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- **ABSTRACT (IN POLISH)**

Niniejsza rozprawa bada chiński handel międzynarodowy z różnych perspektyw, koncentrując się na inicjatywie "One-Belt One-Road" (OBOR) zaproponowanej pod koniec 2013 roku. W szczególności " One-Belt " odnosi się do Silk Road Economic Belt, a " One-Road " odnosi się do Maritime Silk Road. Strategicznym celem inicjatywy jest poprawa infrastruktury krajów wzdłuż szlaku przy jednoczesnym wzmocnieniu współpracy w dziedzinie polityki, handlu, inwestycji i kultury (Office of the Leading Group for Promoting the Belt and Road Initiative, 2019). Na podstawie przeglądu literatury podzieliłem moją pracę na trzy części (handel, GVC i dywersyfikacja eksportu) i zaproponowałem kilka hipotez (patrz Wprowadzenie).

W pierwszym rozdziale badam związek OBOR i jej korytarzy gospodarczych z handlem bilateralnym. W tym rozdziale stosuję model grawitacyjny handlu do zbioru danych składającego się ze 180 krajów i 199 krajów partnerów obserwowanych w latach 2000-2018. Wyniki empiryczne wskazują, że generalnie OBOR ma znaczący związek promujący handel międzynarodowy. Ponadto niektóre korytarze mają silniejszy pozytywny związek z handlem bilateralnym (na przykład Chiny Pakistan (CP), Chiny Mongolia Federacja Rosyjska (CMRF) i Bangladesz Chiny Indie Myanmar (BCIM).

W rozdziale drugim przedstawiam najpierw statystyki opisowe dotyczące udziału Chin i krajów OBOR w globalnych łańcuchach wartości (GVC). Następnie badam również rolę OBOR i jego korytarzy gospodarczych na handel wartością dodaną i GVC. Wreszcie, zagłębiając się w rozwój regionalny Chin i nierównowagę handlową, rozdział ten bada związek między udziałem prowincji w GVC a ich rynkami pracy. Wyniki pokazują, że od 2007 do 2020 r. modernizacja przemysłowa Chin i ekspansja krajowego łańcucha wartości zwiększyły ich pozycję na rynku wyższego szczebla w GVC i utrudniły uczestnictwo w GVC. Następnie OBOR pozytywnie wpływa na handel wartością dodaną i GVC zarówno w próbie wszystkich krajów, jak i w Chinach. Jeśli chodzi o korytarze gospodarcze, CP i BCIM są ważniejsze. Wreszcie, jeśli chodzi o wyniki dotyczące rynku pracy, płaca jest dodatnio skorelowana z zatrudnieniem i produktywnością, podczas gdy uczestnictwo w GVC spowalnia wzrost zatrudnienia i produktywności, prawdopodobnie z powodu "blokady technologii low-end" i braku przewagi w zakresie kosztów pracy.

W trzecim rozdziale skupiam się na weryfikacji wpływu OBOR na dywersyfikację eksportu (rynkową i produktową). Aby uzupełnić definicję OBOR, rozszerzam zakres, aby objąć dwa odrębne wymiary: współpracę polityczną poprzez podpisywanie umów (MoUs) oraz inwestycje finansowe ułatwiane przez Azjatycki Bank Inwestycji Infrastrukturalnych (AIIB). Zebrałem dane dla próby 183 krajów w latach 2000-2018. Ponadto zastosowałem metodę zmiennej instrumentalnej (IV) w celu wyeliminowania potencjalnej endogeniczności. Wyniki wskazują, że OBOR szkodzi dywersyfikacji eksportu w odniesieniu do produktów i rynków. Wyniki AIIB dotyczące różnorodności eksportu są niespójne, ze znaczącą negatywną rolą na poziomie produktu i niejasnymi wynikami na poziomie rynku.

Keywords: One-Belt One-Road, handel, GVCs, dywesyfikacja eksportu

- **ABSTRACT**

This thesis explores China's international trade from different perspectives, focusing on the "One-Belt One-Road" (OBOR) initiative proposed at the end of 2013. Specifically, 'One Belt' refers to the Silk Road Economic Belt and 'One Road' refers to the Maritime Silk Road. The strategic focus is to improve countries' infrastructure along the route while strengthening cooperation in politics, trade, investment, and cultural fields (Office of the Leading Group for Promoting the Belt and Road Initiative, 2019). Based on the literature review, I divided my thesis into three aspects (trade, Global Value Chains and export diversification) and proposed several hypotheses (see Introduction).

The first chapter investigates the association of OBOR and its economic corridors with bilateral trade. In this chapter, I apply the gravity model of trade to a dataset composed of 180 reporters and 199 partners observed in the period 2000-2018. The empirical results indicate that, overall, OBOR has a significant promoting association with international trade. In addition, some economic corridors have a stronger positive relationship with bilateral trade (for example, China Pakistan (CP), China Mongolia Russian Federation (CMRF), and Bangladesh China India Myanmar (BCIM).

In the second chapter, I first present descriptive statistics considering the participation of China and OBOR countries in global value chains (GVCs). Subsequently, I also explore the role of OBOR and its economic corridors on value-added trade and GVCs Finally, delving deeper into China's regional development and trade imbalance, this chapter examines the connection between its provinces' participation in GVCs and their labour markets. The results show that from 2007 to 2020, China's industrial upgrading and domestic value chain expansion increased its upstream position in GVCs and hindered its participation in GVCs. Next, OBOR positively affects value-added trade and GVCs in both the global sample and China as a reporter sample. In terms of economic corridors, CP and BCIM are more important. Finally, regarding the labour market results, the wage is positively correlated with employment and productivity, while employment and productivity are negatively correlated. In addition, the participation of GVCs slows down employment and productivity growth, possibly due to "low-end technology lock-in" and a lack of labour cost advantages.

In the third chapter, I focus on verifying the impact of OBOR on export diversity (market and product). To supplement the definition of OBOR, I expand the scope to encompass two distinct dimensions: political collaboration through the signing of Memorandums of Understanding (MoUs) and financial investment facilitated by the Asian Infrastructure Investment Bank (AIIB). I have established sample data for 183 countries from 2000 to 2018. In addition, I adopted the instrumental variable (IV) method to address endogeneity. The results indicate that OBOR harms export diversity regarding products and markets. AIIB's results on export diversity are inconsistent, with significant adverse roles at the product level and unclear results at the market level.

Keywords: One-Belt One-Road, Trade, GVCs, Export Diversity

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- **ACKNOWLEDGEMENTS**

China's ancients said they must study hard for ten years to be a graduate. Now I will also complete my 25-year study, which starts at a village elementary school in China.

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- **INTRODUCTION**

As one of the "three carriages" of economic growth (Tang et al., 2012), international trade has always been a hot research topic related to China (Bown & McCulloch, 2009; Gong, 2018; Jarreau & Poncet, 2012; Shahbaz et al., 2013), which is regarded as the "world's manufacturing factory" (Mees, 2016). After joining the World Trade Organization in 2001, China became a vital recipient of the global value chain division of labour (mainly assembly and manufacturing) with its large young labour force, GDP growth-oriented performance view, and relatively complete infrastructure (World Bank Group et al., 2017). This process also supports China in absorbing advanced technology (Burstein & Vogel, 2017), cultivating skilled workers (Yin et al., 2013), increasing residents' income (Zhu, 2012), and improving infrastructure construction. In the subsequent 2008 subprime mortgage crisis, the Hu-Wen administration proposed the "four trillion investment plan" (Fu & Wang, 2020), which successfully led the Chinese economy to quickly overcome the decline caused by weakened external demand and improve infrastructure construction (Qin, 2016) (such as high-speed railways, highways, airports, ports, etc.). On the other hand, this also led to severe overcapacity in industries such as steel and cement (Ni et al., 2021) and a greater concentration of residential assets in real estate, with a share of 66% in 2016 (C. Liu & Xiong, 2018).

To get rid of the "middle-income trap" (X. Liu et al., 2017), the Chinese government, on the one hand, has proposed the "Made in China 2025" (L. Li, 2018) and the "One-Belt One-Road" (Y. Huang, 2016) strategies to achieve the goals of industrial upgrading and consumption of its excess capacity (improving the infrastructure of participating countries), on the other hand, has proposed the "dual circulation strategy" (K. X. D. Huang et al., 2021) to foster its domestic market, boost consumption and encourage innovation.

However, with the impact of the Sino-US trade war and the science and technology war, the "Made in China 2025" strategy has gradually been hidden to avoid targeted sanctions (Reuters, 2018). In addition, The widening wealth gap in China[4] and the insufficient consumption capacity of middle-income groups (excessive pressure on real estate, education, and medical expenses) (Sun & Zhang, 2008; Wei et al., 2021) have not made consumption a sustained driving force for economic growth. According to the National Bureau of Statistics of China, from 2002 to 2020, the proportion of final consumption in GDP decreased from 61% to around 55%. In other countries, this proportion is generally above 70%. It is worth noting that after the outbreak of COVID-19, the contribution rate of China's net exports to GDP surged from 11.0% in 2019 to 25.3%, once again highlighting the importance of international trade for China's economic growth.

OBOR has been regarded as one of China's most prominent, influential, and politically significant global cooperation strategies since its proposal at the end of 2013 (Office of the

[4] For example, the wages of low, medium, and high-tech workers in the information and communication technology industry increased by more than 50%, 80%, and 100%, respectively, from 1995 to 2009 (World Bank Group et al., 2017); the rapid growth of real estate prices in China (CityRE Data, 2023) has also exacerbated inequality in household assets.

Leading Group for Promoting the Belt and Road Initiative, 2019). Different from the political slogans, it has comprehensively promoted in different dimensions: 1) infrastructure construction and investment (e.g. Asian Infrastructure Investment Bank (AIIB), the Silk Road Fund), 2) politics (the holding of the OBOR Summit Forum (Chawla, 2020), the expansion of the signatories of the memorandum of understanding, the Central and Eastern European cooperation mechanism (Jakóbowski, 2018), etc.), 3) humanities and culture (like the OBOR Education and International Exchange Fund in Chinese universities) and other fields. So it is meaningful and challenging to explore how OBOR affects international trade.

Although OBOR has only been launched for a few years, it has become a focus for analyzing China's economic growth /welfare (Abbas et al., 2019; Wen et al., 2019; Zhai, 2018), investment (Du & Zhang, 2018; W. Li & Jin, 2018; Sauvant & Chen, 2014; G. Yang et al., 2020), trade (Bastos, 2020; Foo et al., 2020; Golovko & Sahin, 2021; Guo et al., 2017; Herrero & Xu, 2017; A. Liu et al., 2020; Ma et al., 2017; C. Yu et al., 2020; L. Yu et al., 2020) and infrastructure construction (Bandiera & Tsiropoulos, 2020; Chen & Lin, 2020; de Soyres et al., 2020).

However, due to the globalization of labour division and the involvement of OBOR in the investment field, existing literature on its impact on import and export is challenging to describe the effect of countries' participation in OBOR on their value-added trade and global value chain participation. Moreover, most of the existing literature has defects in sample coverage of countries and insufficient time like Ma et al. (2017), Foo et al. (2020) and Yu L. et al. (2020).

In addition, due to the extension of OBOR in different fields, how to accurately define OBOR has become another difficulty in research in this field. Most studies mainly describe the participating country information of OBOR based on geographical location and when the strategy was proposed (C. Liu et al., 2020; Zhang et al., 2019). Some studies (Wang & Tian, 2022) define OBOR from the perspective of political cooperation through official Memorandums of Understanding (MoUs) signatures, which have the advantages of differentiated time nodes for countries to participate in OBOR and more comprehensive coverage of countries[5]. Especially in the context of China's attempts to extend OBOR to countries in Africa (Han & Webber, 2020), Oceania (Szadziewski, 2020), and Latin America (Gélvez Rubio & Gachúz Maya, 2020; González-Sáez, 2019) due to political and trade disputes with European and American countries, as well as the Russo-Ukrainian War, this definition is closer to reality.

Finally, as an indispensable and vital component of international trade research, research on trade diversity has been conducted in multiple dimensions: country or company, import or export, market or product, and unilateral or bilateral (Arkolakis et al., 2021; Beverelli et al., 2015; Cadot et al., 2013; Carrère et al., 2011; Chaney, 2008; Dennis & Shepherd, 2011; Dogruel & Tekce, 2011; Eaton et al., 2007; Felbermayr & Kohler, 2006; Lawless, 2010; Melitz, 2003; Parteka, 2020; Parteka & Tamberi, 2013). However, the research on OBOR's impact on export diversity is minimal. One exception is Wang & Tian (2022), which focuses on China's

[5] Until 2019, China had entered into memorandums of understanding with 138 countries to collaborate on the joint construction of the One Belt One Road initiative, as per our analysis based on the OBOR website https://www.yidaiyilu.gov.cn/xwzx/roll/77298.htm.

trade and reveals that OBOR favours its extensive margin. To the best of my knowledge, no relevant literature delving into the study of OBOR on the variety of participating countries' export products or markets.

The theoretical background of my thesis is international trade theories, among others, the gravity model and theories of global value chains (GVCs). Specifically, the gravity model indicates the trade volume between countries is positively and negatively correlated with their economic scale and distance, respectively (see Chapter 1). GVC is described by Heuser & Mattoo (2017) as a value chain comprising "*the full range of activities that are required to bring a product from its conception, through its design, its sourced raw materials and intermediate inputs, its marketing, its distribution and its support to the final consumer*" (page 2). However, there is no one standard theory of GVCs. They are rooted in many trade theories. Specifically, the structure can be checked in Figure 1. And the measurement methods linked with GVCs are also diversified (for details, see Chapter 2).

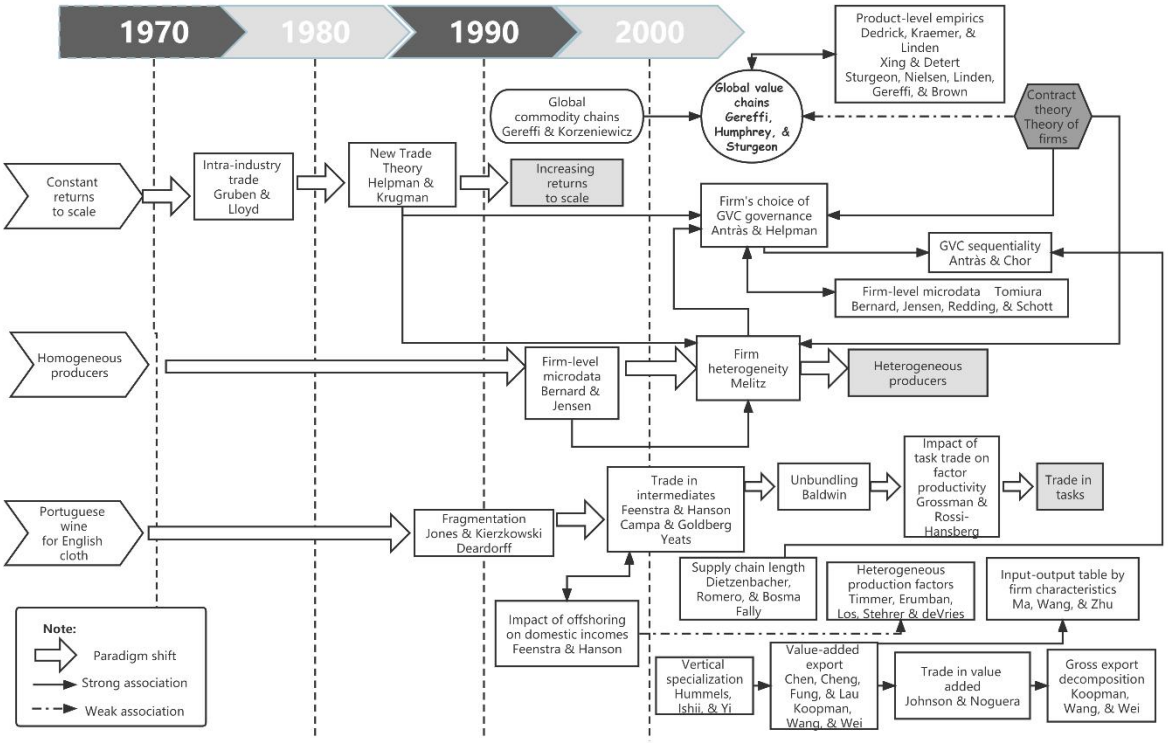

Fig. 1 Analytical Frameworks for Global Value Chains: international trade theories

Source: own elaboration based on Figure 1.1 in Global Value Chain Development Report 2017 (World Bank Group et al., 2017).

Given the shortcomings of the previous literature, I discuss the development of China's international trade and focus on the potential impact of OBOR from the three dimensions of import and export, global value chain and export diversity. I propose the following research hypotheses:

H1: OBOR helps promote bilateral trade. (Chapter 1)

H2: The roles of economic corridors in OBOR in fostering bilateral trade are different. (Chapter 1)

H3: OBOR positively associates with bilateral value-added trade and industrial connections. (Chapter 2)

H4: The economic corridors in OBOR have various relationships with GVCs (due to different industries and developments in each economic corridor). (Chapter 2)

H5: China's GVCs and domestic value chains (PVCs and PRVCs) significantly affect their labour market. (Chapter 2)

H6: OBOR helps to enhance the diversity of participating countries' export products and markets through improved infrastructure. (Chapter 3)

H7: The large influx of Chinese goods may harm OBOR's participation in domestic industries, hurting its export diversity. (Chapter 3)

H8: Chinese firms' investment in OBOR countries (primarily in logistics and energy) may hurt other industries and reduce export product diversification. (Chapter3)

H9: The roles of different company assets (state-owned, private, foreign, etc.) on a firm's export-intensive and extensive margins may differ. (Chapter 3)

This thesis consists of three sub-themes, namely, Chapter 1 - "The impact of China's One-Belt One-Road Initiative on international trade", Chapter 2 - "China and global value chains (gvcs)", and Chapter 3 - "Research on the determinants of export diversification: evidence from China and OBOR".

Specifically, the purpose of my research in the first chapter is to verify the potential impact of OBOR on bilateral imports and exports. In order to better validate its effects from a global perspective, I have established a database covering 186 countries and their 199 trading partners, spanning from 2000 to 2018. In the empirical analysis part, I follow the previous literature and adopt the gravity model as the basis to select appropriate fixed variables, regression equations, and other measures to solve the problems of zero trade, multiple resistance, and endogeneity. The results show that OBOR has a significant promoting effect on international trade, and the following economic corridors have already had a positive impact on trade: China Pakistan (CP), China Mongolia Russian Federation (CMRF), and Bangladesh China India Myanmar (BCIM).

In Chapter 2, my research focus is on global value chains. My first research objective is to verify the effects of OBOR on value-added trade and industrial linkages as a supplement to the first chapter and existing literature on OBOR trade. The second goal is to measure the trend of China's participation and position in GVCs. The final goal is to verify the relationship between global and domestic value chains (intra-provincial and inter-provincial value chains) and labour market variables at China's provincial level.

To achieve the above goals, I have established four sets of data: 1) a value-added trade database covering 61 countries (32 OBOR members) from 2010 to 2017; 2) Introducing a new dependent variable (the value of partner countries' contribution to the total export volume of the reporter) to validate industrial linkages and ultimately establishing a database of 178 countries from 2000 to 2018; 3) A database of global value chain measurement indicators covering 62

countries and 34 sectors from 2007 to 2020 and 4) the data on the labour market, trade, and global value chain covering 31 provinces and 25 sectors in 2005, 2012, and 2017.

For OBOR and value-added trade and industry connection, I follow a similar empirical method (gravity model) as in Chapter 1. For GVC indicators, the primary method relies on the statistical description. At last, I choose seemingly unrelated regression estimation (SURE) to a set of equations to evaluate the simultaneous impact of the participation of various value chains on the labour market (wages, employment and productivity).

The research results indicate that 1) OBOR positively impacts the global sample and China's value-added trade and global value chain as a reporting sample. Regarding economic corridors, CP and BCIM are significant in both global and Chinese samples. 2) From 2007 to 2020, China's industrial upgrading has elevated its position in the global value chain. At the same time, the expansion of the domestic value chain due to the growth of the domestic market ultimately hinders its participation in the global value chain. 3) Regarding the labour market results, wages and employment and wages and productivity are positively connected, whereas employment and productivity are adversely correlated. In addition, the participation of global value chains has slowed down employment and productivity growth, possibly due to "low-end technology lock-in" and a lack of labour cost advantages. For domestic value chain participation, the results are not consistent.

In the third chapter, my main goal is to explore the impact of OBOR on the export diversity (markets and products) of participating countries. In addition, I also verified the relationship between different types of assets (state-owned, private and foreign capital) and their extensive marginal and intensive marginal growth based on Chinese enterprise-level data validation. I established two databases in this chapter: 1) OBOR and export diversity: sample data from 183 countries from 2000 to 2018. 2) By combining the database of Chinese industrial enterprises with the database of Chinese customs, the intensive marginal growth and extensive marginal growth of enterprises above the designated size in Guangdong Province, the most significant economic province in China, with a turnover of over 20 million RMB, were calculated in 2012 and 2013. The method employed in the first analysis is the instrumental variable (IV), which can address endogeneity. I take statistical description as the primary method for intensive and extensive margins. The final result shows that: 1) OBOR damages the export diversity of products and markets. The results of the Asian Investment Bank in terms of export diversity are inconsistent, with significant adverse effects at the product level and unclear results at the market level. 2) Enterprises with more private and state-owned capital often explore new markets and develop new products. The more significant the proportion of foreign investment, the less willing they are to explore new markets.

The main novelty of the thesis is connected with 1) filling the limitation of OBOR research in the value-added trade, GVCs and export diversification, 2) providing a method for calculating GVCs and domestic (intra and inter-provincial) value chains based on domestic and global input-output tables and compensating the gap related to research on value chains and labour

markets. There are also Stata do files and R RMD files[6] which can be used by other researchers to replicate the analysis or to conduct further research on the related theme.

[6] The specific files' information can be checked in Supplementary Materials, and the link to these files is: https://drive.google.com/drive/folders/1l6V7YF0SaTVHoQPL1s7Tp0zs5Gm_xiqg?usp=sharing.

1 THE IMPACT OF CHINA'S ONE-BELT ONE-ROAD INITIATIVE ON INTERNATIONAL TRADE

1.1 Introduction

Since the "reform and opening-up" implementation in 1978, China has been actively integrating into the international market. Especially after it accedes to the world trade organization, its foreign trade has expanded rapidly. According to the WTO's estimation, its share in the world's export reached 13.2% in 2019, ranking first. However, after the subprime mortgage crisis in 2008, China's economic development changed from high-speed growth to medium high-speed growth (e.g. the GDP growth rate has decreased slowly from 10.636% in 2010 to 5.95% in 2019 based on World Bank Database).

The last Hu-Wen administration put forward a 'four trillion investment plan' to block the negative impact of the US subprime mortgage crisis on China's economic growth in 2008. This vast investment led to China's success in getting rid of economic difficulties but also brought colossal government debt (Fu & Wang, 2020), especially the real estate foam[7] and rapid growth of local debt[8] caused by local governments relying on shadow banks to sell land use rights (Sum, 2019). To promote China's growth engine to shift from investment to domestic consumption, reduce the proportion of government debt and further liberalize administrative approval restrictions, prime minister Li proposed 'Likonomics' at the beginning of taking office in March 2013 (Lin & Katada, 2022). Subsequently, in order to cope with the problems of weak economic growth, gradual loss of labour cost advantages (Luo et al., 2019) and overcapacity (Du & Zhang, 2018), the "One-Belt One-Road" initiative (OBOR) was proposed by the Chinese government in September 2013. Its official aims can be combined into five major parts: strengthen policy coordination, infrastructure connectivity, unimpeded trade, financial integration, and connections among people across countries along the Silk Road Economic Belt and the Maritime Silk Road (Office of the Leading Group for Promoting the Belt and Road Initiative, 2019). The geographical members of OBOR can be divided into six economic corridors: Bangladesh-China-India-Myanmar (BCIM), China-Central West Asia (CCWA), China-Indochina Peninsula (CIP), China-Mongolia-Russian Federation (CMRF), China-Pakistan (CP) and New

[7] The average square unit price of second-hand apartments in 367 cities across China increased from 9435 yuan in 2009 to 11860 yuan in 2013 and reached 14042 yuan in 2015. At the same time, the number of houses increased from 6.235 million in 2009 to 18.282 million in 2013 and reached 27.976 million in 2015 (CityRE Data, 2023).

[8] According to (Sum, 2019) and (China electronic localgovernment bond market access, 2023), the local government debt balance has increased from 4.97 trillion yuan at the end of 2010 to 10.9 trillion yuan in June 2013 and 14.7568 trillion yuan in 2015.

Eurasian Land Bridge (NELB) (OECD, 2018). The list of countries and an illustration of the corridors are presented in Figures A.1 and Table A.1.

As OBOR does not introduce specific provisions (tariff reduction or lifting, rules of origin, certificates of origin, customs procedures and trade facilitation provisions, etc.) like trade agreements in the early stage. Besides, it has only been proposed for a few years, and not many researchers are trying to analyze its impacts on the trade aspect. In recent years, China's active participation in the global value chain and seeking industrial upgrading have also brought new research directions and challenges to the research on its international trade.

OBOR is not only one of China's most important and influential foreign cooperation strategies but also an important part that I cannot ignore in exploring the field of China's international trade. OBOR has made remarkable achievements in the field of trade since it was proposed. For example, the value of Trans-Eurasia Logistics (also named by China Railway Express - CR Express) goods in 2020 reached US $50 billion, 6.3 times that of 2016. In addition, The number of CR Express increased from 80 in 2013 to 8225 in 2019 (Xinhua News Agency, 2021). During the same period, the number of return trains also rose from 0 in 2013 to 3700 in 2019, accounting for 44.98% of the total (Institute for Belt & Road Economic and Trade Cooperation, 2021).

Additionally, due to the fact China is regarded as the "world factory" highly involved in international trade, and OBOR covers 64% of the world's population and 30% of the world's GDP (Y. Huang, 2016). Therefore, it may affect the Chinese economy, all participants, and even the world economy. It will also create possibilities for global cooperation (Flint & Zhu, 2019). So the perspectives in the Chapter are Multidimensional (global, participants and China), and the empirical analysis is not limited to China's partners.

The main research objective of this Chapter is: to analyze the current situation of China's international trade and explore the roles of OBOR in this aspect. Within this research objective, three clear goals are presented:

1) verifying the relationship between OBOR and the volume of bilateral trade.

2) examining the different roles of corridors in international trade.

3) checking the difference between different research samples (global, participants and China)

The data on bilateral trade (imports and exports)[9] and gravity variables[10] are taken from the UN Comtrade Database in WITS and CEPII. Current GDP and GDP per capita are drawn from World Bank. Membership in specific regional organizations such as WTO, Association of Southeast Asian Nations (ASEAN), ASEAN-China Free Trade Area (ACFTA), and OBOR rely on

[9] The original data based on imports and exports may differ in the number of observations and values. In this chapter, I will explore the effects of OBOR on imports and exports, respectively. For example, 1) the number of observations for exports and imports is 371,361 and 426,375, respectively. 2)The export volume from Poland to Italy is 1.20e+07 (1000 US Dollar), while Italy imports 1.14e+07 (1000 US Dollar) from Poland. Although mirror statistics can solve many data problems, they cannot reflect the actual situation.

[10] Since gravity variables are not time-varying, so I extended the data from 2015 to 2018.

CEPII, Zhang and Wang (2015), OECD (2018) and the official websites of these organizations. The final global dataset contains information on 186 reporting countries and 199 trading partners from 2000 to 2018.

The novelty of this Chapter is to explore the effects of OBOR on bilateral trade from various perspectives and compare the differences in OBOR economic corridors. The paper is organized as follows. The empirical literature on international trade, OBOR and ACFTA is reviewed in the next section. Then the third section presents the data with descriptive statistics showing trade trends. Followed by the empirical analysis, based on augmented gravity models, is shown in the fourth sub-chapter. The fifth part relates to extensions and robustness, and the last section is the conclusion which discusses findings, contributions, limitations and future research.

1.2 Literature Review

1.2.1 Literature about international trade and the gravity model

The research on the impact factors of international trade has been developed and expanded in the past few centuries. As an early representative of mercantilism, Antoine de Montchrestien suggested that the government impose high tariffs on foreign goods as early as the early 17th century to protect France's manufacturing and handicraft industries (Fontanel et al., 2008). Subsequently, researchers (Anderson, 1979; Antràs & Helpman, 2004; Heckscher, 1919; Krugman, 1979; Melitz, 2003; Ohlin, 1933; Ricardo, 1817; Smith, 1776; Tinbergen, 1962) provide a theoretical basis for exploring the factors affecting bilateral trade (e.g., Absolute advantage trade theory, Comparative advantage trade theory, Heckscher–Ohlin trade theory, New trade theory, New New trade theory, Gravity model of trade and so on).

Among them, the gravity model has been employed and developed by a vast number of researchers to analyze the influence factors of trade. Specifically, the trade volume between two countries is directly positively affected by their economic scales and is inhibited by the distance between them, relying on the gravity trade model (Anderson, 1979). GDP, GNP and population are usually employed for representing economic or country scales and have been proven their positive effects on international trade (Batra, 2006; Jiang & Huo, 2015; Roberts, 2004; Y. Sheng et al., 2014; S. Yang & Martinez-Zarzoso, 2014; Zhang & Wang, 2015). The following variables have been widely added or proved in past empirical works (Batra, 2006; Bussière et al., 2008; Bussière & Schnatz, 2009; Rahman & Dutta, 2012; Roberts, 2004; Stijns, 2003) based on the gravity model: 1) GDP per capita, 2) common border, 3) colonization, 4) common language, 5) the same country in the past, 6) free trade agreement/area (FTA), 7) trade openness ratio, etc. Some researchers also expanded the factors to other aspects like exchange rates, consumer price index, trade policy, trade barriers, migration and so on (Carter & Poast, 2020; Jansen & Piermartini, 2009; Sonora, 2014; Y. Yang & Wong, 2012).

1.2.2 Literature related to the ASEAN-China Free Trade Area (ACFTA)

For promoting trade in goods and services, FTAs have been widely created by countries[11] to eliminate trade barriers (e.g., tariffs, customs clearance costs, trade quotas, technical barriers to trade, etc.) and focused by researchers related to international trade and

[11] According to the WTO-RTA Database, I can find that the number of regional trade agreements has increased from 82 in 2000 to 354 in 2021. Retrieved from https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx on 01.02.2023

gravity model (Irshad et al., 2018; Kahouli & Maktouf, 2015; Kristjansdottir et al., 2022; Timsina & Culas, 2020; J. Wang et al., 2022).

With China's entry into the WTO in 2001, it has become more and more important in international trade[12] and manufacturing[13]. As China's most influential free trade agreement, ACFTA has also been concerned by researchers engaged in China's international trade. Since ASEAN surpassed the United States and the European Union to become China's largest trading partner in 2020 (Wolszczak-Derlacz & Lu, 2022). In addition, the establishment of the Regional Comprehensive Economic Partnership (RCEP) in 2021, the largest regional trade area (Armstrong & Drysdale, 2022) and regarded as an expansion for ACFTA (Ye, 2015). So it is indispensable to review relevant research on ACFTA.

Among them, as early as three years after the ACFTA negotiations, the gravity model has been first used in analyzing the trade flows in this region by Roberts (Roberts, 2004). In his suggestion, the participating countries need to formulate positive strategies to promote the convergence of income levels to obtain the agreement's maximum benefits.

Then Yang & Martinez-Zarzoso (2014) create a database which covers the trade data of four categories of goods from 31 countries between 1995 and 2010. And they introduce a multinomial PML approach to check how ACFTA affects international trade. The promotion effect of ACFTA has been proven on members' overall trade, especially in agriculture and significant manufacturing goods.

Considering the world exports of intermediate goods account for 50 per cent in 2022, which kept a similar level in the past ten years (World Trade Organization, 2022), Sheng et al. (2014) verify the positive impact of ACFTA on components trade. The results also showed that the closer the industrial ties with China, the greater the effect. Additionally, Zhang & Wang (2015) obtain the trade potential index of China's exports to ASEAN members by introducing new economic scale variables based on industrial added value, intermediate imports and GDP in the gravity equation. Based on the trade potential indexes, the ASEAN members can be classified into three groups: huge-potential (Brunei, Indonesia, Cambodia, Myanmar), still not fully developed potential (Philippines, Thailand, Vietnam) and fully developed but needing to recreate potential (Singapore). The results show that the newly employed economic scale variables had more advantages because intermediate products accounted for a higher proportion of trade between China and ASEAN, which is also proved by the unclear result of the RMB's nominal effective exchange rate.

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[12] The share of China's exports worldwide rapidly increased from 4.295% in 2001 to 15.056% in 2021, relying upon UNCTAD Statistics Data.
Retrieved from https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=en on 01.02.2023.

[13] Based on The National Accounts Main Aggregates Database, China's value added by manufacturing activities accounts for the world from 12.628% in 2004 to 30.947% in 2021 (Note: The value-added data in manufacturing activities for China starts from 2004). Retrieved from https://unstats.un.org/unsd/snaama/basic on 01.02.2023.

Follow by Jiang & Huo (2015) confirm the more significant creation impacts on China's export to ASEAN than imports. So it is meaningful to check the different effects of factors on import and export in this Chapter. Based on these literature results, I expect that ASEAN and ACFTA are essential factors affecting international trade, especially for China and, as such, should be added to the extended gravity equation.

1.2.3 Literature pertaining to the One-Belt One-Road (OBOR)

First, as a vital part of OBOR, infrastructure connectivity has attracted the interest of many researchers. For example, Chen & Lin (2020) comprehensively construct the analysis method of the impact of transportation networks on the growth of foreign direct investment (FDI). In addition, they also verify the positive effect of the optimization of transportation networks brought by the infrastructure construction under the OBOR initiative on attracting FDI in OBOR countries and non-OBOR countries. At a similar time, Bandiera & Tsiropoulos (2020) point out that the growth effect brought by OBOR-related infrastructure is not enough to cover the short-term debt risk (especially in those countries with high-risk debt). Besides, De Soyres et al. (2020) extend the research to analyze the impacts of infrastructure construction under OBOR on various aspects like trade, economic growth and welfare, relying on a new trade policy framework.

Some researchers consider the scale effect caused by the industrial agglomeration of OBOR infrastructure to some export cities or regions in Central Asia and the attraction of labour inflow. Bird et al. (2020) indicate that when economies of scale and labour mobility were added to the analysis model, the positive effect of OBOR on real income was more prominent. Lall & Lebrand (2020) also achieve similar results in this field, and they point out that the more restrictions on labour mobility, the unequal income will be. Finally, Baniya et al. (2020) also analyze the impact of OBOR on trade flow from the perspective of trade time and test regional and sectoral differences.

Another research topic related to OBOR is the investment (Sauvant & Chen, 2014), and two key organizations (the Asian Infrastructure Investment Bank and the Silk Road Fund) were established at the early stage of OBOR (W. Li & Jin, 2018). For instance, Du & Zhang (2018) certify that after the implementation of OBOR, China's overseas investment, especially cross-border mergers and acquisitions, increased significantly. They point out that state-owned controlled assets occupied a significant position in infrastructure, while other purchasers mainly focused on non-infrastructure industries. Yang et al. (2020) further confirm that infrastructure investment under OBOR positively affects most countries' economic growth, welfare and foreign trade. Furthermore, OBOR also promotes China's industrial upgrading.

Some researchers also check the impact of OBOR on the welfare aspect and extend to its corridors level. Among them, Zhai (2018) examine the positive effect of OBOR on general welfare. Additionally, Wen et al. (2019) confirm that the Sino-EU trade's potential four economic corridors under OBOR have more advantages than the traditional maritime trade routes. Finally, Abbas et al. (2019) discuss the effect of China Pakistan Economic Corridor afterwards. They

found that it positively affects China and its neighbouring countries, especially its positive impact on Pakistan's employment, income and GDP.

OBOR did not introduce specific provisions (tariff reduction or lifting, rules of origin, certificates of origin, customs procedures and trade facilitation provisions, etc.) like trade agreements in the early stage. In recent years, with OBOR-related infrastructure's improvement and expansion of its memorandum of cooperation members, the research on its trade effects has also increased significantly (Bastos, 2020; Foo et al., 2020; Golovko & Sahin, 2021; Guo et al., 2017; Herrero & Xu, 2017; A. Liu et al., 2020; Ma et al., 2017; C. Yu et al., 2020; L. Yu et al., 2020).

Guo et al. (2017) determine the main influencing variables based on the gravity model and compared China's oil import data in 2008-2012 and 2013-2015. They find that the countries along the OBOR gradually became the central source of countries after implementing the initiative. With the promotion of infrastructure in OBOR, its positive effects on China-EU trade have been proven by Herrero & Xu (2017) and are more significant in Eastern Europe.

Similarly, Ma et al. (2017) use the GMM method in the gravity model to confirm that OBOR promoted agricultural trade between China and Central Asian countries relying on some specific measures (green channel of farm products). Then, Foo et al. (2020) introduce two additional variables (total exports to the world and total imports from countries other than the partner country) in the gravity model from the level of bilateral trade. They verify the significant positive effect of OBOR on trade between China and ASEAN countries. Recently, Bastos (2020) analyze the differences in the effects of China's imports and export on OBOR countries in different industries. Among them, the adverse impact of exports is mainly concentrated in countries similar to China's export structure and the sector close to the final consumption. The upstream industries of these economies are the biggest beneficiaries of China's imports. This study also triggered our research on the diversity of export products by OBOR in the third Chapter. After that, Yu L. et al. (2020) confirm again that OBOR could promote China's export potential and show that it was more prominent in capital-intensive products or the Commonwealth of Independent States (CIS) and South Asian countries. Besides, Yu C. et al. (2020) verify the positive effects of "OBOR" on bilateral trade preferences between China and its partners and extended their research to different economic corridors of OBOR. Besides, Liu et al. (2020) analyze the impact of cultural and institutional distance on trade between countries along OBOR and China. They find that these two kinds of distance hinder trade, in which cultural difference is more sensitive to the inhibition of trade and has been alleviated after the implementation of OBOR. Finally, Golovko and Sahin (2021) use the gravity model to analyze the main factors (distance, border, infrastructure density, free trade policy, etc.) that affect the international integration of Eurasian countries. And they point out that the actual trade outside the region is lower than its potential trade. They believe strengthening infrastructure construction can solve this problem. Therefore, China's One-Belt One-Road initiative is vital for these countries.

However, the above literature is limited to gross trade and has not discussed OBOR from the global value chain perspective. Moreover, the data of some studies do not cover a wide range of countries, e.g. are limited to China's main partners in Ma et al. (2017), Foo et al. (2020) and Yu L. et al. (2020).

1.3 Data and Descriptive Statistics

The global bilateral trade data set sample covers 186 reporting countries and 199 trading partners from 2000 to 2018. Among the variables utilized in further empirical analysis: data on exports and imports come from WITS; gravity variables[14] are taken from CEPII; GDP and GDP per capita from the World Bank. The information about participation in ASEAN and ACFTA is obtained from their official websites, and Zhang & Wang (2015), involvement in OBOR is based on OECD (2018). Membership in WTO is integrated from the WTO website (2000- 2015) and CEPII (2016- 2018). (see Table A.3 and A.4 in Appendix for the sources and descriptive statistics)

1.3.1 Global Perspective

First, the percentages of OBOR participants and its different corridors account for the world's imports and exports are shown in Fig. 1.1 and Fig. 1.2. As I mentioned in the Introduction, China's export accounted for 13.2% in 2019. Additionally, China is naturally a member of OBOR corridors, so I extract China from each economic corridor as a separate part.

According to these two figures, OBOR also plays an increasingly important role in import and export due to the rapid increase of China's share in global trade. Specifically, OBOR and China's ratio of global imports increased from 16.99% and 3.51% in 2000 to 34.41% (double) and 10.66% (triple) in 2018. A similar illustration related to OBOR and China also has been achieved in exports in 2000- 2018 (OBOR: 20.75% to 37.94%; China: 4.31% to 13.94%).

Among all the corridors, China Indo-china Peninsula (CIP) accounts for the most significant proportions in global imports (6.50%) and exports (6.97%), which is consistent with the situation researchers tend to concentrate on the ASEAN countries.

However, in terms of growth rate, the performance of other economic corridors is more prominent. For exports, China-Central West Asia (CCWA), China-Pakistan (CP) and China-Mongolia-Russian Federation (CMRF) all increased by more than 100%, and CCWA and CP tripled (from 1.03% to 3.05% and 0.98% to 3.42%, respectively). The growth rates of CCWA and New Eurasian Land Bridge (NELB) are beyond 100% for import proportions.

[14] The gravity variables including contiguity, bilateral distance, colonial relationship, same country before and common language.

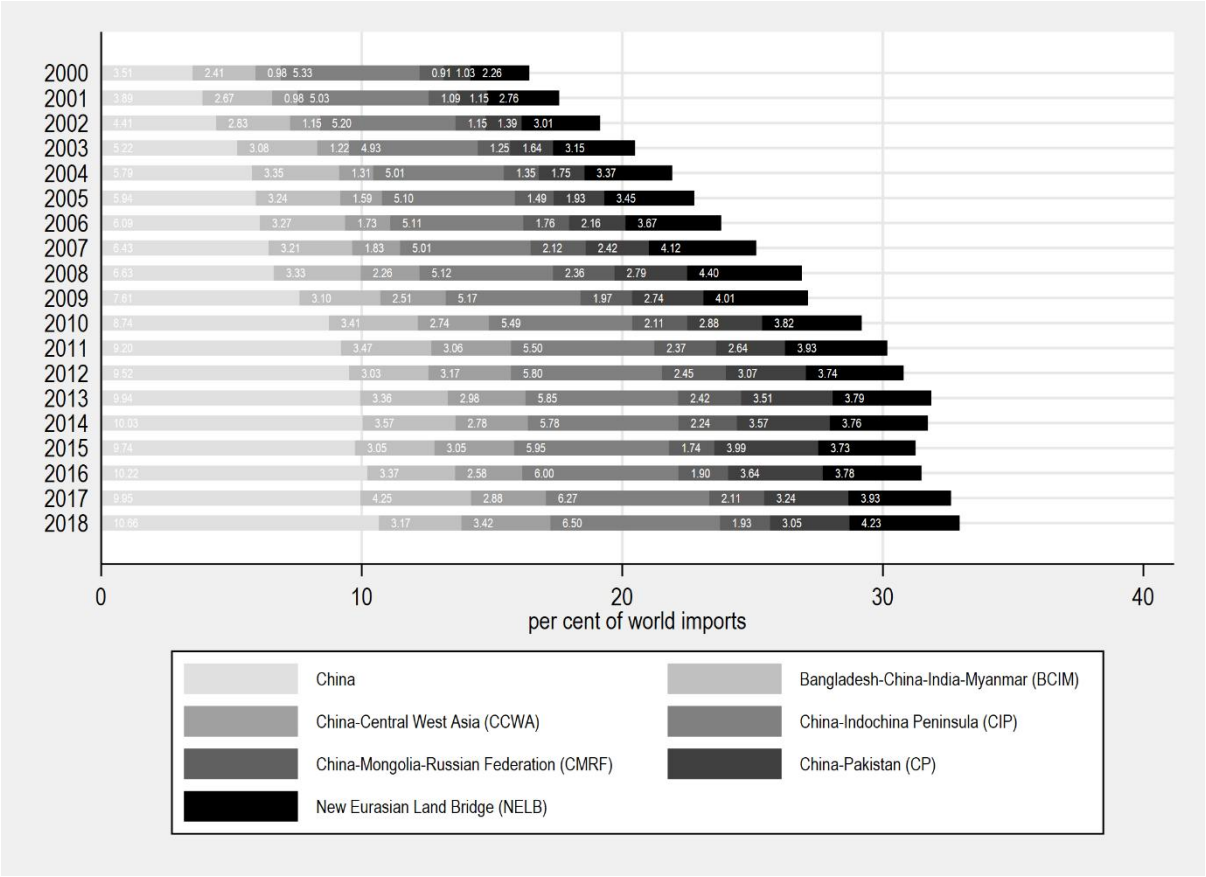

Fig. 1. 1 Share of OBOR's economic corridors in world imports

Note: Since China is a member of all the corridors, it is marked separately.

Source: own elaboration based on data from the UN Comtrade database extracted through WITS.

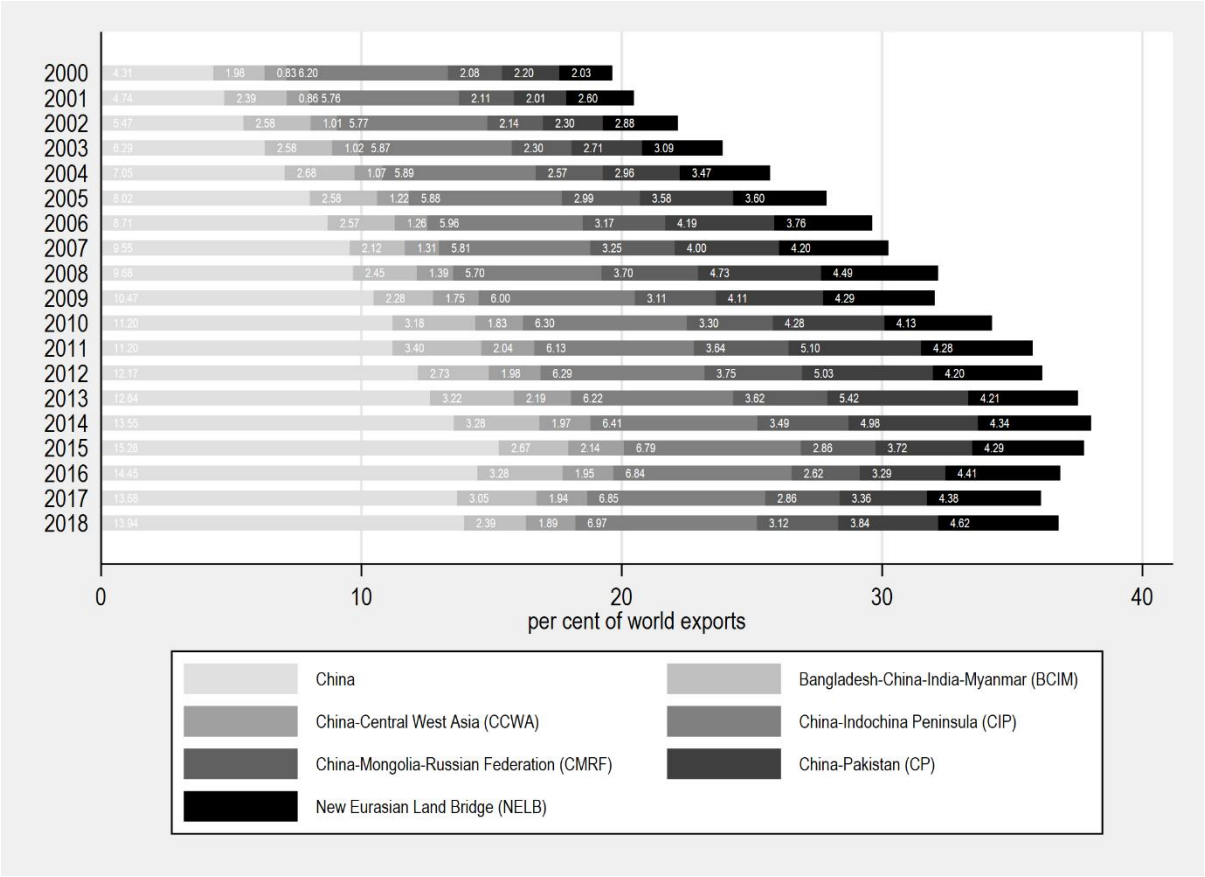

Fig. 1. 2 Share of OBOR's economic corridors in world exports

Note: Since China is a member of all corridors, it is marked separately.

