weightings in an economy do not guarantee a large positive trade or welfare impact from the BRI. This then implies that sectors which receive large investments under the BRI framework will not necessarily see increased trade and welfare in that sector. Third, our findings also suggest that a much greater impact for countries with BRI membership compared to additional Chinese investments will occur in selected EU countries. This is also why China has been pushing to establish and sign MoUs with non-BRI economies. Despite the fact that two-thirds of EU countries are already part of the initiative, having the remaining countries onboard including Germany, France and the Netherlands would see a much bigger impact and positive gains for all regions.

TABLE 6.8: Scenario 3 FI: Results by region, percentage change in exports and welfare

A. Trade effect

Region	D01T02	D24	D20	D19	D26	D27	D25	D03	D10T12	D28	D31T33
China	2.79	1.81	1.84	0.74	0.64	1.11	1.33	1.19	2.19	0.92	0.55
Central Europe & the Baltics	0.94	0.74	0.62	0.18	0.26	0.40	0.37	0.22	0.72	0.35	0.15
East Asia & Pacific	1.63	1.44	1.21	1.11	0.47	0.87	1.09	0.95	1.68	0.68	0.57
Europe & Central Asia	1.21	0.97	0.80	0.49	0.32	0.53	0.56	0.32	0.97	0.45	0.24
European Union	0.92	0.69	0.53	0.07	0.23	0.34	0.34	0.14	0.63	0.30	0.13
Latin America & Caribbean	0.90	0.72	0.54	0.13	0.23	0.45	0.54	0.40	0.84	0.31	0.22
Middle East & North Africa	2.72	2.16	1.72	0.20	0.66	1.14	1.32	1.04	2.20	0.89	0.57
North America	1.56	1.31	1.06	0.66	0.59	0.76	0.58	0.86	1.33	0.58	0.52
South Asia	4.59	4.13	3.97	4.58	1.08	2.27	2.40	2.14	4.08	2.01	1.17
Sub-Saharan Africa	1.96	1.60	1.86	2.02	0.65	1.13	1.33	1.36	1.75	0.86	0.64

	D05T06	D07T08	D09	D29	D23	D30	D17T18	D21	D22	D13T15	D16
China	2.65	-0.69	0.23	1.54	1.87	-0.23	2.46	-0.49	2.00	0.74	1.78
Central Europe & the Baltics	-0.31	1.53	0.03	0.26	0.71	-0.05	0.62	-0.07	0.68	0.17	0.56
East Asia & Pacific	1.43	1.31	0.30	1.08	1.60	-0.14	1.39	-0.34	1.56	0.82	1.48
Europe & Central Asia	-0.23	2.04	0.12	0.48	0.93	-0.07	0.87	-0.11	0.88	0.32	0.93
European Union	-0.84	1.46	0.03	0.24	0.64	-0.04	0.58	-0.05	0.56	0.12	0.48
Latin America & Caribbean	0.08	0.01	0.14	0.56	0.84	-0.04	0.81	-0.14	0.92	0.35	0.67
Middle East & North Africa	3.34	5.55	0.50	1.24	1.79	-0.19	1.79	-0.33	1.62	0.92	1.94
North America	1.56	6.12	0.23	0.36	1.03	-0.12	1.00	-0.26	0.85	0.46	1.04
South Asia	10.18	9.11	0.63	2.41	3.64	-0.36	4.11	-0.57	4.34	1.63	3.97
Sub-Saharan Africa	2.63	2.36	0.32	1.56	2.57	-0.14	1.91	-0.41	1.99	1.06	1.64

B. Welfare effect

Region	D01T02	D24	D20	D19	D26	D27	D25	D03	D10T12	D28	D31T33
China	1.77	1.67	1.80	3.21	0.46	1.03	1.34	1.24	2.34	0.97	0.92
Central Europe & the Baltics	1.03	1.15	1.19	1.64	0.45	0.63	0.62	0.62	0.97	0.48	0.41
East Asia & Pacific	2.22	1.94	2.01	2.51	0.62	1.23	1.55	1.44	2.21	1.14	0.87
Europe & Central Asia	1.52	1.59	1.55	2.41	0.57	0.93	1.05	0.95	1.45	0.74	0.56
European Union	0.86	0.94	0.92	1.18	0.39	0.55	0.56	0.47	0.70	0.42	0.32
Latin America & Caribbean	0.84	0.74	0.85	0.98	0.15	0.57	0.85	0.69	1.04	0.54	0.37
Middle East & North Africa	3.84	3.72	3.63	4.57	1.31	2.35	3.19	2.03	3.91	2.00	1.39
North America	1.23	1.36	1.41	1.26	0.87	1.32	1.14	0.61	1.61	0.88	0.69
South Asia	6.10	5.34	5.24	7.34	2.13	3.32	3.99	3.92	5.09	2.85	1.98
Sub-Saharan Africa	3.95	2.93	3.15	3.71	1.31	1.95	2.37	2.32	3.00	1.49	1.26

