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# **Factors and Potential of Bilateral Trade between China and CEE Countries**

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## Abstract

International trade is the process by which countries exchange products and services. The development of foreign trade has not only expanded the supply radius of producers, but also enriched the demand categories of consumers. As the world's largest developing country, China's economic and trade ties with Central and Eastern European countries have made great progress in recent years. From the "Belt and Road" initiative to the deepening of the 17+1 cooperation framework, the depth and breadth of cooperation between the two countries has continued to increase. But from the current point of view, the trade volume between China and Central and Eastern European countries is still small. This paper attempts to explore the potential of bilateral trade growth between China and Central and Eastern European countries by analyzing the current trade characteristics between China and Central and Eastern European countries, constructing an expanded gravitational model, and analyzing the factors that affect the development of bilateral trade.

The research results show that at present, in the bilateral trade relations between China and CEE countries, China has been in a trade surplus position for a long time, and the product categories of bilateral trade are mainly competitive. The stochastic frontier gravity model shows that the GDP of the two countries, the cumulative annual number of Confucius Institutes, trade freedom and investment freedom index significantly promote the development of trade. Trade between the two countries, such as demographic factors, weighted geographic distance, and EU membership, have an inhibitory effect. There is still a great potential for trade between China and CEE countries. This degree believes that in order to deepen trade exchanges, we should promote the better development of bilateral trade from three aspects: adjustment of industrial structure, enhancement of cultural exchanges and improvement of infrastructure.

**Key Words:** bilateral trade, CEE, factors, trade potential, stochastic frontier analysis, CEE.

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## 1. Introduction

International trade is the process through which countries exchange products and services. The free development of foreign trade has not only expanded the supply radius of producers, but also enriched the categories of consumers' demands. The state-led trade system increases international trade barriers and leads to unstable trade and economic development (Vigvári, 2021). With the acceleration of the global economic integration process, trade is increasingly regarded as an economic activity that promotes the rational allocation of resources, affecting the economic growth, employment changes and technological progress of enterprises in different countries or regions, which is particularly obvious in emerging and developing economies (Lakhanpal et al., 2021).

China is the largest developing country in the world. Since the implementation of reform and opening in 1978, its economic development has made remarkable achievements, contributing more than 30% to global economic growth, and is known as the "China Miracle", which depicts the development phenomenon that China's economy has maintained high-speed growth for a long time and the society has maintained overall stability (Liu, 2020). According to data released by the World Bank (2021), China's GDP was 149.541 billion USD in 1978, reaching 14.723 trillion USD in 2020, with an average growth rate of 11.55%. Although domestic consumption and investment contributed the most to China's economic growth, the effect of trade cannot be ignored either. Since joining the World Trade Organization in 2001, relying on the comparative advantage of abundant domestic labor and an increasingly relaxed investment environment, China's manufacturing industry has developed rapidly and has now become the world's largest exporter, bringing a variety of goods and services to countries around the world with high quality and low price. However, at the same time, due to the sudden changes in the policies of major trading partners such as the United States and the European Union towards China in recent years, the implementation of trade protectionism, import restrictions and other measures have put pressure on China's exports, bringing new impacts to China's economic development, and forcing China to seek new partners in the global market to absorb the huge domestic manufacturing capacity.

As a geopolitical concept, Central and Eastern European countries (CEECs) denote the nations located in central and eastern Europe. Although a majority of them are the first

European countries to establish diplomatic relations with the People's Republic of China since its foundation in 1949, it is mainly other European and American countries that are closely linked to the economic development of these countries. However, since the outbreak of the world financial crisis in 2008, the economic growth of various countries in the world has been in a downturn for a long time. The Greek sovereign debt crisis that broke out at the end of 2009 and the refugee crisis that broke out in 2010 further spread the risk in Europe, severely impacting the economic and social development of CEE countries. Driven by internal and external factors, these countries began to seek development opportunities in the East (Kaczmarek & Jakóbowski, 2015).

Being an important link connecting the Eurasian continent, the countries in CEE region have a long history of conducting foreign trade with China. They are not only the destination of the ancient Silk Road, but also important supporters and participants of the Belt and Road Initiative. The establishment of the China-CEECs cooperation mechanism, whose main aim is to reduce transaction costs. It is also known as 16+1 as the initial cooperation framework included China and 16 CEE countries in 2012, brought new opportunities for the development of both China and CEE nations. In April 2019, the participation of Greece made the cooperation mechanism renamed 17+1<sup>1</sup>. Data from China's Ministry of Commerce (2021) shows that China's foreign direct investment in Central and Eastern European countries has increased from 1,339.98 million USD in 2012 to 3,744.18 million USD in 2020, with an average annual growth rate of 13.71%. And the investment field is wide, involving machinery manufacturing, chemical industry, finance, environmental protection, logistics, new energy, and other fields. Against the background of the intensified debt crisis and refugee crisis of EU member states, CEE countries use investment from China to improve infrastructure construction such as railways, highways, thermal power stations, etc., which is not only conducive to reducing domestic financial burdens, but also beneficial to gaining a wider trade market from the East to stimulate economic growth (Matura, 2019).