Source: own elaboration based on data from the UN Comtrade database extracted through WITS.

1.3.2 China's Perspective

Next, I will perform the analysis from the perspective of China.. First, I explore the trend and growth rate of China's exports from 2000- 2018 in Fig. 1.3. China has increased nearly tenfold in this period by the value of exports. According to the growth rate, China's exports have gradually transited from a high growth rate (over 17%) after joining the WTO in 2001 to a medium and low growth rate after 2012, which is also similar to China's GDP growth trend. Notably, the decline in external demand caused by the subprime crisis in 2008 led to the enormous negative growth of its exports since this century in 2009. To cope with China's export and economy entering the "medium and low-speed growth - new normal" stage (Wang, 2021), the OBOR proposed at the end of 2013. But it has not reversed the adverse situation of China's export at the initial stage (China's export growth rate recorded a negative number in 2015 and 2016). That also explains why there were not many studies on OBOR and trade at the early stage.

Then I explore the properties of twelve central trade economics[15] in China's export in Fig. 1.4. First of all, I find that the proportion of these significant trading objects in China's exports has decreased from more than 70% at the beginning of this century but still has half of the share in 2018, primarily the United States has always occupied the first place in China's exports. Specifically, I find that most OBOR participants (except Singapore, which decreased from 2.31% to 2.00%) in these head markets have nearly doubled their share in China's exports, especially India, which recorded a roughly 5-fold increase (0.63% to 3.08%). In addition to Australia (1.38% to 1.9%), the role of non-OBOR economics in China's exports has declined. In particular, Japan's proportion has dropped by almost two-thirds compared with the beginning of this century (16.72% to 5.90%). This change also can be seen as a basis to guess that the OBOR region's market is increasingly important for China's exports.

Based on exploring the changes in the proportion of each economic corridor in world exports in Fig. 1.2, I try to analyze the role and differences of each corridor in China's exports in Fig. 1.5. The percentage of OBOR members in China's exports has nearly doubled from 2000 to 2018 (12.56% to 26.06%), proving the guesswork in Fig. 1.4. Subsequently, CIP remains the first corridor in China's exports (10.7% in 2018), which keeps its role in world exports (Fig. 1.2). So it is meaningful to check the effect of ASEAN and ACFTA on the trade regardless of the global sample or China aspect. At the same time, CMRF and NELB account for the last two rankings with 2.2% and 2.6%, respectively. As far as the growth rate is concerned, BCIM has become the top leader, which has increased nearly three times (1.45% in 2000 to 4.43% in 2018).

Finally, I examine the proportions of OBOR and non-OBOR participants as two groups in China's trade and their changes in Fig. 1.6. Since the beginning of this century, China's imports and exports to OBOR and non-OBOR markets have significantly progressed and only declined in a few years (2009, 2015 and 2016). It is similar to the trend I get from the overall import and export to China in Fig. 1.1 and Fig. 1.2. Therefore, when I conduct subsequent empirical analysis, I need to consider controlling the challenges caused by the macroeconomic background. After proposing OBOR, the gap between Chinese imports and exports vis-à-vis the OBOR countries narrowed, while that vis-à-vis the non-OBOR countries remained broadly unchanged.

[15] Australia (AUS), Germany (DEU), United Kingdom (GBR), Hong Kong (HKG), India (IND), Japan (JPN), South Korea (KOR), Malaysia (MYS), Russia (RUS), Singapore (SGP), Thailand (THA) and United States (USA).

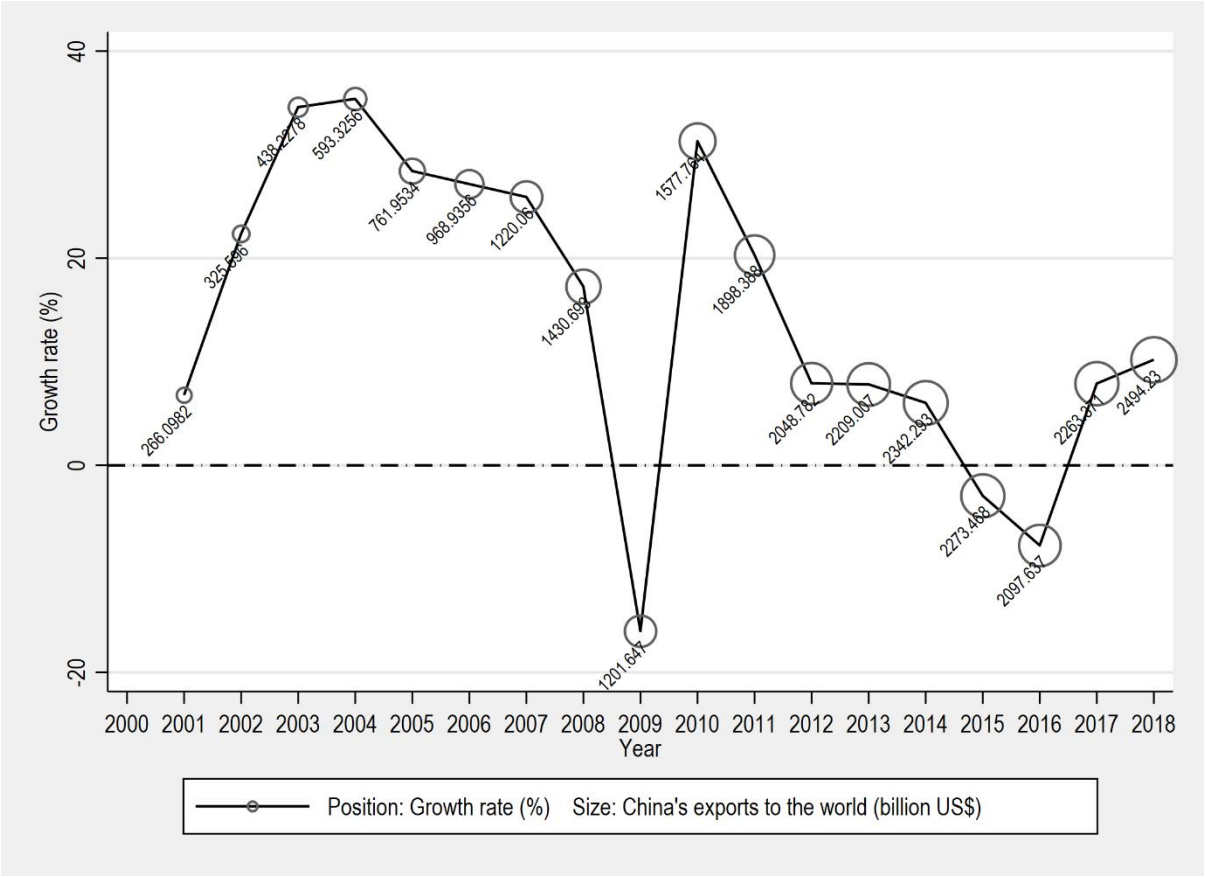

Fig. 1. 3 The trend and growth rate of China's exports to the world

Source: own elaboration based on data from the UN Comtrade database extracted through WITS

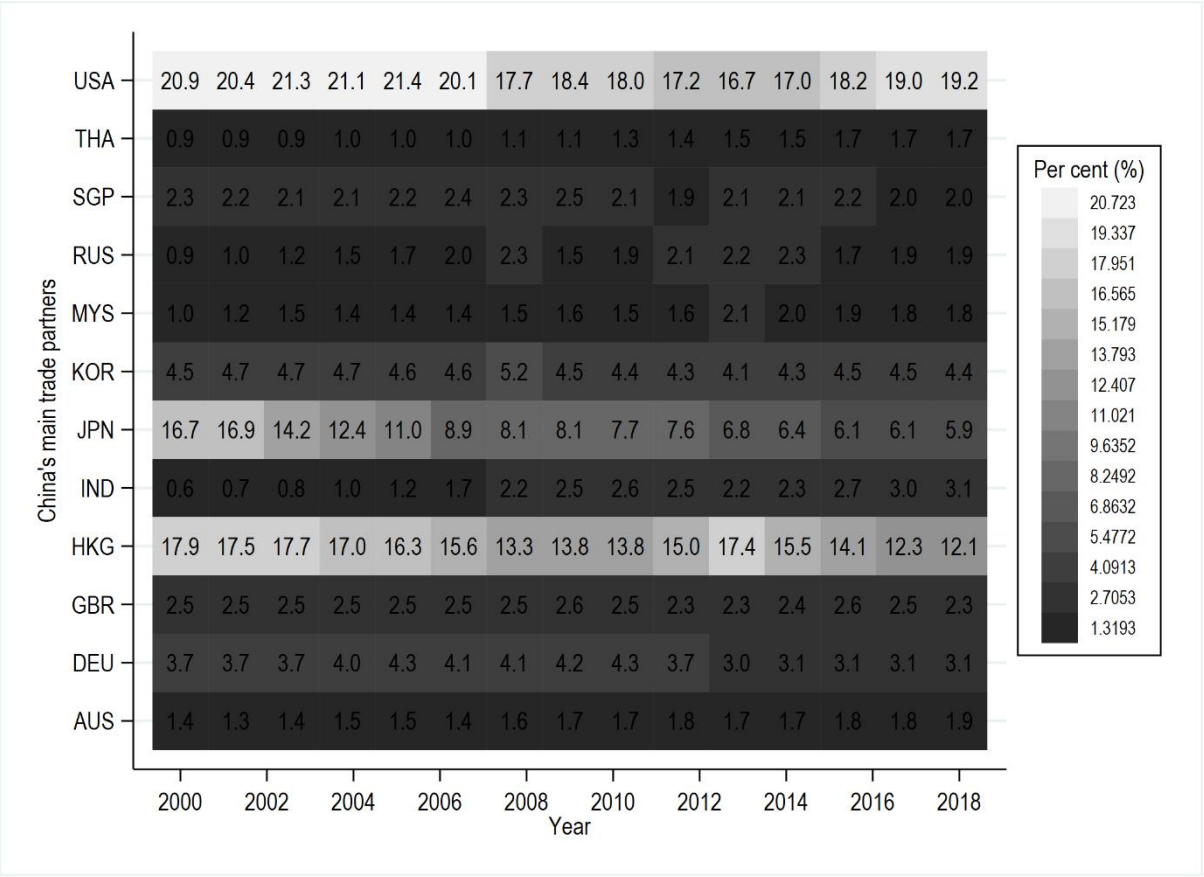

Fig. 1. 4 Proportion of major trading countries in China's total exports

Source: own elaboration based on data from the UN Comtrade database extracted through WITS.

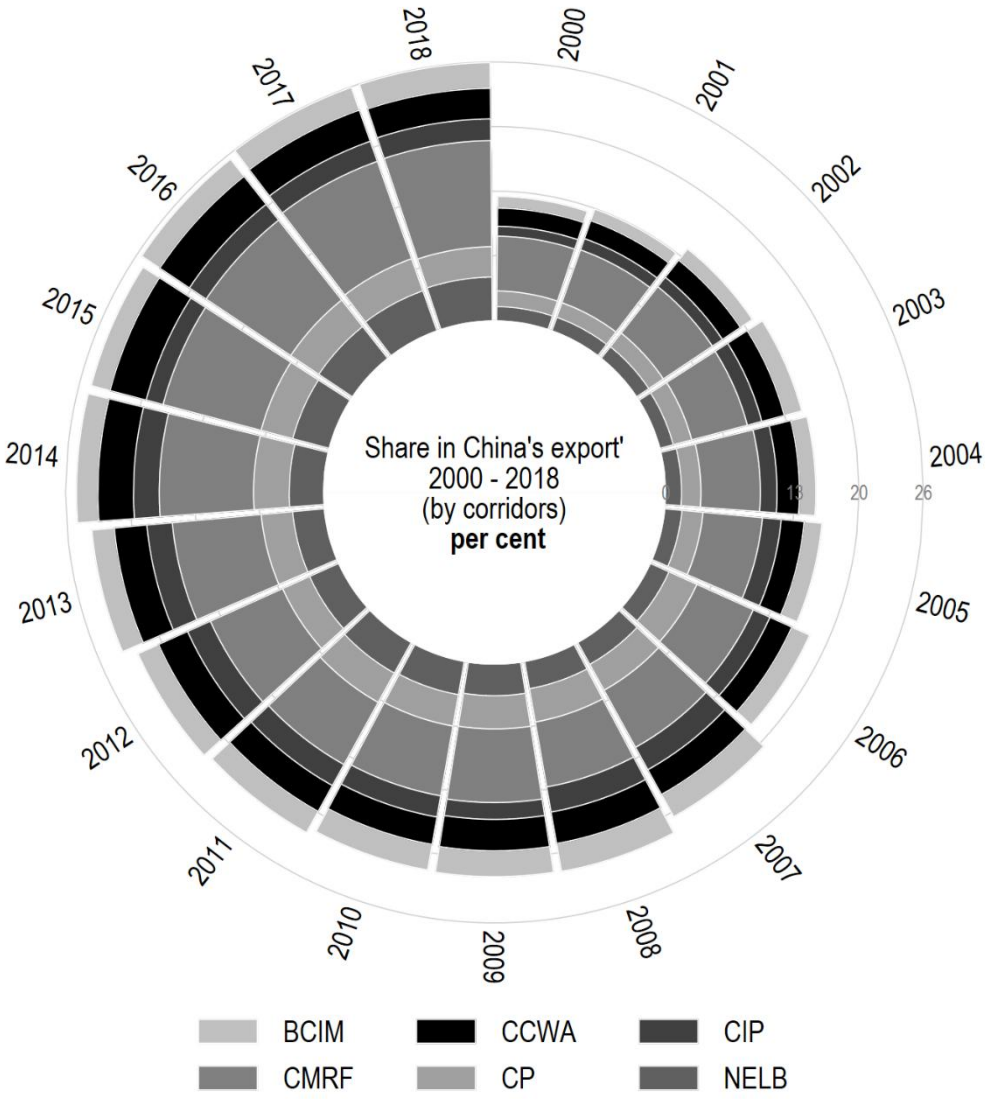

Fig. 1. 5 Proportion of OBOR's different economic corridors in China's total exports

Source: own elaboration based on data from the UN Comtrade database extracted through WITS.

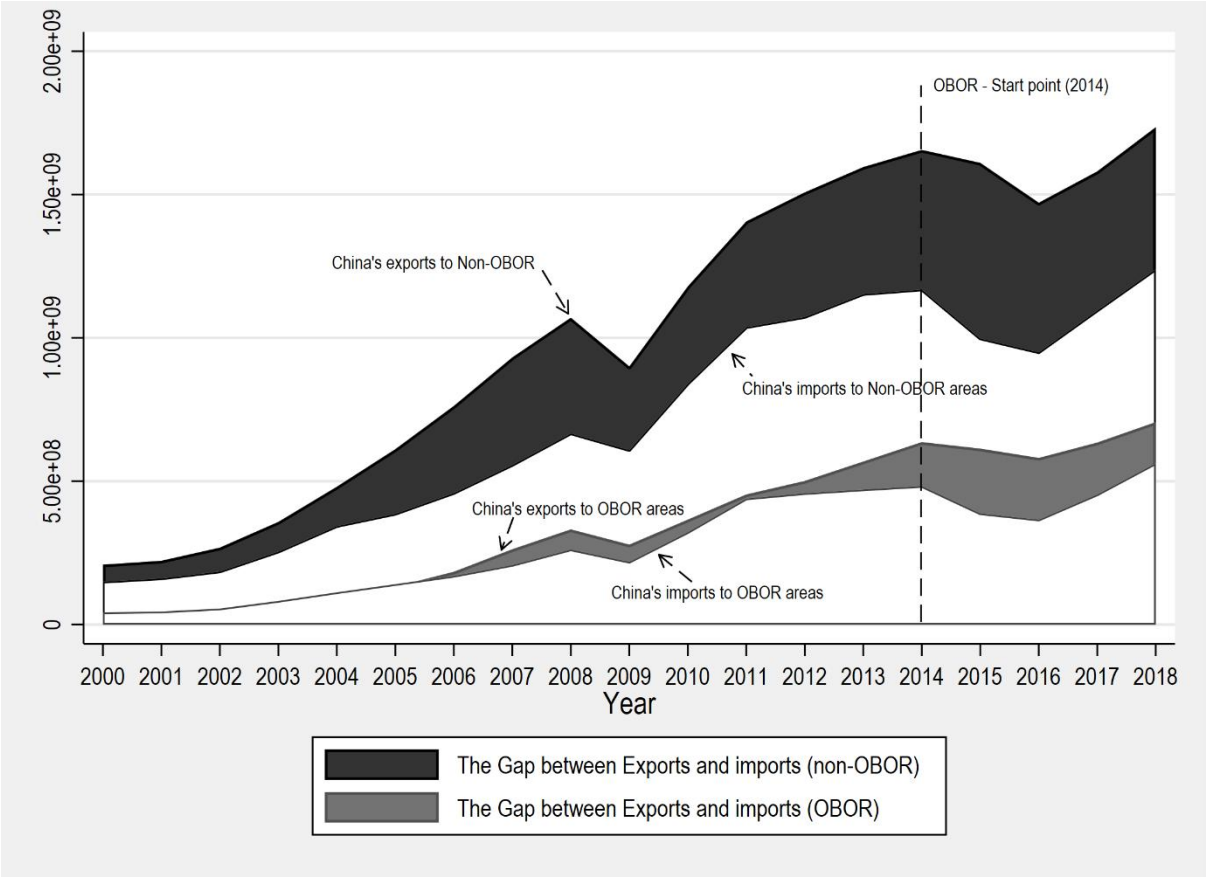

Fig. 1. 6 China's imports and exports vis-à-vis OBOR and non-OBOR countries: 2000-2018 (thousands of USD)

Note: The composition of non-OBOR counties is not constant over time. Missing countries and periods: Aruba (2006); Faeroe Islands (2000-2005); San Marino (2005-2006); Turks and Caicos Isl. (2002); Tuvalu (2000-2001).

Source: own elaboration based on the UN Comtrade database extracted through WITS.

1.4 Empirical Analysis

1.4.1 The gravity model of international trade

As I reviewed in chapter 1.2.1, the gravity model of international trade has been widely used in analyzing the impact factors of bilateral trade, and its reliability has been fully verified. Therefore, I also use it to construct the empirical analysis model in this research.

In the summary of international trade, some studies found that the trade volume between the two countries is proportional to their economic scales and inversely proportional to their distance. Because it is similar to Newton's law of gravity, it is ordered to be the gravity model of international trade (Anderson, 1979; Tinbergen, 1962). And the general formula can be presented like this:

$$X_{rpt} = \alpha Y_{r,t}^{\beta 1} Y_{p,t}^{\beta 2} Dist_{rp}^{\beta 3} \quad (1.1)$$

and usually expressed in log-log form:

$$lnX_{rpt} = \alpha + \beta_1 lnY_{r,t} + \beta_2 lnY_{p,t} + \beta_3 lnDist_{rp} + \epsilon_{rp,t} \quad (1.2)$$

Following this formula, I estimate the augmented version of the gravity model in log-log form:

$$lnX_{rp,t} = \alpha + \beta_1 lnGDP_{r,t} + \beta_2 lnGDP_{p,t} + \beta_3 lnGDPpc_{r,t} + \beta_4 lnGDPpc_{p,t} + \beta_5 lnDist_{rp} + \beta_6 Lang_{rp} + \beta_7 Contig_{rp} + \beta_8 Colony_{rp} + \beta_9 Smctry_{rp} + \beta_{10} WTO_{rp,t} + \beta_{11} ASEAN_{rp,t} + \beta_{12} ACFTA_{rp,t} + \beta_{13} OBOR_{rp,t} + \epsilon_{rp} \quad (1.3)$$

where: $lnX_{rp,t}$ is logarithm of exports or imports of reporter to partner at time *t* (1000 US$); $lnGDP_{r,t}$ and $lnGDP_{p,t}$ are logarithms of reporter's and partner's GDP (current US$) at time *t;* $lnGDPpc_{r,t}$ and $lnGDPpc_{p,t}$ are logarithms of reporter's and partner's GDP per capita (current US$) at time *t;* $lnDist_{rp}$ is logarithm of distance between reporter and partner's capitals (km); $Lang_{rp}$ is a dummy variable which takes a value of 1 if trading partners share a common or primary language with reporter, 0 otherwise; $Contig_{rp}$ is a dummy variable which takes a value of 1 if trading partners share a common border with reporter, 0 otherwise; $Colony_{rp}$ is a dummy variable which takes a value of 1 if trading partners were ever in a colonial relationship with reporter, 0 otherwise; $Smctry_{rp}$ is a dummy variable which takes a value of 1 if trading partners were united with reporter in the past, 0 otherwise; $WTO_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of WTO at time *t*, 0 otherwise; $ASEAN_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of ASEAN at time t, 0 otherwise; $ACFTA_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of ACFTA at time t, 0 otherwise; $OBOR_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of OBOR at time t, 0 otherwise.

1.4.2 Challenges with structural gravity estimation and solutions

As I mentioned in Fig. 1.6, I cannot ignore the effect of macroeconomic background (e.g. economic cycles, subprime crisis) on trade. So the time-fixed effect will be employed in our regressions (S. Yang & Martinez-Zarzoso, 2014). In addition, according to relevant research

(Head & Mayer, 2014; Yotov et al., 2016) on the gravity model, I also need to solve the following potential challenges: multilateral resistance problems, endogenous, zero trade flows, heteroscedasticity and so on.

Specifically, the multilateral resistance problems (Relative transaction cost[16]) can be divided into two types: inward and outward (Anderson & van Wincoop, 2003). Researchers suggest adding country (Feenstra, 2015) or country-time (Olivero & Yotov, 2012) fixed effects to solve this challenge in their advanced gravity model. Then I impose a country-pair fixed effect in our research for dealing with the endogenous problem (Yotov et al., 2016). Afterwards, I take the Poisson Pseudo Maximum Likelihood (PPML) estimator as our regression method to settle the issues with zero trade flows (Silva & Tenreyro, 2006) and heteroscedasticity (Yotov et al., 2016). To match the fixed effects and PPML, I can apply a new PPML estimator that deals with the zeros while controlling for multiple fixed effects (FE-PPML) (Correia et al., 2020).

Finally, to overcome the underestimated standard error caused by neglecting the data cluster, I consider clustering the distance between countries' capitals because it is unique for each pair (Shepherd, 2016).

While I also need to note that if I put fixed effects in FE-PPML could absorb other variables. For example, the pair-fixed set will absorb all bilateral time-invariant covariates, especially for gravity variables. Therefore, I first run the regression relying on an OLS estimator, then panel FE, and finally apply a PPML estimator that deals with the zero trade while controlling for multiple fixed effects (FE-PPML) (Correia et al., 2020).

1.4.3 Results[17]

Following the estimate Equation 1.3, I run OLS and panel FE regressions to explore the relationships between various variables and imports and exports (Table 1.1). The results of the gravity model's essential variables (GDP and distance, which are positive and negative, respectively) are consistent with previous research (Foo et al., 2020; Head & Mayer, 2014; Jiang & Huo, 2015; Y. Sheng et al., 2014; S. Yang & Martinez-Zarzoso, 2014; Yotov et al., 2016; Zhang & Wang, 2015). For gravity variables (common border and language, colonial relationship and same country in the past), I obtain similar promoted effects on trade as previous studies (Batra, 2006; Bussière et al., 2008; Bussière & Schnatz, 2009; Stijns, 2003). Afterwards, relying on the results of WTO in regressions, countries that are a member of WTO have more extensive trade. As I mentioned in the Literature and Descriptive Statistics related to corridors, ASEAN and ACFTA cannot be ignored in the research on China and international trade. However, the results of these two variables don't keep the same direction, which the gravity model challenges (like

[16] It is determined by weighted average trade cost and the average "resistance" faced by exporter. Among them, weighted average trade cost is the relative result between 1) their bilateral trade barrier and 2) importer's resistance to import with all regions. (Bacchetta et al., 2012)

[17] Part of the result in this chapter are based on (Lu, 2021; Lu & Wolszczak-Derlacz, 2020; Wolszczak-Derlacz & Lu, 2022). In these articles I was respionsible for various tasks, including data collection, analysis and interpretation, literature review, preparation of article drafts, and critical revision.

zero trade flows and heteroscedasticity) may cause. As the critical variable, OBOR keeps positive and statistically significant results in most regressions. For details, the trade volume effect triggered by OBOR is not trivial; β=0.206 indicates that if countries belong to OBOR, their bilateral imports are 20.6% greater, and exports are 21.6% greater ([exp(β)-1]x100%).

Table 1. 1 Estimation results of the gravity model: WTO, ASEAN, ACFTA and OBOR among independent variables, OLS/FE

	lnimports			lnexports		
	OLS	OLS	FE	OLS	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
$lnGDP_{r,t}$	1.032***	1.216***	1.332***	1.272***	0.364***	0.598***
	[0.007]	[0.065]	[0.064]	[0.008]	[0.076]	[0.072]
$lnGDP_{p,t}$	1.187***	0.196**	0.262***	0.865***	0.778***	0.761***
	[0.007]	[0.079]	[0.077]	[0.007]	[0.062]	[0.057]
$lnGDPpc_{r,t}$	-0.016*	-0.567***	-0.541***	0.005	0.053	-0.098
	[0.009]	[0.069]	[0.067]	[0.011]	[0.079]	[0.075]
$lnGDPpc_{p,t}$	0.145***	0.064	0.107	0.034***	-0.262***	-0.123**
	[0.009]	[0.081]	[0.079]	[0.010]	[0.065]	[0.059]
$lnDist_{rp}$	-1.273***	-1.593***		-1.359***	-1.738***	
	[0.019]	[0.022]		[0.020]	[0.022]	
$Lang_{rp}$	1.024***	0.964***		0.861***	0.879***	
	[0.042]	[0.041]		[0.044]	[0.043]	
$Contig_{rp}$	0.584***	0.368***		0.847***	0.525***	
	[0.128]	[0.135]		[0.120]	[0.132]	
$Colony_{rp}$	0.748***	0.776***		0.760***	0.839***	
	[0.112]	[0.124]		[0.115]	[0.121]	
$Smctry_{rp}$	1.409***	1.062***		1.266***	1.021***	
	[0.181]	[0.170]		[0.172]	[0.168]	
$WTO_{rp,t}$	0.563***	0.229***	0.069**	0.519***	0.257***	0.047*
	[0.032]	[0.043]	[0.029]	[0.033]	[0.043]	[0.028]
$ASEAN_{rp,t}$	0.672**	-0.253		0.672**	-0.092	
	[0.282]	[0.329]		[0.291]	[0.298]	
$ACFTA_{rp,t}$	0.774***	-0.559**	0.086	0.778***	-0.526**	-0.107
	[0.147]	[0.273]	[0.111]	[0.168]	[0.242]	[0.067]
$OBOR_{rp,t}$	0.077*	0.202***	0.206***	-0.029	0.224***	0.216***
	[0.047]	[0.034]	[0.027]	[0.047]	[0.034]	[0.026]
Year	Yes	Yes	Yes	Yes	Yes	Yes
Reporter effects		Yes			Yes	
Partner effects		Yes			Yes	
Cluster (Dist)	Yes	Yes	Yes	Yes	Yes	Yes
N	406281	406281	406281	350634	350634	350634
R2	0.66	0.74	0.11	0.63	0.73	0.14

Notes: FE: fixed effects estimations when panel id=Reporter x Partner, * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

To overcome the problems of zero trade flows and heteroscedasticity, I apply an FE-PPML to estimate the effect of OBOR in Table 1.2. As I discussed in Table 1.1, after covering the challenges of the gravity model, the results of ASEAN and ACFTA in Table 1.2 are positive and significant. Additionally, I find WTO and OBOR keep consistent positive effects, as shown in Table 1.1. Based on the results in the third and sixth columns, I believe that if one economy belongs to OBOR, its imports and exports are more than others, with 413 US Dollars and 417 US Dollars, respectively (exp(β)x1000). Relying on the results in Table 1.2, I find WTO, ACFTA, and ASEAN have a more vital promotion role in trade.

Table 1. 2 Estimation results of the gravity model, WTO, ASEAN, ACFTA and OBOR among independent variables, fast Poisson estimation under the high-dimensional fixed effect (HDFE)

	imports			exports		
	(1)	(2)	(3)	(4)	(5)	(6)
$WTO_{rp,t}$	0.336***	0.249***	1.528***	0.335***	0.216***	1.743***
	[0.049]	[0.041]	[0.257]	[0.057]	[0.044]	[0.232]
$ASEAN_{rp,t}$	1.339***		1.386***	1.517***		1.577***

	[0.189]		[0.183]	[0.206]		[0.197]
$ACFTA_{rp,t}$	0.614***	0.445***	0.600***	0.808***	0.382**	0.795***
	[0.144]	[0.139]	[0.140]	[0.149]	[0.149]	[0.141]
$OBOR_{rp,t}$	0.487***	0.259***	0.413***	0.505***	0.261***	0.417***
	[0.072]	[0.036]	[0.114]	[0.081]	[0.040]	[0.127]
Year	Yes	Yes		Yes	Yes	
Reporter effects	Yes			Yes		
Partner effects	Yes			Yes		
Reporter#year effects			Yes			Yes
Partner#year effects			Yes			Yes
Reporter#Partner effects		Yes			Yes	
Cluster (Reporter#Partner)	Yes	Yes	Yes	Yes	Yes	Yes
N	426375	424458	426374	371361	368376	371361

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

1.5 Extensions and Robustness

1.5.1 Extension in economic corridors

To achieve the second purpose, 'examining the different roles of corridors in international trade' in Introduction, I have checked the roles of corridors in imports and exports by PPML-HDFE estimation in separate regressions (Similar regression like Table 1.2). In order to compare the difference between corridors, I combine the results of each corridor in these regressions in Table 1.3 (Note: I have not added these corridors in one regression). Besides saving space for the table, I have not presented the results of WTO, ASEAN and ACFTA, which are all statistically significant and positive.

The BCIM, CCWA, CMRF and CP coefficients are positive and statistically meaningful in Table 1.3. Among them, BCIM is a further continuation of the "Kunming Initiative" (Rippa, 2020) put forward at the end of the last century, upgrading its level to the national level and meeting the need to promote the development of eastern India (Marchang, 2021). In addition, CP isn't a fresh cooperation idea, and its history can even be traced to the middle and later parts of the last century (Rippa, 2020). As the most important sample of OBOR, CP has obtained much investment from China to develop basic logistics and energy facilities (Engro Thar Coal Power Project, Gwadar Port, Karakoram Highway, Lahore Metro, etc.) (Javed & Ismail, 2021). And its positive impact of decreasing trade costs and time has been proved in some research (Alam et al., 2019). According to Fig. A.1, the remaining two economic corridors with positive effects (CCWA and CMRF) are highly coincident with CR Express, whose impact on promoting trade has been widely recognized, especially for Central Asia (Bird et al., 2020; Lall & Lebrand, 2020).

The coefficients of CIP keep consistent in most regressions with positive effects, and the most unclear results belong to NELB. I believe that may cause by the trade routes along the line that have not fully realized certain facilities (like the Boten-Vientiane railway) and regional instability (for example, War in Donbas since 2014). By summarizing the results of this part, I find that CP, CMRF and BCIM seem to have more excellent effects on trade.

Table 1. 3 Estimation results of the gravity model, various OBOR economic corridors among independent variables, fast Poisson estimation under HDFE

	imports			exports		
	(1)	(2)	(3)	(4)	(5)	(6)
$BCIM_{rp,t}$	0.488**	0.578***	0.038	0.894***	0.614***	0.436*
	[0.201]	[0.155]	[0.198]	[0.254]	[0.100]	[0.261]
$CCWA_{rp,t}$	0.426**	0.404***	0.142	0.531**	0.387***	0.229
	[0.189]	[0.090]	[0.211]	[0.207]	[0.057]	[0.230]
$CIP_{rp,t}$	0.280***	0.320***	-0.043	0.300***	0.348***	-0.073
	[0.086]	[0.087]	[0.084]	[0.094]	[0.095]	[0.102]
$CMRF_{rp,t}$	0.521**	0.088	0.562**	0.667***	0.085	0.711***
	[0.227]	[0.064]	[0.230]	[0.245]	[0.064]	[0.255]
$CP_{rp,t}$	0.710***	0.412***	0.496***	0.794***	0.409***	0.478**
	[0.166]	[0.085]	[0.185]	[0.201]	[0.098]	[0.209]
$NELB_{rp,t}$	0.252	0.235***	-0.005	0.295	0.168**	0.009
	[0.191]	[0.073]	[0.225]	[0.230]	[0.066]	[0.277]

Year	Yes	Yes		Yes	Yes	
Reporter effects	Yes			Yes		
Partner effects	Yes			Yes		
Reporter#year effects			Yes			Yes
Partner#year effects			Yes			Yes
Reporter#Partner effects		Yes			Yes	
Cluster(Reporter#Partner)	Yes	Yes	Yes	Yes	Yes	Yes
N	426375	424458	426374	371361	368376	371361

Notes: This table summarises the parameters of each economic corridor under various regressions, where corridors are not included simultaneously but one by one. The additional right-hand side variables include WTO, ASEAN and ACFTA (statistically significant and positive parameters), not included in the table for space constraints. * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

1.5.2 Further extension in China's exports

The second extension is to examine the effect of OBOR on China's exports. The first result is under OLS and FE methods in Table 1.4. For details, I employ time-fixed, partner-fixed and cluster distance between China and its partner to overcome challenges introduced in Chapter 1.4.2 and Table 1.1.

Relying on Table 1,4, consistent with the conjecture of Tinbergen (1962) & Anderson (1979), the GDP of China and its partners positively associate with China's exports, while distance hinders exports. For those countries that are adjacent to China or have colonial relations with China and have the same language, they will import more Chinese products. However, OBOR did not have a statistically significant effect on China's exports.

Table 1. 4 Estimation results of the gravity model for exports, OLS/FE (China as the reporter)

	lnexports		
	OLS	OLS	FE
	(1)	(2)	(3)
$lnGDP_{r,t}$	0.723***	0.839***	0.839***
	[0.098]	[0.085]	[0.082]
$lnGDP_{p,t}$	0.994***	1.308***	1.308***
	[0.045]	[0.283]	[0.276]
$lnGDPpc_{p,t}$	-0.263***	-0.535*	-0.535*
	[0.067]	[0.292]	[0.284]
$lnDist_{rp}$	-0.319	-0.168	
	[0.194]	[0.865]	
$Lang_{rp}$	1.495***	0.931	
	[0.336]	[0.587]	
$Contig_{rp}$	0.256	1.388	
	[0.336]	[1.233]	
$Colony_{rp}$	1.203**		
	[0.495]		
$Smctry_{rp}$	0.871	-0.06	
	[0.568]	[0.627]	
$WTO_{rp,t}$	0.499**	0.014	0.014
	[0.233]	[0.098]	[0.095]
$ACFTA_{rp,t}$	0.549**	-0.251*	-0.251*
	[0.242]	[0.151]	[0.146]
$OBOR_{rp,t}$	-0.186	-0.066	-0.066
	[0.120]	[0.078]	[0.076]
Year	Yes	Yes	Yes
Partner effects		Yes	
Cluster (Dist)	Yes	Yes	Yes
N	3570	3570	3570
R2	0.84	0.97	0.82

Notes: FE: fixed effects estimations when panel id=Reporter x Partner,

* p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Using the same method in Table 1.2, I run a similar FE-PPML way to check the effects of WTO, ACFTA and OBOR on China's export in Table 1.5. The consistently positive results in Table 1.2 and related research (C. Yu et al., 2020) have been proved again in this paper. Among them, the most negligible effect was obtained in OBOR with 0.287, which indicates China exports 287 US dollars to the member of OBOR under 1% significant level.

Table 1. 5 Estimation results of the gravity model for exports, fast Poisson estimation under HDFE (China as the reporter)

	exports				
	(1)	(2)	(3)	(4)	(5)
$WTO_{rp,t}$	1.194***	0.044	2.089***	1.194***	0.044
	[0.111]	[0.084]	[0.332]	[0.179]	[0.147]
$ACFTA_{rp,t}$	1.370***	0.323**	0.624*	1.370***	0.323*
	[0.169]	[0.137]	[0.330]	[0.128]	[0.169]
$OBOR_{rp,t}$	0.748***	0.287***	0.195	0.748***	0.287***
	[0.047]	[0.030]	[0.285]	[0.079]	[0.064]
Year		Yes			Yes
Partner effects	Yes	Yes		Yes	Yes
Cluster (Dist)			Yes	Yes	Yes
N	3730	3730	3730	3730	3730

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

As mentioned in the first extension, some economic corridors significantly influence trade. I will check these corridors in China's export again in Table 1.6. For BCIM and CP, I obtain a significant favourable influence on China's export again, as shown in global aspects (Table 1.3). In addition, CIP performs a significant positive result with 0.182, which can be explained by China exporting more on CP participants with an exact value (182 US dollars). Previous research also proved a similar conclusion (Foo et al., 2020; C. Yu et al., 2020).

Table 1. 6 Estimation results of the gravity model, various economic corridors among independent variables, fast Poisson estimation under HDFE (China as the reporter)

	exports
	(1)
$BCIM_{rp,t}$	0.372***
	[0.067]
$CCWA_{rp,t}$	0.131
	[0.085]
$CIP_{rp,t}$	0.374***
	[0.145]
$CMRF_{rp,t}$	-0.178
	[0.117]
$CP_{rp,t}$	0.182**
	[0.092]
$NELB_{rp,t}$	-0.048
	[0.149]
Year	Yes
Partner effects	Yes
Cluster(Reporter#Partner)	Yes
N	3730

Notes: This table summarizes the parameters of each economic corridor from different regressions, where corridors are not included simultaneously but one by one. The additional variables include WTO and ACFTA, which are not included in the table due to space constraints.

* p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

1.5.3 Robustness

After indicating the promotion of OBOR on trade in global or China, I will take two additional ways: a) deleting ASEAN and ACFYA from the set of independent variables (the possible multicollinearity with OBOR), and b) additional estimations restricted to the third aspect (OBOR area).

1.5.3.1 The new set of right-hand independent variables

As the first robustness, I will change the right-hand independent variables in the global (exclude ASEAN and ACFTA) and China aspect (delete ACFTA), shown in Table 1.7- Table 1.10. The positive and significant results of OBOR, which I concluded in previous regressions, have also been achieved in the new set of explanatory variables.

Table 1. 7 Estimation results of the gravity model for imports and exports, ASEAN and ACFTA not in the independent variables, OLS/FE

	lnimports			lnexports		
	OLS	OLS	FE	OLS	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
$lnGDP_{r,t}$	1.033***	1.215***	1.332***	1.274***	0.362***	0.598***
	[0.007]	[0.065]	[0.064]	[0.008]	[0.076]	[0.072]
$lnGDP_{p,t}$	1.188***	0.197**	0.262***	0.867***	0.779***	0.761***
	[0.007]	[0.079]	[0.077]	[0.007]	[0.062]	[0.057]
$lnGDPpc_{r,t}$	-0.018*	-0.567***	-0.541***	0.002	0.054	-0.098
	[0.009]	[0.069]	[0.067]	[0.011]	[0.079]	[0.075]
$lnGDPpc_{p,t}$	0.143***	0.062	0.107	0.031***	-0.264***	-0.123**
	[0.009]	[0.081]	[0.079]	[0.010]	[0.065]	[0.059]
$lnDist_{rp}$	-1.280***	-1.581***		-1.367***	-1.728***	
	[0.019]	[0.021]		[0.020]	[0.022]	
$Lang_{rp}$	1.020***	0.968***		0.856***	0.883***	
	[0.042]	[0.041]		[0.045]	[0.043]	
$Contig_{rp}$	0.626***	0.353***		0.888***	0.515***	
	[0.128]	[0.135]		[0.120]	[0.133]	
$Colony_{rp}$	0.737***	0.778***		0.749***	0.840***	
	[0.112]	[0.124]		[0.115]	[0.121]	
$Smctry_{rp}$	1.403***	1.076***		1.259***	1.033***	
	[0.182]	[0.170]		[0.173]	[0.168]	
$WTO_{rp,t}$	0.566***	0.228***	0.069**	0.523***	0.256***	0.047*
	[0.032]	[0.043]	[0.029]	[0.033]	[0.043]	[0.028]
$OBOR_{rp,t}$	0.117**	0.190***	0.207***	0.013	0.214***	0.216***
	[0.047]	[0.034]	[0.027]	[0.047]	[0.034]	[0.026]
Year	Yes	Yes	Yes	Yes	Yes	Yes
Reporter effects		Yes			Yes	
Partner effects		Yes			Yes	
Cluster (Dist)	Yes	Yes	Yes	Yes	Yes	Yes
N	406281	406281	406281	350634	350634	350634
R2	0.66	0.74	0.11	0.63	0.73	0.14

Notes: FE: fixed effects estimations when panel id=Reporter x Partner, * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Table 1. 8 Estimation results of the gravity model for imports and exports, ASEAN and ACFTA not in the independent variables, fast Poisson estimation under HDFE

	imports			exports		
	(1)	(2)	(3)	(4)	(5)	(6)
$WTO_{rp,t}$	0.315***	0.254***	1.529***	0.303***	0.222***	1.744***
	[0.050]	[0.041]	[0.258]	[0.058]	[0.045]	[0.232]
$OBOR_{rp,t}$	0.641***	0.265***	0.635***	0.724***	0.268***	0.727***
	[0.086]	[0.036]	[0.128]	[0.099]	[0.041]	[0.145]
Year	Yes	Yes		Yes	Yes	
Reporter effects	Yes			Yes		
Partner effects	Yes			Yes		
Reporter#year effects			yes			Yes
Partner#year effects			Yes			Yes
Reporter#Partner effects		Yes			Yes	
Cluster (Reporter#Partner)	Yes	Yes	Yes	Yes	Yes	Yes
N	426375	424458	426374	371361	368376	371361

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Table 1. 9 Estimation results of the gravity model for exports, ASEAN and ACFTA not in the independent variables, OLS/FE (China as the reporter)

		lnexports	
	OLS	OLS	FE
	(1)	(2)	(3)
$lnGDP_{r,t}$	0.724***	0.837***	0.837***
	[0.098]	[0.084]	[0.082]
$lnGDP_{p,t}$	0.995***	1.308***	1.308***
	[0.045]	[0.283]	[0.275]
$lnGDPpc_{p,t}$	-0.271***	-0.539*	-0.539*
	[0.067]	[0.292]	[0.284]
$lnDist_{rp}$	-0.439***	-0.114	
	[0.167]	[0.862]	
$Lang_{rp}$	1.818***	0.77	
	[0.311]	[0.576]	
$Contig_{rp}$	0.232	1.515	
	[0.348]	[1.227]	
$Colony_{rp}$	0.972**		
	[0.443]		
$Smctry_{rp}$	0.452	0.088	
	[0.495]	[0.615]	
$WTO_{rp,t}$	0.536**	0.01	0.01
	[0.229]	[0.098]	[0.095]
$OBOR_{rp,t}$	-0.18	-0.071	-0.071
	[0.120]	[0.078]	[0.076]
Year	Yes	Yes	Yes
Partner effects		Yes	
Cluster (Dist)	Yes	Yes	Yes
N	3570	3570	3570
R2	0.84	0.97	0.82

Notes: FE: fixed effects estimations when panel id=Reporter x Partner,

* p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Table 1. 10 Estimation results of the gravity model for exports, ASEAN and ACFTA not in the independent variables, fast Poisson estimation under HDFE (China as the reporter)

	exports				
	(1)	(2)	(3)	(4)	(5)
$WTO_{rp,t}$	1.243***	0.046	2.119***	1.243***	0.046
	[0.106]	[0.084]	[0.321]	[0.185]	[0.150]
$OBOR_{rp,t}$	0.772***	0.291***	0.317	0.772***	0.291***
	[0.048]	[0.030]	[0.340]	[0.080]	[0.066]
Year		Yes			Yes
Partner effects	Yes	Yes		Yes	Yes
Cluster(Rep#Par)			Yes	Yes	Yes
N	3730	3730	3730	3730	3730

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

1.5.3.2 The aspect of OBOR's participants

The left one will focus on OBOR's participants and present the results in Table 1.11 and Table 1.12 under OLS/FE and FE-HDFE separately. And the consistency and positive results in the specific variable (OBOR) have been proved again.