	D05T06	D07T08	D09	D29	D23	D30	D17T18	D21	D22	D13T15	D16
China	2.84	0.95	0.70	1.72	1.62	-0.32	2.08	-0.77	2.07	0.77	1.97
Central Europe & the Baltics	4.66	3.24	0.17	0.38	0.92	-0.09	0.72	-0.14	0.93	0.82	1.01
East Asia & Pacific	2.46	2.24	0.75	1.85	1.89	-0.31	2.13	-0.72	2.07	1.09	2.00
Europe & Central Asia	3.98	3.60	0.34	0.99	1.41	-0.13	1.40	-0.22	1.49	1.04	1.75
European Union	2.72	2.45	0.13	0.41	0.80	-0.07	0.62	-0.10	0.77	0.68	0.78
Latin America & Caribbean	0.45	0.52	0.44	0.95	0.94	-0.10	1.05	-0.27	1.21	0.38	1.05
Middle East & North Africa	-2.58	7.18	1.00	2.93	4.25	-0.34	3.81	-0.77	3.96	2.00	4.22
North America	1.10	4.57	0.41	0.93	1.50	-0.18	1.04	-0.36	1.55	1.29	1.22
South Asia	6.27	9.39	1.56	4.13	5.50	-0.57	5.69	-1.15	4.88	3.05	6.81
Sub-Saharan Africa	2.12	2.70	0.66	2.29	3.45	-0.35	3.12	-0.92	3.02	1.68	3.10

Notes: This table presents sectoral trade effects (Panel A) and welfare gains (Panel B) computed for conditional general equilibrium in FI scenario and results are presented by region and sector. We apply different sets of transport cost reductions between China and EU, China and BRI countries. Elasticity of substitution is 5.13. 22 industries are represented by their industrial classification based on ISIC Rev.4 in Table 6.1.

TABLE 6.9: Scenario 1-3: Results by region, percentage change in exports and welfare, %

Region	BRI		EU		FI	
	Trade	**Welfare**	**Trade**	**Welfare**	**Trade**	**Welfare**
China	1.22	1.38	1.19	1.39	1.23	1.38
Central Europe & the Baltics	0.42	1.00	0.47	1.20	0.41	0.99
East Asia & Pacific	1.01	1.50	1.02	1.53	1.01	1.51
Europe & Central Asia	0.59	1.30	0.62	1.44	0.59	1.32
European Union	0.34	0.74	0.37	0.89	0.34	0.75
Latin America & Caribbean	0.43	0.64	0.43	0.67	0.43	0.56
Middle East & North Africa	1.49	2.61	1.54	2.72	1.49	2.62
North America	1.01	1.16	0.99	1.15	1.00	1.16
South Asia	3.25	4.22	3.28	4.28	3.25	4.22
Sub-Saharan Africa	1.39	2.18	1.38	2.20	1.39	2.20

Chapter 7

Conclusion

What are the impacts of the BRI on China, EU and the rest of the world from a trade perspective? Is Europe to benefit from the policy? The EU's senior official, European Commission Vice President Maroš Šefcˇovicˇ, once commented on the BRI as "...would love to be more involved in the Belt and Road Initiative, but we need a little bit more information". This is where this research comes in and provides a long-overdue analysis of the impact of the Belt and Road Initiative.

2023 marks the 10th year since the announcement of the BRI, and various projects have already been taking place and making positive economic contributions to host countries. Despite the current global political, economic and financial instability, we still see China's strong commitment to these projects. And there has been a large number of studies as well as debates on the potential economic impact on China, participating countries and the rest of the world. In this thesis, we provide a long overdue assessment of the impact of the BRI by producing a detailed analysis from three perspectives - project, sector and country, using a mixed method, where primary data collection of semi-structured interviews and secondary data collection employing the structural gravity model to perform a full general equilibrium analysis are used. We look at what the BRI entails in Chapter 2 and we also examine the effects of the BRI on the ground in Chapter 4.