Table 1. 11 Estimation results of the gravity model for imports and exports, sample restricted to OBOR's countries as a reporter and all their partners, OLS/FE

	lnimports			lnexports		
	OLS	OLS	FE	OLS	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
$lnGDP_{r,t}$	1.076***	1.302***	1.432***	1.383***	0.223**	0.340***
	[0.013]	[0.082]	[0.080]	[0.013]	[0.091]	[0.086]
$lnGDP_{p,t}$	1.212***	0.068	0.267**	0.899***	0.811***	0.700***
	[0.011]	[0.129]	[0.126]	[0.011]	[0.095]	[0.088]
$lnGDPpc_{r,t}$	-0.062***	-0.593***	-0.578***	-0.092***	-0.024	-0.076
	[0.018]	[0.080]	[0.078]	[0.020]	[0.087]	[0.083]
$lnGDPpc_{p,t}$	0.099***	0.095	-0.001	-0.051***	-0.365***	-0.121
	[0.016]	[0.133]	[0.129]	[0.016]	[0.099]	[0.090]
$lnDist_{rp}$	-1.193***	-1.542***		-1.269***	-1.817***	
	[0.029]	[0.041]		[0.031]	[0.042]	
$Lang_{rp}$	0.645***	0.855***		0.884***	1.168***	
	[0.098]	[0.099]		[0.092]	[0.090]	
$Contig_{rp}$	0.993***	0.641***		0.915***	0.439**	
	[0.183]	[0.179]		[0.180]	[0.175]	
$Colony_{rp}$	0.475**	0.604***		0.671***	0.590***	
	[0.196]	[0.203]		[0.212]	[0.208]	
$Smctry_{rp}$	0.745**	0.165		0.821***	0.485	
	[0.316]	[0.315]		[0.307]	[0.326]	
$WTO_{rp,t}$	0.500***	0.173***	0.092***	0.476***	0.161***	-0.048
	[0.047]	[0.053]	[0.036]	[0.048]	[0.053]	[0.036]
$ASEAN_{rp,t}$	0.739***	-0.058		0.835***	0.026	
	[0.279]	[0.323]		[0.271]	[0.304]	
$ACFTA_{rp,t}$	0.619***	-0.287	0.048	0.482***	-0.371	-0.234***
	[0.153]	[0.260]	[0.112]	[0.143]	[0.245]	[0.074]
$OBOR_{rp,t}$	0.068	0.208***	0.195***	-0.119**	0.085***	0.085***
	[0.050]	[0.034]	[0.032]	[0.050]	[0.032]	[0.030]
Year	Yes	Yes	Yes	Yes	Yes	Yes
Reporter effects		Yes			Yes	
Partner effects		Yes			Yes	
Cluster (Dist)	Yes	Yes	Yes	Yes	Yes	Yes
N	143033	143033	143033	133795	133795	133795
R2	0.65	0.74	0.15	0.6	0.73	0.21

Notes: FE: fixed effects estimations when panel id=Reporter x Partner, * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Table 1. 12 Estimation results of the gravity model for imports and exports, samples restricted to OBOR's countries as a reporter and all their partners, fast Poisson estimation under HDFE

	imports			exports		
	(1)	(2)	(3)	(4)	(5)	(6)
$WTO_{rp,t}$	0.167**	0.01	1.246***	0.147**	-0.038	1.440***
	[0.071]	[0.050]	[0.245]	[0.072]	[0.054]	[0.209]
$ASEAN_{rp,t}$	1.256***		1.263***	1.450***		1.466***
	[0.168]		[0.161]	[0.199]		[0.188]
$ACFTA_{rp,t}$	0.862***	0.048	0.900***	1.146***	-0.021	1.236***
	[0.128]	[0.153]	[0.124]	[0.164]	[0.167]	[0.174]
$OBOR_{rp,t}$	0.093**	0.114***		0.102**	0.119**	
	[0.044]	[0.042]		[0.050]	[0.047]	
Year	Yes	Yes		Yes	Yes	
Reporter effects	Yes			Yes		
Partner effects	Yes			Yes		
Reporter#year effects			Yes			Yes
Partner#year effects			Yes			Yes
Reporter#Partner effects		Yes			Yes	
Cluster (Reporter#Partner)	Yes	Yes	Yes	Yes	Yes	Yes
N	148340	147759	148340	140487	139842	140487

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

1.6 Conclusions

OBOR is one of China's most influenceable cooperation strategies, which covers nearly two-thirds of the population and one-third of the GDP in the whole world and colossal promotes infrastructure construction (like CR Express, the establishment of AIIB, Padma Rail Link in Bangladesh, Peshawar-Karachi Motorway in Pakistan, etc.). In addition, China is regarded as the 'world factory' and accounts for the world's largest exporter (with 13.2% in 2019 relying on the WTO database). So I believe it is essential and meaningful to estimate how OBOR affects international trade no matter in global and China aspects (China-Pakistan Economic Corridor (CPEC) Authority Official Website, n.d.; Y. Huang, 2016; C. Wang et al., 2020; G. Yang et al., 2020; H. Yu, 2017).

In this chapter, I have prepared a global dataset which covers 186 reporting countries and 199 trading partners from 2000 to 2018 and explored the role of OBOR played in international trade, which can be expanded into three exact aims: 1) verifying how OBOR associates with the volume of bilateral trade, 2) examining the different roles of corridors in international trade, and 3) checking the difference between different research samples (global, participants and China).

For covering potential challenges in the gravity model of trade, I have used various regression methods (OLS, LSDV and PPML) with different sets of fixed effects and combined the results as (1) even though I have used various estimation methods, OBOR keeps a consistent promotion role in international trade and China's export but its effect more minor than WTO, ASEAN and ACFTA. (2) There is little difference in economic corridors between global and Chinese samples. For detail, the positive effects of BCIM and CP have been achieved, whether globally or in China. And CMRF and CIP promote international trade and China's exports, respectively.

As I mentioned in the Introduction, the novelties and contributions of this research can be expressed as follows: 1) Expands and makes up for the lack of previous research on OBOR in the field of trade; 2) Summaries various potential challenges in the trade gravity model and their solutions; 3) discusses the heterogeneity of the OBOR economic corridor in trade; and 4) provides the state code file for researchers' use (data combination and regressions) in supplementary materials.

Finally, it should be made clear that this study is based on gross trade. The natural extension of this work is to analyze its impact on China's participation in the global value chain, which will be included in Chapter 2. Additionally, it should be made clear that this study is based on general statistics covering all sectors. A natural extension of this work would be an analysis of specific, individual sectors or export variety (Relative research will be concluded in Chapter 3). The left three future research topics related to OBOR in our mind are 1) Covid-19 and “Zero Covid policy” in China related to the demand, productivity and connectivity, 2) Russian-Uzbekistan War which should affect OBOR from various aspects (no matter in policy or China-Europea trade routes) and 3) Sino-US trade war and Sino-US scientific and technological disputes.

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2 CHINA AND GLOBAL VALUE CHAINS

2.1 Introduction

Since the 1980s, the Digital Revolution (especially communication technology) and trade liberalization have provided a technical basis and policy background for transnational groups' global investment and division of labour to reduce costs and expand markets (R. Baldwin, 2006). With the deepening of the international industrial division, the production of products crosses many national boundaries. The value of products is no longer occupied by the final exporting countries but is shared by many countries (Kano et al., 2020; Seric & Tong, 2019). According to Antràs (2020b), the total share of global value chain trade in total world trade increased from about 40% to more than 50% from 1986-2008. Previous studies have also proved a similar increase trend (Johnson & Noguera, 2012; Kee & Tang, 2016; Szymczak & Wolszczak-Derlacz, 2022; Z. Wang et al., 2013). The increase in the share of intermediate products in global trade has also led to the fact that nominal transactions cannot correctly reflect a country's actual 'profit' due to repeated counting (Caliendo & Parro, 2015; Hayakawa, 2007; Kelly & Cava, 2014; Maurer & Degain, 2012; Miroudot et al., 2009).

On the one hand, as I reviewed in Chapter 1, One-Belt One-Road (OBOR) has already promoted various projects or organizations in recent years. Among them, the establishment of the Asian Infrastructure Investment Bank and Silk Road Fund, the promotion of RMB internationalization[18] and trade routes expansion (Huang, 2016) may deepen the linkage of production chains within these countries to impact GVCs (Y. Ge et al., 2020; Wolszczak-Derlacz & Lu, 2022). It is reasonable to believe OBOR should affect not only total export and import but also GVCs.

On the other hand, as the largest manufacturing country since 2010 (more than 28% of the world's manufacturing output in 2022 depends on the world population review data), China has been regarded as an essential participant in the global production chain. Therefore, the research on China's participation in GVC has been one of the "hot topic" in recent years. The fields involved include trade (Y. Ge et al., 2020; Kohl, 2019; X. Wang et al., 2019; Zeng et al., 2021), politics (Gopalakrishnan et al., 2022; Volgina & Pengfei, 2021; Wu et al., 2021), environment (Q. Li et al., 2022; Qu et al., 2020), industrial upgrading (Q. Chen & Shen, 2021; Du & Agbola, 2022; N. Yang et al., 2020), etc. However, based on the considerable differences in economic development, resident income and opening up in different regions of China, I think that conducting relevant research in China's provinces and industrial levels is vital. Some studies explored GVCs from the regional level, but most are still limited to trade or environment (Mi et al., 2017; L. Wang et al., 2020; Xie et al., 2021). Considering that China's high income, large economic scale and densely populated areas (Heihe-Tengchong Line) are often concentrated in

[18] This is mainly accomplished in the following ways: 1) increasing the share of RMB in trade settlement (about one-third in 2015), 2) issuing bonds denominated in RMB overseas, 3) expanding and investing in overseas markets of Chinese enterprises and banks, and 4) increasing the share of RMB in foreign exchange reserves of OBOR countries.(Handwerker, 2020; Liang, 2020)

the eastern and southern coastal provinces (Guangdong, Shanghai, Jiangsu, Zhejiang, etc.) with sizeable foreign trade, I doubt whether the trade and GVCs of each area are related to its labour market[19]. And wage, employment, and productivity are seen as the three main routes to affect the labour market in previous studies (Autor et al., 2013; J. Baldwin & Yan, 2021; Bamber et al., 2014; Banga, 2022; Caraballo & Jiang, 2016; Lu et al., 2019; Opazo-Basáez et al., 2021; Shepherd, 2013; Taglioni & Winkler, 2016). Although the impact mechanism of GVCs on the labour market can be explained simply by the following process (production transfer, employment opportunities reduction, wage reduction), the empirical research on different samples does not have a consistent and clear answer.

Overall, the specific research objectives in this chapter can be divided into three parts: 1) descriptive statistics on participation in GVCs, 2) OBOR and GVCs and 3) China provinces' GVCs and labour market.

First, for participation in GVCs, the main goal is: measuring and describing the trend of participation and position indexes in GVCs (China and OBOR countries).

The second part is an expansion of the research in Chapter 1. There are three clear aims included, which are 1.) investigating the role of the Belt and Road initiative on value-added trade and global value chains; 2) examining the different roles of corridors in value-added exports and GVC and 3) describing the trend of China's domestic value-added absorbed aboard.

At last, I set a threefold aim considering the relationship between China provinces' GVCs and the labour market. Relying on previous studies (Gao & Wang, 2020; L. Wang et al., 2020; Xie et al., 2021) and my own combined provincial multi-regional input-output table (CEMRIO), I can divide one province value chain into three parts: international/Global value chains (GVCs), interprovincial value chains (PRVCs), and provincial value chains (PVCs). The primary purpose is to check the association between trade, GVCs, PRVCs, and PVCs with wages, employment and productivity in China provinces. And three specific aims are proposed: 1) to describe the trend and difference of GVCs, PVCs and PRVCs in Chinese provinces; 2) to investigate the influence of trade on the labour market (wage, employment and productivity) in China province level, and 3) to estimate the effect of China regional various value chains (GVCs, PVCs and PRVCs) on their labour market.

First, the data for participation in GVCs are obtained from Regional Input-Output Tables - Asian Development Bank and Country (ADB-MRIO) GVC Indicators/ WWZ Frameworks, which cover 62 countries and 34 sectors from 2007 to 2020.

Second, to explore OBOR and GVCs, I have created two databases. (1) Following the classification of value added (Z. Wang et al., 2013), I obtained domestic value-added variables from the ADB-MRIO2018 database in UIBE GVC Indicators. Then combined with other variables I introduced in Chapter 1, the first dataset covers 61 countries (32 OBOR members) from 2010 to 2017. (2) For exploring the role of OBOR on GVCs, I employ a new variable (the value

[19] The data linked to Chinese provinces' economic development, trade and labour market can be obtained from the National Bureau of Statistics of China - National Data (stats.gov.cn). https://data.stats.gov.cn/english/easyquery.htm?cn=E0103

contributed by a partner country in the reporter's total exports) from UNCTAD-Eora Global Value Chain Database. After combining other variables, the second dataset will include 178 countries from 2000-2018.

Third, the data on the labour market, trade and GVCs covers 31 provinces and 25 sectors in 2005, 2012 and 2017. Its original data sources include China Labor Economy Database, Chinese provinces' Statistics Yearbooks, China's Multi-Regional Input-Output Tables (CMRIO) in the Carbon Emission Account & Datasets for emerging economies, the Multi-Regional Input-Output Table published by the Asian Development Bank (ADB-MRIO), EPS China Data platform and the World Development Indicators. (The details of each dataset can be checked in section 3, Data and Descriptive Statistics)

The innovation, advantages and contributions of this Chapter can be classified as following aspects: 1) By measuring various indicators of GVCs (OBOR countries and China), I can have a more detailed understanding of the role of China (OBOR) play in GVCs and its trend. 2) From the perspective of value-added trade and the degree of industrial linkage, this chapter supplements the research of OBOR on trade effects and discusses the differences in economic corridors. 3) The research on China, GVC and the labour market will be expanded to provincial and departmental levels. In addition, the value chain is subdivided into GVCs, PRVCs and PVCs, which helps to explore their differences. Finally, I apply seemingly unrelated regression estimation (SURE) to a set of equations to evaluate the simultaneous impact of the participation of various value chains on the labour market (wages, employment and productivity).

This Chapter is organized as follows. The second section reviews the relevant literature on theoretical aspects of GVCs and their measure, value-added trade, and labour market elements. Data and basic descriptive statistics are presented in section 3. Then I introduce the methodology models and empirical results in the next section. Section 5 includes extensions and robustness. Finally, the conclusion related to the finding, contribution and limitation will be discussed in section 6.

2.2 Literature Review

2.2.1 Literature related to Global value chains - theoretical background

As I pointed out in the introduction, global enterprises rely on developing communication technology to divide the activities or links of research and development, production and assembly, marketing and logistics, after-sales support and other activities into at least two countries. To optimize production, companies reduce costs and expand the market globally by utilizing the benefits and endowments of different regions (Antràs, 2020a; Seric & Tong, 2019).

Porter (1985) first puts forward the view of the "value chain" from the perspective of enterprises. He believes an enterprise is a collection of activities to design, produce, sell and distribute its products. Because every value-added activity here is like every link in the chain, the value chain concept is proposed. At the same time, these value-added activities can be divided into main activities (inbound logistics - import materials, operation, outbound logistics - delivery, marketing and sales, after-sales service, etc.) and support activities (enterprise infrastructure, human resources management, technology development, procurement, etc.). He extends his research perspective to the economic exchanges between different enterprises (suppliers and distributors). He puts forward the concept of value system (supplier value chain, organization value chain and buyer value chain), which researchers regarded as the basis of GVC.

At the same time, Kogut (1986) proposes a value-added chain consisting of three parts to analyze the international strategic advantages. The first integrates raw materials, labour, capital and other elements to form various input links. These links are then assembled to create the final product. Finally, the circulation of value is accomplished through market transactions and consumption. It is worth noting that enterprises only participate in specific links or incorporate the whole value-added process into the enterprise hierarchy. Considering that a country or enterprise may only have comparative advantages in some value chain links, this also promotes the value chain's vertical separation and global distribution.

As mentioned, multinational enterprises extend this division of labour and cooperation from different enterprises in specific regions to other regions (overseas joint ventures, acquisitions, mergers and acquisitions, authorized agents and branches, etc.). Gerefi & Korzeniewicz (1994) put forward the concept of a "global commodity chain" based on the analysis of the retail industry's value chain in the United States and the combination of value chain analysis and industrial organization research. Specifically, in the context of economic globalization, the production process of commodities is divided into different places. In other words, the transnational production organization system formed around the production of a particular thing organizes enterprises of various sizes worldwide into an integrated production network, creating a global commodity chain. They divide the global commodity chain into two types: buyer-driven (to establish the supply base in a way other than external market supervision, rather than direct ownership, to establish a global production and distribution system) and production-driven (a vertical division of labour system in which multinational manufacturers play a central role in establishing and regulating production networks). In addition, Gereffi (1995)

emphasizes four conditions of the global commodity chain. Specifically, the input-output structure is related to the process according to the order of value-added activities. Secondly, regionality means that multinational enterprises distribute non-core competitive links in different regions to form a global production system. Then, governance refers to the unified organization, coordination and control of the entire chain by the value chain managers. Finally, the institutional framework mainly discusses how the domestic and foreign institutional background affects the value chain of each node.

Because the global commodity chain has not got rid of the restriction of commodity concept and has not highlighted the importance of enterprises in value creation and value acquisition, some research (Gereffi et al., 2005; Gereffi & Kaplinsky, 2001) focus on the process of globalization from the perspective of the value chain. They propose the basic concept and theoretical framework of the global value chain. They believe that globalization can be seen as the worldwide distribution of the value chain. In addition, they think that forming a value chain is a process for enterprises to continuously participate in the value chain and obtain necessary technical capabilities and service support. Therefore, being familiar with the value chain operation is of great help to the management or decision-making of enterprises and countries. Sturgeon (2001) defines the global value chain from three dimensions. The first dimension refers to the size of the organization. The global value chain includes all entities producing specific products or services. The second dimension: the geographical scale of the worldwide value chain, must be within the global scope. The last part focuses on productive actors, including integrated enterprises, retailers, leading manufacturers, suppliers, etc. Finally, a similar definition from Heuser & Mattoo (2017) is the following: A value chain comprises "*the full range of activities that are required to bring a product from its conception, through its design, its sourced raw materials and intermediate inputs, its marketing, its distribution and its support to the final consumer*" (P. 2). A GVC emerges when these activities are undertaken by entities based in or from different countries. Under the increasingly complex division of labour in production, intermediate goods trade has gradually become an essential component of international trade, accounting for over half of its contribution to the growth of manufacturing trade from 2000 to 2014. Traditional trade describes production in one country while consumption in another country. With the rise of intermediate trade, products may need to cross multiple national boundaries from production to final consumption, and traditional trade statistics may double calculate the added value of each country (World Bank Group et al., 2017). In Chapter 2.2, I will describe how relevant research measures GDP and the GVC component in the final product.

2.2.2 Literature related to GVCs measures

The research in measuring GVCs can be divided into three aspects: (1) Country level (Amador & Cabral, 2016; Antràs et al., 2012; R. Baldwin & Lopez-Gonzalez, 2015; Dietzenbacher & Romero, 2007; Fally, 2011; Johnson, 2014; Johnson & Noguera, 2012; Koopman et al., 2014; Los et al., 2015, 2016; Timmer et al., 2014; Z. Wang et al., 2015, 2017b), (2) from the perspective of a single product (Ali-Yrkkö et al., 2011; Dedrick et al., 2010) or sector

and (3) micro-firm analysis (Kee & Tang, 2016; Upward et al., 2013; Vrh, 2019; J. Zhang et al., 2013).

2.2.2.1 Specific product or sector

The first view tracks the production steps of one product or sector. One of the representative examples is Apple's mobile phone (iPhone). Although "Made in China" is printed on nearly all iPhones, relying on Fig. 2.1, the value of the iPhone is not entirely owned by China, which is responsible for the final production and export. For details, China gets only $65 out of its $1875, which nearly accounts for only 3.47 per cent. In contrast, most of the value is occupied by developed economics (e.g. KOR - 42.67%, USA - 12.21%, TWN - 11.04%, etc.). Similar results are obtained in other products or sectors (Ali-Yrkkö et al., 2011; Dedrick et al., 2010). As I discussed in the previous chapter on trade theory (e.g. comparative advantage, H-O), enterprises conduct industrial transfer and intra-product division of production based on the relative advantages of different countries. The global value chain theory also came into being. Considering that the production of a product often requires a variety of other intermediate products or materials, how to comprehensively evaluate and measure the role of a country in the global value chain has become the focus of relevant research.

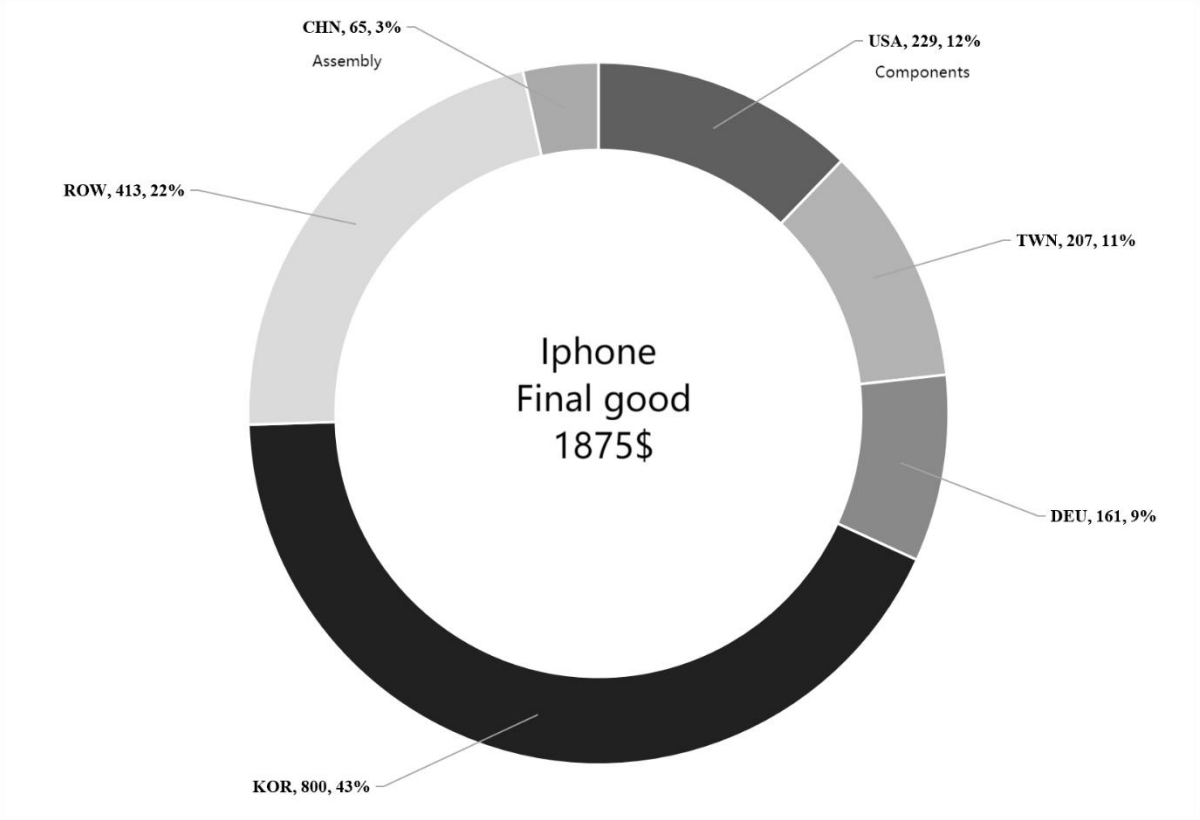


Fig. 2. 1 Who is the real beneficiary of the iPhone?

Source: "Topics in international trade - Pol Antràs" course in Kiel Institute for the World Economy (03 - 07 May 2021)

2.2.2.2 Country level

As the most popular part, one country's GVC can be measured from the following aspects: import-based measures, export-based measures (export decomposition), production/output decomposition and position (length) index.

(1) Import-based measures

For the import-based measures, the representative researchers (Feenstra & Hanson, 1999; Hijzen & Swaim, 2007) propose a measurement index which is "*the ratio of imported intermediates (using the import-use matrix) to value-added*" (p. 87), and it can be extended divided into two types (intra- and inter-sector offshoring). The specific formula can be checked in equation (2.1):

$$R_i = R_i^{intra} + R_i^{inter} = \frac{IM_{j=i}}{VA_i} + \frac{\sum_{j=1}^{j} IM_{j\neq i}}{VA_i} \quad (2.1)$$

(2) Export-based measures (export decomposition)

Since the trade volume of intermediate products and parts is snowballing, value-added trade has gradually replaced the concept of measuring trade in traditional ways (by total imports and total exports). Many researchers proposed different ways of export decomposition (Daudin et al., 2011; Hummels et al., 2001; Johnson & Noguera, 2012; Koopman et al., 2010, 2014; Z. Wang et al., 2009, 2013). The research employs input-output tables (e.g. single country input-out table and world input-out table) as their primary tool to explore the input and output relationship within one country or between different countries at sectoral levels. Many organisations or institutions have proposed their Input-Output table databases: (1) World Input-Output Database (WIOD) by Groningen Growth and Development Centre, (2) Input-Output Tables (IOTs) by OECD, (3) ADB-MRIO, (4) Singel Country's Input-Output Table (like China's Multi-Regional/ City-Level Input-Output Tables in Carbon Emission Accounting & Datasets) and so on.

To measure the development level of vertical specialization division in each country's industry, Hummels et al. (2001) propose the share of vertical specialization in the country's total exports (*VSS*=*VS*/*X*). The vertical specialization (*VS*) volume is the trade created by imported intermediate goods in a country's total exports. So the formula can be (Hummels, Ishii & Yi , 2001):

$$VS_k/X_k = uA^M[I - A^D]^{-1}X/X_k \quad (2.2)$$

Where: *u* is 1×n vector of 1's; A^M is the n×n imported coefficient matrix; *I* is the identity matrix, A^D is the n×n domestic coefficient matrix, *X* is an n×1 vector of exports, and n is the number of sectors. Considering their research is based on a country's input-output table, they can not measure the *VS1 index* (The part of a country's exports used as an intermediate input by other countries for export).

Then Z. Wang et al. (2009) propose a new measurement method of *VS* and the calculation formula of *VS1* by constructing the value-added share (*VAS*) matrix. They rely on the world input-output table and decompose a country's export into foreign value-added (FVA) and domestic value-added (DVA) components. And the domestic value-added of export products can be further divided into the value-added formed directly in the country and the domestic

value-added contained in the imported intermediate products. Followed by Daudin et al. (2011) rely on the Global Trade Analysis Project (GTAP) data to construct the Multi-Country input-output table. Additional exports embedded in re-imported goods absorbed as inputs for final domestic use (VS1*) are also involved. Next, Johnson & Noguera (2012) select the proportion of value added in exports (VAX) to measure the degree of participation in the international division. Z. Wang et al. (2013) decompose the total export into 16 parts, propose a multi-level whole trade flow decomposition method including the full export, sector and bilateral levels, and represent the calculation methods of VS, VS1, VS1* and VAX. This method marks the maturity of the vertically specialized measurement theory (WWZ method). To dynamically reflect the proportion of exports and measure vertical specialization, I usually divide them by the total exports. Among the ratios of these four variables (VS, VS1, VS1* and VAX), the lower the VAX ratio value, the higher the degree of international specialization.

Besides, Koopman et al. (2010) integrate all the existing indicators and decompose a country's total exports into five parts: (1) the domestic added value of final exports, (2) the domestic added value of intermediate exports absorbed by the final domestic demand of the importing country, (3) the intermediate exports absorbed by the domestic production of the importing country to the third country, (4) the returned domestic added value, and (5) the foreign added value of exports (KPWW method). Considering the VAX ratio underestimates the domestic comment on exports caused by the repeated counting error, the decomposition of a country's total exports is divided into nine parts (Koopman et al., 2014).

Specifically, gross exports (E) can be divided into three parts: Value-added exports (VT), Domestic content in intermediate exports that finally returns (VS1*) and foreign content (VS). After further refinement, VT includes Domestic value (DV) in direct final goods exports (P1), DV in intermediates exports absorbed by direct importers (P2), and DV in intermediates reexported to third countries (P3). Then VS1* combines DV in intermediates returns via final imports (P4), DV in intermediates returns via intermediate imports (P5) and double-counted intermediate exports produced at home (P6). Finally, Foreign value (FV) in final goods exports (P7), FV in intermediate goods exports (P8), and double-counted intermediate exports produced abroad (P9) make up VS.

They also make the following guiding points for using these parts:

1. Export GDP equals the sum value from (P1) to (P5).

2. The domestic content of a country's exports is equal to the sum of (P1) to (P6).

3. The part of a country's exports used as an intermediate input by other countries for export (VS1) defined by Daudin et al. (2011): adding from (P3) to (P6).

4. Exports embedded in re-imported goods absorbed as inputs for final domestic use (VS1*) in Daudin et al. (2011) are different from this paper’s definition and equal (P4).

A similar result is also achieved by decomposing one country’s trade flows in further research (Los et al., 2016).

(3) Production/output decomposition

More recent research (Z. Wang et al., 2017b) decomposes production activities into the following parts: 1) domestic demand, 2) traditional trade, and 3) complex and straightforward cross-border production activities. And they further decompose the final product and added value into the Leontief decomposition and proposed GVCs indicators such as forward chain length and backward chain length. When the current participation index is higher than the backward participation index, the economies are more involved in upstream production activities; When the current participation index is smaller than the backward participation index, the economy is more engaged in downstream production activities. Their specific derivation steps are as follows:

First, they assume each country has N counties worldwide and S sectors. z_{ij}^{ab} means the intermediate (produced - Sector *i* of Country *a* and consumed - Sector *j* of Country *b*). So *Z* represents the use of intermediate products made by various countries and is an NS × NS matrix. Then they set a country's gross output (*X*), intermediate output (*Z*) and final output (*Y*). Then $\widehat{X}$ is the diagonal matrix of X. And $A = Z\widehat{X}^{-1}$ is an NS × NS matrix whose element is $a_{ij}^{ab} = z_{ij}^{ab}/x_j^b$ and the input coefficient matrix because it represents the input quantity of intermediate goods of Industry *i* in Country *a* if Industry *j* in Country *b* produces 1 unit of output. So, the coefficient of value added $V = Va\widehat{X}^{-1}$ is a 1 × NS matrix whose element is $v_i^a = va_i^a/x_i^a$. Because a country's gross output (*X*) equals intermediate output (*Z*) plus final output (*Y*), so $X = AX + Y$. Then $X = (I - A)^{-1}Y = CY$ and set $(I - A)^{-1} = C$ (Leontief inverse matrix). The input coefficient matrix (A) can be divided into the intermediate coefficient of domestic production used in the domestic output (A^D) and the import input coefficient matrix (A^F). The specific matrix volume is:

$$\begin{pmatrix} A^{11} & A^{12} & \cdots & A^{1N} \\ A^{21} & A^{22} & \cdots & A^{2N} \\ \vdots & \vdots & \ddots & \vdots \\ A^{N1} & A^{N2} & \cdots & A^{NN} \end{pmatrix} = \begin{pmatrix} A^{11} & 0 & \cdots & 0 \\ 0 & A^{22} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & A^{NN} \end{pmatrix} + \begin{pmatrix} 0 & A^{12} & \cdots & A^{1N} \\ A^{21} & 0 & \cdots & A^{2N} \\ \vdots & \vdots & \ddots & \vdots \\ A^{N1} & A^{N2} & \cdots & 0 \end{pmatrix} \quad (2.3)$$

Because the final goods (*Y*) can be consumed in 2 areas which are the domestic area (Y^D) and foreign countries (Y^F), the specific matrix volume is:

$$Y = \begin{pmatrix} \sum_{b=1}^{N} Y^{1b} \\ \sum_{b=1}^{N} Y^{2b} \\ \vdots \\ \sum_{b=1}^{N} Y^{Nb} \end{pmatrix} \qquad Y^D = \begin{pmatrix} Y^{11} \\ Y^{22} \\ \vdots \\ Y^{NN} \end{pmatrix} \qquad Y^F = \begin{pmatrix} \sum_{b=1\ and \neq 1}^{N} Y^{1b} \\ \sum_{b=1\ and \neq 2}^{N} Y^{2b} \\ \vdots \\ \sum_{b=1\ and \neq N}^{N} Y^{Nb} \end{pmatrix} \quad (2.4)$$

Hence, the gross output can be:

$$X = A^D X + A^F X + Y^D + Y^F = A^D X + Y^D + E \quad (2.5)$$

Where $E = A^F X + Y^F$, it means the gross export (the export of intermediate + the export of final goods).

Because $X = A^D X + Y^D + E$, so $X(I - A^D) = Y^D + E$ then $X = (I - A^D)^{-1}Y^D + (I - A^D)^{-1}E$. I set $(I - A^D)^{-1} = L$, then $X = LY^D + LE = LY^D + LA^F X + LY^F$. Because $\mathrm{X} = (\mathrm{I} - \mathrm{A})^{-1}\mathrm{Y} = \mathrm{CY}$, so $LY^D + LA^F CY + LY^F = \mathrm{CY}$. After diagonalizing the vectors, $L\widehat{Y}^D + LA^F C\widehat{Y} + L\widehat{Y}^F = \mathrm{C}\widehat{\mathrm{Y}}$. Then times the diagonalization matrix of added value coefficient $\widehat{V}$ on the left, $\widehat{V}L\widehat{Y}^D + \widehat{V}LA^F C\widehat{Y} + \widehat{V}L\widehat{Y}^F = \widehat{V}\mathrm{C}\widehat{\mathrm{Y}}$. So that can be divided like:

$$\begin{aligned}\widehat{V}C\widehat{Y} = {} & \widehat{V}L\widehat{Y}^D + \widehat{V}L\widehat{Y}^F + \widehat{V}LA^F(L\widehat{Y}^D + (C\widehat{Y} - L\widehat{Y}^D) \\ & = \widehat{V}L\widehat{Y}^D + \widehat{V}L\widehat{Y}^F + \widehat{V}LA^FL\widehat{Y}^D + (\widehat{V}LA^FC\widehat{Y} - \widehat{V}LA^FL\widehat{Y}^D) \\ & = \widehat{V}L\widehat{Y}^D + \widehat{V}L\widehat{Y}^F + \widehat{V}LA^FL\widehat{Y}^D + [\widehat{V}L(A^FC)^D\widehat{Y} + \widehat{V}L(A^FC)^F\widehat{Y} - \widehat{V}LA^FL\widehat{Y}^D] \\ & = \widehat{V}L\widehat{Y}^D + \widehat{V}L\widehat{Y}^F + \widehat{V}LA^FL\widehat{Y}^D + \{\widehat{V}L(A^FC)^D\widehat{Y} + \widehat{V}L[(A^FC)^F\widehat{Y} - A^FL\widehat{Y}^D]\}\end{aligned} \tag{2.6}$$

Where, $A^FC = (A^FC)^D + (A^FC)^F$. $(A^FC)^D$ is its diagonal matrix and $(A^FC)^F$ is its non-diagonal matrix. $\widehat{V}C\widehat{Y}$ is the value-added input to meet the output, and its element is $v_i^a c_{ij}^{ab} y_j^b$ which means the total added value of Industry *i* in Country *a* to meet the demand of final product production of Industry *j* in Country *b*.

1. $\widehat{V}L\widehat{Y}^D$ is the value added produced by domestic to meet the domestic need, and it doesn't refer to international trade.

2. $\widehat{V}L\widehat{Y}^F$ is the value added in the final good produced by the domestic to meet the foreign need.

3. $\widehat{V}LA^FC\widehat{Y}$ is the value added in intermediate export goods across the border for production at least once. Among it, 3.1 $\widehat{V}LA^FL\widehat{Y}^D$ is the value added in intermediate export goods whose production will be finished in the first importer (A simple cross-border division of production); 3.2 $\widehat{V}LA^FC\widehat{Y} - \widehat{V}LA^FL\widehat{Y}^D$ means the value added in intermediate goods which will not finish the production in the first importer (Complex cross-border division of production). Then it can be divided into 2 parts. 3.2.1 $\widehat{V}L(A^FC)^D\widehat{Y}$ means the value added in intermediate goods that the importer will use to produce and return to the home country. The final production step will be completed in the home country. 3.2.2 $\widehat{V}L[(A^FC)^F\widehat{Y} - A^FL\widehat{Y}^D]$ means the value added in intermediate goods that the importer will use to produce and send to other countries. The final production step will be completed outside the home country. Because $\widehat{V}C\widehat{Y} = \widehat{V}L\widehat{Y}^D + \widehat{V}L\widehat{Y}^F + \widehat{V}LA^FL\widehat{Y}^D + \widehat{V}LA^F(C\widehat{Y} - L\widehat{Y}^D)$, so $\widehat{V}CY = \widehat{V}LY^D + \widehat{V}LY^F + \widehat{V}LA^FLY^D + \widehat{V}LA^F(CY - LY^D)$.

They define the GVC participation by value-added (forward linkage-based) and final product (backwards linkage-based) decomposition. By adding the rows of the matrix, I can decompose the matrix according to the forward linkage:

$$Va' = \widehat{V}CY = \underbrace{\widehat{V}LY^D}_{(1)\,-V\_D} + \underbrace{\widehat{V}LY^F}_{(2)\,-V\_RT} + \underbrace{\widehat{V}LA^FLY^D}_{(3a)\,-V\_GVC\_S} + \underbrace{\widehat{V}LA^F(CY - LY^D)}_{(3b)\,-V\_GVC\_C} \tag{2.7}$$

I use Table 2.1 to show the decomposed items to understand their definition and structure clearly.

Table 2. 1 The decomposition results of sector GDP based on forward industrial linkage

Sum	First level	Second level	Third level	Description
Value Added production by country /industry	V_D	V_D	V_D	Value added in the production of final goods to the domestic market directly
	V_RT	V_RT	V_RT	Value added in the production of final exports directly (cross the border once)
	V_GVC	V_GVC_S	V_GVC_S	Value added absorbed by the direct importer (simple GVCs and cross border once)
		V_GVC_C	V_GVC_C (D)	value added return and consumed in the home (complex GVCs and cross border twice more)

			V_GVC_C (C)	Value added for the production of re-exports that finally consumed abroad (complex GVCs and cross border twice more)

Source: Own compilation based on Z. Wang et al (2017b).

Then I can decompose the matrix according to the backward linkage by adding the columns of the matrix:

$$Y^{'} = \widehat{V}\mathrm{CY} = \underbrace{\widehat{V}LY^{D}}_{(1)\,-Y\_D} + \underbrace{\widehat{V}LY^{F}}_{(2)\,-Y\_RT} + \underbrace{\widehat{V}LA^{F}LY^{D}}_{(3a)\,-Y\_GVC\_S} + \underbrace{\widehat{V}LA^{F}(CY - LY^{D})}_{(3b)\,-Y\_GVC\_C} \quad (2.8)$$

Table 2. 2 The decomposition results of sector final goods production based on backward industrial linkage

Sum	First level	Second level	Third level	Description
Final goods and service production by country/sector	Y_D	Y_D	Y_D	Domestic value-added in domestically used final products
	Y_RT	Y_RT	Y_RT	Domestic value-added in final exports (cross border once)
	Y_GVC	Y_GVC_S	Y_GVC_S	Partner value-added in production of domestic used products (cross border once)
		Y_GVC_C	Y_GVC_C (D)	Domestic value-added in the production of exported products
			Y_GVC_C (C)	Foreign value-added in the production of exported products

Source: Own compilation based on Z. Wang et al (2017b).

Where: (1) $-V\_D$ and $-Y\_D$ mean value added produced by domestic to meet the domestic need, and it doesn't refer to international trade. (2) $-V\_RT$ and $-Y\_RT$ mean value added in final goods produced by domestic to meet the foreign need.

(4) Position (length) index

Many researchers focus on the position (length) index in GVCs. Among them, Dietzenbacher et al. (2005) and Dietzenbacher & Romero (2007) propose "Average propagation length" to measure the average number of production stages contained in each branch of the production network. Then some studies related production stages and distance to final demand (Fally, 2011, 2012). Specifically, he offers two methods to measure the vertical division of the production chain, which are the number of steps needed to produce a product and reach the final demand ("Number of production stages" and "Upstreamness"). And the formula can be written as follows:

$$U_{2i} = 1 + \sum_{j=1}^{N} \delta_{ij}\, U_{2j} \quad (2.9)$$

Where: δ_{ij} is the share of the sector *i*'s total output purchased by industry *j* for intermediate input use.

Antràs et al. (2012) construct the index of upstream according to the OECD input-output table, which can reflect the upstream and downstream relationship of different industries in the value chain of various countries. The specific derivation is as follows:

First, the total output of an industry (*Y*) in a country can be expressed as the total consumption of its final products (*F*) and other industries' intermediate products (Z), according to

Leontief. They begin with output identity for industries $i \in \{1, 2, 3, ..., N\}$ and get the following formula:

$$Y_i = F_i + Z_i = F_i + \sum_{j=1}^{N} d_{ij} Y_j \quad (2.10)$$

Where: d_{ij} is the value of *i*'s output needed to produce one dollar worth of industry *j*'s output (direct requirements coefficient)

After iterating, the formula can be:

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij} F_j + \sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj} F_j + \sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il}d_{lk}d_{kj}F_j + \dots \quad (2.11)$$

U_i is the weighted average of the proportion of final and intermediate products in the total output of industry *i*. The farther the intermediate products are from the final products, the higher the weight is. Each term in formula (2.11) can be weighted by their distance from the last use (plus 1), then normalizing by Y_i:

$$U_{1i} = 1 \times \frac{F_i}{Y_i} + 2 \times \frac{\sum_{j=1}^{N} d_{ij} F_j}{Y_i} + 3 \times \frac{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj} F_j}{Y_i} + 4 \times \frac{\sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il}d_{lk}d_{kj}F_j}{Y_i} + \dots \quad (2.12)$$

U_{1i} is greater than or equal to 1, if and only if all products in industry *i* are final products, U_{1i} is equal to 1. At the same time, the farther the industry i is from the final consumer goods, the higher its upstreams. Because the natural assumption ($\sum_{j=1}^{N} d_{ij} < 1$) so the numerator of U_{1i} is the *i-th* entry of $[I - D]^{-2}F$.

Where: *D* is the matrix of d_{ij}'s; F is the column vector whose *i-th* entry is F_i. That will be valid if $d_i < 1$ because $[I - D]^{-1}$ would exist.

Following the eq. (2.9) proposed by Fally (2012) and U_{2i} is bigger or equal to 1, they express U_{2i} as the following formula:

$$U_2 = [I - \Delta]^{-1}\theta \quad (2.13)$$

Where: Δ is the matrix with $dij\ Yj/Yi$ in entry (i, j), and θ is a column vector of ones. As mentioned above, OECD's input-output table reflects the input-output relationship of various domestic industries. In contrast, this table cannot observe the input-output situation in the external world. So I can not compare the upstreams across countries. Then they provide the third measurement by holding constant the demand for output for final use (F) in the first step. Then they try to explain that from the value added (V) aspect and hold constant the matrix Δ.

$$U_{3i} = \frac{1}{Y_i}\sum_{j=1}^{N} \frac{\partial Y_{ij}}{\partial d_{ij}} = \sum_{j=1}^{N} \frac{\partial Y_j}{\partial V_i} \quad (2.14)$$

They give U_{3i} two economic meanings: one is the increment of all sectors' output when an industry's added value rises by $1, reflecting the industry's forward correlation. Another is the semi-elasticity of an industry's output to a constant change in input-output linkages within sectors. In addition, they prove that the three measurement methods they used are equivalent. (For $U_1 = U_2$: Matrix manipulation. For $U_3 = U_2$: Show that U_3 satisfies the same recursive relationship as U_2).[20]

[20] Production Length and Upstreamness part was based on the course "Topics in international trade - Pol

Z. Wang et al. (2017a) put forward the concept of “average production chain length” and “relative upstream degree”, reflecting the complexity of the production process and position. Production length is the average number of production stag-es required for the added value created by factor input of a national sector to reach another national industry and be used to produce the final product.

2.2.2.3 Firm level approach

Most of the research on GVCs at the national level is based on the Input-Output Table (Macro). So some research uses firm-level (micro) data to verify the value-added exports of enterprises, industries or countries (Kee & Tang, 2016; Upward et al., 2013; Vrh, 2019).

More recently, some studies (Johnson, 2018) point out deficiencies in the Input-Output Table: 1). The difference between import and domestic input is ignored. 2). Its "average input intensity" can not cover the error caused by the difference in import input used by enterprises in the same industry in producing products for export and domestic markets. Therefore, on the one hand, it cannot explain some details (for example, how much-imported cotton is used in China's clothing production and the heterogeneity of the use of cotton imported from different countries). On the other hand, it will also lead to the distortion of GVCs (especially in China, as the "world processing factory"). Similar deviation in the export of value-added also has been achieved in some studies (De La Cruz et al., 2013; Koopman et al., 2012).

Bems & Kikkawa (2021) further divide aggregate sectoral deviations into direct and indirect parts caused by 1) the different intensities of direct foreign trade of enterprises and 2) the heterogeneity of indirect foreign trade via other domestic enterprises separately. They point out that the overvaluation of Belgium's value-added exports in the input-output table accounted for 2% to 5% of its total exports. This deviation would be further amplified in the processing trade countries. In addition, they also confirm the significant effect of differences in enterprise size and industry category. However, due to the non-public nature of most enterprise-level data (regulations or trade secrets), the difficulty of statistics, and the untimely year, the current research on corporate-level GVCs is insufficient.

Through the review of GVCs measurement literature, I find that the research on GVCs at the provincial and municipal levels is insufficient. Therefore, it is considered to explore the heterogeneity of related industries in different value chains from three dimensions: intra-regional, intra-regional and global. On the one hand, it serves as a supplement to the research on GVCs measurement, and on the other hand, it also provides a basis for me to discuss "GVCs on the labour market - China's provincial perspective" in this chapter.

2.2.3 Literature on the One-Belt One-Road (OBOR) and value-added trade

As I mentioned in the first chapter, OBOR is not a simple trade agreement but a multi-level cooperation strategy: (1) Politics - OBOR Cooperation Memorandum, China-CEEC cooperation, OBOR Summit and so on (Chawla, 2020; Jaklič & Svetličič, 2019; Kong, 2015; Roussi, 2019; Wang & Tian, 2022); (2) Economy – like RMB internationalization, the Asian

Antràs" in Kiel Institute for the World Economy (03 - 07 May 2021).

Infrastructure Investment Bank and the Silk Road Fund (Handwerker, 2020; W. Li & Jin, 2018; Liang, 2020); (3) Infrastructure construction and investment - e.g. CR Express, Lao–China Railway, Gwadar Sea Port, Port of Piraeus (Casarini, 2016; Fardella & Prodi, 2017; Y. Li et al., 2018; Wolszczak-Derlacz & Lu, 2022); (4) Humanity, culture and education - for example, Confucius Institute, OBOR Overseas Scholarship and Science Alliance (M. Liu et al., 2020; Rezaei & Mouritzen, 2021; H. Wang et al., 2021). Therefore, I expect that OBOR will reduce the political contradictions, trade costs, investment resistance, etc., among its members, thus promoting industrial transfer, deepening the industrial links, and finally having an effect on value-added trade and GVCs (Y. Ge et al., 2020; Wolszczak-Derlacz & Lu, 2022).

Although many studies have discussed the relationship between OBOR and nominal trade (Bastos, 2020; Foo et al., 2020; Golovko & Sahin, 2021; Guo et al., 2017; Herrero & Xu, 2017; A. Liu et al., 2020; Ma et al., 2017; C. Yu et al., 2020; L. Yu et al., 2020), less research links it with value-added trade and GVCs.

With the process of OBOR in investment and infrastructure construction, some literature relative to GVCs or Value-added trade and OBOR can be seen. The first research (Damoah et al., 2019) has explored the influence of OBOR on GVCs' position or intermediate goods production networks - "Spider type". The production networks in Western Europe, North America and East Asia, with Germany, the United States and China as the centres, and the production links between them constitute the main body of the global intermediate goods network. Regarding the OBOR organisation, China's central position is unshakable, and the Association of Southeast Asian Nations (ASEAN) regional network centred on Singapore, Malaysia and Indonesia is the main part, which reflects the strengthening of industrial links between China and ASEAN. When combining the OBOR network with major global networks, they found that most relations between China and the European region were indirectly through Germany rather than directly. As far as China is concerned, its intermediate import goods network is much more complex than its export, which fully reflects the characteristics of China as a processing country. Another research linked with the GVCs measure index is by Ge et al. (2020). They confirm that the government's active actions in the intermediate production sector (consistency and sustainability of policies, maintenance of industry norms) can positively affect the participation of GVCs in the country. In addition, they also find that the area covered by OBOR is in the "valley" of global value chain participation. However, its sample only includes 43 economies with 17 OBOR participants, and its period (2000-2014) is mainly before the formal proposal of OBOR. This study is more about the background analysis of GVC and does not explore the effect of OBOR.

Two additional papers related to value-added export and OBOR are found. Cieślik (2020) confirms the positive effect between 1) China's export potential to European OBOR participating countries and 2) the proportion of China's added value in the region's exports. At the same time, they also discussed the heterogeneity of countries and industries—specifically, China's added value accounts for a higher proportion of these members' exports than others. China's most immense export potential belongs to the electrical industry, while the highest proportions of

China's value-added is concentrated in the computer and clothing industries. Kohl (2019) establishes sample data covering 64 economies spanning 2002-2011. Compared with the above research in the field of nominal trade, he has solved the problem of "double counting" and confirms the positive effect of OBOR on value-added trade. In addition, it discusses the heterogeneity of members and concludes that developing areas (ASEAN) gain more benefits. He confirms it has a stronger positive association than the other essential agreements (the Regional Comprehensive Economic Partnership - RCEP and Trans-Pacific Partnership - TPP) covering the ASEAN region.

In general, the above documents have the following defects: 1) The sample time is insufficient (the years after the formal implementation of OBOR is missing); 2) The number of sample countries is insufficient (lack of global perspective); 3) The empirical analysis of the degree of industrial linkages is insufficient (GVCs perspective).

Therefore, by expanding the sample coverage of countries and time, analysing the effect and robustness of OBOR implementation is beneficial. In addition, the added value of a partner in one economic's value-added trade (similar to Cieślik (2020)) and export can be used to explore the role of OBOR on "real trade" and "industrial linkages".

2.2.4 Literature on the effect of GVCs on the labour market

As described above, based on making use of the advantages elements of various countries to reduce production and trade costs, the global production division with transnational groups as the main body has promoted the rise of global value chains (Antràs, 2020a; R. Baldwin, 2006; Kano et al., 2020; Seric & Tong, 2019).

This mode of division of production (usually represented by offshore outsourcing) will inevitably bring changes to the labour market through three main channels (employment, productivity and wage) (Autor et al., 2013; J. Baldwin & Yan, 2021; Bamber et al., 2014; Banga, 2022; Caraballo & Jiang, 2016; Lu et al., 2019; Opazo-Basáez et al., 2021; Shepherd, 2013; Taglioni & Winkler, 2016), significantly with the gradual division expansion from manufacturing to other industries (Costinot et al., 2012; Farole, 2016a; Feenstra & Hanson, 1996; Helpman, 2016; Hollweg, 2019; Ndubuisi & Owusu, 2022; Szymczak & Wolszczak-Derlacz, 2022; Zhu & Trefler, 2005).

2.2.4.1 GVCs and employment

Relevant research obtained inconsistent conclusions in the first channel, "employment". The methods of GVCs affect employment include job opportunity and job redistribution (Kabeer & Mahmud, 2004; Nadvi et al., 2004).

First, with the increase in the proportion of intermediate goods trade, value-added trade has replaced the import and export volume as a measure of a country's "real income" (Daudin et al., 2011; Hummels et al., 2001; Johnson & Noguera, 2012; Koopman et al., 2010, 2014; Z. Wang et al., 2009, 2013). Similarly, traditional trade divides its related labour market into import (foreign) and export (domestic). The labour factors represented by GVCs are mainly composed

of the following three parts: foreign factors in export, domestic factors in import, and factors from third countries in import (Jiang, 2015). Therefore, relevant research believes GVCs bring additional employment opportunities (Bamber et al., 2014).

Second, each country establishes its responsible part based on its comparative advantages in the commercial activities of different products, thus triggering changes in the structure of domestic labour demand and ultimately leading to the redistribution of domestic employment. As discussed in the wage part, relying on Heckscher – Ohlin model, GVcs will increase the demand for skilled workers in exports (Feenstra & Hanson, 1995, 1996; OECD, 2016; World Bank Group et al., 2017). In addition, the training and labour mobility factors caused by GVCs will further improve the skills of the local labour force (Pan, 2020). However, Caraballo & Jiang (2016) believe that the impact of exports is still mainly concentrated on low-skilled rather than high-skilled employment.

In addition, some studies (Autor et al., 2013; Crinò, 2010; Grossman & Rossi-Hansberg, 2008) express doubts about the above positive results because offshore outsourcing will inevitably lead to reduced market employment opportunities in the short term. In addition, GVCs may also lead to the "hollowing" (deindustrialization) of some industrial industries in developed countries, reducing industrial employment opportunities (Meng et al., 2020). Therefore, it is necessary to invest huge costs and sustainable investment in education to shift to the service economy (Fontagné & Harrison, 2017).

2.2.4.2 GVCs and productivity

GVCs have a specific promotion effect on the productivity of the source and destination countries of offshore outsourcing (Banga, 2022; OECD, 2012; Opazo-Basáez et al., 2021; Taglioni & Winkler, 2016).

Specifically, the source countries (primarily developed economies) increase the investment in the relatively profitable industries by transferring the labour-intensive or low-end sectors to other countries to realize the specialization of production and ultimately improve productivity (Criscuolo & Timmis, 2017; Grossman & Rossi-Hansberg, 2006). At the same time, the recipient countries (mainly developing or emerging economies) promote productivity by gaining investment, technology transfer, advanced management experience, new product categories and access to larger international markets (R. Baldwin & Robert-Nicoud, 2014; Constantinescu et al., 2019).

GVCs also can help the relevant domestic enterprises to improve their productivity (Pittiglio et al., 2016) in the following ways: 1) improving the production process and management process to cope with the "competition" of transnational enterprises (Ishikawa & Horiuchi, 2012), 2) "imitating" the public behaviour of multinational enterprises (Y. "Anthea" Zhang et al., 2014), and 3) "learning" advanced production process and management experience by recruiting technicians and managers from multinational enterprises (Villar et al., 2020).

However, the opportunities for local enterprises to improve their productivity depend on the specific market and government management system and their ability to narrow the technological gap with transnational corporations (Shepherd, 2013). For example, multinational enterprises pay more for skilled workers, which may lead to the loss of highly skilled employees of local enterprises and ultimately reduce productivity (Aitken et al., 1996; Z. Chen et al., 2011; Nguyen et al., 2020).

2.2.4.3 GVCs and wage

The research on the impacts of GVCs on wages is an extension (Ndubuisi & Owusu, 2022) of the studies on trade and inequality (Adam et al., 2012; Adão et al., 2022; Helpman et al., 2017; Klein et al., 2013; Lee, 2020; Meschi & Vivarelli, 2009; Sampson, 2014).

With the popularity of GVCs research, researchers have tried to explore the potential relationship between GVCs and income inequality/ wage from multiple aspects of countries (Gonzalez et al., 2015; Szymczak & Wolszczak-Derlacz, 2022), industries (Ndubuisi & Owusu, 2022; Paweenawat, 2022) and enterprises (Lu et al., 2019; Wolszczak-Derlacz & Nikulin, 2022). However, there are still no consistent results on this topic due to the research objects' heterogeneity (Hummels et al., 2018).

Specifically, the first heterogeneity is related to the development of countries. As one of the crucial characteristics of GVCs, offshore outsourcing is more to transfer labour-intensive industries from developed countries to developing countries (World Bank, 2012), so this trend is unfavourable for low-skilled workers' wages in developed countries (Acemoglu, 2003; Baumgarten et al., 2013; Geishecker & Görg, 2013; Hummels et al., 2014; Ndubuisi & Owusu, 2022) and has the opposite impact in developing areas (Banga, 2016; Farole, 2016b). Specifically, productivity improvements related to global value chain participation may also affect local workers' wages, and their wages should increase with their higher marginal productivity (Pittiglio et al., 2015).

Subsequently, due to the above offshore outsourcing and the focus on high-value-added industries, the relative demand for high-tech talents in developed economies has increased, ultimately benefiting the wages of high-tech talents and finally causing the heterogeneity of workers' skills (Anwar et al., 2013; Crinò, 2009; Feenstra & Hanson, 1999; Hijzen, 2007). The similar increasing wage for skilled workers also happened in developing markets because of the higher payment for skilled workers from Multinational companies than local corporates (Driffield & Girma, 2003). Domestic firms are also willing to pay more to avoid “brain drain” (Muñoz-Bullón & Sánchez-Bueno, 2013). Past empirical studies have widely verified this heterogeneity (J. Baldwin & Yan, 2021; Shepherd, 2013). However, this may depend on the relative GVC position, as shown in Szymczak and Wolszczak Derlacz (2022). In addition, higher wages may also be related to the intensification of wage inequality between skilled and unskilled occupations and the weakening of the bargaining power of low-skilled people, which may lead to further deterioration of their working conditions (Abd Rahman et al., 2022; W. Wang et al., 2021).

The last heterogeneity (corporates) stems from the widely proven (Burstein & Vogel, 2017; Coşar et al., 2016; Wolszczak-Derlacz & Nikulin, 2022; Yeaple, 2005) wage differences among different enterprises' employees who work in the same country and industry and have similar personal characteristics (e.g. skill, gender, age, etc.).

2.2.4.4 GVCs and the labour market in China

So far, the research on the impact of China's global value chain participation on local wages, productivity and employment is not sufficient, and most of it is concentrated at the enterprise level.

First of all, the results of GVCs on the employment of Chinese enterprises are inconsistent. Based on the data of Chinese enterprises from 2000 to 2006, Lü et al. (2018) point out that the participation of global value chains can promote employment through exports, the substitution of intermediate products and the international division of labour of multinational companies. And the heterogeneity of enterprises also has been confirmed. Specifically, its effect is more significant in capital/technology-intensive and private enterprises. However, after considering the environmental costs, GVCs have somewhat hindered employment growth and are more serious in the eastern region, with female and low-skilled workers (S. Wang et al., 2022).

Subsequently, regarding wages, relevant studies (L. Li et al., 2017; Lu et al., 2019; L. Zhang et al., 2021) confirm that the participation of GVCs is beneficial on the whole. Among them, Lu et al. (2019) further explore the heterogeneity of enterprises. And capital-intensive and foreign-funded enterprises play significant winners. This finding is consistent with the research on employment (Lü et al., 2018). L. Zhang et al. (2021) believe that the driving force of this growth stems from productivity improvement and job redistribution. However, compared with the industrial chain of enterprises, the effect of GVCs participation on the average wage of enterprises and the proportion of skilled workers is not apparent (S. Wang et al., 2022).

Finally, J. Ge et al. (2018) show the positive impact of GVCs on productivity, especially in capital and technology-intensive industries and public trading enterprises. They also confirmed that R&D and government subsidies strengthen the productivity effect of GVCs participation. However, due to the lack of enterprise-level data, these efforts are limited to the first decade of this century (most studies cover 2000-2006).

In more recent literature, Bai et al. (2022) confirm that China's value-added trade positively affects global employment. Still, in simple and complex GVCs, it has inhibited and promoted engagement, respectively. And Wu et al. (2021) simulate the impact of GVCs remodelling on China's employment after the complete decoupling of China and the United States.

Reviewing the existing literature shows that the relationship between wages, employment and productivity is not simply a one-way relationship, so it is necessary to consider these variables together while exploring the effects of GVCs on the labour market. In addition, the research on this aspect of China has not covered enough years. Finally, relevant research

has not gone deep into China's provincial level to explore the difference between the effects of the domestic and global value chains on China's labour market.

2.3 Data and Descriptive Statistics

2.3.1 Participation in GVCs

2.3.1.1 Data source

The data for participation in GVCs used in this analysis cover 62 economics and 34 sectors from 2007-2017, obtained from ADB-MRIO GVC Indicators/ WWZ Frameworks. And the specific GVCs indices include upstreamness, the participation index and length. The information related to OBOR and GDP is taken from OECD (2018) and World Bank.

2.3.1.2 Descriptive statistics

The relationship between upstreamness and backward GVCs participation index in 2020 is shown in Fig. 2.2, including 62 countries (33 OBOR countries). Considering the impact of domestic market size on global value chain participation, I use GDP to express this variable.

The forecast line shows a positive correlation between upstreamness and participation (Van der Marel, 2015). In addition, I add two dividing lines on the coordinate axis according to the median value of the upstreamness and participation of these countries.

The first finding is, except for China and India, most countries along OBOR are small economies. And the distribution of upstreamness and participation is relatively uniform (19 and 18 economies in the 33 OBOR members of the sample have higher upstreamness and participation index than the median, separately). Secondly, large economies such as China, the United States and Germany have low backward participation in GVCs. The reason is countries with larger economies tend to have more vital industrial production capacity. Therefore, they tend to attract more successive stages, use more domestic inputs in exports and reduce the use of import inputs. Finally, based on the fact that most large economies are located below the middle line of the upstreamness, there is a negative correlation between the upstreamness and the economic scale.

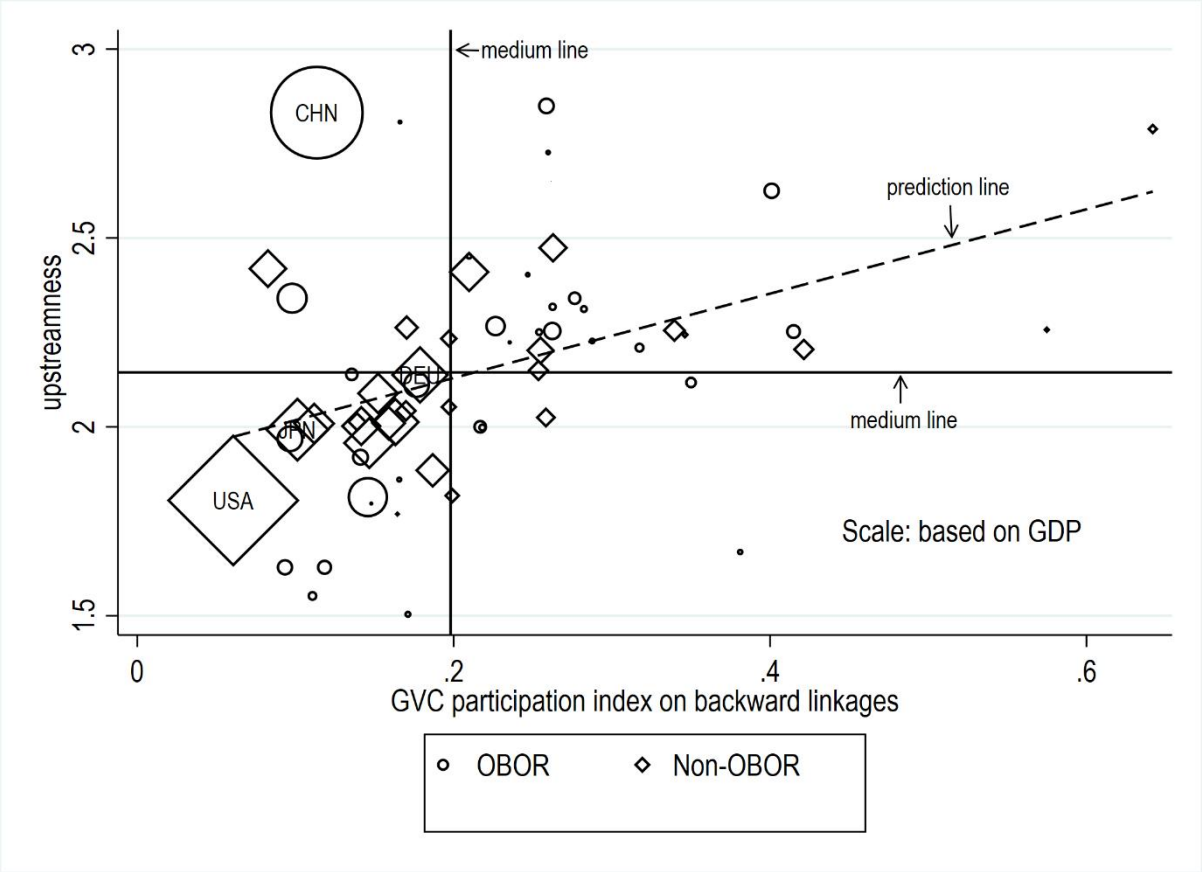


Fig. 2. 2 Upstreamness and GVC participation indexes in 2020 (OBOR VS Non-OBOR)

Source: own elaboration based on data from ADB-MRIO GVC Indicators, OECD (2018) and World Bank.

The overall performance of China's GVCs participation (decrease) and average production length (increase) during this period is opposite in Fig. 2.3. Specifically, (1) The decline of China's participation in GVCs is related to the growth of the domestic value chain triggered by the rapid expansion of the domestic market (Beverelli et al., 2019). (2) China's participation in backward GVCs is more significant, which means that compared with the domestic component of intermediate exports, the foreign part of China's final products is more effective. And it is consistent with Fig. 2.1 (iPhone's value decomposition). (3) The growth of average production length is inseparable from commodity production's further decomposition and fragmentation. (4) Some studies (Z. Wang et al., 2017b) believe that the relative position of a country in GVCs can be determined by calculating the ratio of forward production length (upstream degree) and backward production length (downstream degree). I found that China's forward production length gradually narrowed the gap between its backward production length and surpassed it in 2018, which means that China's upstream position in GVCs has improved. That is also inseparable from the phased results achieved in industrial upgrading in recent years(Li Sun et al., 2010).

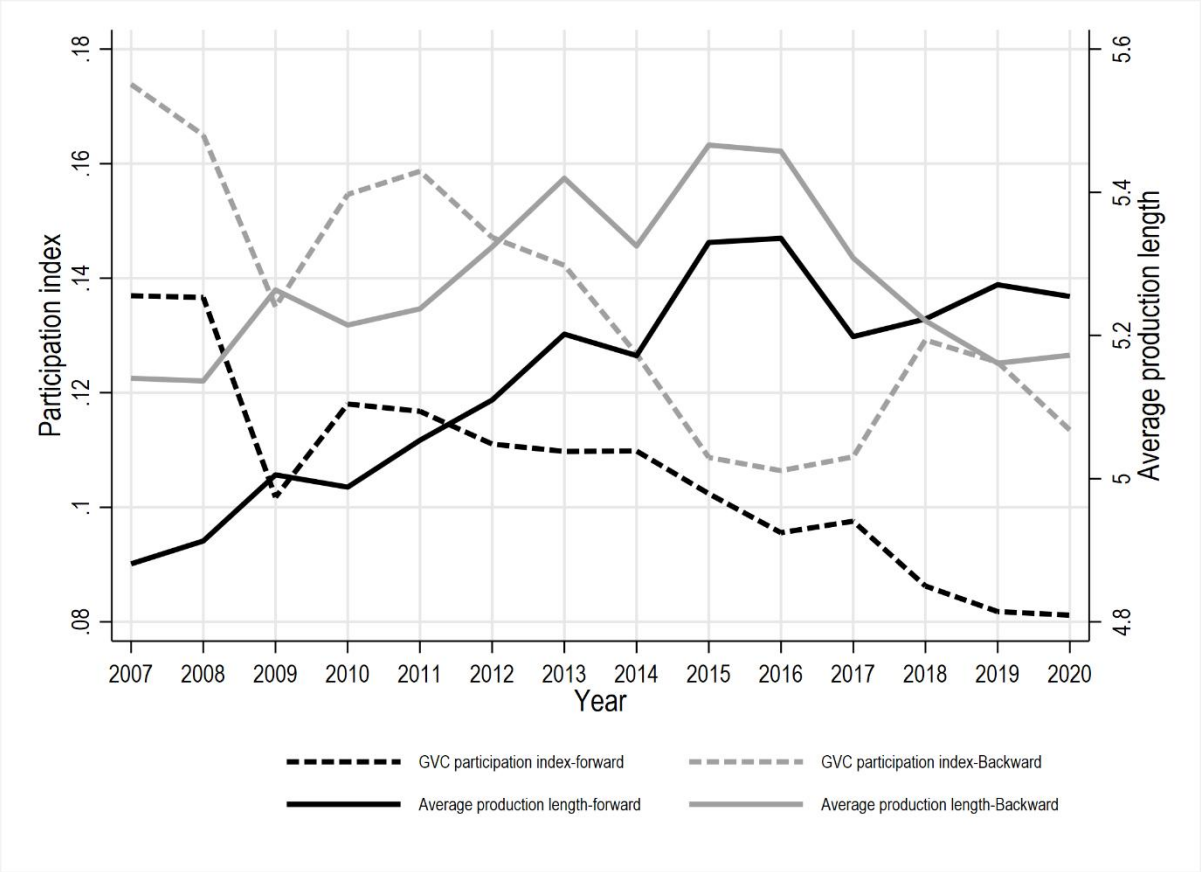


Fig. 2. 3 China's GVCs participation index and Average production length in 2007-2020

Source: own elaboration based on data from ADB-MRIO GVC Indicators.

First, according to the fitting line in Fig. 2.4, I found that at the industry level, there is a positive correlation between upstream degree and global value chain participation, consistent with Fig. 2.2. Regarding the involvement of GVCs, the industry that occupies the "top" is the high R&D industry. In contrast, the GVC participation index of some service industries (C35 Private Households with Employed Persons, C29 Real Estate Activities, C28 Financial Intermediation, etc.) is relatively small because these industries still serve the domestic market.

Second, C2 mining and quarrying, C1 Agriculture, hunting, forestry and fishing, a few manufacturing industries (C7 paper making, C10 rubber), and C17 hydropower services are relatively upstream positions. However, real estate activities, utilities, construction and other services (such as C35 private households with employed persons, C18 construction and C33 health and social work) are less upstream. That is because the follow-up industries serve the end consumers.

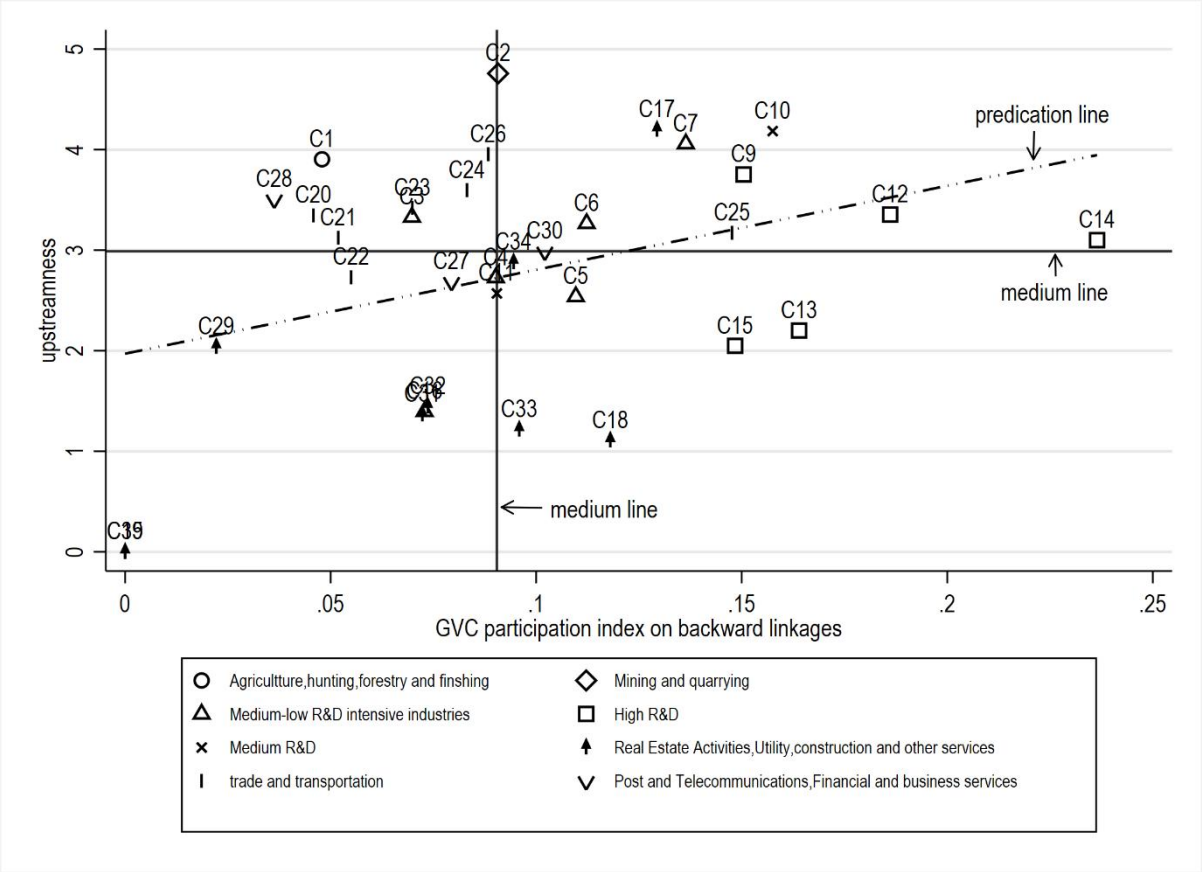


Fig. 2. 4 China's GVCs participation index and average production length in 2007-2020

Source: own elaboration based on data from ADB-MRIO GVC Indicators.

2.3.2 OBOR and GVCs

2.3.2.1 Data source

First, following the classification of value added (Z. Wang et al., 2013), I get the domestic value-added in trade from the ADB-MRIO2018 database in UIBE GVC Indicators. Then it combined with other variables (gravity variables, GDP, GDP per capita, the participant information in ASEAN, ACFTA, OBOB, and WTO) from the same sources introduced in Chapter 1. Finally, the first dataset covers 61 countries (32 OBOR members) from 2010 to 2017.

Considering the limitations of value-added trade data and examining the impact of OBOR on global value chains from another perspective, I used a new variable from the UNCTAD Eora global value chain database (the value contributed by one partner in the total exports of the reporter). After incorporating other identical variables, the second dataset will include 178 countries from 2000 to 2018 (see Tables A2 and A3 in the appendix for source and descriptive statistics).

2.3.2.2 Descriptive statistics

First, I explore the trend of China's DVA exports and the distribution in intermediate and final parts in Fig. 2.5. Overall, the total DVA exports increased from 888.89 billion US in 2010 to 1237.12 billion US in 2017. If connected with the information in Fig. 1.3, I can find DVA and total exports in China have a similar tendency during this period (a little decline in 2015 and 2016). I have also checked for a difference between intermediate and final goods. The results show intermediate products play a more critical role (43% to 47%) in DVA exports which can also explain the increase of China's GVCs position (average length production forward - upstream) in Fig. 2.3.

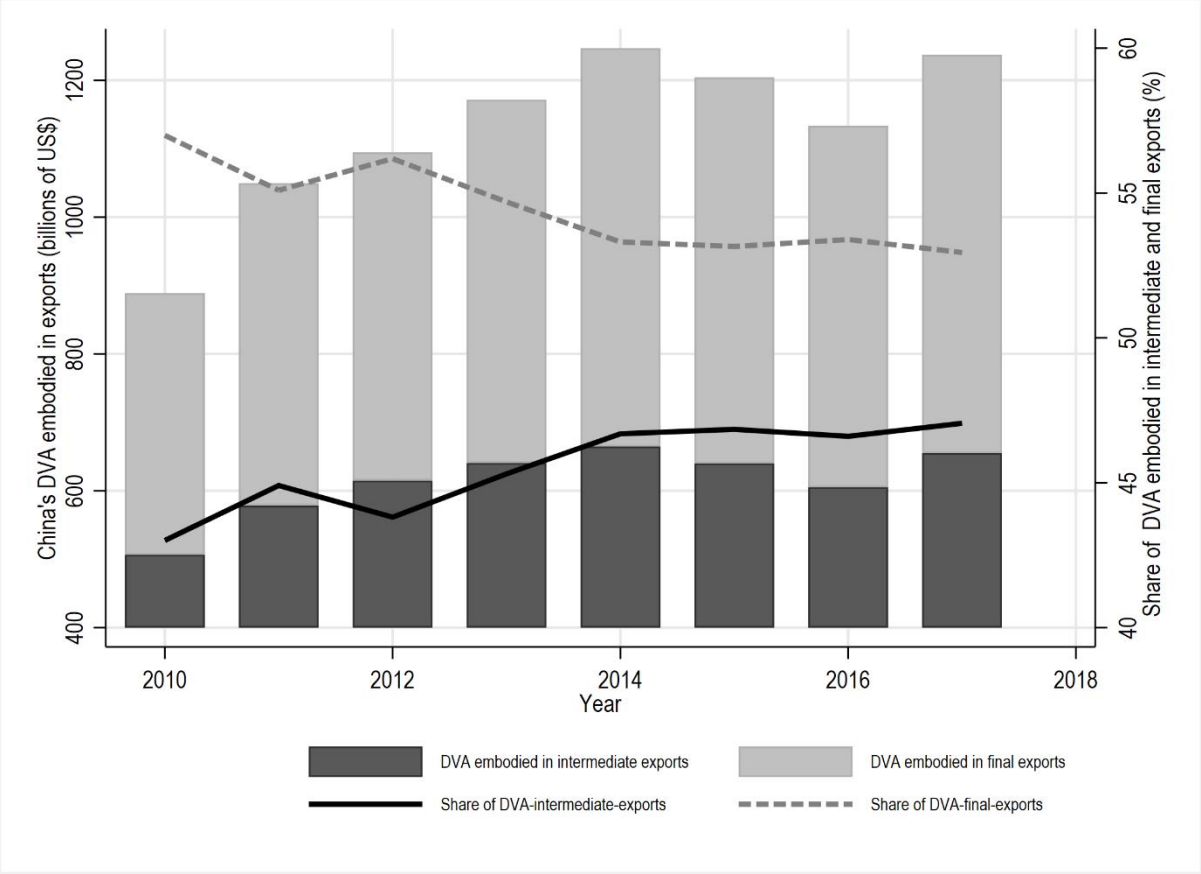


Fig. 2. 5 China's DVA embodied in export from 2010 to 2017

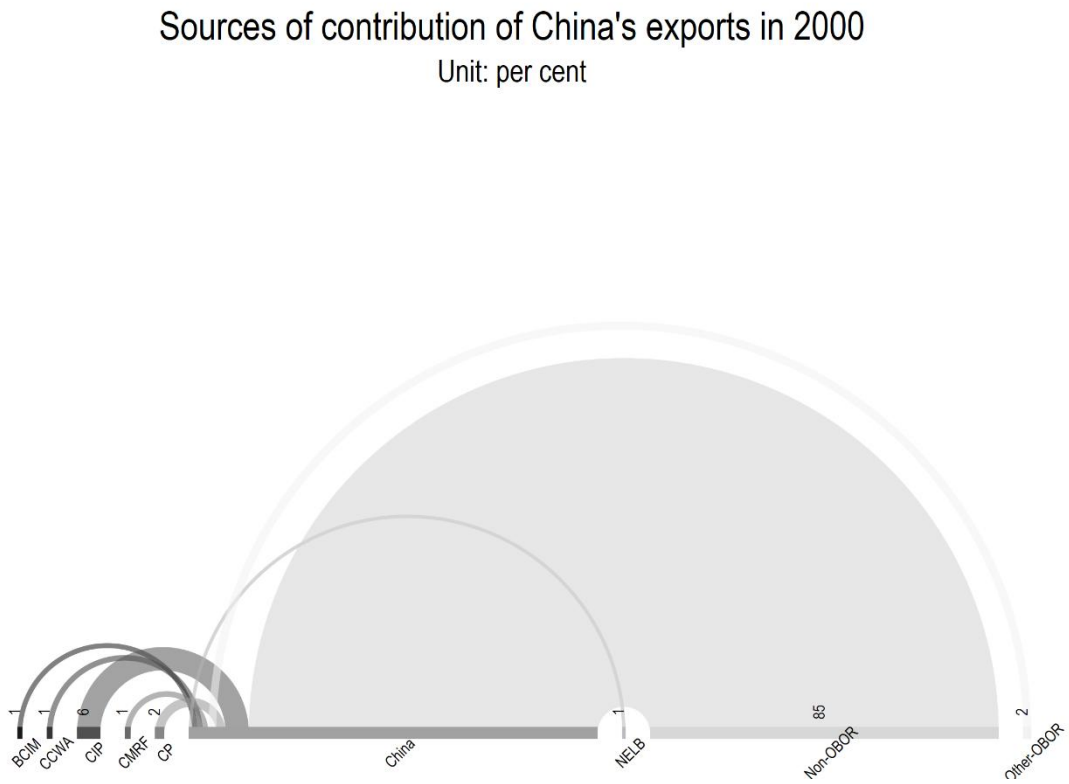
Note: The initial value of the ordinate is 400 (billions of US $)

Source: own elaboration based on data from ADB-MRIO2018 database of UIBE GVC Indicators.

Then I check the change and distribution of different OBOR economic corridors in the second variable- one economic's contributed value in another country's exports in Fig. 2.6. Here, I choose China as the receiver or contributor.

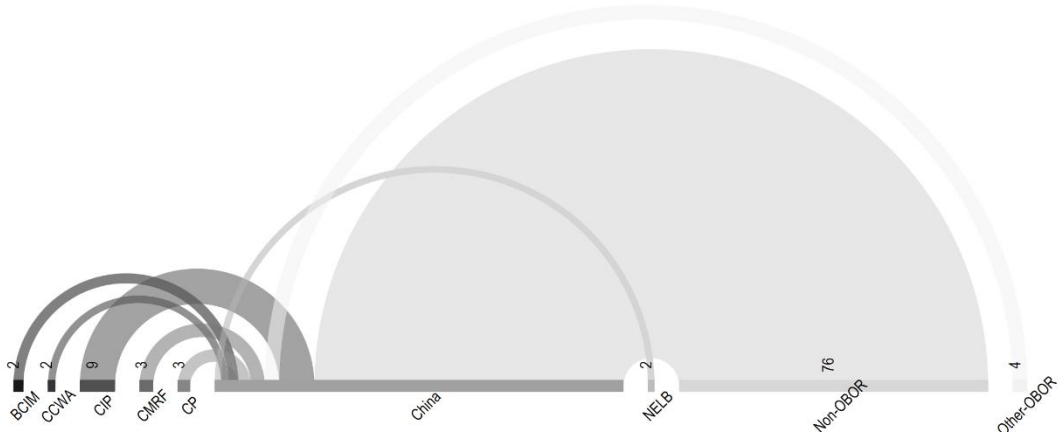
First, relying on the two charts in the upper part of Fig. 2.6, I have obtained the following findings: 1) OBOR economics account for more share (14.68% to 24.40%) in the whole

contributor to China's exports from 2000 to 2018. That represents OBOR economics playing an increasingly crucial intermediate product supplier (directly or indirectly) in China's export-orient production lines. 2) Among the economic corridors, CIP accounts for the majority ratio in OBOR. For details, it accounted for 8.6% in 2018, nearly 36% of OBOR. And the fastest increase corridor is CMIF which has increased from 1.39% to 3.35% and exceeded CP to become the second-largest corridor in 2018. Second, I explore China's contributed value destinations in the same period. The results for OBOR show a tiny increasing trend, with a rise from 18.18% to 21.70%. It means China also account for more share in intermediate goods (direct or indirect) used for OBOR country's exports. Based on the previous inverse-direction contribution value analysis, China's industrial ties with the OBOR region are becoming closer (regional value chain). At the level of economic corridors, CIP still "dominates", but its share has decreased from 11.69% to 11.17%. NELB, CCWA, BCIM, CMRF, and CP have followed closely with 5.04%, 1.92%, 1.41%, 0.83%, and 0.63%, respectively. In addition, there are differences in economic corridors in terms of growth rates. (Positive: BCIM '+149%', NELB' +97.6%', CCWA' +58.5%' and CMRF' +43.2%'; Negative: CP '- 3.1%' and CIP '- 4.5%'.)



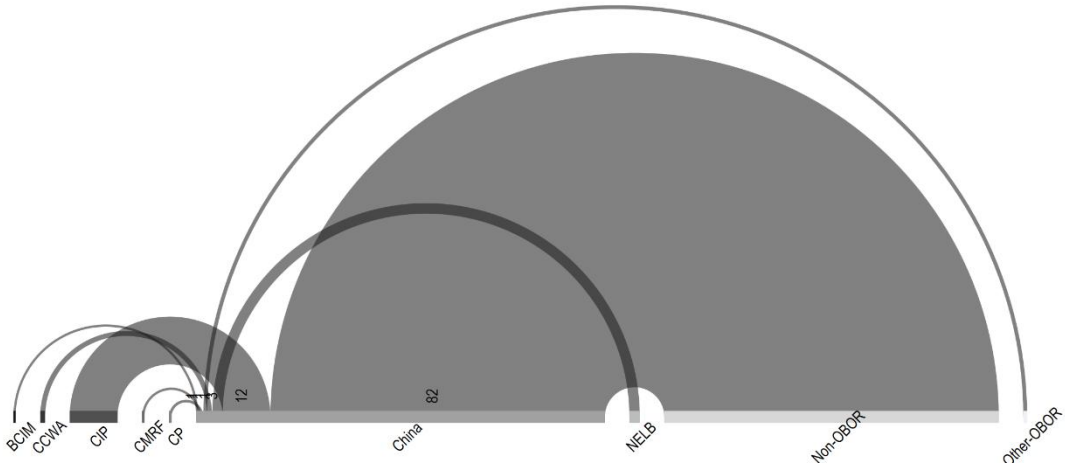
Sources of contribution of China's exports in 2018

Unit: per cent



Destinations for China's contribution in 2000

Unit: per cent



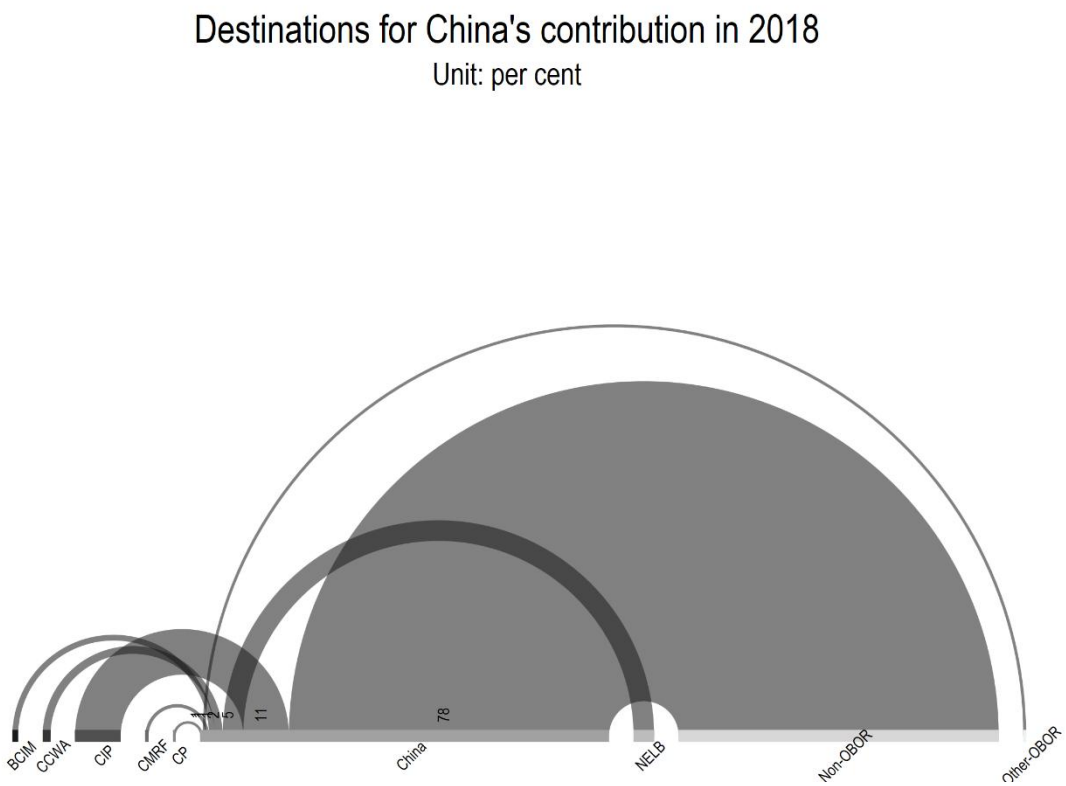


Fig. 2. 6 The sources and destinations of contributed value in exports – China as an aspect

Source: own elaboration based on data from UNCTAD Eora global value chain database and OECD (2018).

2.3.3 GVCs and the labour market

2.3.3.1 Data source and integration

The data on the labour market, trade and GVCs covers 31 China's provinces and 25 sectors in 2005, 2012 and 2017. The dataset includes four main parts: 1) labour market variables (employment, real wage and productivity), 2) various value chain participation indexes, 3) Research and development variables and 4) export data. Since several data sources were used to calculate separate variables (like labour market variables and value chain participation indexes), I created a structured chart for a clearer view (Fig. 2.7).

As the original data sources' sector classifications are erratic, I combine the data into the same 25 sectors as the first step (see Table A.5 in the Appendix for details).

Among the labour market variables, wage, employment and female-worker proportion are directly obtained from the China Labour Economy Database in the EPS China Data platform. Then I take value-added information from the China Multi-Regional Input-Output Tables (CMRIO) in the Carbon Emission Account & Datasets and calculate the ratio between it and employment (productivity). Finally, I employ GDP deflator (2015=100) from World Development Indicators for measuring real wages and productivity. Additionally, I use the Chinese Provinces' Statistical Yearbooks and CMRIO to combine additional R&D-related and export information separately.

Finally, I integrate CMRIO into ADB-MRIO to create the provincial multi-regional input-output table (CEMRIO). As the data in the province-foreign area at the sector level can not get from these two input-output tables, I employ bilateral sector trade between them from the China Industries Trade dataset in the EPS platform. Fig. 2.8 presents all details of the CEMRIO integration.

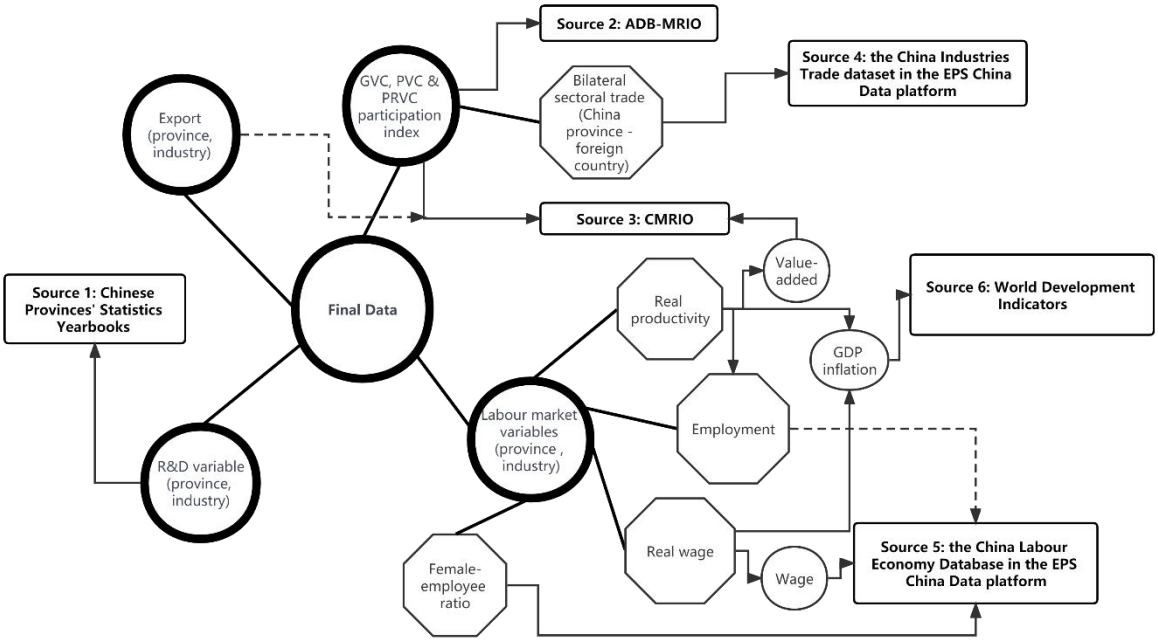


Fig. 2. 7 The structure and source of China's GVC and labour market dataset (province-sector level)

Source: own elaboration.

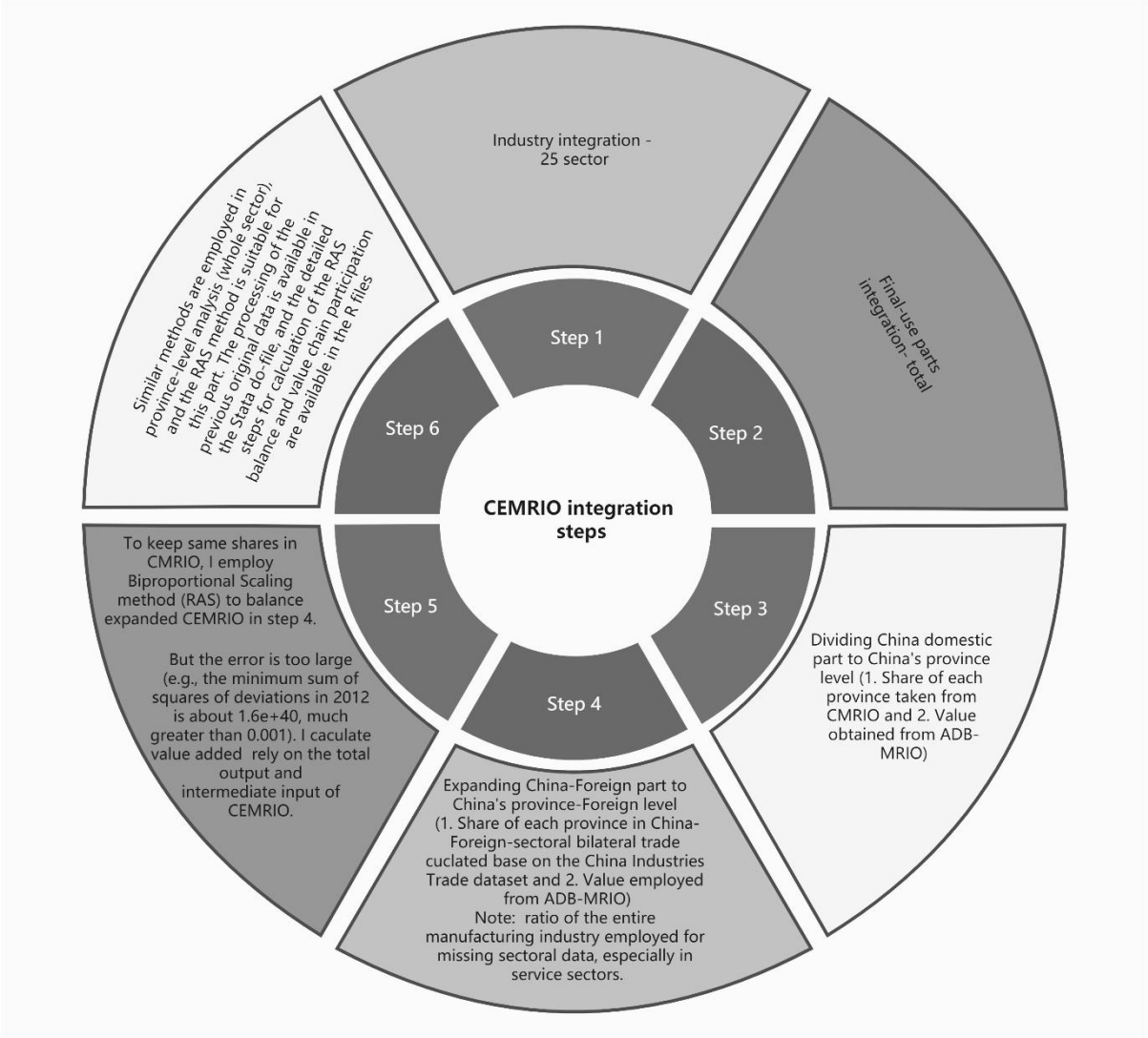


Fig. 2. 8 The integration steps of the provincial multi-regional input-output table (CEMRIO)

Note: I follow the process method Gao & Wang (2020) introduced to solve missing sectoral province-foreign bilateral trade data.