The BRI is clearly having a positive impact from a trade and welfare perspective. From stimulating infrastructure investment to developing new global supply chains, some of the promises of the BRI are being materialised. Yet they are not enough. In April 2019, the so-called "BRI 2.0" or debt sustainability and green sustainability which will strengthen BRI sustainability, which are the two weaknesses of the BRI that have been criticised for years, was introduced (IMF, 2019). BRI 2.0 is also seen to be able to benefit from increased transparency, open procurement with competitive bidding, and better risk assessment in project selection. In addition, the environmental impacts of the programme have also been taken into account in this new BRI policy, which is also one of the aspects that we wish to explore more in our case study. The question now is whether potential international participants without BRI membership would take part in the new BRI 2.0 given it addresses some of the key concerns.

As our findings indicate that at sector level, the mining and energy sectors are among the top industries to gain from the BRI as these two sectors receive more Chinese investments compared to other sectors and they are crucial for the growing Chinese domestic consumption needs. However, the concept of "greening BRI", the focal point of the new BRI 2.0, means that those sectors with negative environmental impacts but positive trade and welfare impacts, including mining and energy (oil and gas), will have to reconsider, halt or terminate, and they will be replaced by projects in renewable energy, power grids and logistics sectors that are considered more eco-friendly. It then poses a more challenging situation for those countries/regions with massive projects backed by the BRI such as Central Asia and Africa with low or mid-income levels as to whether they could still benefit from the initiative in the long term if not short term.

Secondly, another challenge that the BRI 2.0 or Chinese investment, in general, may face is the rising alternative initiatives that are being introduced by Western countries, including the EU's Response to the BRI - "Globally Connected Europe", which is said also to include a list of infrastructure projects; and The Group of Seven (G7)'s global infrastructure and investment partnership aimed at countering China's BRI to provide infrastructure needs to low and mid-income countries. Whether these responses to the BRI would fly or not, all depends on how quickly those groups of countries work collectively to contextualise these initiatives in real terms, and it is a time-consuming process given that the BRI was introduced almost 10 years ago with the ability to finance its own projects. Therefore, we argue that it will be a long time until we see these BRI-alternatives making actual impacts on host countries, as there is still a lot of catching up to do. And during now and then, the BRI is still strong and committed to providing those infrastructure needs and financing options to those countries that are happy to get onboard, despite all the concerns and criticisms.

Thirdly, additional investments are on the horizon and unless there have been changes (legal and regulatory issues) made to those BRI projects, top EU economies might still hold their view and position of joining the BRI given that they have also come up with ideas to tackle issues around member states and the Eurasia region. While we find that if all EU member states joined the BRI would see a much greater gain, it would be interesting to know the full effects of those alternative infrastructure frameworks once implemented and quantified. In addition, further research should also focus on cross-country comparisons that can help us shed light on similar proposed or existing investment projects across Europe. We are seeing Chinese investments in ports in Spain, the Netherlands and Portugal, and it would be worth comparing the size of Chinese investments made in those ports; the operational and managerial style in Chinese-run and host-country-run sides of the port; as well as the labour regime and unionisation across these European ports.

Finally, we are unsure which might happen first: whether the new version of the BRI (BRI 2.0) would change some European countries' perceptions about the initiative and therefore subsequently their actions; or whether we would see those alternative policies catching up in this global infrastructure development race; or whether those eco-friendly BRI projects that have already been implemented in some countries are paying economic dividends. But one thing remains clear from our research findings: Chinese investment under the BRI has made positive impacts on trade, and welfare, connecting countries where trade costs are high, and filling much-needed infrastructure gaps for countries across the world. And the policy will continue to have a positive impact on global supply chain networks as it always has been done for the past 10 years, and there will be opportunities, challenges and risks to accompany these Chinese investments in whichever country they wish to target. Therefore, we argue that for Europe, given our findings at project, industry and country levels, the EU as a whole should welcome the opportunity at all levels, but perhaps should do so with strings attached in order to maximise the benefits of the BRI while managing China's growing footprint in an effective way. Europe might need more than just a counter-BRI programme.

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