Source: own elaboration.

Then I try to calculate the participation indexes of each province sector in value chains which can be defined from two aspects: foreign (GVCs) and domestic (DVCs). And DVCs can be further expanded into the province (PVCs) and interprovince levels (PRVCs). (Z. Wang et al., 2017b)

At the beginning of all, I employ A^D and A^{DP} to represent the domestic and provincial input coefficient matrixes.[21]

[21] Our final CEMRIO has C (63) countries and P (31) provinces. To have a clear view, I have not extended the equations to the sectoral level.

$$A^D = \begin{bmatrix} A^{11} & 0 & 0 & \cdots & 0 \\ 0 & A^{22} & 0 & \cdots & 0 \\ 0 & 0 & A^{33} & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & A^{CC} \end{bmatrix}$$

(2.15)

Where: A^{11} represents China's domestic input coefficient matrix, and A^{CC} means Country/Economy C's domestic input coefficient.

To illustrate the provinces' scenario, I expand A^{11} into a matrix (31×31) and took the quantity of 'provinces' in foreign economies as 1. The new, improved A^D is proven in equation 2.16:

$$A^D = \begin{bmatrix} A_{11}^{11} & A_{12}^{11} & \cdots & A_{1P}^{11} & 0 & 0 & \cdots & 0 \\ A_{21}^{11} & A_{22}^{11} & \cdots & A_{2P}^{11} & 0 & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ A_{P1}^{11} & A_{P2}^{11} & \cdots & A_{PP}^{11} & 0 & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 & A^{22} & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 & 0 & A^{33} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 0 & 0 & 0 & \cdots & A^{CC} \end{bmatrix}$$

(2.16)

So the provincial input coefficient matrix is as follows:

$$A^{DP} = \begin{bmatrix} A_{11}^{11} & 0 & \cdots & 0 & 0 & 0 & \cdots & 0 \\ 0 & A_{22}^{11} & \cdots & 0 & 0 & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & A_{PP}^{11} & 0 & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 & A^{22} & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 & 0 & A^{33} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 0 & 0 & 0 & \cdots & A^{CC} \end{bmatrix}$$

(2.17)

Where: A_{PP}^{11} represents the provincial input coefficient in province P.

As the total output can be presented like:

$$X = AX + Y$$

$$(I - A)X = Y$$

$$X = (I - A)^{-1}Y = BY$$

(2.18)

Where: X means the total output matrix, A is the input coefficient matrix, Y represents the final goods matrix, I is defined as the Identity matrix, and B indicates the Leontief inverse matrix. The input coefficient matrix comprises domestic and foreign parts (A^D and A^F). So total output matrix can be expanded like this:

$$X = A^D X + A^F X + Y$$

So, it can be presented as:

$$(I - A^D)X = A^F X + Y$$

$$X = (I - A^D)^{-1}A^F X + (I - A^D)^{-1}Y$$

$$X = LA^F X + LY$$
$$BY = LA^F BY + LY$$

(2.19)

Where: A^D denotes the domestic input coefficient matrix, A^F is the foreign input coefficient matrix, and L represents the domestic Leontief inverse matrix.

Converting Y into a diagonal matrix and multiplying each aspect of equation (2.19) via $\widehat{VA}$, the new equation can be presented as:

$$\widehat{\mathrm{VA}}\mathrm{B}\widehat{\mathrm{Y}} = \widehat{\mathrm{VA}}\mathrm{L}\mathrm{A}^{\mathrm{F}}\mathrm{B}\widehat{\mathrm{Y}} + \widehat{\mathrm{VA}}\mathrm{L}\widehat{\mathrm{Y}}$$
$$\widehat{\mathrm{VA}}\mathrm{B}\widehat{\mathrm{Y}} = \widehat{\mathrm{VA}}\mathrm{L}\mathrm{A}^{\mathrm{F}}\mathrm{B}\widehat{\mathrm{Y}} + \widehat{\mathrm{VA}}\mathrm{L\_P}\widehat{\mathrm{Y}} + \widehat{\mathrm{VA}}(\mathrm{L} - \mathrm{L\_P})\widehat{\mathrm{Y}} \quad (2.20)$$

Where: $\widehat{VA}$ denotes the diagonal matrix of value-added, L_P the provincial Leontief inverse matrix, $\widehat{\mathrm{VA}}\mathrm{L}\mathrm{A}^{\mathrm{F}}\mathrm{B}\widehat{\mathrm{Y}}$ is related to GVCs, $\widehat{VA}L\widehat{Y}$ to DVCs, $\widehat{VA}L\_P\widehat{Y}$ to PVCs, and $\widehat{VA}(L - L\_P)\widehat{Y}$ to PRVCs.

Following the method introduced by Z. Wang et al. (2017b), I prolonge the forward (value added) and backward value chain participation (final product) to PVC and PRVC. Hence, value-added can be shown like:

$$VA^{'} = \widehat{VA}BY = \widehat{VA}LA^F BY + \widehat{VA}L\_PY + \widehat{VA}(L - L\_P)Y \quad (2.21)$$

Where: $VA^{'}$ denotes the transposed matrix of value-added, $\widehat{VA}LA^F BY$ indicates the value added related to GVC, $\widehat{VA}L\_PY$ means the value added related to PVC, and $\widehat{VA}(L - L\_P)Y$ represents the value added related to PRVC.

Similarly, I use the following equation to represent the final product value from the backwards aspect:

$$Y^{'} = VAB\widehat{Y} = VALA^F B\widehat{Y} + VAL\_P\widehat{Y} + VA(L - L\_P)\widehat{Y} \quad (2.22)$$

where $Y^{'}$ represents the transposed matrix of final product value, $VALA^F B\widehat{Y}$ denotes the final product value related to GVC, $VAL\_P\widehat{Y}$ is the final product value associated with PVC and $VA(L - L\_P)\widehat{Y}$ means the final product value related to PRVC.

At last, the participation indexes of various value chains can be written as:

$$GVC\_forward = \widehat{VA}LA^F BY/VA^{'}$$
$$DVC\_forward = \widehat{VA}LY/VA^{'}$$
$$PVC\_forward = \widehat{VA}L\_PY/VA^{'}$$
$$PRVC\_forward = \widehat{VA}(L - L\_P)Y/VA^{'}$$
$$GVC\_backward = VALA^F B\widehat{Y}/Y^{'}$$
$$DVC\_backward = VAL\widehat{Y}/Y^{'}$$
$$PVC\_backward = VAL\_P\widehat{Y}/Y^{'}$$
$$PRVC\_backward = VA(L - L\_P)\widehat{Y}\ /Y^{'} \quad (2.23)$$

Where: GVC_forward, DVC_forward, PVC_forward, PRVC_forward, GVC_backward, DVC_backward, PVC_backward, and PRVC_backward are the participation index in GVCs, DVCs, PVCs and PRVCs from forwards and backwards aspects.

2.3.3.2 Descriptive statistics

As mentioned in the previous part, I employ the RAS method to get the combined CEMRIO (province level) table. Then I achieve the participation indexes of provinces in distinct value chains following previously extended equations.

I draw exclusive maps primarily based on the participation indexes to exhibit the inter-regional variations inside China. Fig. 2.9-2.11 present China's forward and backward participation maps in global, domestic, provincial, and interprovincial fee chains for 2012, 2015 and 2017.

(1) China’s participation in various value chains in 2017

On the one hand, I have the following findings linked to the heterogeneity of provincial involvement in value chains (2017) from the forward aspect:

Among them, I can see that the involvement of Chinese provinces in domestic value chains (provincial and cross-provincial) is generally higher than in global value chains. Secondly, in terms of GVCs, the participation of eastern provinces (such as Jiangsu, Zhejiang, and Shanghai) and southern coastal provinces (such as Guangdong) is significantly higher than that of the central and western regions. These high participation regions overlap with China's two leading economic, transportation and manufacturing centres (the Yangtze River Delta and the Pearl River Delta) (X. Liu et al., 2016). This finding indicates that the added value created by coastal provinces is more involved in global production by exporting intermediate products. Thirdly, the opposite results are found in DVCs. Specifically, high provincial value chain participation regions are mainly concentrated in the southwestern provinces of China. At the same time, the participation of these regions in the inter-provincial value chain is somewhat weak compared to other areas. That indicates that the added value these provinces create is more likely to enter their intra-provincial production activities through intermediate products rather than inter-provincial production chains. It is also in line with the fact that the southwest region is one of the least developed regions in China, located in a high-altitude area (the Qinghai-Tibet Plateau), where the industrial infrastructure and logistics facilities are relatively backward. Finally, the Northeast Province has the highest interprovincial participation index, but its global value chain participation is not at the forefront. That indicates that although these provinces are not heavily involved in global production, they are closely related to production in other regions of China. It reflects that the area has been marked by heavy industry and significant energy production, with its added value being more widely involved in production activities in other provinces. However, since the reform and opening up, the region has lagged far behind the eastern coastal areas in opening up to overseas trade due to the lack of seaports[22], the solidification of local industries, and the unfavourable business environment[23].

[22] Due to Russia's invasion and occupation of Chinese territory in modern times. Although Jilin Province is very close to the Sea of Japan, it has no seaport (Olson & Morgan, 1992).

[23] As the famous saying goes for Chinese capital, "Investments do not go beyond the Shanhaiguan Pass" (LiaoNing University, 2022).

On the other hand, the backward participation of Chinese provinces in various value chains shows: 1) The participation of backward GVCs is also generally smaller than that of DVCs. It indicates that the production of final products largely depends on the added value created by production factors in each province, with only a small proportion coming from other provinces and countries. 2) The difference in participation of Chinese provinces in the global value chain is relatively similar to the forward direction: the eastern and southern coastal provinces have a higher degree of backward participation in the global value chain. That indicates that these provinces absorb more foreign production factors reflected in intermediate products when producing final products. 3) The backward and forward participation rates vary within and between provinces. The low level of PRVC participation and high level of PVC participation in the central region indicates that the production of final products in this region of China mainly depends on production factors within the province.

(2) The trend of China's participation in various value chains from 2012 to 2017

Based on Fig. 2.9-2.11, I attempt to analyze the trend of changes in the participation of various value chains (GVC, DVC, PVC, PRVC) in multiple provinces in China during 2012-2017.

Firstly, coastal provinces have been playing the "main force" role in GVCs' participation in global value chains. Except for a few central and western regions and Liaoning Province (Dandong Port[24]), most provinces' forward and backward global value chain participation indexes decreased to some extent in 2012-2017. This trend may reflect China's industrial upgrading (relocation of some processing industries, such as the clothing industry), overcapacity, rising labour costs, and a general decline in the share of global value chains in world trade during this period (Zhan et al., 2020).

Consistent with the abovementioned theory, most provinces exhibit changes (increases) in DVCs opposite to GVCs. It means that industrial linkages within or between areas have become closer, probably due to the steady improvement of domestic infrastructure (high-speed railways, highways) and the transfer of some industries from eastern provinces to central and western regions (China's Western Development Plan).

Finally, I discussed the changes in PVC and PRVC, respectively. These changes are more complex. Specifically, the level and value of participation by provinces have changed during this period. Some regions with high PVC and low PRVC rankings (such as Hubei and Sichuan) have little change. That means these regions have relatively strong industrial agglomeration and low connectivity with other provinces. The reason is that in the context of the "Central China Rise Strategy", these provinces have established their own "one hour (or 100 kilometres)" industrial clusters around provincial capital cities (Chengdu, Wuhan) (Ke & Feser, 2010). On the other hand, the PVC forward and backward rankings of Jilin Province (located on

[24] In 2012, the opening of the Northeast East Railway Passage, which runs through 13 cities in the eastern part of Northeast China, made the eastern regions of Heilongjiang and Jilin provinces the hinterland of Dandong Port (https://zh.m.wikipedia.org/wiki/%E4%B8%B9%E4%B8%9C%E6%B8%AF, downloaded 29 Nov 2022.)

the northeast border) have significantly decreased, with the most significant increase in PRVC rankings. That indicates that Jilin Province is increasingly closely connected with other areas of China under the revitalization plan for the northeast region as a traditional heavy industrial base and coal producer.

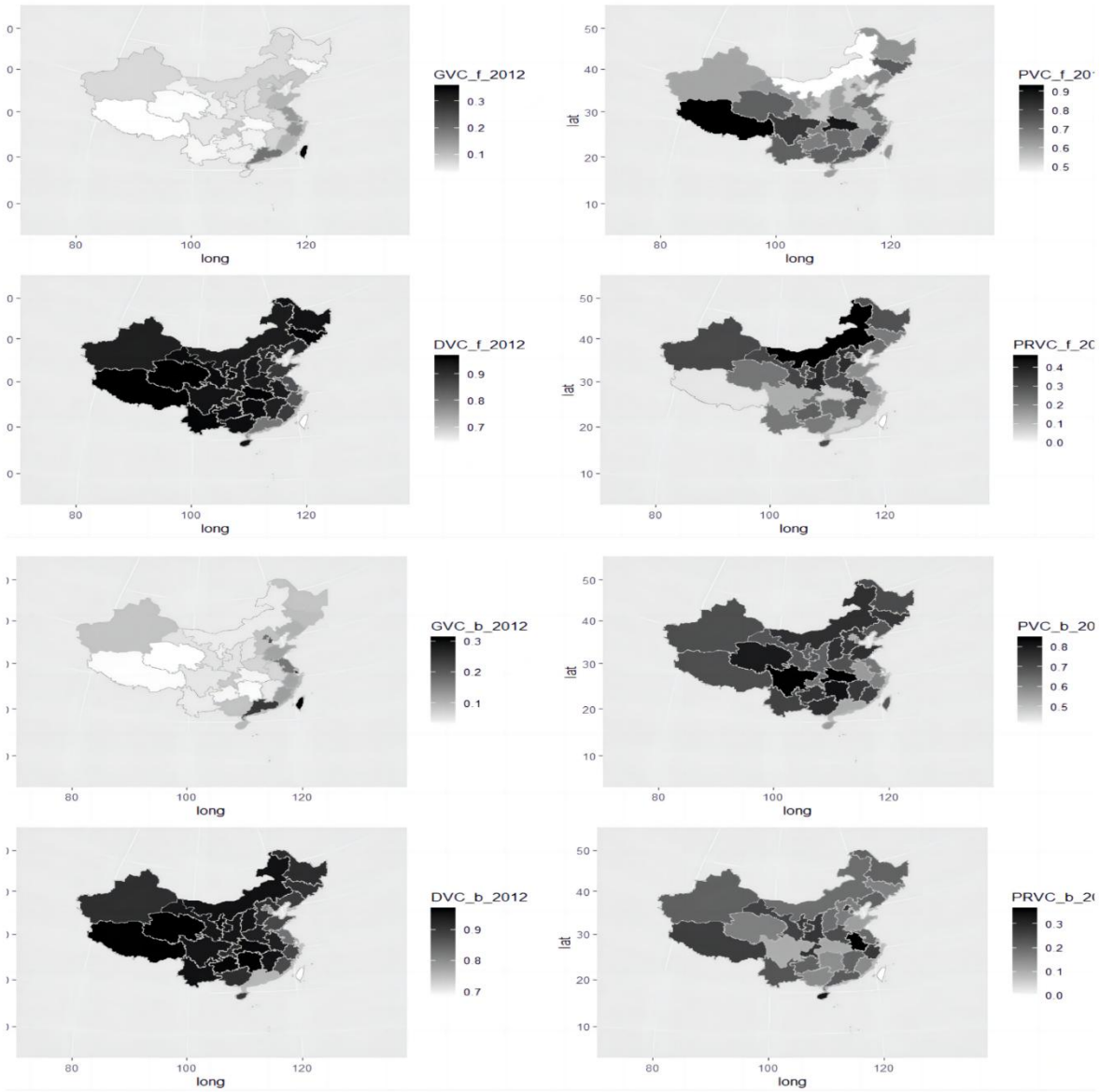


Fig. 2. 9 Chinese provincial participation indexes in 2012

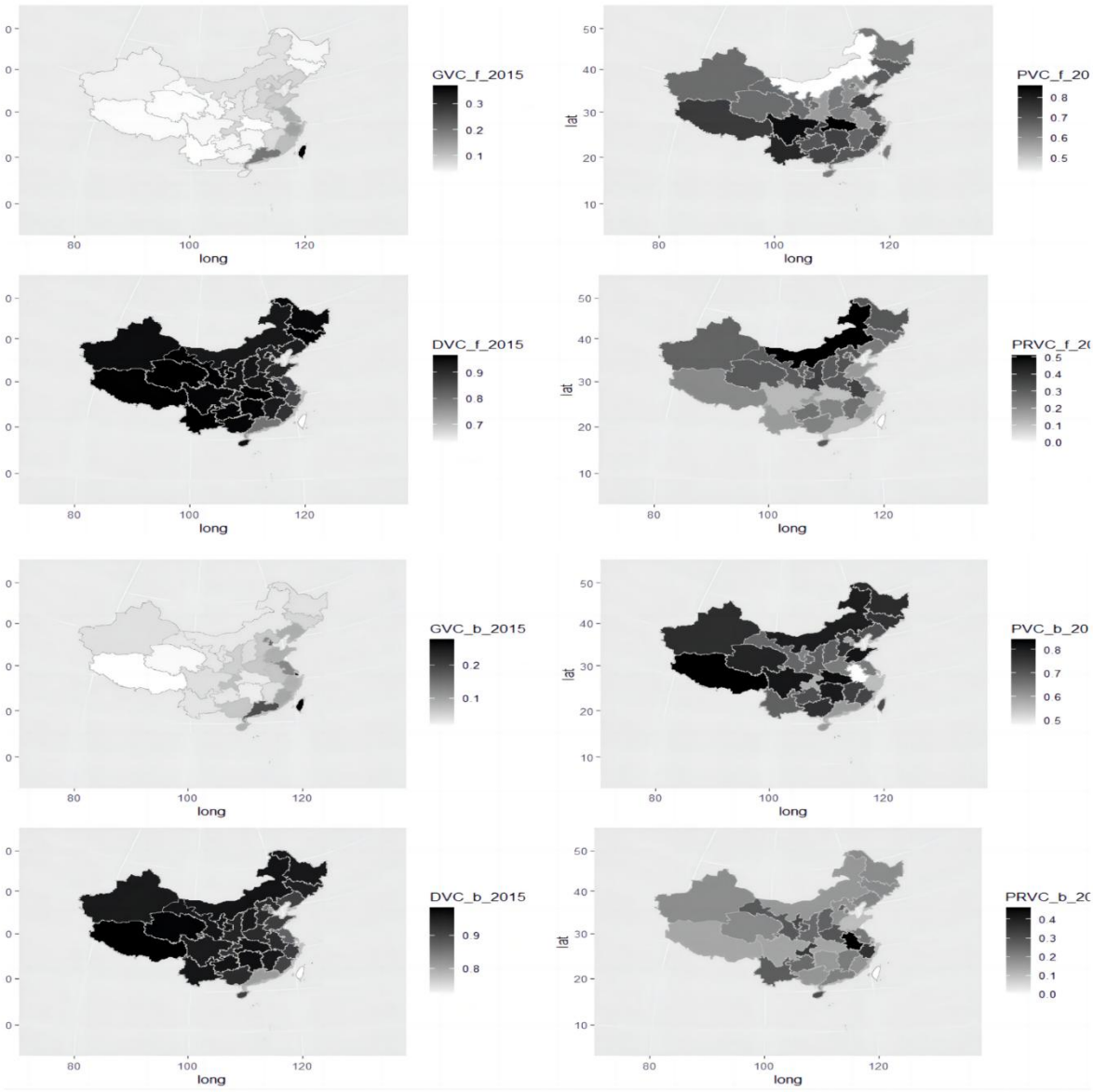


Fig. 2. 10 Chinese provincial participation indexes in 2015

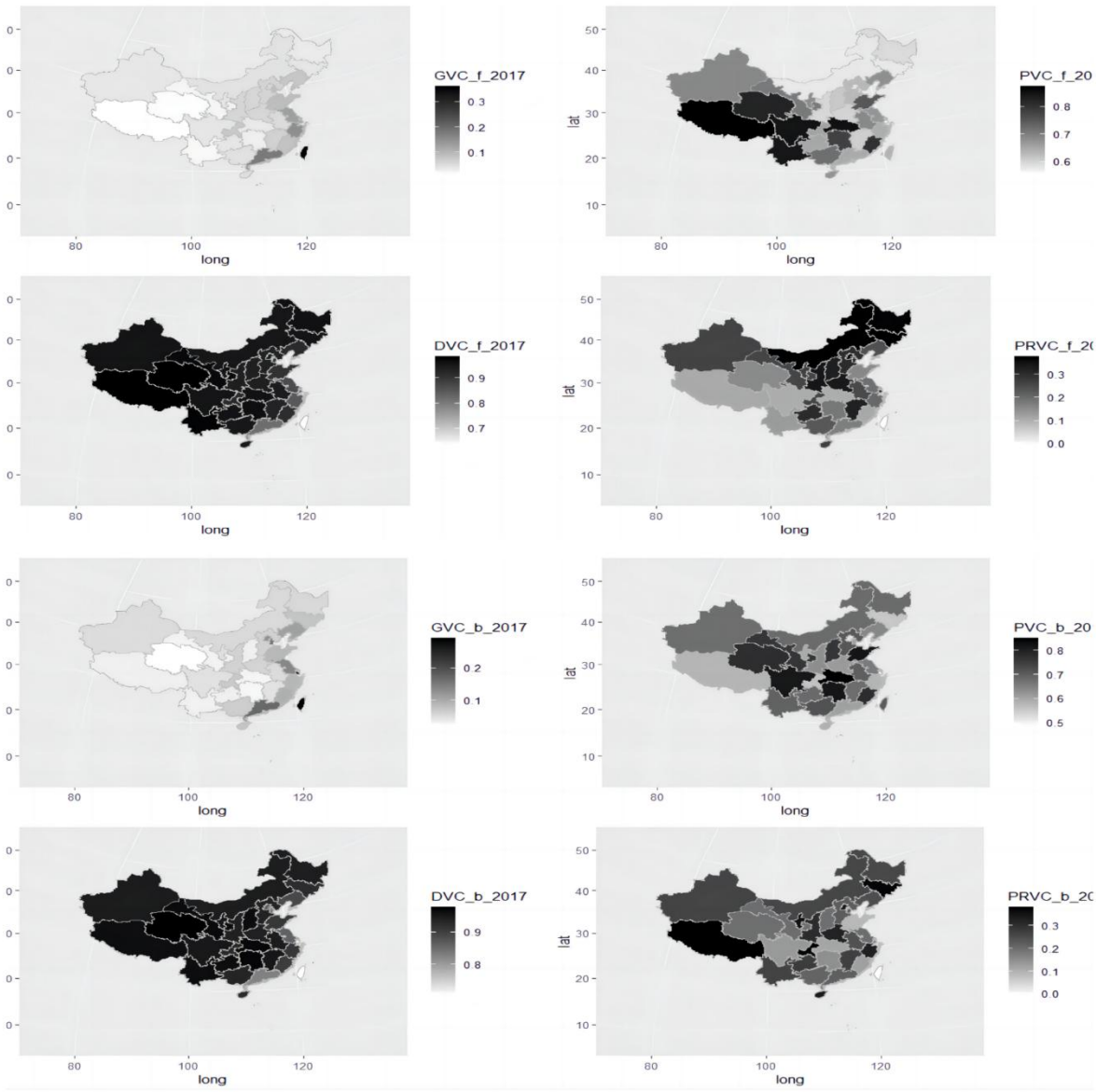


Fig. 2. 11 Chinese provincial participation indexes in 2017

2.4 Empirical Analysis

2.4.1 Empirical analysis link to OBOR and GVCs

2.4.1.1 The gravity model of value-added trade and contributed value in exports

As the gravity trade model employed in Chapter 1, I will use two variables (value-added trade and value contributed in exports) related to GVCs to replace import/ export as the new dependent variables separately.

Following the model in the previous Chapter, we define the new augmented regression models as follows:

$$lnX_{rp,t} = \alpha + \beta_1 lnGDP_{r,t} + \beta_2 lnGDP_{p,t} + \beta_3 lnGDPpc_{r,t} + \beta_4 lnGDPpc_{p,t} + \beta_5 lnDist_{rp} + \beta_6 Lang_{rp} + \beta_7 Contig_{rp} + \beta_8 Colony_{rp} + \beta_9 Smctry_{rp} + \beta_{10} WTO_{rp,t} + \beta_{11} ASEAN_{rp,t} + \beta_{12} ACFTA_{rp,t} + \beta_{13} OBOR_{rp,t} + \epsilon_{rp} \quad (2.24)$$

where: $lnX_{rp,t}$ includes three separate variables, which are the log of 1)Domestic value added (DVA) in exports (millions US$), 2)Foreign value-added (FVA) in exports (millions US$) from reporter to partner at time t, and 3)The value contributed by a partner in the reporter's total export at time *t* (1000 US$);

$lnGDP_{r,t}$ and $lnGDP_{p,t}$ are the log of the reporter's and partner's GDP (current US$) at time *t;*

$lnGDPpc_{r,t}$ and $lnGDPpc_{p,t}$ are the log of the reporter's and partner's GDP per capita (current US$) at time *t;*

$lnDist_{rp}$ is the log of the distance between the reporter and partner's capitals (km);

$Lang_{rp}$ is a dummy variable which takes a value of 1 if trading partners share a common or primary language with the reporter, 0 otherwise;

$Contig_{rp}$ is a dummy variable which takes a value of 1 if trading partners share a common border with the reporter and 0 otherwise;

$Colony_{rp}$ is a dummy variable which takes a value of 1 if trading partners were ever in a colonial relationship with the reporter, 0 otherwise;

$Smctry_{rp}$ is a dummy variable which takes a value of 1 if trading partners were united with the reporter in the past and 0 otherwise;

$WTO_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of WTO at time *t*, 0 otherwise;

$ASEAN_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of ASEAN at time t, 0 otherwise;

$ACFTA_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of ACFTA at time t, 0 otherwise;

$OBOR_{rp,t}$ is a dummy variable which takes a value of 1 if trading partners and reporter are all the members of OBOR at time t, 0 otherwise.

For methodology, I have followed the same regression methods presented in Chapter 1 for solving the multilateral resistance problems, endogenous, zero trade flows, heteroscedasticity,

etc.

2.4.1.2 Results

(1) Global aspect

Following the estimate Equation 2.23, I run OLS, panel FE and fast Poisson estimation under the high-dimensional fixed effect regressions to explore the roles of various variables in DVA, FVA and value contributed by a partner in the reporter's total export in Table 2.3 and Table 2.4.

Among them, the results related to DVA are consistent with Chapter 1 in most gravity variables (1. promoted effect - common border and language and colonial relationship and 2. negative influence- distance). However, the results of GDP and the same country in the past are unclear, which may be caused by the limitation of the dataset (fewer countries and no-continuous). Afterwards, relying on the results of WTO, ASEAN, ACFTA and OBOR in these regressions, countries that are a member of WTO or OBOR have more extensive trade. In comparison, ASEAN and ACFTA do not have a significant conclusion in OLS or FE regressions. The potential reasons include: 1) the members of WTO and OBOR are wider than them, especially since the number of economics in DVA data is only 61, and 2) the gravity model challenges (like zero trade flows and heteroscedasticity).

As the critical variable, OBOR keeps positive and statistically significant results in most regressions. For details, the trade volume effect triggered by OBOR is not trivial; β=0.383 indicates that if countries belong to OBOR, their domestic value added in exports is 383,000 US$ greater at a significant level of 1 per cent (exp(β)x1000000).

The second interesting independent variable is FVA, and the regressions prove there is a significant and positive effect of OBOR on FVA in esports. To cover the limitations of value-added datasets, I select the value contributed by a partner in the reporter's total exports as the last GVCs variable whose dataset covers 178 countries from 2000 to 2018. The results of other traditional variables are more consistent with past augmented gravity model studies (Batra, 2006; Bussière et al., 2008; Bussière & Schnatz, 2009; Foo et al., 2020; Stijns, 2003). Finally, in most specifications, dummies participating in free trade zones positively correlate with global value chain indicators. According to the OBOR coefficient, when two countries belong to OBOR, they contribute more value to each other's total exports, meaning their value linkages are stronger. But its promotion effect is very tiny. For example, in the results in the ninth column of Table 2.4, its promotion effect only accounts for 233 US$ and only nearly 14.4% of WTO impact with 1579 US$. (exp(β)x1000).

Table 2. 3 Estimation results of the gravity model for domestic value added (DVA), foreign value added (FVA) and value contributed by a partner to the reporter's total exports (VCp_IN_Er), OLS and FE

	lnDVA			lnFVA			lnVCp_IN_Er		
	OLS	OLS	FE	OLS	OLS	FE	OLS	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$lnGDP_{r,t}$	0.910***	-0.661***	-0.649***	0.788***	-1.374***	-1.374***	0.702***	-0.176***	-0.177***
	[0.012]	[0.112]	[0.111]	[0.014]	[0.127]	[0.127]	[0.005]	[0.019]	[0.019]
$lnGDP_{p,t}$	0.773***	0.104	0.116	0.847***	0.474***	0.474***	0.754***	0.387***	0.382***
	[0.012]	[0.118]	[0.118]	[0.014]	[0.122]	[0.122]	[0.005]	[0.019]	[0.018]

$lnGDPpc_{r,t}$	-0.059**	1.573***	1.576***	0.169***	1.931***	1.936***	0.283***	0.160***	0.170***
	[0.025]	[0.119]	[0.117]	[0.028]	[0.133]	[0.132]	[0.006]	[0.021]	[0.020]
$lnGDPpc_{p,t}$	0.083***	0.608***	0.611***	-0.084***	0.327***	0.332***	0.103***	0.124***	0.137***
	[0.025]	[0.121]	[0.120]	[0.026]	[0.126]	[0.125]	[0.005]	[0.021]	[0.020]
$lnDist_{rp}$	-0.948***	-1.082***		-1.066***	-1.155***		-0.464***	-0.581***	
	[0.030]	[0.034]		[0.032]	[0.035]		[0.016]	[0.013]	
$Lang_{rp}$	0.637***	0.278**		0.599***	0.240**		0.178***	0.247***	
	[0.116]	[0.123]		[0.121]	[0.121]		[0.030]	[0.023]	
$Contig_{rp}$	0.613***	0.523***		0.505***	0.484***		0.984***	0.734***	
	[0.134]	[0.142]		[0.148]	[0.153]		[0.110]	[0.086]	
$Colony_{rp}$	0.374***	0.493***		0.335**	0.559***		0.863***	0.536***	
	[0.140]	[0.144]		[0.150]	[0.149]		[0.097]	[0.085]	
$Smctry_{rp}$	-0.295	-0.108		-0.233	-0.2		0.567***	0.651***	
	[0.198]	[0.190]		[0.229]	[0.193]		[0.151]	[0.118]	
$WTO_{rp,t}$	0.245***	0.032	0.01	0.644***	0.058	0.012	0.186***	0.197***	-0.010*
	[0.082]	[0.034]	[0.029]	[0.088]	[0.038]	[0.031]	[0.019]	[0.016]	[0.006]
$ASEAN_{rp,t}$	0.09	-0.115		0.267	-0.003		0.415	0.026	
	[0.259]	[0.201]		[0.311]	[0.184]		[0.477]	[0.247]	
$ACFTA_{rp,t}$	0.349**	-0.047	-0.141	0.177	-0.197	-0.13	1.121**	0.219	-0.189***
	[0.169]	[0.128]	[0.120]	[0.231]	[0.127]	[0.128]	[0.444]	[0.225]	[0.073]
$OBOR_{rp,t}$	-0.316***	0.081**	0.053***	-0.468***	0.051	0.071***	0.080**	0.120***	0.248***
	[0.074]	[0.039]	[0.020]	[0.078]	[0.040]	[0.022]	[0.032]	[0.016]	[0.009]
year	yes	yes	yes	yes	yes	yes	yes	yes	yes
Reporter effects		yes			yes			yes	
Partner effects		yes			yes			yes	
Cluster (Dist)	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	32938	32938	32938	32936	32936	32936	552483	552483	552483
R2	0.8	0.89	0.61	0.77	0.89	0.59	0.78	0.91	0.67

Notes: FE: fixed effects estimations when panel id=Reporter x Partner, * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Table 2. 4 Estimation results of the gravity model, WTO, ASEAN, ACFTA and OBOR among independent variables, fast Poisson estimation under the high-dimensional fixed effect (HDFE)

	DVA			FVA			$VC_p\_IN\_E_r$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$WTO_{rp,t}$	0.258***	0.245***	1.950***	0.380***	0.388***	1.883***	0.262***	0.186***	1.579***
	[0.073]	[0.075]	[0.283]	[0.077]	[0.074]	[0.441]	[0.029]	[0.022]	[0.265]
$ASEAN_{rp,t}$	0.846***		0.874***	1.055***		1.067***	1.389***		1.414***
	[0.203]		[0.201]	[0.216]		[0.215]	[0.187]		[0.186]
$ACFTA_{rp,t}$	0.583***	0.915***	0.514***	0.714***	0.590***	0.679***	0.670***	0.347***	0.702***
	[0.161]	[0.116]	[0.161]	[0.178]	[0.138]	[0.175]	[0.139]	[0.066]	[0.138]
$OBOR_{rp,t}$	0.323***	0.024	0.383***	0.247**	0.004	0.310**	0.381***	0.280***	0.228***
	[0.100]	[0.043]	[0.141]	[0.108]	[0.034]	[0.156]	[0.062]	[0.044]	[0.083]
year	yes	yes		yes	yes		yes	yes	
Reporter effects	yes			yes			yes		
Partner effects	yes			yes			yes		
Reporter#year effects			yes			yes			yes
Partner#year effects			yes			yes			yes
Reporter#Partner effects		yes			yes			yes	
Cluster (Rep#Par)	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	32940	32940	32940	32938	32938	32938	598614	598614	598614

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

(2) China as a reporter

I have changed the research sample limited to China and its partner in this part. To comprehensively study the relationship between OBOR and China's domestic value-added exports, I employ the DVA in total, intermediate and final export as the new independent variables and present the analyses in Table 2.5. Because of the mentioned limitations of the value-added dataset in the last part, the results of ASEAN and ACFTA are not precise. So here, I have not presented them here. One exciting finding is OBOR (positive) and WTO (negative)

present oppositive influences on DVA in total, intermediate and final exports. For details, OBOR's promotion effect on DVA in medium exports is more significant. Based on the results in the third column in Table 2.5, I believe that if one economy belongs to OBOR, China's DVA in intermediate export to it is more than others, with 233,000 US Dollars (exp(β)x1000).

Then I try to explore how OBOR affects GVCs from a different direction. The chosen independent variable is the value contributed by a partner in China's total exports (See Table 2.6). The positive result of OBOR represents if one economy participates in OBOR, its value contributes to China's export account for 138 US$. (exp(β)x1000) And it also can be explained as a more important intermediate or raw material supplier for China's exports or production.

Table 2. 5 Estimation results of the gravity model, WTO and OBOR among independent variables, fast Poisson estimation under the high-dimensional fixed effect (HDFE) (China as a reporter)

	DVA		DVA_I		DVA_FIN	
	(1)	(2)	(3)	(4)	(5)	(6)
WTO_{rpt}	-0.058	-0.162*	-0.004	-0.098	-0.04	-0.147
	[0.110]	[0.096]	[0.131]	[0.096]	[0.103]	[0.104]
$OBOR_{rpt}$	0.173***	0.055	0.233***	0.06	0.099*	0.025
	[0.040]	[0.066]	[0.039]	[0.079]	[0.052]	[0.069]
year		yes		yes		yes
Partner effects	yes	yes	yes	yes	yes	yes
Cluster(Rep#Par)		yes		yes		yes
N	480	480	480	480	480	480

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

Table 2. 6 Estimation results of the gravity model, WTO and OBOR among independent variables, fast Poisson estimation under the high-dimensional fixed effect (HDFE)

	$VC_{p\_IN\_E_r}$				
	(1)	(2)	(3)	(4)	(5)
WTO_{rpt}	1.064***	0.074	1.981***	1.064***	0.074
	[0.101]	[0.049]	[0.388]	[0.126]	[0.056]
$ACFTA_{rpt}$	1.401***	0.344***	0.705*	1.401***	0.344***
	[0.179]	[0.090]	[0.375]	[0.085]	[0.117]
$OBOR_{rpt}$	0.420***	0.138***	-0.201	0.420***	0.138***
	[0.051]	[0.021]	[0.281]	[0.072]	[0.044]
year		yes			yes
Partner effects	yes	yes		yes	yes
Cluster(Rep#Par)			yes	yes	yes
N	3363	3363	3363	3363	3363

Notes: * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

2.4.2 Empirical analysis link to GVCs and China's labour market[25]

2.4.2.1 The seemingly unrelated regression

As I review the studies on GVCs and the labour market, three potential paths (productivity, wage and employment) for GVCs affect the market. To answer our research questions, I have estimated a system of structural equations relying on a similar method in Szymczak & Wolszczak-Derlacz (2022):

$$lnWage_{i,p,t} = \alpha + \beta_1 lnEmp_{i,p,t} + \beta_2 lnProd_{i,p,t} ++ \beta_3 lnTrade_{i,p,t} + \beta_4 GVC_{i,p,t} + \gamma_i + \delta_p + \theta_t + \epsilon_{i,p,t} \quad (2.25)$$

$$lnEmp_{i,p,t} = \alpha + \beta_1 lnWage_{i,p,t} + \beta_2 lnProd_{i,p,t} ++ \beta_3 lnTrade_{i,p,t} + \beta_4 GVC_{i,p,t} + \gamma_i + \delta_p + \theta_t + \epsilon_{i,p,t} \quad (2.26)$$

$$lnProd_{i,p,t} = \alpha + \beta_1 lnWage_{i,p,t} + \beta_2 lnEmp_{i,p,t} ++ \beta_3 lnTrade_{i,p,t} + \beta_4 GVC_{i,p,t} + \gamma_i + \delta_p + \theta_t + \epsilon_{i,p,t} \quad (2.27)$$

Where: *i* denotes sector, *p* province, and *t* time.

Lnwage$_{i,p,t}$ is the log of real wages in 2015 prices in the sector *i* and provice *p* at time *t* (1000 CNY);

LnEmp$_{i,p,t}$ is the log of employment number in the sector i and provice p at time t (person);

LnProd$_{i,p,t}$ is the log of real producitivity (value added/employment) in 2015 prices in the sector *i* and provice *p* at time *t* (10,000 CNY/per person);

LnTrade$_{i,p,t}$ is the log of export in the sector i and provice p at time t (10,000 CNY);

GVCs$_{i,p,t}$ is the forwards/backwards Global value chains participation indexes of the sector i and provice p at time t;

PVCs$_{i,p,t}$ is the forwards/backwards provincial value chains participation indexes of the sector i and provice p at time t;

PRVCs$_{i,p,t}$ is forwards/backwards interprovincial value chain participation indexes of the sector i and provice p at time t.

All specs encompass sector (γi), province (δp) and time (θt) fixed effects. Including individual effects have to clear up several problems, such as the greater intensive GVC involvement of particular sectors (e.g. those with notably lower wages). Moreover, time-varying shocks may also affect GVC, wages, employment, and productivity (global monetary shocks, say, or technological advancement). We undertake the reputedly unrelated regression (SURE) developed with the aid of Zellner (1962), which makes use of the asymptotically efficient, feasible, generalized least-squares estimator.

2.4.2.2 Results

Based on Equation 2.24-26, I used simultaneous regression to explore the association of

[25] This part is partly based on the analysis in: Lu, Sica & Wolszczak-Derlacz (2023). Global value chains, wages, employment and productivity in China: A regional approach.

participation in GVCs, PVCs, and PRVCs with the labour market of various provinces and banks in China and presented the results in Table 2.7.

First, concerning the three variables in the labour market, we have reached the following conclusions: (1) A positive and significant relationship exists between productivity and wages: as expected, the average wages in sectors with higher productivity are also higher. (2) There is also a positive correlation between wages and employment, possibly due to higher employment rates (less unemployment) forcing companies to raise wages to attract and retain workers. Given the positive correlation between wages and employment, wage growth may encourage people to migrate from rural areas to urban areas and attract urban workers from other provinces or industries. In the short term, increasing the labour supply should reduce wages. This, in turn, will translate into output expansion. Still, it will also increase the demand for labour, at least partially offsetting the inhibitory effect and instead putting upward pressure on wages. In our case, the results show that wage increase outweighs the factors of wage decrease.

Secondly, the results of three regressions between traditional trade and other value-chain participation are inconsistent, reflecting that conventional trade is insufficient to explain the increasingly complex value-chain network.

Specifically, traditional trade (simple trade in final products) harms wages. On the contrary, the backward participation of GVC and PRVC has a significant promoting effect on the average salary of the department. Employment regression analysis shows that traditional trade, PVC participation, and forward PRVC linkages generate positive coefficients. The coefficients of GVC and backward PRVC are negative. Similar results were confirmed in productivity regression.

Based on these regression results, I believe that the increase in trade (exports) means an increase in demand. So enterprises are also urged to improve their production capacity to a certain extent. One path here is through providing more jobs. On the contrary, rising participation in global value chains has inhibited employment growth. That is because, within the time frame of this analysis (2012-2017), some regions or industries in China are considering outsourcing some industries to cope with rising labour costs, thereby enhancing GVC participation. However, job demand will also be reduced since these outsourcing industries are mostly concentrated in labour-intensive industries. For example, between 2012 and 2017, some industries (footwear and clothing) attempted to transfer production lines to Vietnam, India, and other low-wage countries. In addition, industries with high participation in global value chains mean a more optimized allocation of industry resources, which is unfavourable for China's labour force, which does not has a comparative advantage with some emerging economies like India. Given China's comparative advantages in some intermediates and necessities, this has strengthened China's industrial ties with these regions (with higher participation in global value chains), but at the expense of employment opportunities. Finally, the increase in PVC means the province is expected to add new production links and create new employment opportunities.

Finally, improving productivity can also realise the demand for an increased production capacity of enterprises brought about by trade. In addition, due to "low-end technology lock-in",

China is still at the low value-added end of the global value chain (production, assembly, etc.). Although China's productivity has increased significantly in recent decades, the increased participation of low-value-added industries has hindered productivity improvement. At the same time, greater involvement in global value chains has deepened the dependence of Chinese provinces on them. On the one hand, there are policy restrictions on introducing or absorbing advanced technology (such as export management regulations). On the other hand, these products hinder the development and market of similar products in China, thereby hindering productivity (such as in high-end chips, high-end medical instruments, and precision machine tools). At the same time, more OVCs have participated in improving the industrial chain in various provinces, reducing logistics costs and delivery times, thereby increasing productivity.

Table 2. 7 Estimation of wages, employment and productivity regressions

	Forward linkages		Backward linkages	
	(1)	(2)	(3)	(4)
Dependent variable: $lnWage_{i,p,t}$				
$lnEmp_{i,p,t}$	0.105***	0.100***	0.100***	0.099***
	[0.006]	[0.006]	[0.005]	[0.005]
$lnProd_{i,p,t}$	0.139***	0.131***	0.127***	0.126***
	[0.007]	[0.008]	[0.006]	[0.006]
$lnTrade_{i,p,t}$	-0.005*	-0.003	-0.006**	-0.006**
	[0.002]	[0.002]	[0.002]	[0.002]
$GVC_{i,p,t}$	-0.004		0.046***	
	[0.115]		[0.016]	
$PVC_{i,p,t}$		0.017		-0.02
		[0.115]		[0.015]
$PRVC_{i,p,t}$		-0.093		0.024***
		[0.123]		[0.009]
Dependent variable: $lnEmp_{i,p,t}$				
$lnWage_{i,p,t}$	1.973***	1.561***	2.000***	1.964***
	[0.105]	[0.097]	[0.102]	[0.101]
$lnProd_{i,p,t}$	-1.051***	-1.061***	-0.977***	-0.974***
	[0.025]	[0.022]	[0.024]	[0.024]
$lnTrade_{i,p,t}$	0.138***	0.121***	0.146***	0.150***
	[0.010]	[0.009]	[0.010]	[0.010]
$GVC_{i,p,t}$	-1.015**		-0.794***	
	[0.501]		[0.069]	
$PVC_{i,p,t}$		1.057**		0.548***
		[0.457]		[0.065]
$PRVC_{i,p,t}$		3.740***		-0.460***
		[0.481]		[0.039]
Dependent variable: $lnProd_{i,p,t}$				
$lnEmp_{i,p,t}$	-0.636***	-0.702***	-0.619***	-0.620***
	[0.015]	[0.015]	[0.015]	[0.015]
$lnWage_{i,p,t}$	1.580***	1.360***	1.607***	1.592***
	[0.081]	[0.078]	[0.081]	[0.081]
$lnTrade_{i,,t}$	0.096***	0.090***	0.099***	0.103***
	[0.008]	[0.008]	[0.008]	[0.008]
$GVC_{i,p,t}$	-1.073***		-0.646***	

	[0.389]		[0.055]	
$PVC_{i,p,t}$		1.067***		0.389***
		[0.370]		[0.053]
$PRVC_{i,p,t}$		3.056***		-0.371***
		[0.390]		[0.031]
N	1541	1541	1760	1760
R^2 (*lnWage*)	0.8	0.8	0.79	0.79
R^2 (*lnEmp*)	0.82	0.85	0.81	0.81
R^2 (*lnProd*)	0.64	0.67	0.61	0.61

Notes: * p<0.10, ** p<0.05, *** p<0.01. Industry, province and time dummies included in all specifications, SURE regressions.

Source: own compilation.

2.5 Extensions and Robustness

2.5.1 Extension for the research of OBOR and GVCs

2.5.1.1 Global aspect

To achieve the second purpose, 'examining the different roles of corridors in value-added trade and value contributed in exports' in Introduction, I employ a set of regressions in Table 2.4. To have a clear view of all corridors' roles and check their difference, I combine each corridor's results in these regressions in Table 2.8 (Note: I add these corridors separately in the regressions, not put all of them). To avoid miss understanding related different results of WTO, ASEAN and ACFTA, I have not shown their results here. And their significant and positive results have been proved in each regression.

Columns 1-3 of Table 2.8 display the outcomes for DVA and the several OBOR routes. The corridors with positive and considerable domestic value-added criteria in most specifications are BCIM and CP. CCWA and NELB can't present a favourable image of DVA. Similar results indicate that BCIM and CP are crucial for fostering links in FVA (columns 4-6). Nonetheless, it is not unexpected that only a few corridors exhibit meaningful positive associations considering that the database only includes data for 61 nations and does not include information for 2001–2009. Most economic corridors demonstrated favourable connections for value added by a partner to the reporter's overall exports (columns 7-9). Except for CIP, we receive consistent, noteworthy, and favourable outcomes for most of our parameters for other economic corridors. We find that CP, CMRF, and BCIM appear to have an enormous influence on value-added trade and value contributed in exports when we summarize the findings of this portion.

Table 2. 8 Estimation results of the gravity model for DVA, FVA and VCp_IN_Er, various OBOR economic corridors among independent variables, fast Poisson estimation under HDFE

	DVA			FVA			VCp_IN_Er		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$BCIM_{rpt}$	0.708***	0.178*	0.655***	0.560**	-0.028	0.656**	0.816***	0.570***	0.487**
	[0.202]	[0.095]	[0.218]	[0.259]	[0.042]	[0.294]	[0.251]	[0.196]	[0.231]
$CCWA_{rpt}$	-0.087	0.212***	-0.204	-0.139	0.062*	-0.163	0.313**	0.405***	0.088
	[0.261]	[0.076]	[0.273]	[0.283]	[0.035]	[0.314]	[0.157]	[0.132]	[0.142]
CIP_{rpt}	0.046	0.236***	-0.196	-0.003	0.043	-0.098	0.249**	0.276***	-0.068
	[0.128]	[0.083]	[0.132]	[0.103]	[0.079]	[0.122]	[0.101]	[0.100]	[0.100]
$CMRF_{rpt}$	0.429*	-0.187**	0.628***	0.319	-0.256*	0.515**	0.406*	0.260**	0.24
	[0.220]	[0.081]	[0.204]	[0.275]	[0.137]	[0.246]	[0.243]	[0.109]	[0.236]
CP_{rpt}	1.052***	0.349**	0.960***	0.793***	0.153***	0.846***	0.548**	0.265***	0.321
	[0.219]	[0.148]	[0.218]	[0.296]	[0.033]	[0.314]	[0.216]	[0.065]	[0.216]
$NELB_{rpt}$	0.011	0.062	-0.082	0.175	0.115*	0.104	0.446***	0.390***	0.18
	[0.238]	[0.102]	[0.273]	[0.280]	[0.063]	[0.316]	[0.171]	[0.129]	[0.178]
year	yes	yes		yes	yes		yes	yes	
Reporter effects	yes			yes			yes		
Partner effects	yes			yes			yes		
Reporter#year effects			yes			yes			yes
Partner#year effects			yes			yes			yes
Reporter#Partner effects		yes			yes			yes	

Cluster (Rep#Par)	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	32940	32940	32940	32938	32938	32938	598614	598614	598614

Notes: This table is a summary of the parameters of each economic corridor under various regressions, where corridors are not included simultaneously but one by one. The additional right-hand side variables include WTO, ASEAN and ACFTA (statistically significant and positive parameters), not included in the table for space constraints. * p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

2.5.1.2 China as a reporter

In Table 2.9, where I examine the roles of several economic corridors, I discover that BCIM, CCWA, and CP favourably increase DVA and are statistically significant. The outcomes for DVA-FIN and DVA I are close. I believe that the CMRF has negative consequences, which indicates a decrease in the domestic added value of China's exports to the countries along the corridor. In the most recent regression, all economic corridors exhibit favourable effects, but only BCIM, CIP, and CMRF are statistically significant. I use CMRF as an example here and discover that the nations from this trade route will contribute more to China's exports. In other words, the CMRF's members gain from their business dealings with China. CIP does not significantly affect local value-added because of the limits of value-added data in time and the number of countries. But it still has a positive value. Overall, BCIM, CIP, CCWA, and CP are more critical for China's value-added trade or the contributed value from these corridors members to China's exports.

Table 2. 9 Estimation results of the gravity model, various economic corridors among independent variables, fast Poisson estimation under the high-dimensional fixed effect

	DVA	DVA_I	DVA_F	VC_p_IN_E_r
	(2)	(3)	(4)	(5)
$BCIM_{rpt}$	0.072*	0.051	0.081	0.207***
	[0.037]	[0.042]	[0.053]	[0.040]
$CCWA_{rpt}$	0.101**	0.112**	0.089**	0.061
	[0.046]	[0.056]	[0.045]	[0.054]
CIP_{rpt}	0.16	0.13	0.149	0.088*
	[0.125]	[0.144]	[0.101]	[0.046]
$CMRF_{rpt}$	-0.198***	-0.207***	-0.169**	0.155***
	[0.067]	[0.076]	[0.067]	[0.058]
CP_{rpt}	0.294***	0.186***	0.395***	0.056
	[0.024]	[0.039]	[0.019]	[0.045]
$NELB_{rpt}$	-0.064	-0.04	-0.122	0.063
	[0.129]	[0.065]	[0.229]	[0.042]
year	yes	yes	yes	yes
Partner effects	yes	yes	yes	yes
Cluster(Rep#Par)	yes	yes	yes	yes
N	480	480	480	3363

Notes: This table summarises the parameters of each economic corridor from different regressions, where passages are not included simultaneously but one by one. The additional variables include WTO and ACFTA, which are not included in the table due to space constraints.

* p<0.10, ** p<0.05, *** p<0.01

Source: own compilation

2.5.2 *Further extension in GVCs and China's labour markets*

I include R&D spending and the proportion of female employees to our baseline criterion to broaden the scope of the investigation. According to Table 2.10, growth in R&D spending has increased employment, productivity, and earnings, mainly the first two. Investment in R&D undoubtedly promotes technical advancements and more productive manufacturing. It also contributes to the modernization of the industrial sector, the decrease in energy consumption, the development of more competitive goods, the expansion of the local and global markets, and the expansion of jobs. Also, the growth in R&D spending directly generates employment in the field. The coefficients of important variables—trade and our GVC measurement—are incredibly comparable to those of the standard regression.

Table 2. 10 Estimation of wages, employment and productivity, additional covariate: R&D

	Forward linkages		Backward linkages	
	(1)	(2)	(3)	(4)
Dependent variable: lnWage				
ln_RD	0.044***	0.046***	0.026***	0.024***
	[0.008]	[0.008]	[0.007]	[0.006]
lnEmp	0.021*	0.022*	0.050***	0.056***
	[0.011]	[0.012]	[0.009]	[0.010]
lnProd	0.069***	0.068***	0.066***	0.070***
	[0.010]	[0.011]	[0.010]	[0.010]
lnTrade	-0.003	-0.003	-0.008**	-0.008**
	[0.004]	[0.004]	[0.003]	[0.003]
GVC	0.037		0.024	
	[0.163]		[0.017]	
PVC		-0.032		-0.041*
		[0.163]		[0.021]
PRVC		-0.096		0.034**
		[0.172]		[0.014]
Dependent variable: lnEmp				
ln_RD	0.470***	0.396***	0.409***	0.384***
	[0.022]	[0.023]	[0.022]	[0.021]
lnWage	0.307*	0.301*	0.864***	0.892***
	[0.165]	[0.158]	[0.163]	[0.155]
lnProd	-0.402***	-0.570***	-0.521***	-0.571***
	[0.039]	[0.039]	[0.038]	[0.036]
lnTrade	0.057***	0.061***	0.072***	0.078***
	[0.014]	[0.013]	[0.014]	[0.013]
GVC	-0.01		-0.199***	
	[0.628]		[0.072]	
PVC		0.117		0.507***
		[0.602]		[0.084]
PRVC		1.860***		-0.485***
		[0.633]		[0.053]
Dependent variable: lnProd				
ln_RD	0.120***	0.112***	0.147***	0.174***
	[0.032]	[0.029]	[0.026]	[0.026]
lnEmp	-0.445***	-0.566***	-0.479***	-0.564***

	[0.043]	[0.039]	[0.035]	[0.036]
lnWage	1.131***	0.914***	1.063***	1.084***
	[0.170]	[0.155]	[0.155]	[0.153]
lnTrade	0.062***	0.062***	0.074***	0.076***
	[0.014]	[0.013]	[0.013]	[0.013]
GVC	-0.951		-0.288***	
	[0.659]		[0.069]	
PVC		0.79		0.424***
		[0.599]		[0.084]
PRVC		2.891***		-0.406***
		[0.621]		[0.054]
N	545	545	646	646
R^2 (*lnWage*)	0.85	0.85	0.84	0.84
R^2 (*lnEmp*)	0.88	0.89	0.86	0.87
R^2 (*lnProd*)	0.58	0.65	0.6	0.61

Notes: * p<0.10, ** p<0.05, *** p<0.01. Industry, province and time dummies included in all specifications, SURE regressions.

Source: own compilation

The similar estimations of three regressions with the addition of the female ratio as a covariate are shown in Table 2.11. Although slowing salary growth, the percentage of women in the workforce has increased employment and productivity. Regarding employment, the increased rate of female employees does not correspond to a decline in the male labour force but rather to a shift of more women from the home to the workforce. The "one-child policy" in China throughout the 20th century undoubtedly slowed population growth (Z. Yang & Dunford, 2018). Still, it also helped to increase girls' education to a certain extent, which paved the way for women's access to skilled occupations. High housing costs, the necessity to assist parents, the cost of school, etc., put a lot of financial pressure on children when they leave home to start a family, which in a manner, "forces" women to work. The statistics on earnings, however, show that there is still gender discrimination in the labour market, even though more women are working than ever before. The outcomes of this enhanced regression for the effect of trade and GVCs align with the baseline specification at the end, supporting the findings above.

Table 2. 11 Estimation of wages, employment and productivity, additional covariate female ratio

	Forward linkages		Backward linkages	
	(1)	(2)	(3)	(4)
Dependent variable: lnWage				
R_female	-0.004***	-0.004***	-0.005***	-0.005***
	[0.001]	[0.001]	[0.001]	[0.001]
lnEmp	0.110***	0.105***	0.107***	0.105***
	[0.006]	[0.006]	[0.005]	[0.005]
lnProd	0.141***	0.134***	0.130***	0.128***
	[0.007]	[0.008]	[0.006]	[0.006]
lnTrade	-0.005**	-0.003	-0.006**	-0.006**
	[0.002]	[0.002]	[0.002]	[0.002]
GVC	0.006		0.053***	
	[0.116]		[0.016]	
PVC		0.003		-0.018

		[0.116]		[0.015]
PRVC		-0.113		0.023***
		[0.124]		[0.009]
Dependent variable: lnEmp				
R_female	0.017***	0.014***	0.023***	0.020***
	[0.003]	[0.003]	[0.003]	[0.003]
lnWage	2.041***	1.631***	2.111***	2.067***
	[0.104]	[0.097]	[0.100]	[0.100]
lnProd	-1.047***	-1.056***	-0.969***	-0.966***
	[0.025]	[0.022]	[0.024]	[0.024]
lnTrade	0.134***	0.118***	0.139***	0.144***
	[0.010]	[0.009]	[0.010]	[0.010]
GVC	-0.848*		-0.796***	
	[0.502]		[0.068]	
PVC		0.937**		0.520***
		[0.459]		[0.065]
PRVC		3.556***		-0.444***
		[0.483]		[0.038]
Dependent variable: lnProd				
R_female	0.011***	0.010***	0.013***	0.011***
	[0.003]	[0.003]	[0.003]	[0.003]
lnEmp	-0.645***	-0.709***	-0.631***	-0.630***
	[0.015]	[0.015]	[0.015]	[0.015]
lnWage	1.619***	1.399***	1.664***	1.635***
	[0.082]	[0.079]	[0.081]	[0.081]
lnTrade	0.094***	0.089***	0.097***	0.101***
	[0.008]	[0.008]	[0.008]	[0.008]
GVC	-0.959**		-0.656***	
	[0.393]		[0.055]	
PVC		0.981***		0.379***
		[0.375]		[0.053]
PRVC		2.947***		-0.366***
		[0.395]		[0.031]
N	1540	1540	1759	1759
R^2 (*lnWage*)	0.8	0.8	0.79	0.8
R^2 (*lnEmp*)	0.82	0.85	0.82	0.82
R^2 (*lnProd*)	0.64	0.67	0.61	0.61

Notes: * p<0.10, ** p<0.05, *** p<0.01. Industry, province and time dummies included in all specifications, SURE regressions.

Source: own compilation

Then I calculate the regressions for manufacturing (Table 2.12). Once more, the outcomes are relatively close to the starting point.

Table 2. 12 Estimation of wages, employment and productivity, Manufacturing industries

	Forward linkages		Backward linkages	
	(1)	(2)	(3)	(4)
Dependent variable: lnWage				
lnEmp	0.111***	0.110***	0.109***	0.109***
	[0.007]	[0.008]	[0.007]	[0.007]

lnProd	0.102***	0.099***	0.105***	0.105***
	[0.009]	[0.010]	[0.008]	[0.008]
lnTrade	-0.003	-0.001	-0.007*	-0.007*
	[0.004]	[0.004]	[0.004]	[0.004]
GVC	-0.05		0.022	
	[0.133]		[0.016]	
PVC		0.058		-0.021
		[0.133]		[0.016]
PRVC		-0.085		0.016
		[0.144]		[0.010]
Dependent variable: lnEmp				
lnWage	2.006***	1.572***	2.048***	2.017***
	[0.133]	[0.120]	[0.124]	[0.123]
lnProd	-0.899***	-0.933***	-0.863***	-0.847***
	[0.032]	[0.028]	[0.030]	[0.030]
lnTrade	0.220***	0.198***	0.209***	0.206***
	[0.016]	[0.014]	[0.015]	[0.015]
GVC	-1.833***		-0.520***	
	[0.561]		[0.070]	
PVC		1.975***		0.462***
		[0.500]		[0.069]
PRVC		4.576***		-0.342***
		[0.528]		[0.042]
Dependent variable: lnProd				
lnEmp	-0.635***	-0.739***	-0.603***	-0.608***
	[0.023]	[0.022]	[0.021]	[0.022]
lnWage	1.301***	1.130***	1.383***	1.401***
	[0.115]	[0.109]	[0.106]	[0.107]
lnTrade	0.158***	0.158***	0.140***	0.138***
	[0.014]	[0.013]	[0.013]	[0.013]
GVC	-1.738***		-0.480***	
	[0.471]		[0.058]	
PVC		1.888***		0.303***
		[0.444]		[0.060]
PRVC		4.019***		-0.284***
		[0.472]		[0.036]
N	909	909	1095	1095
R^2 (*lnWage*)	0.76	0.77	0.76	0.76
R^2 (*lnEmp*)	0.86	0.89	0.84	0.85
R^2 (*lnProd*)	0.56	0.61	0.55	0.55

Notes: * p<0.10, ** p<0.05, *** p<0.01. Industry, province and time dummies included in all specifications, SURE regressions.

Source: own compilation

2.5.3 Robustness in GVCs and China's labour market

Next, I repeat the regression leaving out one sector or province at a time to ensure a

particular area or industry does not skew the findings. The average value of each coefficient in 25 regressions for industry heterogeneity and 31 regressions for regional heterogeneity are shown in Tables 2.13 and 2.14 in the Appendix. The results remain unchanged when specific sectors and/or provinces are excluded.

Table 2. 13 Estimation of wages, employment and productivity, sector heterogeneity

	Forward linkages		Backward linkages	
	(1)	(2)	(3)	(4)
Dependent variable: lnWage				
lnEmp	0.105	0.099	0.100	0.099
	Significant	Significant	Significant	Significant
lnProd	0.138	0.131	0.127	0.126
	Significant	Significant	Significant	Significant
lnTrade	-0.005	-0.003	-0.006	-0.006
	Significant		Significant	Significant
GVC	-0.004		0.046	
			Significant	
PVC		0.016		-0.021
PRVC		-0.094		0.024
				Significant
Dependent variable: lnEmp				
lnWage	1.972	1.561	1.998	1.964
	Significant	Significant	Significant	Significant
lnProd	-1.049	-1.059	-0.975	-0.973
	Significant	Significant	Significant	Significant
lnTrade	0.138	0.121	0.146	0.150
	Significant	Significant	Significant	Significant
GVC	-1.007		-0.800	
	Significant		Significant	
PVC		1.052		0.554
		Significant		Significant
PRVC		3.730		-0.459
		Significant		Significant
Dependent variable: lnProd				
lnEmp	-0.636	-0.701	-0.618	-0.620
	Significant	Significant	Significant	Significant
lnWage	1.575	1.355	1.603	1.589
	Significant	Significant	Significant	Significant
lnTrade	0.096	0.090	0.099	0.103
	Significant	Significant	Significant	Significant
GVC	-1.071		-0.651	
	Significant		Significant	
PVC		1.068		0.395
		Significant		Significant
PRVC		3.056		-0.370
		Significant		Significant

Notes: Industry, province and time dummies included in all specifications, SURE regressions.

The results correspond to the average values of the relevant variable's coefficients in 25 regressions (excluding sectors one at a time, which means there are 24 sectors in each regression). 'Significant' means

the value of the variable is significant in most regressions.

Source: own compilation

Table 2. 14 Estimation of wages, employment and productivity, province heterogeneity

	Forward linkages		Backward linkages	
	(1)	(2)	(3)	(4)
Dependent variable: lnWage				
lnEmp	0.105	0.100	0.100	0.099
	Significant	Significant	Significant	Significant
lnProd	0.139	0.131	0.127	0.126
	Significant	Significant	Significant	Significant
lnTrade	-0.005	-0.003	-0.006	-0.006
	Significant		Significant	Significant
GVC	-0.005		0.046	
			Significant	
PVC		0.017		-0.020
PRVC		-0.093		0.024
				Significant
Dependent variable: lnEmp				
lnWage	1.971	1.560	1.998	1.963
	Significant	Significant	Significant	Significant
lnProd	-1.050	-1.061	-0.977	-0.974
	Significant	Significant	Significant	Significant
lnTrade	0.138	0.121	0.146	0.150
	Significant	Significant	Significant	Significant
GVC	-1.010		-0.800	
	Significant		Significant	
PVC		1.054		0.554
		Significant		Significant
PRVC		3.735		-0.461
		Significant		Significant
Dependent variable: lnProd				
lnEmp	-0.636	-0.702	-0.619	-0.621
	Significant	Significant	Significant	Significant
lnWage	1.580	1.360	1.607	1.593
	Significant	Significant	Significant	Significant
lnTrade	0.096	0.090	0.099	0.103
	Significant	Significant	Significant	Significant
GVC	-1.068		-0.650	
	Significant		Significant	
PVC		1.063		0.394
		Significant		Significant
PRVC		3.053		-0.371
		Significant		Significant

Notes: Industry, province and time dummies included in all specifications, SURE regressions.

The results correspond to the average values of the relevant variable's coefficients in 31 regressions (excluding provinces one at a time, which means there are 30 provinces in each regression). 'Significant' means the variable's value is significant in most regressions.

Source: own compilation.

2.6 Conclusions

The international division of production within global value chains has increasingly

supplanted the national division of labour in manufacturing, and intermediate products are now a crucial component of international commerce for the majority of nations. So, traditional trade can not measure international business's actual situation or profit (Caliendo & Parro, 2015; Hayakawa, 2007; Kelly & Cava, 2014; Maurer & Degain, 2012; Miroudot et al., 2009). With the establishment of the Asian Infrastructure Investment Bank and Silk Road Fund, the promotion of RMB internationalization (Handwerker, 2020; Liang, 2020) and trade routes expansion (Huang, 2016), OBOR also functions as an investment plan. As a result, I anticipate that all of these variables will have an influence on global value chains, and as a result, I have expanded the study in Chapter 1 to include value-added commerce and GVCs.

Furthermore, although pertinent research on China's involvement in GVCs has extended to include a variety of topics (trade, politics, environment, industrial upgrading, etc.), I have discovered that the study on the labour sector is insufficient. It piques my curiosity that GVCs participate in the labour market field, given the overlap between China's high GVC participation regions and its economically developed, high-density, and skilled population regions. Since 2012, China has been implementing some strategies or policies on industrial upgrading, the Belt and Road, domestic and foreign double circulation, the rise of the central region, the revitalization of the Northeast, and the promotion of cross-provincial industrial mutual assistance and transfer, which will inevitably result in changes to its domestic/external industrial chain. As a result, I have also tried to track changes in GVCs-related metrics in China and compare the associations of GVCs and DVCs in the Chinese labour market (at the provincial department level).

In this chapter, I have prepared four datasets linked to (1) Participation in GVCs- covering 62 economics and 34 sectors from 2007-2017, (2) OBOR and GVCs - Value-added data- covering 61 countries from 2010 to 2017, (3) OBOR and GVCs – Value contributed in export data- including 178 countries from 2000 to 2018, and (4) China provinces' GVCs and labour market- covering 31 China's provinces and 25 sectors in 2005, 2012 and 2017.

The purposes also can be classified into three parts:

(1) Participation in GVCs - measuring and describing the trend of participation and position indexes in GVCs (China and OBOR countries);

(2) OBOR and GVCs – exploring the role of the Belt and Road initiative in value-added trade and global value chains

(3) China provinces' GVCs and labour market - checking the association between trade, GVCs, PRVCs, and PVCs with wages, employment and productivity in China provinces

In the previous chapter, I employ the same regression method (OLS, LSDV and PPML) to cover potential challenges in the gravity model research in OBOR and GVCs. To indicate each province’s participation index in GVCs and DVCs, I have created input-output tables at the departmental level for all provinces in China and worldwide. Based on Z. Wang et al. (2017b) research, I divide the value chain into international, interprovincial, and intra-provincial. Then I estimated a system of structural equations relying on a similar method in Szymczak & Wolszczak-Derlacz to check the various labour market variables simultaneously.

The results of participation in GVCs show: 1) China's participation in GVCs decreased

between 2007 and 2020, mainly due to the country's domestic value chain expanding owing to the rapid growth of its domestic market. 2)In the same period, China's upstream position in GVCs has improved over time which is inextricably linked to its gradual improvements in industry upgrading.

The findings in OBOR and GVCs show that: (1) OBOR maintains a consistently minor promotion role in value-added trade and value provided by a partner in the reporter's overall exports, despite my use of a variety of estimating techniques. (2) There aren't many differences between the global and Chinese samples' economic corridors. Detail: Whether internationally or in China, the benefits of CP and BCIM have been realized. 1) CMRF, 2) CIP and CCWA support, respectively, international commerce and Chinese exports.

The most recent research on GVCs and the labour market in China shows that: 1) Between 2012 and 2017, GVC involvement declined in every province; the highest participation areas are mainly in the eastern and southern coastal regions; provincial value chains predominate, whilst GVC participation is minimal. 2) Regarding labour market outcomes, wages and employment as well as wages and productivity, are positively connected, whereas employment and productivity are adversely correlated. 3) The contradictory findings on the effects of traditional international commerce and GVC participation on the labour market demonstrate that trade cannot account for the complexity of today's global supply networks. GVC involvement slows down employment and productivity growth, presumably as a result of "low-end technological lock-in" and a lack of a labour cost advantage. The associations of PVC and PRVC with the variables affecting the labour market are also less consistent. Participation in PVC has often encouraged increases in production and employment.

As I mentioned in the Introduction, the novelties and contributions of this research can be expressed as follows: 1) This Chapter provides a more thorough grasp of China's (OBOR) participation in GVCs and its trend by monitoring several GVCs indicators (including those for OBOR nations and China). 2) This report adds to OBOR's research on the effects of trade by examining value-added trade and the degree of industrial linkage. It also examines the variations among economic corridors. 3) The provincial and departmental levels will be included in the research on China, GVC, and the labour market. Moreover, it adds a fresh perspective to research, including regional and international studies. 4) provides the state code file and RMD file for researchers' use (Data combination and regressions) in SUPPLEMENT MATERIALS.

Finally, the research about OBOR and GVCs is based on value-added trade. The natural extension of this work is to analyze the relationship between OBOR and export variety, which will be included in Chapter 3. For the research linked to GVCs and China’s labour markets, it's essential to recognize that this study has certain limitations. Secondly, the employment figures are only for metropolitan regions and are not continuous (available only for 2012, 2015, and 2017).

Furthermore, the topics covered in this work have consequences for two other areas of research that will be pursued in the future. One possibility is to expand the study to consider the effects of policy considerations or narrow it down by focusing on particular goods/industries (like

the chip production chain) or geographical areas (regional value chains). Second, follow-up research on the effects of these events on China's GVC involvement and the Chinese labour market might be helpful to give how the COVID-19 outbreak and the Sino-US trade war disrupted Chinese exports and global supply chains.

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3 RESEARCH ON THE DETERMINANTS OF EXPORT DIVERSIFICATION:

EVIDENCE FROM CHINA AND OBOR

3.1 Introduction

As an indispensable and vital component of international trade research, research on trade diversity has been conducted in multiple dimensions: country or company, import or export, market or product, unilateral or bilateral (Arkolakis et al., 2021; Beverelli et al., 2015; Cadot et al., 2013; Carrère et al., 2011; Chaney, 2008; Dennis & Shepherd, 2011; Dogruel & Tekce, 2011; Eaton et al., 2007; Felbermayr & Kohler, 2006; Lawless, 2010; Melitz, 2003; Parteka, 2020; Parteka & Tamberi, 2013).

The product type and target market can measure a country's export diversity. Specifically, measurement methods include the number of products or markets, diversification and concentration ratio index (Carrère et al., 2011; Dennis & Shepherd, 2011; Dogruel & Tekce, 2011; Parteka & Tamberi, 2013). However, this toolbox is not practical at the enterprise level due to the limitations of the number of enterprise products/markets. According to the new trade theory, the growth of enterprise exports is mainly achieved through "intensive margin" (the increase of trade scale in the original trade chain) and "extensive margin" (the expansion of new export products or target markets) (Amiti & Freund, 2010; Bernard et al., 2003, 2009, 2011; Chaney, 2008; Haddad et al., 2010; Helpman et al., 2008; Melitz, 2003). Therefore, the diversity of enterprise exports is mainly achieved by measuring the "extensive margin", which comprises the following products' ratios in the total output value: (1) new products exported to the old market, (2) old products exported to new markets and (3) new products exported to new markets.

First, as mentioned in the previous Chapter, One-Belt One-Road (OBOR) is a comprehensive cooperation strategy involving infrastructure construction, financial and investment cooperation, trade facilitation, and cultural and political communication(Office of the Leading Group for Promoting the Belt and Road Initiative, 2019; Shahriar et al., 2020). Relevant research institutes have confirmed its positive effects on trade and industry connections (Foo et al., 2020; Guo et al., 2017; Herrero & Xu, 2017; A. Liu et al., 2020; Ma et al., 2017; Wolszczak-Derlacz & Lu, 2022; C. Yu et al., 2020; L. Yu et al., 2020). Some studies have also pointed out that OBOR may cause some challenges. For example, China's investment in OBOR countries is mainly limited to the energy and transport industries[26], which may hinder industrial upgrading and damage the environment (Ascensão et al., 2018; Maliszewska & van der Mensbrugghe, 2019). In addition, the influx of many cost-effective Chinese goods has caused damage to the local market and industry (Ostashko et al., 2021). Finally, excessive infrastructure investment and borrowing may lead to debt risk (S. Zhao, 2020).

Export diversity seems to be an essential indicator for evaluating export security and industrial outcomes (Lee & Yu, 2019; Prebisch, 1962). And the research on OBOR's relationship

[26] Since the implementation of OBOR, these two industries have consistently accounted for more than half of the total OBOR investment from China, reaching 73.41% in 2020 (Nedopil Wang, 2021).

with export diversity is minimal. Therefore, in this Chapter, I will delve deeper into its effects on the variety of participants' exports and propose the following research assumptions.

H1: OBOR facilitates the improvement of infrastructure[27] among its member countries, enhancing their international trade conditions. This improvement, in turn, promotes a greater quantity and variety of products that can be exported to a broader range of potential markets.

H2: OBOR has led to a rise in China's investments in member countries, focusing on the energy and transportation sectors (Institute for Belt & Road Economic and Trade Cooperation, 2021; Nedopil Wang, 2021). This situation has the potential to facilitate the transfer of Chinese technology and subsequently boost productivity or improve comparative advantage in select industries. The resultant effect of this would impede the progress of other sectors due to the heightened appeal of energy and transportation. This particular imbalance can potentially result in a reduction in product export diversification.

H3: As expressed in related literature (Ostashko et al., 2021), OBOR has raised concerns regarding the potential for Chinese products to dominate the markets of participating countries due to their superior cost-effectiveness, potentially leading to further harm to local industries. The ultimate objective is to enhance the variety of China's export market and diminish the diversification of the export commodities of OBOR member countries.

Subsequently, examining the potential factors associated with the firm’s intensive and extensive margins will focus on Chinese enterprises. Since initiating the "reform and opening up" policy in 1978, China has expanded foreign investment opportunities while maintaining limitations on equity investment in various sectors. Several joint ventures, including SAIC Volkswagen, Dongfeng Honda, and FAW Toyota, have emerged under a policy characterized by a combination of openness and restrictions.

According to the Law on Sino-Foreign Equity Joint Ventures, the Law on Sino-Foreign Cooperative Joint Ventures, and the Law on Foreign Funded Enterprises (collectively called the "Three Capital Enterprise Law"), funds from Hong Kong, Macao, and Taiwan are the same as foreign capital in terms of administrative approval. But because of politics, the data on the asset structure of corporations follow the idea of separate statistics. So, Chinese companies' assets can be put into several groups: state-owned or joint, private, foreign, and capital from Hong Kong, Macao, and Taiwan. In my earlier hypotheses about OBOR and export diversity (country), the effects of Chinese investment and exports of commodities were given special attention.

As the actual separate exporter from China, it is essential to examine how exporting companies' internal asset structure affects their intensive and extensive margins. Guangdong province is the starting point of the OBOR-Maritime Silk Road. It is also known as the "window" of China's reform and opening up and is China's most significant economic province. So, I will choose export businesses in Guangdong Province as an example to study how different types of

[27] For example, Seaports - Gwadar, Hambantota, Tanjung Priok; Expressway - Cambodia's Golden Port Expressway, Montenegro's North-South Expressway, Serbia's E763 Expressway; Railway- CR Express, China Laos Railway, Hungary Serbia Railway; Central Asia–China gas pipeline, etc (S. Zhao, 2020).

capital affect exports from a micro and Chinese viewpoint (as a supplement to the study of OBOR and export diversity).

The first data pertaining to OBOR and export diversification come from various reputable sources, including the Centre d'Études Prospectives et d'Informations Internationales (CEPII), the World Table of the University of Pennsylvania (PWT 10), World Development Indicators (WDI), OECD (2018), and the official websites of OBOR[28] and the Asian Infrastructure Investment Bank (AIIB). The data set covers a time span of 23 years, from 1996 to 2019, and encompasses a total of 183 countries.

Second, given the substantial presence of intermediary agents within the Chinese Customs Database, it is imperative to consolidate the customs Database with the Chinese Industrial Enterprise Database via enterprise nomenclature. This consolidation process ultimately yields comprehensive enterprise data, financial statements, and import/export information (including volume, ports, trade and transportation modes, products, transit countries, etc.) from 2000 to 2013.

The innovation, advantages and contributions of this Chapter can be classified as follows: 1) In traditional OBOR research, the definition of OBOR has always been a sophisticated and challenging issue. Based on previous research, I define OBOR in this Chapter through three dimensions: geographical location[29], memorandums of understanding documents (MoU)[30] and Asian Infrastructure Investment Bank (AIIB)[31] (The details can be checked in Table A.2). 2) The present study provides a comprehensive definition of export diversity by examining it from various perspectives, such as countries, enterprises, products, and markets. The indicators that are used to measure export diversification include the extensive margin ratio of enterprises' exports, the number of export product lines, the concentration ratio index of product exports (measured by the Herfindahl Hirschman Index and the Theil indexes), and the index of export market connection (IEMP). 3) The models were estimated utilizing instrumental variables as a means of addressing the issue of endogeneity.

The present Chapter is structured in the following manner. The subsequent section provides an overview of pertinent literature concerning the theoretical underpinnings of export diversification. Section 3 contains the presentation of data and fundamental descriptive statistics. Subsequently, the succeeding section presents the methodology models and empirical findings. Section 5 pertains to the aspects of extensions and robustness. Section 6 will provide a

[28] The website https://www.yidaiyilu.gov.cn is pertinent to the One-Belt One-Road initiative, and was utilised as a source for the data on countries involved in OBOR.

[29] A binary variable has been created to differentiate between countries that are formal members of the One-Belt One-Road (OBOR) initiative and those that are not, starting from the year 2014 (OECD, 2018).

[30] In 2019, China had entered into memorandums of understanding with 138 countries to collaborate on the joint construction of the One Belt One Road initiative, as per our own analysis based on the OBOR website.

[31] The AIIB, established in 2015 by a consortium of 18 nations, has since grown to encompass 82 member countries as of 2020.

comprehensive discussion on the conclusion pertaining to the findings, contributions, and limitations.

3.2 Literature Review

The examination of the export structure has emerged as a crucial viewpoint for scrutinizing trade, economic expansion, worldwide value chains, and industrial enhancement, particularly in the milieu of production globalization, where intermediate inputs hold a central position in global trade. In the contemporary global context, which is marked by intricate and volatile conditions such as the COVID-19 pandemic, trade tensions between China and the United States, and the ongoing conflict between Russia and Ukraine, any disruption to the worldwide value chain represents a significant threat to a nation's economic equilibrium. The significance of enhancing export diversity is on the rise, as proposed by Lee and Yu (2019) and Prebisch (1962).

The theoretical basis for the structural assessment of trade expansion is provided by the heterogeneous trade theory, as posited by Bernard et al. (2003), Helpman et al. (2008), and Melitz (2003). According to this theory, the ability to overcome fixed costs associated with export trade and achieve exports is limited to the most efficient enterprises. As trade costs decrease, firms already engaged in exporting will likely increase their trade volume. Firms operating solely in the domestic market may also consider entering the international trade arena. Simultaneously, the augmentation of extant trade volume and the diversification of export products or markets can be instrumental in attaining trade growth. The theory of heterogeneous enterprise trade decomposes a nation's export growth into two distinct margins, namely the "intensive margins" and the "extensive margins". The former refers to the increase in export volume that arises from existing trade lines, while the latter pertains to changes that occur due to the emergence of new export products or markets.

The literature on export diversity can be categorized into two main streams: macro studies and micro studies. Macro studies include works by Carrère et al. (2011), Dennis and Shepherd (2011), Dogruel and Tekce (2011), Felbermayr and Kohler (2006), Khan et al. (2021), Lee and Ho (2022), Parteka (2020), and Parteka and Tamberi (2013). Micro studies, on the other hand, comprise works by Arkolakis et al. (2021), Du and Li (2020), Kamal and Zaki (2018), Kapri (2019), and Spilker et al. (2018). The investigation of diversity at a macroscopic level can be categorized into various subfields, including the national level, the bilateral analysis proposed by Felbermayr and Kohler (2006), and cross-country differences explored by Parteka (2020).

3.2.1 Literature related to export diversification measurement

3.2.1.1 Micro aspect

The literature on the subject displays a lack of consistency in the definition and measurement methods pertaining to the extensive margin.

Amiti and Freund (2010) exclusively compute the intensive and extensive margin based on the diversity of exported goods. Bernard et al. (2009) studied the binary margin of export trade across various countries based on product and target market. According to Bernard et al.

(2011) analysis, the export extension margin encompasses the diversified product export of a single enterprise. In their study, Haddad et al. (2010) incorporated the product pricing variable in their export trade composition analysis. Additionally, they extended the concept of the "binary margin" to a "ternary margin."

According to Chaney (2008), the method for breaking down export trade into intensive and extensive margins can be expressed through the following formula:

$$\overline{X}_{ij} = \alpha * (\frac{Y_j}{Y})^{(\mu-1)/Y} * (\frac{\theta_j}{\delta_{ij}})^{(\mu-1)} * (\frac{\varphi}{\omega_i})^{(\mu-1)}$$

(3.1)

$$X_{ij} = \frac{TX_{ij}}{\overline{X}_{ij}} = (\frac{\mu}{\mu-1})^{\mu-1} * (\frac{Y_i Y_j}{Y}) * f_{ij}^{-\gamma/(\mu-1)} * (\frac{\omega_i * \delta_{ij}}{\theta_j})^{-\gamma} \quad (3.2)$$

Where: $\overline{X}_{ij}$ represents the average export volume per enterprise from country i to country j - "intensive margin";

X_{ij} is the number of export enterprises from country i to country j - "extensive margin";

TX_{ij} means the total exports from country i to country j;

Y is the market scale;

θ_j is Multilateral resistance;

δ_{ij} represents the variable cost from country i to country j;

f_{ij} means the fixed cost from country i to country j;

ω_i is productivity;

α, γ & μ are other exogenous parameters.

As per the formula, it can be deduced that the fixed cost does not influence the intensive margin, which pertains to the pre-existing export of products to a familiar market that has already incurred a particular "sunk cost".

Conversely, it exerts an adverse influence on the extensive margin, as introducing existing products to novel markets and exporting new products necessitate payment of a specific market development expense. The variable cost harms the dual margin (the increase in transportation cost raises the export threshold).

Drawing upon extant literature, my research will operationalize the concepts of "intensive margin" and "extensive margin" at the firm level.

The initial concept posits that the total export level of an enterprise can be determined by calculating the ratio of the total export volume to the total output value.

The term "intensive margin" refers to the ratio of the sales volume of the old products exported to the old market to the total output value. And the extensive margin can be measured in the following ways:

1. The ratio of the sales volume of new products exported to the old market to the total output value.

2. The ratio of the sales volume of old products exported to new markets to the total output value.

3. The ratio of the sales volume of new products exported to new markets to the total output value.

3.2.1.2 Macro aspect

The concept of export diversity in terms of markets can be operationalized by utilizing either the index of export market connection (IEMP) or the number of export markets (Brenton & Newfarmer, 2009; Parteka, 2013). Previous studies have put forward several ways to measure a nation's good export diversity. The number of operational export lines (goods) has been identified as a highly valuable metric (Carrère et al., 2011; Dennis & Shepherd, 2011; Parteka, 2020). Moreover, several researchers (Agosin et al., 2012; Ali et al., 2022; Cieślik & Parteka, 2021; Dogruel & Tekce, 2011; Fosu & Abass, 2019; Mania, 2020; Parteka, 2010, 2020; Parteka & Tamberi, 2013; Vahalík, 2015) have endeavoured to investigate the phenomenon of export diversity from an alternative perspective, specifically by utilizing measures of export specialization such as Theil, Gini, the value of variation, and HH indices, as well as relative indices such as dissimilarity, relative Theil, and Gini indices[32]. Among them HH index is widely utilized in most related research (for example, Vahalík (2015), Dogruel and Tekce (2011), Parteka (2020), etc.)

3.2.2 Literature related to the determinants of export diversification

The pertinent factors influencing export diversity can be succinctly categorized as follows: 1) the level of economic development as measured by per capita GDP or productivity, 2) the size of the country as determined by population, GDP, and land area, 3) the ease or difficulty of trade as influenced by factors such as distance and free trade agreements, 4) the level of human capital, 5) the degree of technological advancement, 6) the availability of natural resources, 7) the role of exchange rate fluctuations, 8) the amount of foreign direct investment, and 9) policy-related factors.

The indicators of economic development hold a prominent spot in research pertaining to export diversity, whether it is utilized as an explanatory variable (Beverelli et al., 2015; Cieślik & Parteka, 2021; Dogruel & Tekce, 2011; Parteka, 2020; Parteka & Tamberi, 2013) or as an outcome variable (Aditya & Acharyya, 2013; Cadot et al., 2011; Sannassee et al., 2014; Sarin et al., 2022). Hence, it can be inferred that a reciprocal causal association exists between export diversity and economic growth, as posited by Gözgör and Can (2017).

A lack of uniformity exists in the theoretical framework concerning export diversity's influence on the economy's advancement. As per the Heckscher-Ohlin model, a nation ought to prioritize the development of industries that possess comparative advantages instead of broadening its range of export commodities (Salvatore, 2009). Sarin et al. (2022) discovered that export diversity has a promotion on economic growth, supported by the Prebisch-Singer hypothesis and contemporary product lifecycle and development models.

The correlation between economic progress and export diversity has been found to exhibit variability across distinct phases of economic development, as per recent research (Imbs & Wacziarg, 2003). Cadot et al. (2011) contend a positive correlation exists between a nation's

[32] The specific measure steps can be checked in the supplementary materials-Stata do file.

per capita GDP growth and the diversification of its exports during the initial stages of economic development. Then export diversity experienced a decline as developing nations progressively established economies with high-income levels, concentrating on a limited number of industries that offer high value-added benefits. A comparable relationship exhibiting an inverted U-shape has also been validated in samples worldwide (Parteka, 2013). Shahzad et al. (2021) conducted a comparative analysis of seven advanced and seven emerging nations. Their findings suggest a non-linear relationship across energy consumption along with export variety.

Previous research has extensively confirmed the favourable impacts of national scale, trade facilitation, and expenditures on export diversity. Jetter and Ramirez Hassan (2012) conducted a study wherein they analyzed 43 conceivable variables that could affect export diversity. Their findings revealed that the number of people is one of four noteworthy factors. The study conducted by Parteka (2020) has established that there exists a noteworthy favourable correlation between land space and the diversity of exports. The World Trade Organisation is a prominent trade organization that holds significant importance. Numerous research studies have demonstrated the favourable consequences of being a participant in this organization on the diversity of exports (Beverelli et al., 2015; Gnangnon, 2019). According to the study conducted by Parteka and Tamberi (2013), a negative correlation exists between the distance from the nearest main marketplace and export diversity.

Conversely, export diversity is positively influenced by international trade liberalization and regional free trade agreements. Foster et al. (2011) approximated that implementing free trade agreements would yield comparable favourable outcomes. The positive correlation between trade facilitation and export diversity was examined by Feenstra and Ma (2014), Aditya and Acharyya (2015) and Persson (2013) through the utilization of port efficiency, tariffs, and ship time as variables. Dennis and Shepherd (2011) conducted a study on a worldwide population and provided a detailed analysis of the repressive consequences of diverse trade expenses, with a particular emphasis on tariffs, on the diversity of exports.

The noteworthy aspect pertains to the influence of human resources and modern technology on the diversity of exports. Jetter and Ramirez Hassan (2012) employed the primary school enrollment rate as a metric for human capital resources and exhibited its extraordinarily favourable impact on export diversity. Giri et al. (2019) have reaffirmed the affirmative implications of human resources.

According to the theory proposed by Heckscher-Ohlin, it is advisable for nations to engage in the exportation of commodities that align with their respective comparative advantages. Hence, scholars have also taken into account the factor of resource endowment in their investigation of the underlying factors behind export diversification. Arawomo (2015) discovered that the export diversity of a nation is contingent upon its classification as abundant in resources or not. Additionally, Arawomo (2015) found that natural resources have an adverse effect on the export diversity of impoverished nations. Likewise, the distinction between fuel and mineral rent presents a challenge to achieving rich export diversification (Parteka, 2020).

Insufficient research has been conducted on the impact of fluctuations in exchange rates on export diversity, and there are inconsistent findings across various nations.

Méon and Sekkat (2008) as well as Rodrik (2008), have discovered that the undervaluation of accurate exchange rates plays a significant role in fostering export diversity within developing nations. According to Sekkat (2016), the effect of exchange rate misalignment on export diversity is insignificant. Arawomo (2015) posits that the performance of the entity in economies with abundant resources and those without is dissimilar. The study revealed that fluctuations in exchange rates hold no significance for countries that do not rely heavily on natural resources. However, a low exchange rate could impede export variety expansion in nations abundant in natural resources.

As previously stated, large multinational companies have implemented a worldwide manufacturing separation via overseas investment to decrease manufacturing costs and effectively leverage various nations' unique advantages and resources. As per De Backer et al. (2018), it can be inferred that the internal trade of large multinational companies presently constitutes the majority of global business. Consequently, foreign direct investment has emerged as a significant factor influencing the diversity of exports. Multinational corporations invest in Country A to accomplish exports to other nations, which fosters the diversity of Nation A's exports (Ekholm et al., 2007). Jayaweera (2009) and Rehman et al. (2020) reported a similar positive impact. According to Rehman et al. (2020), in the case of a resource-based economy such as country A, foreign direct investment tends to be focused primarily on the mining sector, which may not be advantageous for promoting export variety. Several studies have demonstrated that specific policies can impact the diversity of exports. The export of rare earth elements is subject to regulatory regulations of the Chinese government, which significantly affects their availability as a critical high-tech resource (He, 2014). The United States has implemented measures, such as prohibiting the sale of premium chips to Chinese technology enterprise Huawei, to impede its progress.

The preceding Chapter's literature review on OBOR reveals that the majority of studies have concentrated on trade volume (Foo et al., 2020; Guo et al., 2017; Herrero & Xu, 2017; A. Liu et al., 2020; Ma et al., 2017; C. Yu et al., 2020; L. Yu et al., 2020) or value-added/industry linkages (Wolszczak-Derlacz & Lu, 2022). However, there is a shortage of research on export diversity. Several studies have indicated that the industries of the countries involved in OBOR and China exhibit greater complementarity than the competition (Igbinoba, 2017). These studies have mainly concentrated on the energy sector (Y. Zhao et al., 2019). Furthermore, OBOR is expected to facilitate the relocation of China's surplus production capacity in specific industries to nations along the route that possess abundant labour resources and inadequate infrastructure (Johnston, 2019). Nonetheless, limited research has specifically investigated the influence of the Belt and Road initiative on the export variety of its participating entities. Wang and Tian (2022) represent an anomaly. The study centred on China's trade and revealed that the Belt and Road initiative favours its extensive margin.

OBOR differs from a free trade agreement in that it is a collaborative effort encompassing trade and investment facilitation, political consultation, people-to-people exchanges, cultural exchanges, and RMB internationalization. Hence, conducting a comprehensive analysis of the impact of OBOR on export diversity is deemed the most arduous and significant task. In essence, antecedent literature has delineated OBOR through two distinct approaches. The majority of research endeavours have utilized the methodology outlined in OECD (2018), which incorporates the 65 nations situated along the designated corridor (as per its geographical location) (C. Liu et al., 2020; Zhang et al., 2019). According to Wang and Tian (2022), signing an MoU is considered by some individuals as a distinctive characteristic. In light of the potential impact of foreign direct investment on a nation's export diversity, an additional classification has been incorporated into this section: the accession to the AIIB. The appendix displays a comprehensive list of OBOR members and their respective dates of inclusion per the three definitions outlined. Please refer to Table A.2 and Fig. A.1 for further details.

3.3 Data and Descriptive Statistics

3.3.1 OBOR and export diversity

3.3.1.1 Data source

The present study aims to investigate the factors that influence export diversity thoroughly. The research incorporates various economic development indicators, population size, trade facilitation or costs, human resources, and technology as explanatory variables to achieve this objective. The database encompasses 183 countries and spans the time frame from 1996 to 2019.

The calculation of export diversity, which encompasses the quantity of exported products, IEMP, HH, and Theil indices, is conducted through the utilization of trade flows (HS1996) sourced from the CEPII basic dataset. The economic development parameter I utilize involves the calculation of productivity by dividing the Gross Domestic Product (rgdpo) by the total number of employed individuals (emp) obtained from the Penn World Table 10 (pwt10). The database provided information on multiple countries' population size and human resources. The human resources index, as it stands, lacks the technical component. To address this limitation, I have incorporated the proportion of research and development expenditure in GDP, obtained from the World Development Indicators, as a supplementary measure.

The prospect of joining the World Trade Organisation as a trade facilitation parameter is also considered. Utilizing the gravity data available through CEPII, I have conducted calculations to determine the distance of each country to the nearest significant consumer markets, namely the United States, China, and Germany, to quantify trade expenses. The present study primarily centres on the OBOR, which encompasses the subsequent three delineations: According to the Organisation for Economic Cooperation and Development (OECD) report of 2018, the term "OBOR corridor" refers to the 65 nations that are located in OBOR. Furthermore, I choose the joint year for nations to endorse the Memorandum of Understanding for OBOR as the second definition. Ultimately, the membership information of AIIB members will be taken into consideration. The sources of these three definitions can be traced back to OECD (2018), the websites of OBOR, and AIIB. (Please consult Fig. 3.1 for further information.)

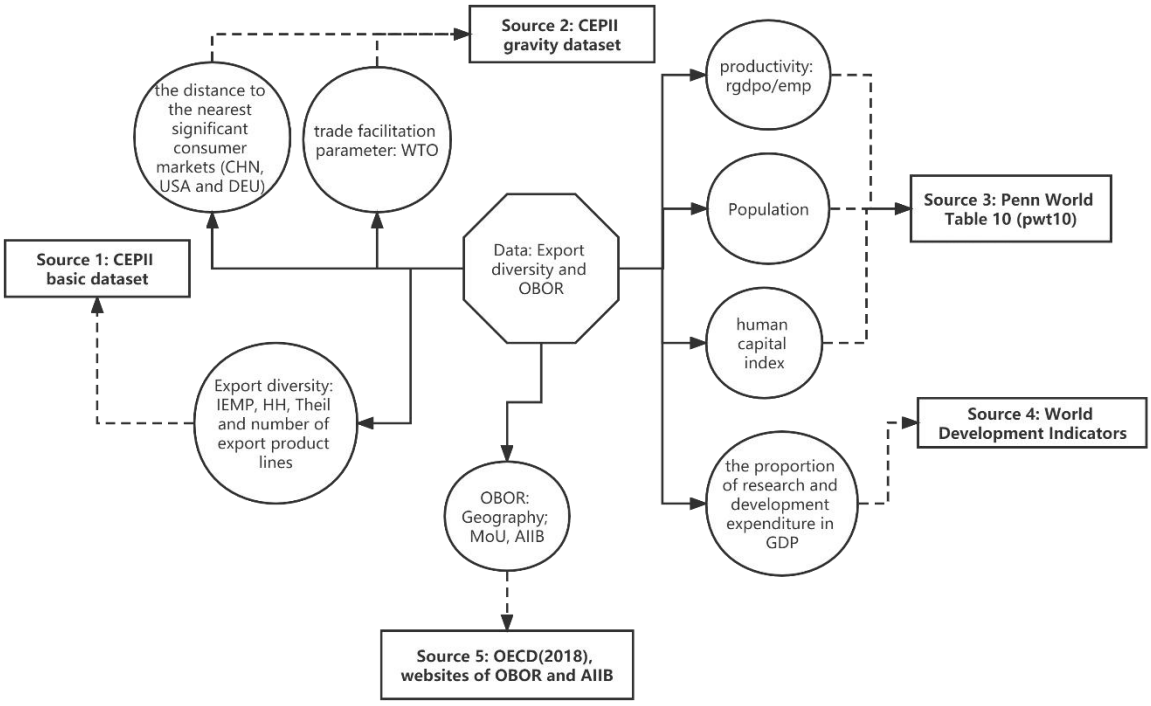


Fig. 3. 1 The integration steps of the export diversity and OBOR data

Source: own elaboration

3.3.1.2 Descriptive statistics

Drawing on the extant literature on economic growth and export diversity, it can be affirmed that the association between these variables displays heterogeneity across various stages of economic growth and country typologies (i.e., resource-based or non-resource-based). The present study encompasses a significant portion of the globe and spans a duration of approximately 25 years. The initial analysis focuses on investigating the potential existence of a non-linear correlation between productivity and export diversity. Fig. 3.2 displays the distribution relationship between the four chosen export diversity variables and productivity.

The relationship between productivity and the quantity of exported products follows an inverted U-shaped pattern. Subsequently, it was discovered that both the HH export concentration ratio and the Theil index exhibited a U-shaped correlation with productivity. Thus, it can be inferred that nations exhibiting lower productivity levels tend to encourage diversification of product exports as productivity levels rise until reaching a specific threshold, after which export diversity declines with further productivity increases.

Finally, the last down-right figure shows an oppositive non-linear relationship between productivity and diversification in the export market, which is characterized by a U-shaped pattern.

The correlation between export market diversification and productivity exhibits an initial negative trend, followed by a positive trend; however, the inflexion point is observed at significantly lower levels of productivity. The phenomenon observed is that in countries with low

productivity, the diversification of export markets initially experiences a decline but subsequently exhibits an upward trend as productivity improves. The correlation between product and destination diversification can be elucidated by real facts.

On one hand, when comparing countries with marginally higher productivity to those with the lowest productivity, such as Venezuela, Ethiopia, and Nigeria, it can be observed that the latter possess comparative advantages in natural resources such as agriculture, food, and oil. The limited value-added potential of certain products, such as food and oil, has resulted in a comparatively narrow range of product exports in certain countries. Conversely, the range of market exports in these countries is relatively broad due to the expansive demand for these commodities.

On the other hand, nations with elevated productivity opt to export high-value-added commodities while relinquishing specific low-profit sectors, owing to labour expenses and other factors. In contrast to other sectors, a limited number of developed nations dominate the high-value-added industries as a result of specific barriers to entry. A positive correlation exists between the size of the potential market and the level of market competition, such that a decrease in competition leads to an increase in market potential. In contrast to nations exhibiting lower levels of productivity, those with higher levels tend to have a reduced number of export commodities, yet they penetrate a greater number of markets.

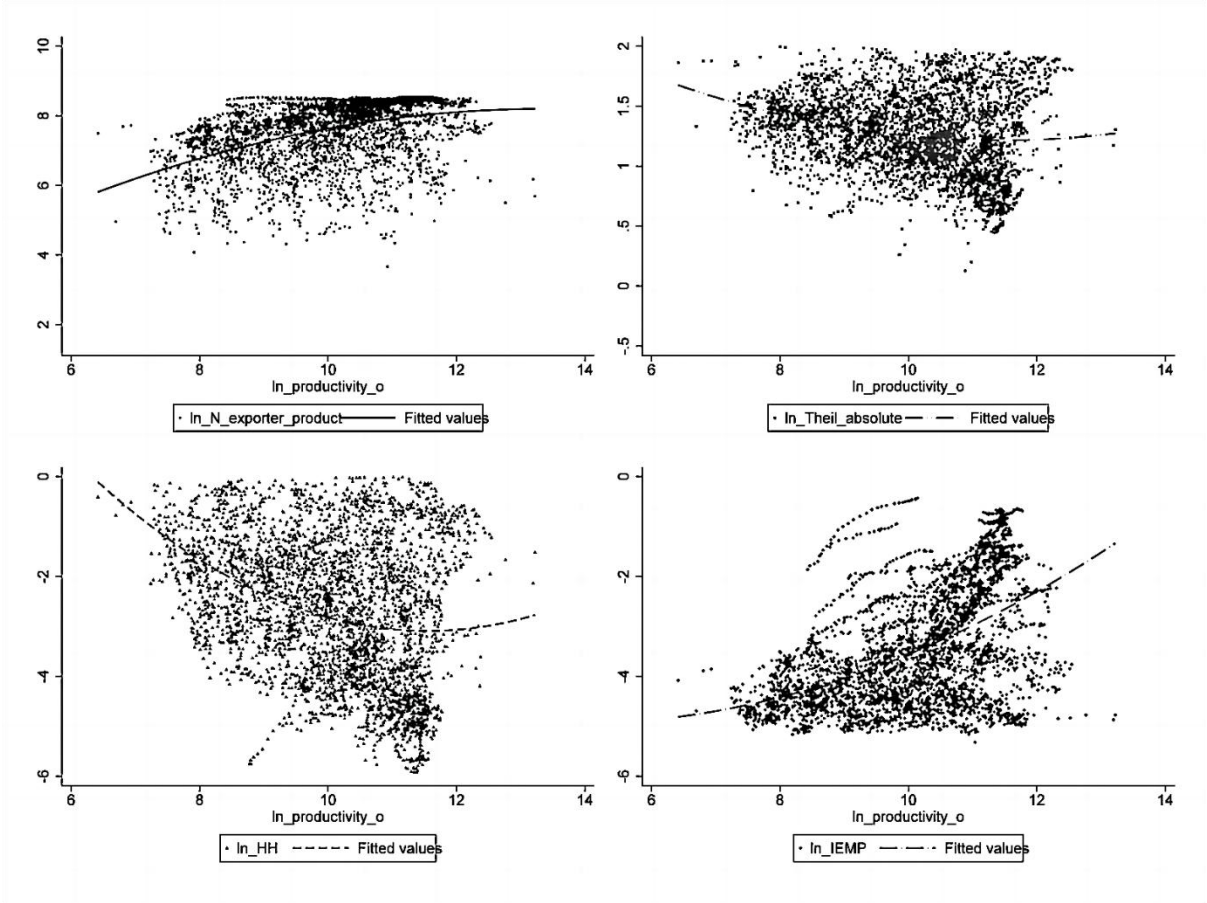


Fig. 3. 2 Distributional information on the diversity of exports and the level of productivity

Source: own elaboration.

The alterations in export diversity between 1996 and 2019, as gauged by the quantity of export goods lines, are illustrated in Fig. 3.3. During this particular timeframe, it was observed that the nations exhibiting a significant number of export product categories were predominantly those belonging to The Group of Twenty (G20). So a positive correlation has been noted between a country's size and its export diversity. Simultaneously, a majority of these nations exhibit a high level of development, including Europe, the United States, Japan, and Australia, among others. The range of export commodities originating from countries with elevated productivity levels remains highly extensive, as depicted in the chart located in the upper left quadrant of Fig. 3.2.

The current trajectory of developed nations characterized by a high degree of export diversification remains uncertain. My combined final data indicates a marginal decline in export diversity, as depicted in Fig. 3.2, thereby suggesting an inverse relationship between product export diversity and productivity in nations with the highest productivity. Notably, the export commodities of certain nations in Southeast Asia, Central and Eastern Europe, Central Asia, and Africa with lower productivity levels are exhibiting a growing trend towards diversification. It can be posited that the augmentation of productivity in said nations correlates with a commensurate expansion in the variety of exported goods emanating from countries with lower productivity levels. Given the substantial intersectionality between the aforementioned nations and those affiliated with the One-Belt One-Road initiative, as evidenced by Table A.2, it is pertinent to investigate the role of OBOR in the facilitation or impediment of export diversification within the area.

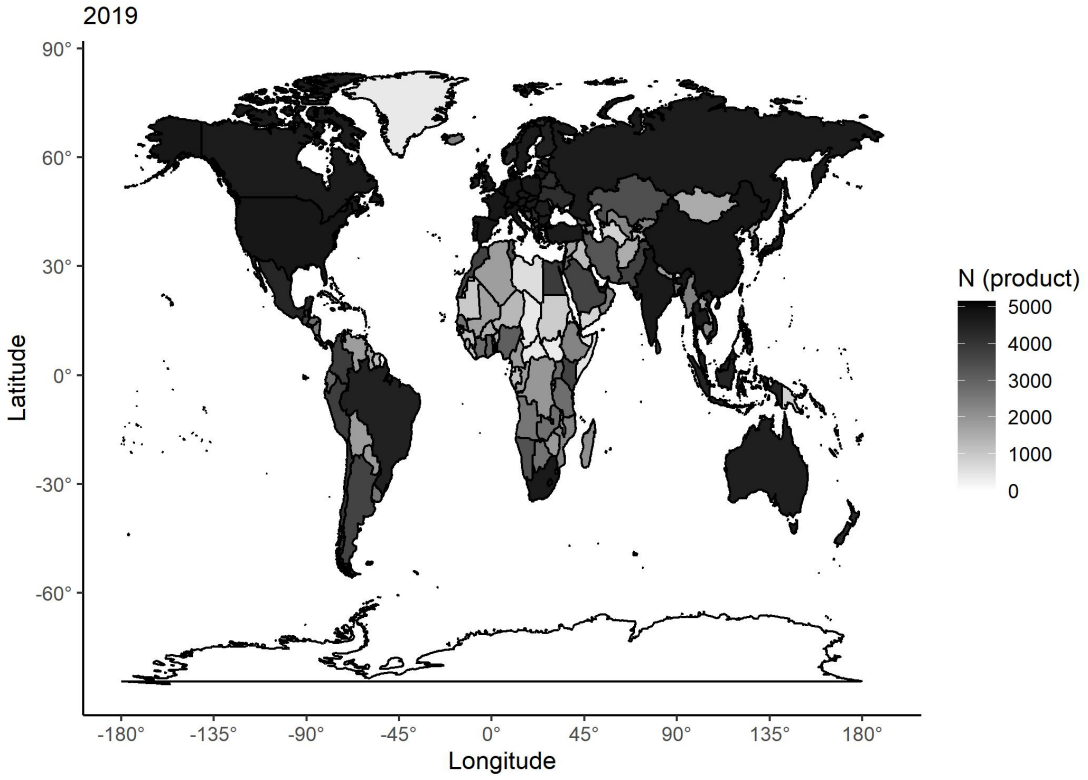


Fig. 3. 3 The animated map of export diversity by country from 1996 to 2019

Source: own elaboration.

Note: The complete statistics (1996-2019) and an interactive map are available for download under the Supplemental material.

3.3.2 Intensive and extensive margins in Chinese firms

3.3.2.1 Data source

To enhance the correlation analysis between the intensive and extensive margin and diverse assets of Chinese enterprises. My current endeavour aims to establish integration between the Chinese customs database and the Chinese industrial enterprise database. Acquire enterprise financial, location and labour information and import and export data from 2000 to 2014. This trade data include information on quantity, port, trade mode, transportation mode, product, transit country, and other relevant details.

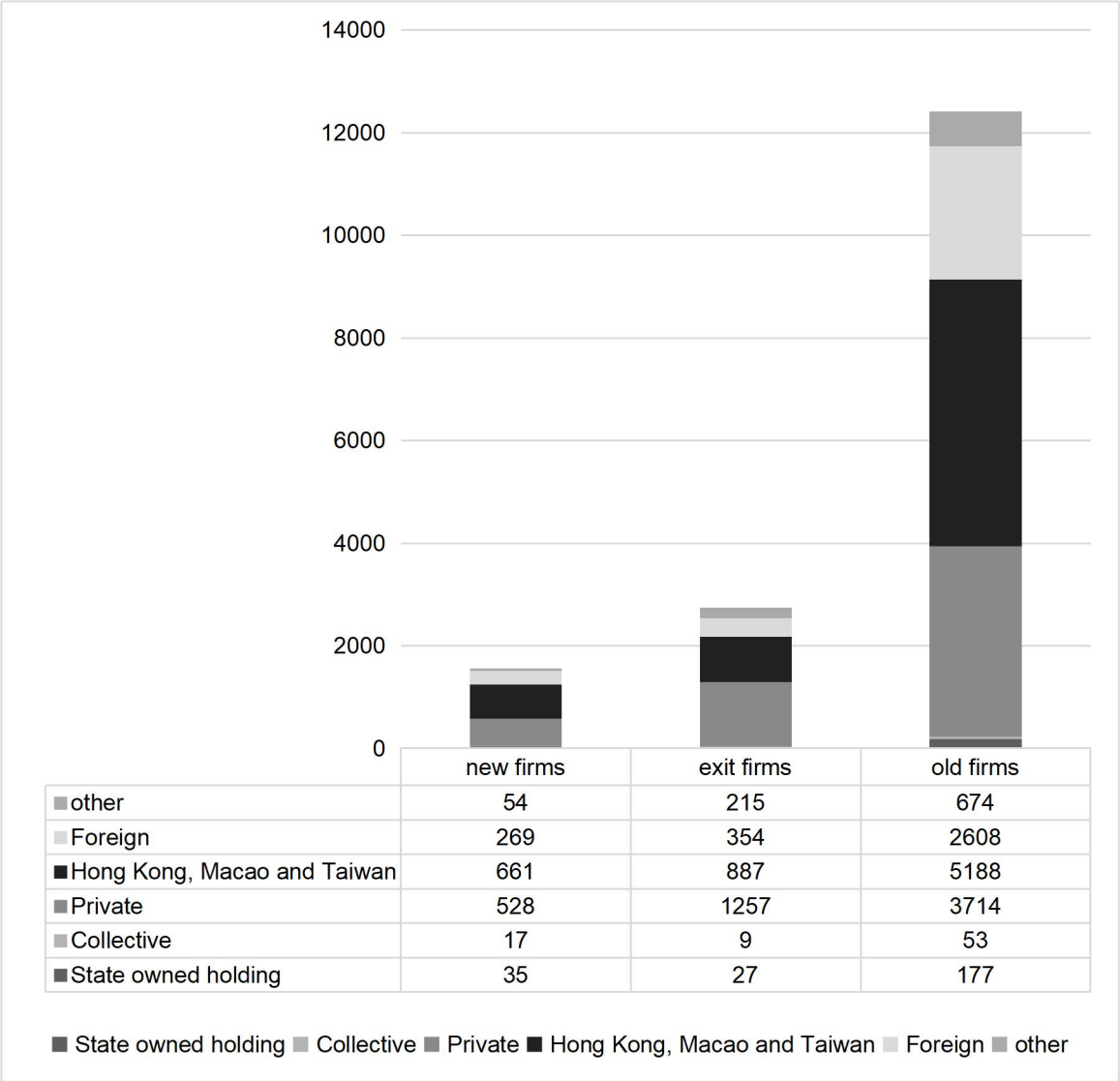
In this Chapter, I will use data from 2012 and 2013 to determine the intense and extensive marginal indices for firms in Guangdong Province, China, in 2013. Also, as some businesses' names change yearly, I merge using the unique identification code (firm_code) corresponding to the company[33].

3.3.2.2 Descriptive statistics

According to the data presented in Fig. 3.4, it can be observed that in 2013, the export enterprises in Guangdong Province were predominantly comprised of private enterprises, as well as those from Hong Kong, Macao, Taiwan, and foreign-funded enterprises. In contrast, it can be observed that state-owned and collective enterprises[34], which are predominantly controlled by the government, constitute a relatively minor proportion.

[33] The STATA log of do file can be downloaded in Supplementary materials.

[34] Collective enterprises can be defined as a socialist society where a portion of the working class collectively owns the means of production and equally shares the benefits of their labour within a collective framework.
These enterprises operate with independent management and self-financing mechanisms.



	new firms	exit firms	old firms
other	54	215	674
Foreign	269	354	2608
Hong Kong, Macao and Taiwan	661	887	5188
Private	528	1257	3714
Collective	17	9	53
State owned holding	35	27	177

Fig. 3. 4 The quantifiable quantity of firms engaged in exporting activities within the Guangdong province in 2013

Source: own elaboration based on Chinese Customs Database and Chinese Industrial Enterprise data.

To enhance the depiction of the influence of distinct forms of capital on businesses' intensive and extensive margins. The double marginal indicators for each enterprise in 2013 were obtained through data integration and calculation. The extensive margin comprises three components: the ratio of the value of new products exported to the old market in relation to the total output, the proportion of enterprises exporting old products to the new market, and the ratio of enterprises exporting new products to the new market. The precise procedures may be found in the supplementary materials: STATA log file.

Through Fig. 3.5, we can observe the following points: 1. The role of the proportion of private capital on the intensive margin[35] is not apparent (right upper figure). 2. The state-owned capital has a slight inhibitory effect on the intensive margin (left upper figure). On the contrary,

[35] Intensive margin whch is calculated as: the ratio of the sales volume of the old products exported to the old market to the total output value

foreign capital and Hong Kong, Macao, and Taiwan enterprises positively associate with the intensive margin (figures in the second row). In Fig. 3.6-3.8, which describe the extended margin, we find the opposite result to the intensive margin. Enterprises with more private capital and state-owned capital tend to expand new markets and develop new products. The larger the proportion of foreign capital and Hong Kong, Macao and Taiwan capital, the less inclined they are to open new markets. This is also consistent with our previous research on China's global value chain, that is, foreign capital's investment in China is mainly to manufacture products for its inherent market. The positive impact of state-owned capital and private capital on the extensive margin also reflects the enhancement of the competitiveness of local Chinese enterprises, especially in the type of new products to new markets.

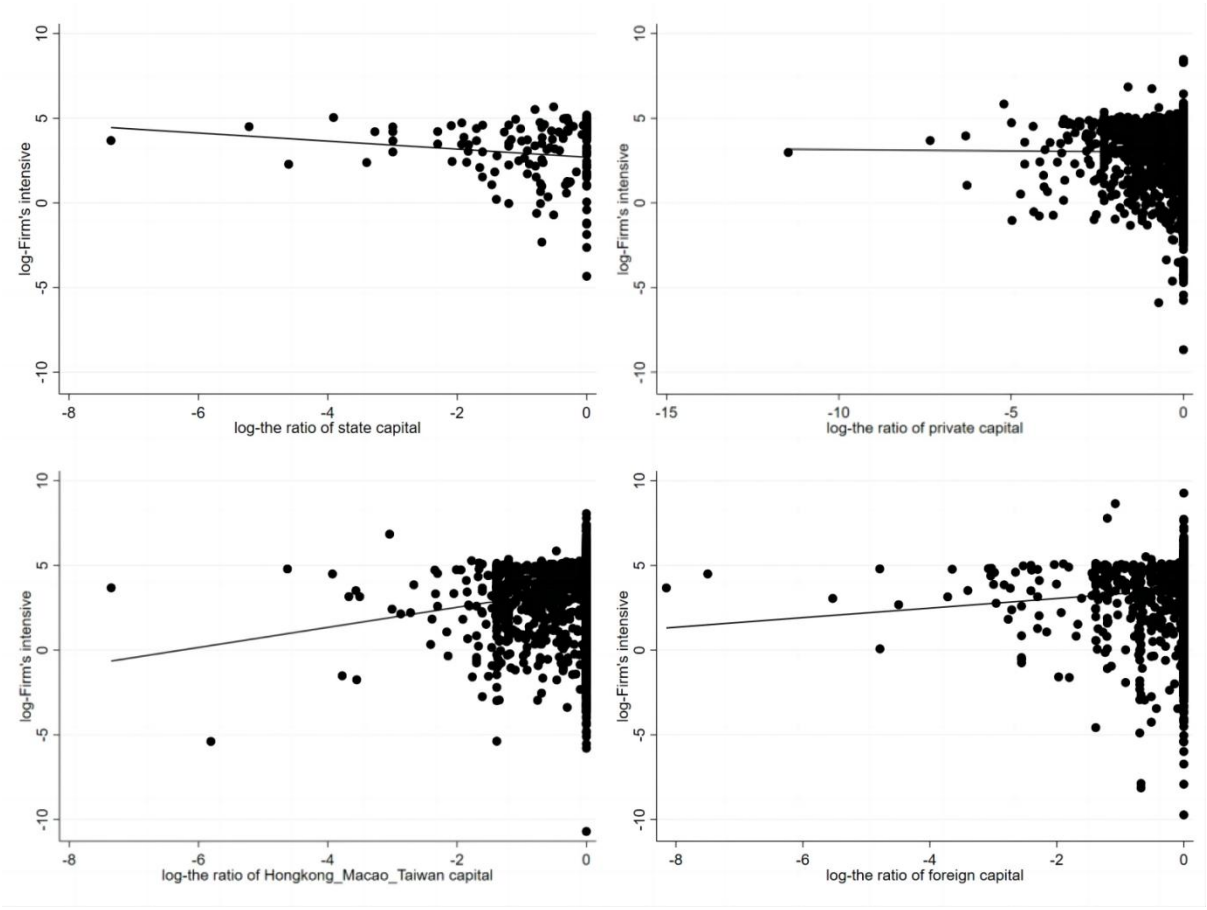


Fig. 3. 5 The relationship between the intensive index and different capital in 2013 (Guangdong province)

Source: own elaboration based on Chinese Customs Database and Chinese Industrial Enterprise data.

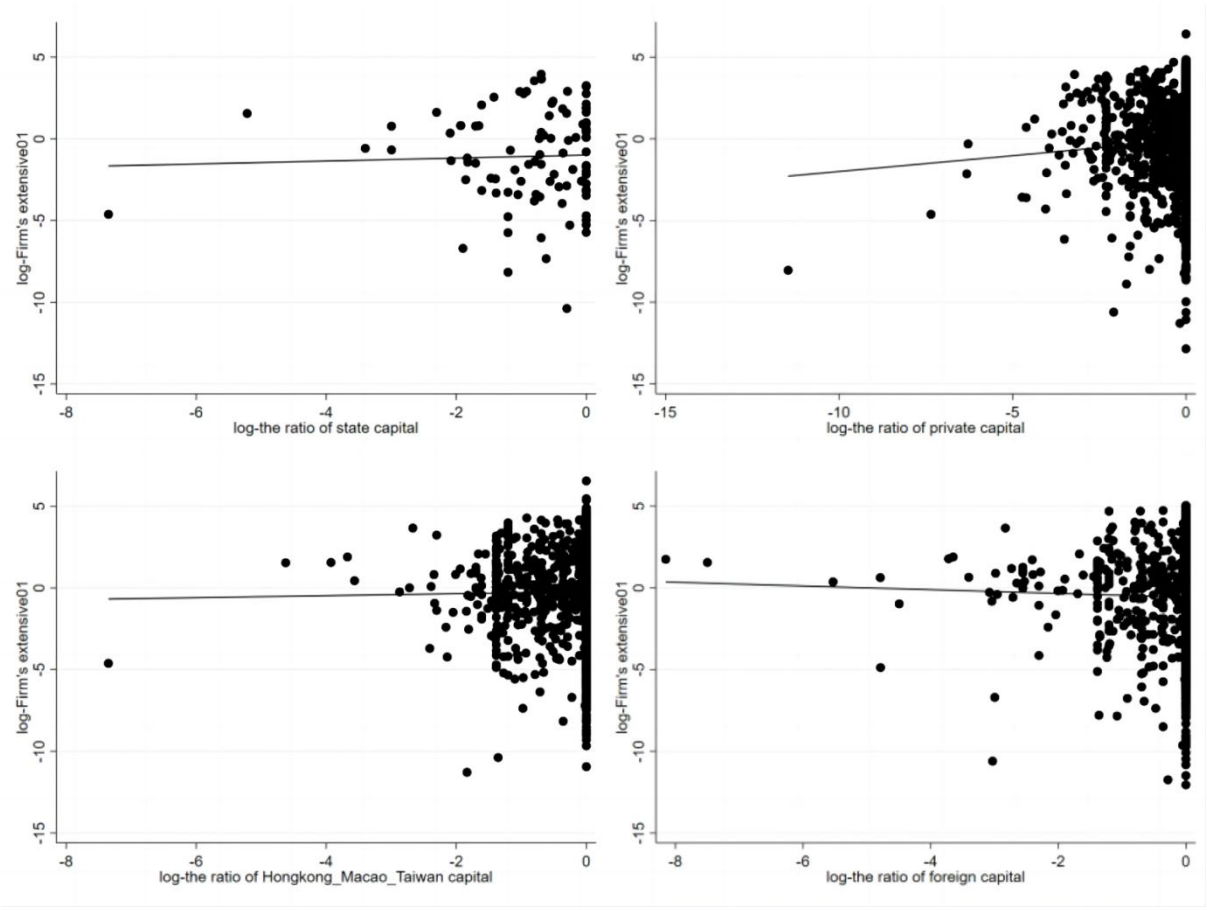


Fig. 3. 6 The relationship between extensive margin (new products exported to the old market) and different capital in 2013 (Guangdong province)

Source: own elaboration based on Chinese Customs Database and Chinese Industrial Enterprise data.

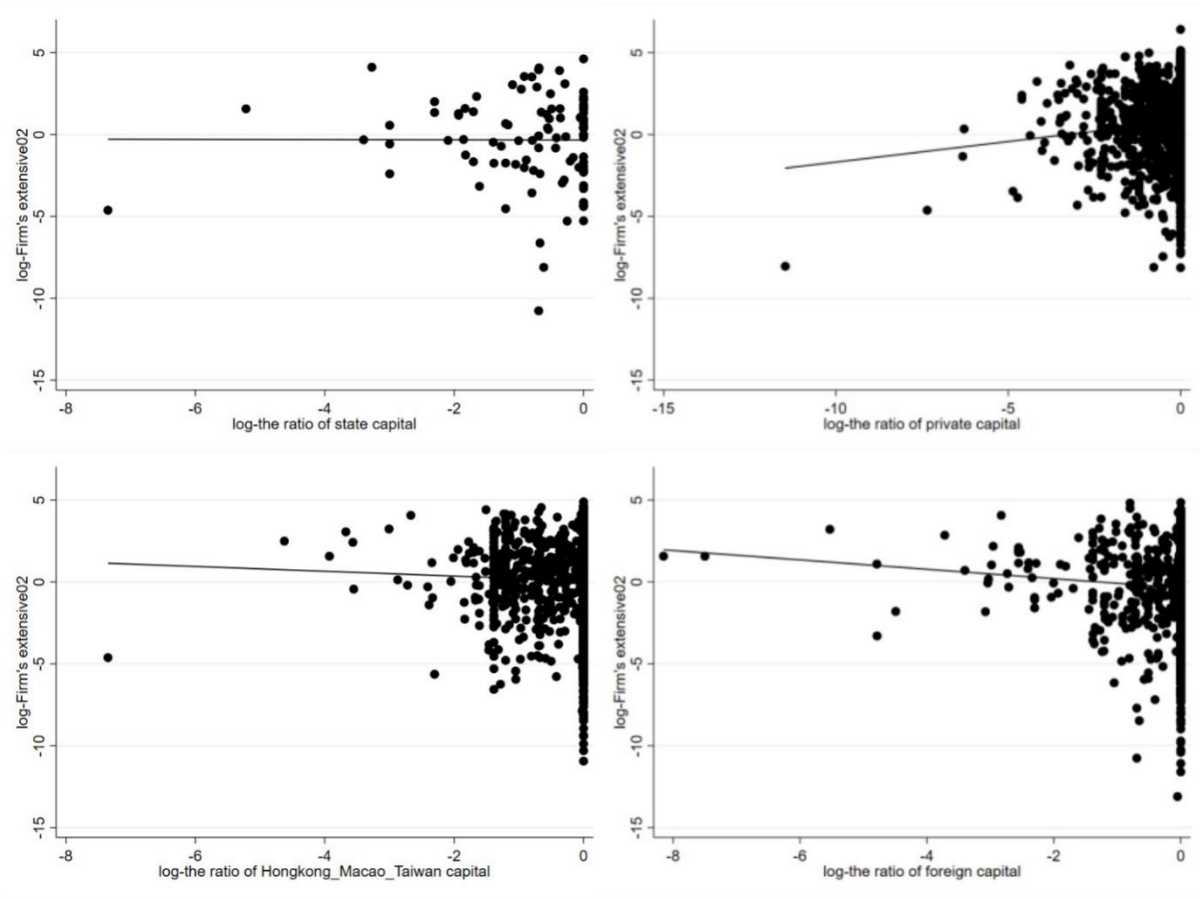


Fig. 3. 7 The relationship between extensive margin (old products exported to new markets) and different capital in 2013 (Guangdong province)

Source: own elaboration based on Chinese Customs Database and Chinese Industrial Enterprise data.

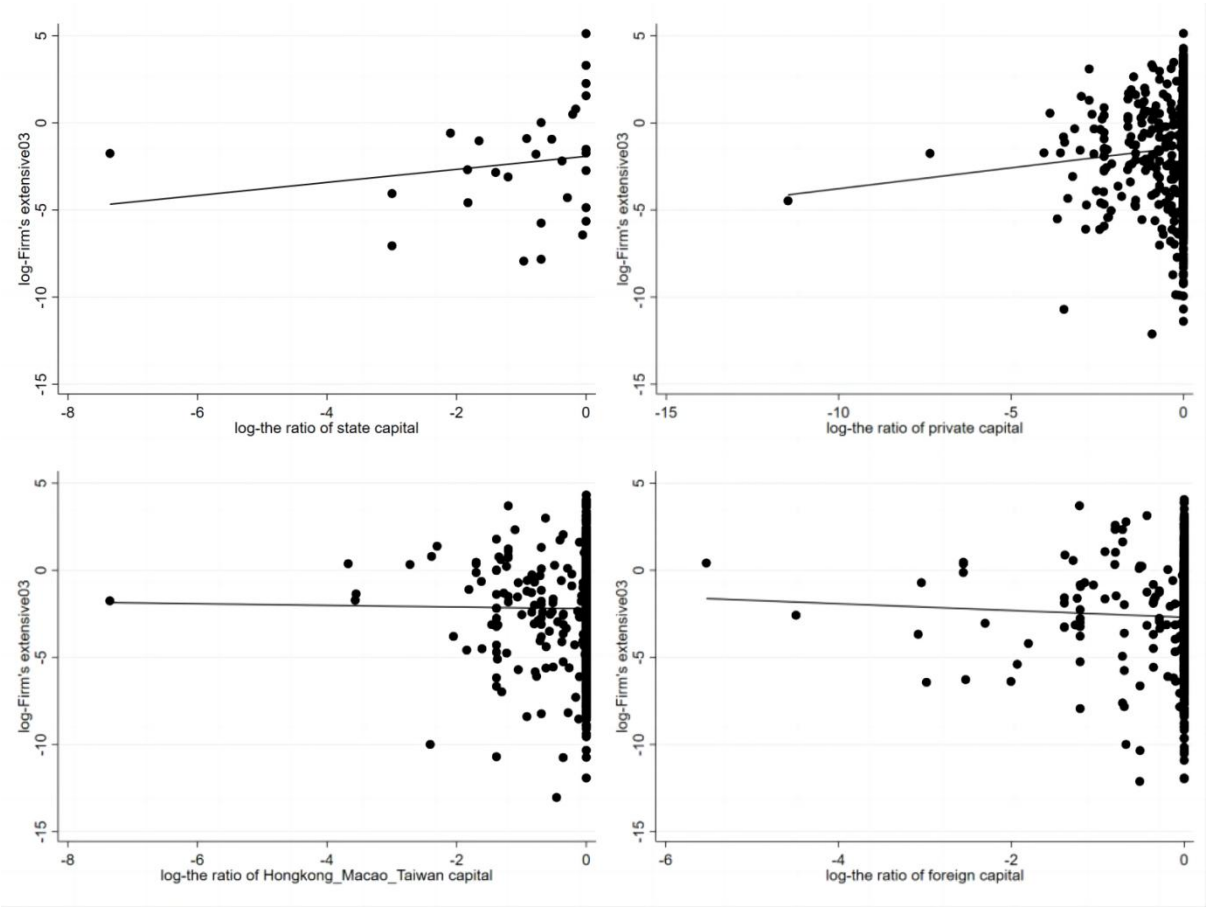


Fig. 3. 8 The relationship between extensive margin (new products exported to new markets) and different capital in 2013 (Guangdong province)

Source: own elaboration based on Chinese Customs Database and Chinese Industrial Enterprise data.

3.4 Empirical Analysis

3.4.1 Specific model to OBOR and export diversity

In this section, a specific model will be discussed in relation to the One-Belt One-Road (OBOR) initiative and the diversity of exports. Following previously related research (Beverelli et al., 2015; Gnangnon, 2019; Parteka, 2013; Parteka & Tamberi, 2013), the augmented regression equation (3.3) is as follows:

$$lnED_{i,t} = \alpha + \beta_1 lnProd_{i,t} + \beta_2 lnProd^2{}_{i,t} + \beta_3 lnX_{i,t} + \beta_4 V_{i,t} + \beta_5 OBOR_{i,t} + \delta_t + \phi_i + \epsilon_{i,t} \quad (3.3)$$

where *i* denotes country and *t* time.

The study employs a regression model to examine the relationship between export diversity ($ED_{i,t}$) and productivity ($Prod_{i,t}$), where the latter is defined as the actual gross domestic product (GDP) over the overall amount of employees. To adjust the potential non-linear relationships, the square of productivity ($Prod^2_{i,t}$) is also included in the model. Additionally, the model controls for the effects of an aset of factors (*X* and *V*) and affiliation in the One-Belt One-Road initiative ($OBOR_{i,t}$).

Initially, export diversity ($ED_{i,t}$) is measured through four distinct parameters, categorized into two categories, namely export diversity in goods and destinations. The good's export diversity is calculated based on two components: the number of goods exported ($N\_exporter\_product_{i,t}$) and the utilization of inverse factors, such as concentrations of exported goods indices ($HH_{i,t}$ and $Theil_{i,t}$). The index of export market penetration ($IEMP_{i,t}$) is utilized to quantify the market's export diversity.

A supplementary collection of variables (*X*) comprises three parameters: the number of people ($Pop_{i,t}$) utilized as an indicator for nation size, the distance ($dist_i$) between nation *i* and its nearest significant market, and the index of human capital ($hc_{i,t}$). An additional group of covariates (*V*) comprises two variables: the proportion of spending on research and development in GDP ($RD_{i,t}$) and a binary indicator that takes on a value of 1 if a nation is an affiliate of the World Trade Organisation at time t along with 0 if not ($WTO_{i,t}$).

This study's primary factor of interest is the binary indicator for affiliation in the One-Belt One-Road initiative, denoted as $OBOR_{i,t}$. The measurement is determined by three separate definitions: $OBOR_{i,t}$, which is a binary variable that takes a value of one when nation *i* is an affiliate of OBOR along its corridors at the years *t*; $MOU_{i,t}$, which is a binary variable that takes a value of one for nation *i* that have reached MoUs at the years *t*; and $AIIB_{i,t}$, which is a binary variable that takes a value of one for the Asian Infrastructure Investment Bank affiliation.

Furthermore, the study incorporates fixed effects for the time and country denoted as δ_t and ϕ_i, respectively. This approach eliminates the influence of time-varying trends, such as worldwide economic downturns or the development of technology, on the estimated effect. The available estimation techniques comprise Ordinary Least Squares (OLS), Least Squares Dummy Variables (LSDV), and Instrumental Variables (IV). The study employs the utilization of

productivity and the square of productivity as instrumental factors, with a lag, while also assessing the presence of under-identification or weak identification.

3.4.2 Results

The initial regression model will incorporate a more comprehensive analysis, utilizing solely productivity and its corresponding squared value as covariates. Table 3.1 illustrates the non-linear correlation between export diversity in terms of goods and productivity. The prediction margin is depicted in Fig. 3.9 for illustrative purposes. The graph in the upper left quadrant illustrates the anticipated margin of diversity in goods exportation. It is observed that there exists a positive correlation between productivity levels and the extent of export diversity.

Nevertheless, beyond a particular threshold, the augmentation of productivity results in a deceleration of export diversity. There is an inverted U-shaped curve that depicts the correlation between export diversity and productivity, indicating economic growth. Various estimation techniques corroborate this assertion. Specifically, the initial column of Table 1 presents the outcomes of Ordinary Least Squares (OLS) despite fixed effects. The second column displays the results of the Least Squares Dummy Variable (LSDV) with a fixed-year effect, while the third column exhibits the outcomes of LSDV with countryl effects. Finally, the fourth column showcases the fixed effects of country and year. The estimations for columns 5-8 are reiterated utilizing the variable instrumental technique. The instrumental variable (IV) estimation method has passed the tests for inadequate and weak identification, and the results validate the non-linear association between export diversity and productivity.

Table 3. 1 Estimate of product export variety and development

	Dependent variable: lnN_exporter_product							
	(1) OLS	(2) LSDV	(3) LSDV	(4) LSDV	(5) IV	(6) IV	(7) IV	(8) IV
$lnProd_{it}$	1.315***	1.282***	1.951***	2.081***	1.319***	1.298***	1.919***	2.161***
	[0.196]	[0.180]	[0.337]	[0.184]	[0.175]	[0.172]	[0.158]	[0.133]
$lnProd^2_{it}$	-0.049***	-0.048***	-0.077***	-0.103***	-0.050***	-0.050***	-0.078***	-0.107***
	[0.010]	[0.009]	[0.016]	[0.009]	[0.009]	[0.009]	[0.008]	[0.007]
year		yes		yes		yes		yes
country			yes	yes			yes	yes
N	4241	4241	4241	4241	4059	4059	4059	4059
R^2	0.2	0.26	0.87	0.92				
Under					0.000	0.000	0.000	0.000
Weak					26809.56	27117.91	3856.09	3267.99

Notes: The stated numbers pertaining to the under-identification verification denote the p-values, which are associated with the Kleibergen-Paap rk LM evaluate statistic. In this context, the rejection of the null hypothesis signifies that the instruments are not under-identified. The Kleibergen-Paap Wald rk F-statistic test is utilized to detect the existence of weak instruments and is commonly referred to as the weak identification test. According to Staiger and Stock (1997), a minimum statistic of 10 is advisable as a general guideline. Failure to meet this criterion may indicate weak identification and should be considered problematic. In IV regression analyses, I employ productivity and the square of productivity as the instrumental factor, using a time delay.* p<0.10, ** p<0.05, *** p<0.01.

Source: own compilation

The outcomes of additional export diversity metrics are also presented in Fig. 3.9. The top-right as well as lower-left graphs, respectively, depict the HH and Theil exponents. As the trade concentration rate increases, there is a corresponding decrease in export diversity. Thus, the predicted margin chart is U-shaped. The outcomes of IEMP are depicted at the bottom-right of Fig. 3.9.

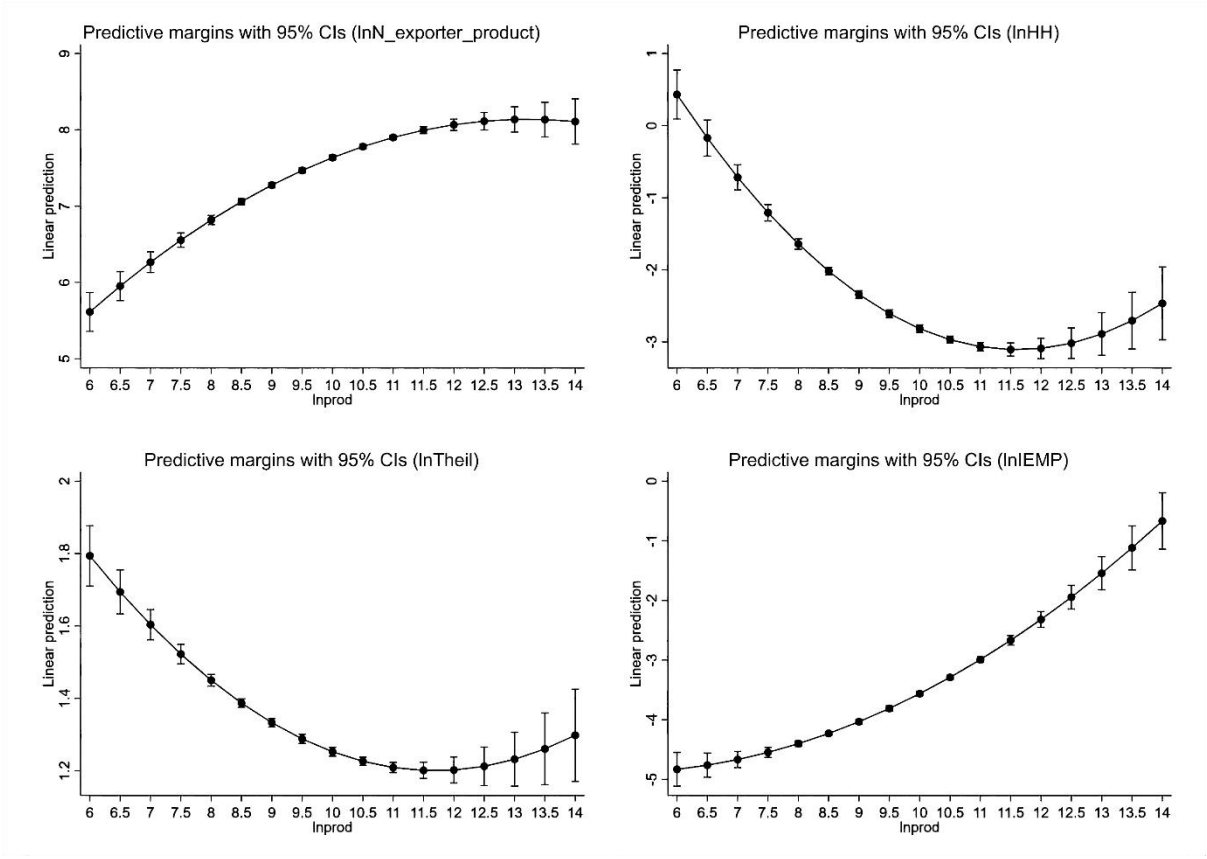


Fig. 3. 9 The predictive margins of productivity, specifically focusing on the outcomes derived from Column 2 of Table 3.1

Source: own compilation

Table 3.2 presents an enhanced analysis of regression that includes additional variables, with a particular emphasis on instrumental variable estimation. A negative association between distance and export diversity has been observed, indicating that countries located at greater distances from crucial markets tend to exhibit fewer export product lines. A positive correlation exists between export diversity and factors such as the number of people (the country's size), human capital, accession to the World Trade Organisation, and research and development expenses. The critical parameter OBOR demonstrates an unfavourable relationship with export diversity. On average, OBOR members display lower levels of export diversity, thereby contradicting original hypothesis 1. Notably, the relationship between membership in the One-Belt One-Road initiative and export diversity exhibits dissimilarities compared to that of the World Trade Organisation. According to our perspective, this disparity could potentially be contingent upon two distinct factors. In accordance with Hypothesis 2, it can be observed that China's investment in countries that are members of the One Belt One-Road initiative has experienced a rise. However, it is noteworthy that a significant portion of this investment has been directed towards select industries such as transportation and energy. This may result in a potential diversion of capital and labour towards these industries, potentially impacting other industries. In addition, an increasing number of Chinese enterprises, including smartphone manufacturers such as Xiaomi, Vivo, and Transsion (Yoshida, 2019), steel companies such as

Wen'an and Baowu Steel (China United Steel Network, n.d.), and commodity market operators such as Yiwu commodity market operators and Wólka Kosowska's Chinese shopping centre (Shepard, 2016), are expanding their presence in the OBOR region. The potential negative impact on local industries due to the comparative advantage held by Chinese enterprises in the majority of manufacturing sectors, compared to their counterparts in other nations participating in the One-Belt One-Road initiative, aligns with hypothesis 3.

Table 3. 2 Estimation of goods export diversity in relation to the One-Belt One-Road (OBOR) initiative, using the instrumental variable (IV) method

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
$lnProd_{it}$	1.442***	1.507***	1.553***	1.121***	1.185***	1.592***
	[0.121]	[0.121]	[0.121]	[0.103]	[0.099]	[0.141]
$lnProd^2_{it}$	-0.051***	-0.057***	-0.059***	-0.045***	-0.048***	-0.067***
	[0.006]	[0.006]	[0.006]	[0.005]	[0.005]	[0.007]
$lnPop_{it}$	0.261***	0.245***	0.247***	0.176***	0.183***	0.124***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
$lndist_i$		-0.143***	-0.147***	-0.042***	-0.053***	-0.080***
		[0.012]	[0.012]	[0.011]	[0.010]	[0.010]
$lnhc_{it}$				0.731***	0.708***	0.196***
				[0.038]	[0.036]	[0.045]
WTO_{it}					0.367***	0.324***
					[0.022]	[0.025]
RD_{it}						0.021**
						[0.010]
$OBOR_{it}$			-0.153***	-0.154***	-0.138***	-0.049*
			[0.033]	[0.028]	[0.027]	[0.027]
year	yes	yes	yes	yes	yes	yes
N	4059	4004	4004	3293	3293	1789
R^2	0.62	0.62	0.62	0.66	0.68	0.63
Under-identification	0.000	0.000	0.000	0.000	0.000	0.000
Weak identification	27115.68	26063.4	25919.67	44209.19	44278.61	42395.71

Notes: Notes as under Table 3.1. * p<0.10, ** p<0.05, *** p<0.01.

Source: own compilation

3.5 Extensions and Robustness

Several other exported goods diversity indices have been employed as the alternative dependent variable, and the regression results are illustrated in Tables 3.3 and 3.4. The correlation between the HH and Thiel indexes of export concentration rates and OBOR participants is favourable. This finding supports the outcomes of my primary metric (number of exported product lines) utilized for gauging export diversity.

Table 3. 3 Estimation of goods export diversity in relation to the One-Belt One-Road (OBOR) initiative: Dep. V - lnHH

	(1) OLS	(2) LSDV	(3) IV	(4) IV	(5) OLS	(6) LSDV	(7) IV	(8) IV
$lnProd_{it}$	-3.328***	-3.321***	-3.454***	-3.453***	-4.566***	-4.231***	-4.626***	-4.317***
	[0.205]	[0.205]	[0.244]	[0.243]	[0.456]	[0.464]	[0.450]	[0.448]
$lnProd^2_{it}$	0.161***	0.160***	0.167***	0.166***	0.233***	0.215***	0.236***	0.219***
	[0.010]	[0.010]	[0.012]	[0.012]	[0.023]	[0.023]	[0.022]	[0.022]
$lnPop_{it}$	-0.204***	-0.207***	-0.201***	-0.204***	-0.212***	-0.217***	-0.209***	-0.215***
	[0.008]	[0.008]	[0.009]	[0.009]	[0.013]	[0.012]	[0.014]	[0.014]
$lndist_i$	0.962***	0.954***	0.957***	0.949***	0.855***	0.828***	0.850***	0.827***
	[0.025]	[0.025]	[0.025]	[0.025]	[0.030]	[0.030]	[0.031]	[0.031]
$lnhc_{it}$					-0.287*	-0.365**	-0.259*	-0.337**
					[0.158]	[0.158]	[0.145]	[0.144]
WTO_{it}					-1.167***	-1.210***	-1.169***	-1.212***
					[0.109]	[0.108]	[0.081]	[0.080]
RD_{it}					-0.204***	-0.188***	-0.209***	-0.194***
					[0.030]	[0.030]	[0.033]	[0.032]
$OBOR_{it}$	0.141**	0.148**	0.142**	0.147**	0.194***	0.181**	0.183***	0.180**
	[0.057]	[0.066]	[0.056]	[0.067]	[0.071]	[0.085]	[0.068]	[0.084]
year		yes		yes		yes		yes
N	4183	4183	4004	4004	1838	1838	1789	1789
R^2	0.46	0.47	0.46	0.46	0.53	0.54	0.52	0.54
Under identification			0	0			0	0
Weak identification			25674.69	25919.67			39637.61	42395.71

Notes: as under Table 3.1. * p<0.10, ** p<0.05, *** p<0.01.

Source: own compilation

Table 3. 4 Estimation of goods export diversity in relation to the One-Belt One-Road (OBOR) initiative: Dep. V - lnTheil

	(1) OLS	(2) LSDV	(3) IV	(4) IV	(5) OLS	(6) LSDV	(7) IV	(8) IV
$lnProd_{it}$	-0.580***	-0.573***	-0.611***	-0.606***	-0.795***	-0.678***	-0.810***	-0.707***
	[0.056]	[0.054]	[0.059]	[0.058]	[0.110]	[0.110]	[0.108]	[0.106]
$lnProd^2_{it}$	0.031***	0.030***	0.032***	0.031***	0.043***	0.037***	0.044***	0.038***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.005]	[0.006]	[0.005]	[0.005]
$lnPop_{it}$	-0.013***	-0.015***	-0.015***	-0.017***	-0.050***	-0.052***	-0.050***	-0.052***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]
$lndist_i$	0.268***	0.258***	0.266***	0.258***	0.244***	0.235***	0.242***	0.234***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.007]	[0.007]	[0.007]	[0.007]
$lnhc_{it}$					-0.076**	-0.101***	-0.072**	-0.095***
					[0.036]	[0.035]	[0.035]	[0.034]
WTO_{it}					-0.256***	-0.271***	-0.256***	-0.271***
					[0.024]	[0.024]	[0.019]	[0.019]
RD_{it}					-0.059***	-0.055***	-0.059***	-0.056***
					[0.007]	[0.007]	[0.008]	[0.008]
$OBOR_{it}$	0.043***	0.003	0.040***	0.006	0.053***	0.028	0.049***	0.027
	[0.013]	[0.016]	[0.014]	[0.016]	[0.016]	[0.020]	[0.016]	[0.020]
year		yes		yes		yes		yes
N	4183	4183	4004	4004	1838	1838	1789	1789
R^2	0.38	0.41	0.39	0.41	0.57	0.59	0.56	0.58
Under identification			0	0			0	0
Weak identification			25674.69	25919.67			39637.61	42395.71

Notes: as under Table 3.1. * p<0.10, ** p<0.05, *** p<0.01.

Source: own compilation

The diversity of export markets is another dependent parameter that pertains to the

extent of geographical variation in a nation's exports. This is quantified by the exportation of either existing products to fresh marketplaces or new goods to both new and traditional markets. Table 3.5 illustrates that the export diversity of the nations that are part of the One-Belt One-Road initiative, as per destination, is comparatively deficient, thereby negating Hypothesis 1. In 2019, our perspective is that the transportation network along the One-Belt One-Road (OBOR) route has yet to undergo comprehensive enhancements. Thus far, there is no confirmation regarding its effectiveness in reducing costs related to exports and increasing the range of destinations for export.

Table 3. 5 Estimation of markets export diversity in relation to the One-Belt One-Road (OBOR) initiative

	(1) OLS	(2) LSDV	(3) IV	(4) IV	(5) OLS	(6) LSDV	(7) IV	(8) IV
$lnProd_{it}$	-0.162	-0.149	-0.116	-0.103	0.397*	0.369	0.449**	0.407*
	[0.140]	[0.138]	[0.130]	[0.129]	[0.239]	[0.243]	[0.208]	[0.210]
$lnProd^2_{it}$	0.036***	0.035***	0.034***	0.033***	0.003	0.004	0	0.002
	[0.007]	[0.007]	[0.007]	[0.007]	[0.012]	[0.012]	[0.010]	[0.010]
$lnPop_{it}$	0.383***	0.382***	0.386***	0.385***	0.411***	0.412***	0.411***	0.412***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.006]	[0.006]	[0.007]	[0.007]
$Indist_i$	-0.415***	-0.421***	-0.413***	-0.417***	-0.318***	-0.317***	-0.317***	-0.315***
	[0.013]	[0.014]	[0.013]	[0.013]	[0.014]	[0.014]	[0.014]	[0.015]
$lnhc_{it}$					0.363***	0.370***	0.370***	0.380***
					[0.071]	[0.071]	[0.067]	[0.067]
WTO_{it}					0.745***	0.749***	0.753***	0.757***
					[0.052]	[0.052]	[0.037]	[0.038]
RD_{it}					0.187***	0.185***	0.186***	0.184***
					[0.015]	[0.015]	[0.015]	[0.015]
$\boldsymbol{OBOR_{it}}$	-0.129***	-0.214***	-0.141***	-0.220***	-0.05	-0.063	-0.054*	-0.065
	[0.035]	[0.039]	[0.030]	[0.036]	[0.039]	[0.044]	[0.032]	[0.039]
year		yes		yes		yes		yes
N	4183	4183	4004	4004	1838	1838	1789	1789
R^2	0.79	0.79	0.79	0.79	0.85	0.85	0.85	0.85
Under identification			0	0			0	0
Weak identification			25674.69	25919.67			39637.61	42395.71

Notes: as under Table 3.1. * p<0.10, ** p<0.05, *** p<0.01.

Source: own compilation

Furthermore, the CR express railway line, a recognized accomplishment within the framework of the One-Belt One-Road initiative, can potentially enhance the linkage between nations situated along the route and China. Country along the One-Belt One-Road (OBOR) initiative has demonstrated a greater inclination towards accessing the Chinese market, particularly developing nations and small to medium-sized markets, compared to other countries situated along the route. This trend is anticipated to adversely affect the variety of export markets. Simultaneously, evidence indicates that introducing Chinese corporations and commodities into countries situated along the route exerts a restraining influence on their specific domestic sectors.

To date, the affiliation of OBOR has been delineated as active involvement within its corridor, commencing from 2014. There are various methods to modify the definition. Initially, it is advisable to contemplate the signing of Memorandums of Understanding with China to facilitate the development of nations participating in the One Belt One Road initiative. The findings presented in Table 3.6 exhibit conformity with the previous regression outcomes. Subsequently, dummy factors are employed to substitute OBOR affiliation, constituting one of the two primary indications of OBOR investment (refer to Table 3.7). The affiliates of AIIB can be classified into

two distinct categories: those participating in the One-Belt One-Road initiative and certain advanced countries. Hypothesis 3 indicates that solely the regression analysis, despite fixed year effects, displayed noteworthy (and adverse) values of exported goods diversity in this estimation. This observation demonstrates that AIIB members concurrently involved in the OBOR initiative are comparatively more prone to obtaining investments from AIIB. The allocation of funds will primarily be directed towards infrastructure, potentially resulting in the disproportionate utilization of resources (both labour and capital), impeding the growth of other sectors, and limiting the variety of exported products. Furthermore, as elucidated in the research review, advanced member countries exhibit a comparatively limited variety of goods exports due to their concentration on specific high-value-added sectors.

Table 3. 6 Estimation of export diversity in relation to the One-Belt One-Road (OBOR) initiative: OBOR defined as MoU

	Export variety (product)				Export variety (destination)			
	(1) OLS	(2) LSDV	(3) IV	(4) IV	(5) OLS	(6) LSDV	(7) IV	(8) IV
$lnProd_{it}$	1.665***	1.663***	1.619***	1.586***	0.388	0.369	0.440**	0.406*
	[0.166]	[0.170]	[0.141]	[0.141]	[0.239]	[0.242]	[0.208]	[0.209]
$lnProd^2_{it}$	-0.070***	-0.070***	-0.068***	-0.067***	0.003	0.004	0.001	0.002
	[0.008]	[0.008]	[0.007]	[0.007]	[0.012]	[0.012]	[0.010]	[0.010]
$lnPop_{it}$	0.126***	0.126***	0.123***	0.123***	0.411***	0.412***	0.411***	0.412***
	[0.005]	[0.005]	[0.004]	[0.004]	[0.006]	[0.006]	[0.007]	[0.007]
$lndist_i$	-0.085***	-0.084***	-0.083***	-0.080***	-0.318***	-0.317***	-0.317***	-0.314***
	[0.008]	[0.009]	[0.010]	[0.010]	[0.014]	[0.014]	[0.014]	[0.015]
$lnhc_{it}$	0.177***	0.186***	0.181***	0.194***	0.365***	0.370***	0.372***	0.380***
	[0.062]	[0.062]	[0.045]	[0.045]	[0.071]	[0.071]	[0.067]	[0.067]
WTO_{it}	0.314***	0.318***	0.319***	0.324***	0.746***	0.749***	0.753***	0.757***
	[0.043]	[0.044]	[0.025]	[0.025]	[0.052]	[0.052]	[0.037]	[0.038]
RD_{it}	0.020***	0.020***	0.022**	0.021**	0.186***	0.184***	0.186***	0.183***
	[0.007]	[0.007]	[0.010]	[0.010]	[0.015]	[0.015]	[0.015]	[0.015]
$\boldsymbol{MOU_{it}}$	-0.079***	-0.056**	-0.082***	-0.056*	-0.072*	-0.106**	-0.075**	-0.108**
	[0.023]	[0.027]	[0.023]	[0.030]	[0.040]	[0.049]	[0.034]	[0.045]
year		yes		yes		yes		yes
N	1838	1838	1789	1789	1838	1838	1789	1789
r2	0.62	0.63	0.62	0.63	0.85	0.85	0.85	0.85
Under identification			0	0			0	0
Weak identification			39412.35	42586.55			39412.35	42586.55

Notes: as under Table 3.1. * p<0.10, ** p<0.05, *** p<0.01. MoU indicates the signature of a Memorandum of Understanding.

Source: own compilation

Table 3. 7 Estimation of export diversity in relation to participation in the Asian Infrastructure Investment Bank

	Export variety (product)				Export variety (destination)			
	(1) OLS	(2) LSDV	(3) IV	(4) IV	(5) OLS	(6) LSDV	(7) IV	(8) IV
$lnProd_{it}$	1.617***	1.626***	1.571***	1.549***	0.375	0.335	0.428**	0.374*
	[0.168]	[0.171]	[0.141]	[0.141]	[0.240]	[0.242]	[0.210]	[0.210]
$lnProd^2_{it}$	-0.068***	-0.068***	-0.066***	-0.065***	0.004	0.006	0.001	0.004
	[0.008]	[0.008]	[0.007]	[0.007]	[0.012]	[0.012]	[0.010]	[0.010]
$lnPop_{it}$	0.126***	0.127***	0.123***	0.124***	0.411***	0.412***	0.410***	0.412***
	[0.005]	[0.005]	[0.004]	[0.004]	[0.006]	[0.006]	[0.007]	[0.007]
$lndist_i$	-0.085***	-0.083***	-0.083***	-0.079***	-0.318***	-0.315***	-0.317***	-0.313***
	[0.008]	[0.009]	[0.010]	[0.010]	[0.014]	[0.014]	[0.014]	[0.015]
$lnhc_{it}$	0.172***	0.183***	0.176***	0.191***	0.350***	0.361***	0.356***	0.371***
	[0.062]	[0.062]	[0.045]	[0.045]	[0.071]	[0.071]	[0.067]	[0.067]
WTO_{it}	0.315***	0.319***	0.320***	0.325***	0.744***	0.750***	0.752***	0.759***
	[0.043]	[0.044]	[0.025]	[0.025]	[0.052]	[0.053]	[0.038]	[0.038]
RD_{it}	0.025***	0.023***	0.027***	0.024**	0.190***	0.188***	0.190***	0.187***
	[0.007]	[0.007]	[0.010]	[0.010]	[0.015]	[0.015]	[0.015]	[0.015]
$\boldsymbol{AIIB_{it}}$	-0.083***	-0.063**	-0.083***	-0.060**	-0.022	-0.024	-0.023	-0.022

	[0.019]	[0.027]	[0.023]	[0.030]	[0.037]	[0.048]	[0.035]	[0.045]
year		yes		yes		yes		yes
N	1838	1838	1789	1789	1838	1838	1789	1789
r2	0.62	0.63	0.62	0.63	0.85	0.85	0.85	0.85
Under identification			0	0			0	0
Weak identification			38847.99	42412.53			38847.99	42412.53

Notes: as under Table 1. * p<0.10, ** p<0.05, *** p<0.01.

Source: own compilation

3.6 Conclusions

This Chapter aims to extend the existing research on international trade concerning the "One-Belt One-Road" initiative (OBOR) to encompass the domain of export diversity, which is widely recognized as a critical metric for assessing a country's export risk (Lee & Yu, 2019; Prebisch, 1962).

Drawing on pertinent research, I posit the following assumptions to corroborate their relationship more effectively.

H1: OBOR has the potential to enhance the infrastructure of participating nations, diminish trade expenses, and potentially stimulate the export of member products or diversify their markets.

H2: China's investment in the OBOR region, with a focus on the energy and logistics sectors, can impede the growth of local manufacturing industries in other member countries, which could hinder their export diversification.

H3: The significant influx of Chinese goods has the potential to dominate the OBOR region market, resulting in unfavourable conditions for other members' products and disrupting the existing industrial chain, ultimately leading to a reduction in export variety.

To thoroughly examine the influence of OBOR on the export diversity of nations involved, I incorporated OBOR as an explanatory factor into my analysis. Drawing on established determinants of export diversity, including economic development, country size, trade facilitation and costs, and human resources, I constructed a sample dataset encompassing 183 countries and spanning the years 1996 to 2019.

The initial step in constructing regression models involved verifying the existence of a non-linear relationship between export diversity and productivity, as depicted in Fig. 3.2. Subsequently, the challenge of endogeneity was addressed by introducing instrumental variables in the form of productivity and its squared value (with a lag). As the extension and validation, the export product aggregation indexes (HH, Theil indexes) and the export market connection (IEMP) index were utilized as alternative indicators for gauging export diversity regarding products and markets, respectively. Furthermore, I have expanded the scope of OBOR to encompass two distinct dimensions, namely political collaboration through the signing of Memorandums of Understanding (MoUs) and financial investment facilitated by the Asian Infrastructure Investment Bank (AIIB).

The regression analysis findings indicate a positive correlation between export diversity and various factors, including population size, membership in the World Trade Organisation, human capital, and expenditure on research and development. Conversely, a negative correlation was observed between export diversity and the distance from a country's primary market. The findings presented in this study are in alignment with prior comprehensive research conducted by some researchers (Arawomo, 2015; Beverelli et al., 2015; Giri et al., 2019; Gnangnon, 2019; Jetter & Ramirez Hassan, 2012; Parteka, 2013, 2020).

Regarding the OBOR, our findings indicate that it had a discernible effect on the diversity of exports. The export diversity, in terms of product and destination, among member countries of

OBOR is relatively low on average, resulting in a high export concentration ratio based on our data.

It is noteworthy that OBOR plays a contrary role to World Trade Organisation (WTO). The findings suggest that the decision to become a member of AIIB is associated with reducing the diversity of exported products. However, there is no statistically significant effect on the diversity of export destinations.

The aforementioned outcome carries noteworthy ramifications for policy. The research findings indicate that OBOR possesses distinct attributes compared to other free trade regions, which predominantly hinge on trade liberalization as a means to curtail trade expenses and finally augment the diversity of exports, such as the World Trade Organisation (WTO).

This Chapter serves as an extension to previous research that has demonstrated the positive association of OBOR with trade volume, added value, and industrial linkages. These findings have been documented in various studies, including those conducted by the following studies (Foo et al., 2020; Guo et al., 2017; Herrero & Xu, 2017; Ma et al., 2017; Wolszczak-Derlacz & Lu, 2022; C. Yu et al., 2020; L. Yu et al., 2020).

The findings of this study suggest that while OBOR aims to enhance trade relations among its member nations, it may have the unintended consequence of stifling the variety of exports from participating countries.

This statement broadly indicates the pivotal role of China as an OBOR and its impact on the restructuring of the value chain system with China at the centre. This study not only makes an original contribution to the literature on world trade but also has significant implications for economic development and social welfare. The vulnerability of the high concentration of developing countries' exports poses a considerable risk, particularly in unforeseen circumstances such as economic downturns or the COVID-19 pandemic. The primary concern pertains to the manner in which less developed nations can leverage OBOR to enhance their infrastructure, assimilate some of China's industries, and augment their industrial production capacity. This must be achieved without succumbing to subordinate status as a supplier of raw materials to China or yielding to a debt crisis, as some research institutions have cautioned (Ascensão et al., 2018; Maliszewska & van der Mensbrugghe, 2019; Ostashko et al., 2021; S. Zhao, 2020).

Furthermore, as an adjunct to enhancing export variety, I also incorporated information from Chinese enterprises to scrutinize the influence of their asset composition on their expanded profit margin. Nonetheless, the investigation of OBOR's link with the export diversity of Chinese industrial enterprises from a micro perspective remains underdeveloped due to data constraints (available up to 2015). This presents a promising area for future research.

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- **CONCLUSIONS**

The four nodes of China's foreign trade stage since the "reform and opening up" in 1978 can be roughly divided into five stages: exploration, breakthrough, deepening, transformation and high quality, based on the establishment of the socialist market economic system in 1992 (Deng Xiaoping's southern tour), China's accession to the WTO in 2001, the subprime crisis in 2008 and the New Normal[36] of China's economy in 2013 (B. Sheng et al., 2019).

The proposal of the OBOR strategy coincides with the latest stage of China's foreign trade. Based on the fact that China's economic growth has entered the New Normal (about 5% in the middle and low speed), China's industrial transformation (the middle and low end manufacturing industries have gradually shifted to Southeast Asia), the overcapacity of the steel and cement industries due to the general improvement of China's infrastructure and the saturation of the real estate industry, and the contribution of China's consumer spending to economic growth has been dragged down by education, medical care, and real estate spending, The China OBOR strategy is considered to strengthen industrial ties between the region and China by improving participation in regional infrastructure construction and exporting China's excess production capacity and industrial manufacturing standards (e.g. China's high-speed rail projects in Indonesia, Laos, Saudi Arabia), in order to counter the United States' implementation of technological, political, and trade disputes (Jackson & Shepotylo, 2021; Volgina & Pengfei, 2021). Nowadays, OBOR has become one of the most influential cooperation strategies in the world, covering nearly two-thirds of the global population and one-third of GDP.

Based on the reality of OBOR in infrastructure construction (like CR Express, the establishment of AIIB, Padma Rail Link in Bangladesh, Peshawar-Karachi Motorway in Pakistan, etc.) (China-Pakistan Economic Corridor (CPEC) Authority Official Website, n.d.; Y. Huang, 2016)., the establishment of AIIB and the Silk Road Fund (Handwerker, 2020; Liang, 2020), and the preference of Chinese enterprises for investment in this region (Institute for Belt & Road Economic and Trade Cooperation, 2021; Nedopil Wang, 2021), I have reason to assume that OBOR has certain effects on import and export trade, value-added trade, GVCs, and export diversity. Based on the theory and literature review of previous studies I propose the following hypotheses:

H1: OBOR helps promote bilateral trade. (Chapter 1)

H2: The roles of economic corridors in OBOR in fostering bilateral trade are different. (Chapter 1)

H3: OBOR positively associates with bilateral value-added trade and industrial connections. (Chapter 2)

H4: The economic corridors in OBOR have various relationships with GVCs (due to different industries and developments in each economic corridor). (Chapter 2)

[36] The new normal is linked with the economic slowdown, industrial restructuring, and transformation of growth momentum (driven by innovation) (Wang, 2021).

H5: China's GVCs and domestic value chains (PVCs and PRVCs) significantly affect their labour market. (Chapter 2)

H6: OBOR helps to enhance the diversity of participating countries' export products and markets through improved infrastructure. (Chapter 3)

H7: The large influx of Chinese goods may harm OBOR's participation in domestic industries, hurting its export diversity. (Chapter 3)

H8: Chinese firms' investment in OBOR countries (primarily in logistics and energy) may hurt other industries and reduce export product diversification. (Chapter3)

H9: The roles of different company assets (state-owned, private, foreign, etc.) on a firm's export-intensive and extensive margins may differ. (Chapter 3)

To test these conjectures, I first take bilateral import and export, domestic value-added export, contribution value in another country's export, number of export products/concentration ratio of export products and diversity of export markets as dependent variables, respectively. And I construct the following four datasets: (1) a global import and export dataset covering 186 reporting countries and 199 trading partners from 2000 to 2018 – Chapter 1. (2) OBOR and GVCs - Value added data covering 61 countries from 2010 to 2017 – Chapter 2, (3) OBOR and GVCs - Value contributed in export data including 178 countries from 2000 to 2018 – Chapter 2, (4) A sample dataset covering 183 countries (including traditional export diversity influencing factors such as economic development, country size, trade facilitation and costs, and human resources) covering the period from 1996 to 2019 – Chapter 3.

When validating OBOR and import and export (Chapter 1), value-added trade and GVCs (Chapter 2), to cover the potential challenges in the trade Gravity model, I used various regression methods (OLS, LSDV and PPML) with different fixed effects based on the Gravity model. The results indicate that OBOR significantly associates with import and export, value-added trade, and industrial linkages. However, compared to ASEAN and WTO, it is smaller. The performance of economic corridors in import and export trade and GVCs is generally consistent. China-Pakistan (CP) and Bangladesh-China-India-Myanmar (BCIM) are more significant.

Subsequently, in the third chapter of the OBOR and export diversity study, I introduced productivity and its square as instrumental variables to solve the endogeneity problem. The results showed that OBOR had a significant inhibitory effect on export diversity (market and product). The association of AIIB with product and market export diversity are not consistent.

In addition, in the second chapter of the review of research on China's participation in global value chains, I found that research on GVCs and the labour market is very limited, mainly limited to a single labour variable and has not been able to delve deeply into the differences between GVCs and domestic value chains (DVCs). Therefore, as a supplement to Chapter 2, I attempt to track the changes in indicators related to China's global value chain and compare the roles of GVCs and DVCs (intra-provincial (PVCs) and inter-provincial (PRVCs) value chains) in China's labour market (at the provincial level).

To achieve this goal, I have established two sets of databases: 1) GVCs measurement

indicators - covering 62 economics and 34 sectors from 2007-2017; 2）GVCs, PVCs, PRVCs and labour market variables (productivity, wage and employment) - covering 31 China's provinces and 25 sectors in 2005, 2012 and 2017. In the empirical analysis of the labour market and various value chains, I employ seemingly unrelated regression estimation (SURE) to a set of equations. The empirical results indicate 1) Between 2012 and 2017, the participation of each province in the global value chain decreased. Provincial value chains dominate, while global value chains have the lowest level of participation. 2) Wages and productivity (employment) are positively correlated, but employment and productivity are negatively correlated. 3) The participation of global value chains hinders the development of employment and productivity. The roles of PVC and PRVC on labour market factors are inconsistent. The participation of PVC has increased productivity and employment opportunities.

The last research is linked with micro-level data. I have checked the relationship between firms' owned capitals (like state, private, foreign, etc.) and dual margins (intensive and extensive) by merging the companies' information in Guangdong province and their Customs trade data in 2012- 2013.

The statistical description shows that: foreign investment in China mainly involves manufacturing products for its inherent market. The positive association of state-owned and private capital with the extensive margin reflects the enhanced competitiveness of Chinese domestic enterprises, especially in terms of new product types facing new markets.

The novelty and contribution of this thesis can be expressed as follows:

1) This thesis researches the current trade situation in China from multiple dimensions, such as import and export, global value chain, and export diversity, focusing on exploring the role of OBOR in it. The provided Stata do file and R code file (data preparation, maps and regression) can help researchers replicate my study and process similar research topics easier.

2) Chapter 1:

A. Expand and makes up for the lack of previous research samples on OBOR in the field of trade;

B. Summarize various potential challenges and solutions in the trade gravity model;

C. Discuss the heterogeneity of OBOR economic corridor in trade

3) Global Value Chain (Chapter 2):

A. Complement the shortcomings of research on value-added trade and industrial linkages in OBOR and its economic corridors.

B. Through monitoring several global value chain indicators (including those of the Belt and Road countries and China), we have a more comprehensive understanding of China's participation and position in the global value chain.

C. Construct the input-output table of China's provincial and world industries and introduce GVCs and DVCs into the labour market for the first time, providing new research perspectives for labour economics, international trade and regional economics.

4) Chapter 3:

A. Complement the shortcomings of research on OBOR and export diversity and

enriches the definition of OBOR from three perspectives: geography, politics, and investment.

B. As an extension, I have included enterprise-level data in my research on export diversity, which provides a research approach for subsequent OBOR research on enterprise export diversity (extensive margin).

Finally, there are the following areas of potential future research and expansion pertain to this thesis:

For the follow-up research on OBOR, I plan to start from the following perspectives. The first idea is China's "Zero covid policy" related to the demand, productivity, and connectivity, as well as the influence on OBOR and China's trade after China's opening up at the end of 2022. Second, I believe the Russia-Ukraine war that will affect OBOR and the potential risks (how to balance China-Russia relations with China-EU relations) and opportunities (reconstruction of Ukraine, extension of Chinese forces in Central Asia) caused by China's position. Finally, the Sino-US dispute has posed challenges to OBOR, gradually extending from trade to technology (chip warfare), politics, and education (sanctions against some Chinese universities).

Global Value Chains and China's labour market research can focus on specific products/industries (such as chip production chains) or geographical regions (regional value chains) and merge them with enterprise-level data.

The last potential research is expanding the OBOR and export diversity research to bilateral and cross-country differences perspectives.

- **APPENDICES**

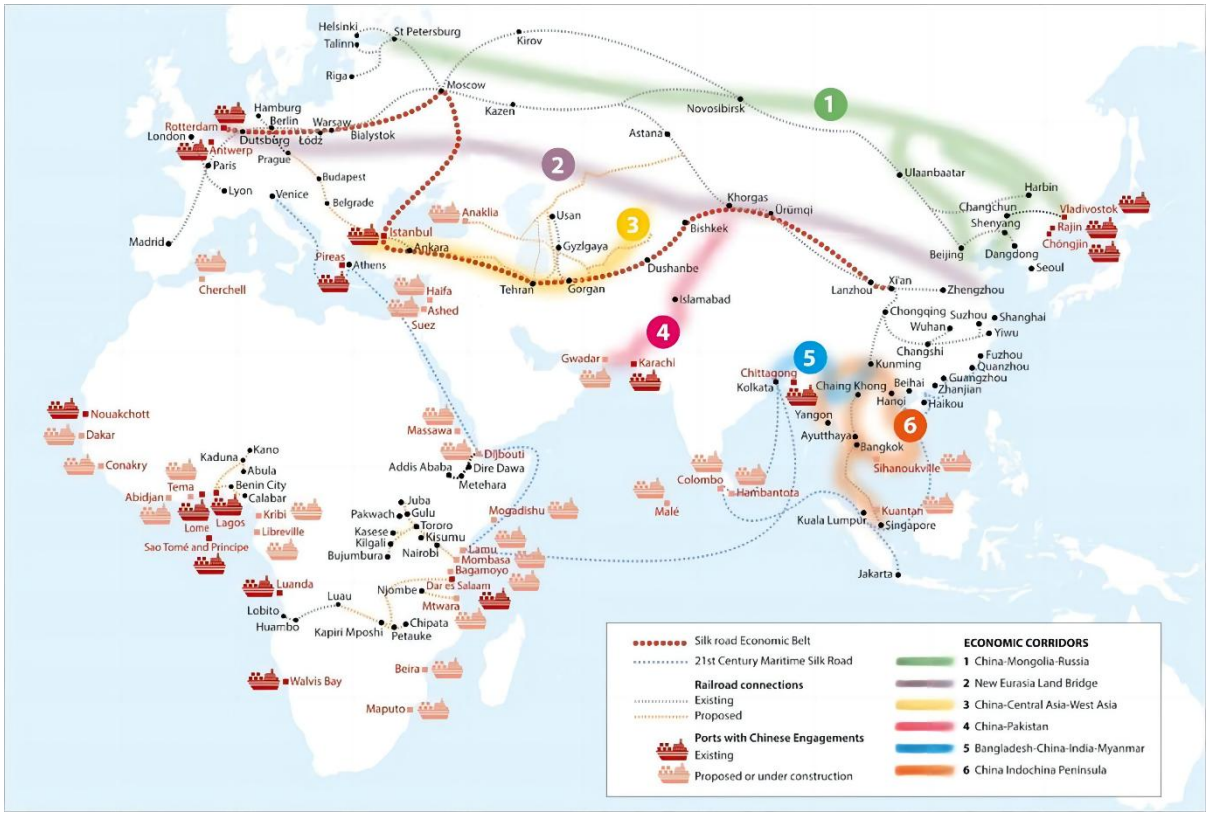

Fig. A. 1 One-Belt One-Road and its economic corridors

Source: OECD (2018).

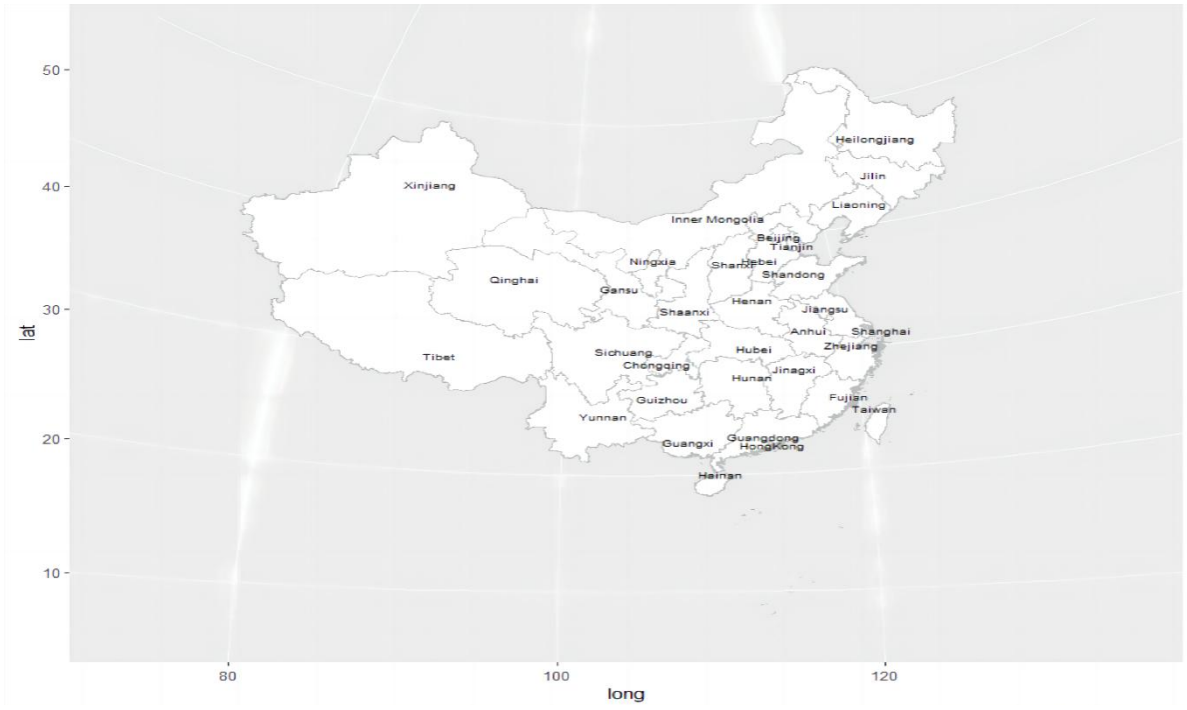

Fig. A. 2 Names and addresses of provinces in China

Source: own elaboration

Table A. 1 Participating countries and economic corridors in OBOR

Economic Corridors in OBOR	Country Code (ISO3)
1 Bangladesh-China-India-Myanmar (BCIM)	CHN; BGD; BTN; IND; MMR; NPL; LKA.
2 China-Central West Asia (CCWA)	CHN; ALB; ARM; AZE; BIH; BGR; HRV; GEO; IRN; IRQ; ISR; JOR; KGZ; LBN; MKD; MDA; MNE; PSE; ROU; SRB; SYR; TJK; TUR; IKM; UZB.
3 China-Indochina Peninsula (CIP)	CHN; BRN; KHM; LAO; MYS; PHL; SGP; THA; VNM; TLS.
4 China-Mongolia-Russian Federation (CMRF)	CHN; BLR; EST; LVA; LTU; MNG; RUS.
5 China-Pakistan (CP)	CHN; AFG; BHR; KWT; OMN; PAK; QAT; SAU; ARE; YEM
6 New Eurasian Land Bridge (NELB)	CHN; CZE; HUN; KAZ; POL; SVK; SVN; UKR
Other members	EGY; IDN; MDV

Source: Own compilation based on OECD (2018).

Table A. 2 OBOR participating countries, by different definitions

The location along the OBOR initiative corridor	
Year	Country Code (ISO3)
2014	AFG; ALB; ARE; ARM; AZE; BGD; BGR; BHR; BIH; BLR; BRN; BTN; CHN; CZE; EGY; EST; GEO; HRV; HUN; IDN; IND; IRN; IRQ; ISR; JOR; KAZ; KGZ; KHM; KWT; LAO; LBN; LKA; LTU; LVA; MDA; MDV; MKD; MMR; MNE; MNG; MYS; NPL; OMN; PAK; PHL; POL; PSE; QAT; ROU; RUS; SAU; SGP; SRB; SVK; SVN; SYR; THA; TJK; TKM; TLS; TUR; UKR; UZB; VNM; YEM
Economic Corridors in OBOR	Country Code (ISO3)
1 Bangladesh-China-India-Myanmar (BCIM)	CHN; BGD; BTN; IND; MMR; NPL; LKA.
2 China-Central West Asia (CCWA)	CHN; ALB; ARM; AZE; BIH; BGR; HRV; GEO; IRN; IRQ; ISR; JOR; KGZ; LBN; MKD; MDA; MNE; PSE; ROU; SRB; SYR; TJK; TUR; IKM; UZB.
3 China-Indochina Peninsula (CIP)	CHN; BRN; KHM; LAO; MYS; PHL; SGP; THA; VNM; TLS.
4 China-Mongolia-Russian Federation (CMRF)	CHN; BLR; EST; LVA; LTU; MNG; RUS.
5 China-Pakistan (CP)	CHN; AFG; BHR; KWT; OMN; PAK; QAT; SAU; ARE; YEM.
6 New Eurasian Land Bridge (NELB)	CHN; CZE; HUN; KAZ; POL; SVK; SVN; UKR.
Other members	EGY; IDN; MDV.
Signature of Memorandum of Understanding	
Year	Country Code (ISO3)
2014	BLR; CHN; KAZ; KGZ; KWT; LKA; QAT
2015	ARM; AZE; BGR; CZE; GEO; HUN; IRQ; KOR; MKD; POL; RUS; SRB; SVK; TJK; TUR; UKR; UZB
2016	AFG; BGD; EGY; IRN; KHM; LAO; SAU
2017	ALB; BIH; BRN; EST; HRV; LBN; LTU; LVA; MAR; MDA; MDG; MDV; MMR; MNE; MNG; MYS; NPL; NZL; PAK; PAN; ROU; SGP; SVN; THA; TLS; VNM
2018	AGO; ARE; ATG; AUT; BDI; BHR; BOL; CHL; CIV; CMR; COG; COK; CPV; CRI; CUB; DJI; DMA; DOM; DZA; ECU; ETH; FJI; FSM; GAB; GHA; GIN; GMB; GRC; GRD; GUY; IDN; KEN; LBY; MLT; MOZ; MRT; NAM; NGA; NIU; OMN; PHL; PNG; PRT; RWA; SDN; SEN; SLE; SLV; SOM; SSD; SUR; SYC; TCD; TGO; TON; TTO; TUN; TZA; UGA; URY; VEN; VUT; WSM; ZAF; ZMB; ZWE
2019	BEN; BRB; COM; CYP; GNQ; ITA; JAM; LBR; LSO; LUX; MLI; NER; PER; SLB; YEM
Membership of Asian Infrastructure Investment Bank	
2015	AUS; AUT; BRN; CHN; DEU; GBR; GEO; JOR; KOR; LUX; MMR; MNG; NLD; NOR; NZL; PAK; RUS; SGP
2016	ARE; AZE; BGD; CHE; DNK; EGY; FIN; FRA; IDN; ISL; ISR; ITA; KAZ; KGZ; KHM; LAO; LKA; MDV; MLT; NPL; OMN; PHL; POL; QAT; SAU; SWE; THA; TJK; TUR; UZB; VNM
2017	AFG; ESP; ETH; FJI; HKG; HUN; IRL; IRN; MYS; PRT; TLS;
2018	BHR; CAN; CYP; MDG; ROU; SDN; VUT; WSM
2019	BEL; BLR; DZA; ECU; GIN; GRC; SRB

Source: Own compilation based on OECD (2018) (pp. 9-12); official website of OBOR and AIIB.

Table A. 3 Data and sources (Chapter 1)

Variable	Definition	Data source	Period
Import	Gross imports from partner (1000 US$)	WITS/ UN Comtrade/ HS1996	2000 - 2018
Export	Gross exports to partner (1000 US$)	WITS/ UN Comtrade/ HS1996	2000 - 2018
GDP	GDP (current US$)	World Bank	2000-2018
GDPpc	GDP per capita (current US$)	World Bank	2000-2018
Dist	Simple distance between capitals (km)	CEPII	2000 - 2018
Contig	1= Contiguity, 0 otherwise.	CEPII	2000 - 2018
Lang	1= Common official or primary language, 0 otherwise.	CEPII	2000 - 2018
Colony	1= Pair ever in colonial relationship, 0 otherwise.	CEPII	2000 - 2018
Smctry	1 = countries were or are the same country, 0 otherwise.	CEPII	2000 - 2018
WTO	1= both partners are GATT/WTO members, 0 otherwise.	CEPII (2000-2015); WTO (2016-2018)	2000 - 2018
OBOR	1= both partners are OBOR members, 0 otherwise.	OECD (2018)	2000 - 2018
ASEAN	1= both partners are ASEAN members, 0 otherwise.	Association of Southeast Asian Nations-ASEAN	2000 - 2018
ACFTA	1= both partners are ACFTA members, 0 otherwise.	ASEAN-China Free Trade Area Business Portal based on Zhang and Wang (2015)	2000-2018
Corridor	BCIM; CCWA; CIP; CMRF; CP; NELB	OECD (2018)	2000-2018

Source: own compilation

Table A. 4 Descriptive Statistics (Chapter 1)

VarName	Obs	Mean	SD	Min	Median	Max
$lnimport_{rpt}$	426341	7.284	4.439	-6.908	7.528	20.149
$lnexport_{rpt}$	364629	8.053	4.005	-6.908	8.222	19.989
$lnGDP_{rt}$	452180	24.712	2.229	18.146	24.655	30.654
$lnGDP_{pt}$	441981	24.265	2.370	16.395	24.155	30.654
$lnGDPpc_{rt}$	452180	8.744	1.517	4.718	8.751	11.685
$lnGDPpc_{pt}$	441981	8.545	1.569	4.718	8.536	11.685
$lnDist_{rp}$	458287	8.675	0.817	4.088	8.873	9.899
$Contig_{rp}$	458287	0.019	0.137	0.000	0.000	1.000
$Lang_{rp}$	458287	0.154	0.361	0.000	0.000	1.000
$Colony_{rp}$	458287	0.015	0.123	0.000	0.000	1.000
$Smctry_{rp}$	458287	0.010	0.101	0.000	0.000	1.000
WTO_{rpt}	458287	0.682	0.466	0.000	1.000	1.000
$ACFTA_{rpt}$	458287	0.004	0.061	0.000	0.000	1.000
$ASEAN_{rp}$	458287	0.003	0.057	0.000	0.000	1.000
$OBOR_{rpt}$	458287	0.034	0.181	0.000	0.000	1.000

Notes: Data sources: WITS/UN COMTRADE, World Bank, CEPII, WTO, OECD (2018). Import/export: 186 reporters and 199 partners (2000-2018). The data is available as Supplementary materials.

Table A. 5 Sector classification integration table (Chapter 2)

Sector ID	Sector	ADB-MRIO	CMRIO
1	Agricultural, forestry, animal husbandry and fishery products and services	1	1
2	Mining	2	2;3;4;5
3	Food and tobacco	3	6
4	Textile and garment industry	4;5	7;8
5	Wood products and furniture	6	9
6	Paper printing and cultural, educational and sporting goods	7	10
7	Petroleum, coking products and nuclear fuel processing products	8	11
8	Chemical products	9;10	12
9	Non-metallic mineral products	11	13
10	Metal smelting and metal products	12	14;15
11	General and special equipment	13	16;17;24
12	Transportation equipment	15	18
13	Electrical and optical equipment	14	19;20;21
14	Other manufactured products	16	22;23
15	Production and supply of electricity, heat, gas and water	17	25;26;27
16	Architecture	18	28
17	Wholesale and retail	19;20;21	29
18	Transportation, storage and postal service	23;24;25;26;27	30
19	Catering and accommodation	22	31
20	finance	28	33
21	real estate	29	34
22	Leasing and business services	30	35
23	education	32	39
24	Health and social work	33	40
25	Other services	31;34;35	32;36;37;38;41;42

Notes: Due to space limitations, sector integration related to R&D, employment, trade, and other variables is not given here. The specific classification and integration process can be obtained in the do-file of Stata provided.

Source: Own compilation.

- **SUPPLEMENTARY MATERIALS**

1. Stata do file (Data preparation - OBOR with Trade, Value-added and Value contributed in partner's export - Chapter 1 and Chapter 2).
2. Stata do file (Data analysis and empirical analysis - OBOR with Trade, Value-added and Value contributed in partner's export - Chapter 1 and Chapter 2).
3. RMD file (Data preparation- RAS balance steps -GVC, PVC, PRVC and labour market - Chapter 2).
4. RMD file (Data preparation and description- GVC, PVC, PRVC and Maps - GVC, PVC, PRVC and labour market - Chapter 2).
5. Stata do file (Data preparation -GVC, PVC, PRVC and labour market - Chapter 2).
6. Stata do file (Data analysis and empirical analysis -GVC, PVC, PRVC and labour market - Chapter 2).
7. Stata do file (Data preparation - OBOR and Export Variety - Chapter 3).
8. Stata do file (Data analysis and empirical analysis - OBOR and Export Variety - Chapter 3).
9. RMD file (Interactive Maps- OBOR and Export Variety - Chapter 3).
10. Interactive Maps:

Gif 1. The animated map of export diversity by country from 1996 to 2019

Gif 2. The animated map showing the progress of countries signing a Memorandum of Understanding for participation in OBOR, 2013-2019

11. Stata log file (The research on intensive margin and extensive margin of different ownership enterprises' export in Guang Dong province China - Chapter 3).
12. Data Source (OBOR and Trade, Value-added trade, Value contributed in partner's export and export variety – Chapters 1, 2 and 3).

The link to supplementary materials is:
https://drive.google.com/drive/folders/1l6V7YF0SaTVHoQPL1s7Tp0zs5Gm_xiqg?usp=sharing