Based on the internal and external shocks faced by China and CEE countries, the thesis intends to investigate the factors affecting bilateral trade between China and countries in CEE region and to measure their trade potential, to better promote cooperation between China and

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<sup>1</sup> Unless otherwise specified, CEE countries in this thesis refer to twelve EU member states and five Balkan states — Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Montenegro, North Macedonia, Poland, Romania, Serbia, Slovakia and Slovenia.

Central and Eastern European countries and participate in the Belt and Road Initiative and the China-CEE Cooperation Framework. In order to accomplish this research goal, the dissertation will analyze the current situation of trade development between China and CEE countries after reviewing relevant literature, and then collect relevant data from some official authoritative databases to ensure the credibility of the research results, construct an econometric model to discuss the influencing factors, and finally measure the potential of bilateral trade between China and these 17 countries in Central and Eastern European countries.

The significance of the research is mainly reflected in two aspects: from a theoretical point of view, although the cooperation mechanism between China and Central and Eastern European countries has brought new opportunities to bilateral trade, as the trade cooperation between CEE countries and China accounts for a relatively small proportion of shares, there are currently not many studies on the topic of economic and trade cooperation between China and CEE countries. Hence, the research methods and conclusions of the proposed dissertation can supplement existing research area. From a practical perspective of view, the proposal of the 17+1 cooperation framework and the Belt and Road Initiative has attracted a lot of attention around the world. By analyzing the competitiveness and complementarity of China and CEE countries, it is beneficial to explore their relative comparative advantages in trade. In addition, analyzing the factors and their contribution rate to bilateral trade and estimating trade potential can help to invest labor and capital in trade activities more targeted and improve trade efficiency, to promote mutual benefit and common prosperity.

The research structure is the following: Chapter 1 is the Introduction, where the research background, structure, and the significance of the research are expounded in detail. Chapter 2 is Literature review that is mainly to sort out the recent existing literature about the theories and factors that affect trade, and the calculation methods of trade potential. The techniques are based on historical review and methodological review. Chapter 3 is the description of the characteristics of trade development between China and CEE countries, which is mainly based on the trade data from 2002 to 2020, with the help of some indices to measure trade, to analyze the competitiveness and complementarity of trade between China and CEE countries in terms of trade scale and trade structure. Chapter 4 is the construction of the stochastic frontier gravity model, the selection of variables and the description of data sources. Chapter 5 is data analysis on factors and potential of bilateral trade between China and 17 CEECs. And the last section, chapter 6 is research conclusions that includes policy recommendations, research limitations, and future research directions for the thesis topic.

## 2. Literature review

The purposes of the thesis under study are to analyze the factors affecting bilateral trade between China and CEE countries, and to theoretically measure the potential of bilateral trade. To accomplish the research objective, the relevant research questions are subdivided into the following three: What is the status quo of trade between China and CEE countries? What factors affect the trade between China with CEE countries? How much room for improvement is there for bilateral trade between China and CEE countries? To better answer these questions in the study of the later chapters, the existing literatures related to the theoretical and methodological background are read and commented in this section.

The academic circle has always paid attention to the foreign trade of these countries, but it is not high, mainly of local scholars who focus on the trade situation of the corresponding country or region. In terms of the trade between China and CEE countries, its research interest that has gradually become more and more popular can be dated back with the establishment of the cooperation framework between China and CEE countries in 2011 and the proposal of the Belt and Road Initiative in 2013, since when the trade status of China and these partner countries has gradually increased, and hence, a stream of research has produced, both from theoretical and practical perspectives.

In this part, the methods of historical review and methodological review are mainly used to review the literature of the selected time and year.

### 2.1 Economic and trade development between China and CEE countries

In terms of the research objects, some scholars study the development of trade between China and CEE countries as a whole, others concentrate on a country in the region as an individual research object, and still others focus on a specific industry's situation.

Based on China's motives for external economic growth and foreign trade activities, Semerák (2015) presents stylized facts about current trade trends between China and 16 countries in Central and Eastern Europe. The author discusses the possible impact of the 16+1 cooperation framework and the "One Belt, One Road" initiative on CEE region. China's current market size tends to lead to economies of scale, making it the world's largest economy once

again, while contributing to global productivity, which is the role of China in the global economy. And CEE countries and China both play an important role in the global value chain and have close trade ties. Following the "Belt and Road" initiative, a series of infrastructure projects reduced transportation and transaction costs, and promoted bilateral trade development, which presents new opportunities. Herrero and Xu (2017) measure that the average marginal impact of tariff reductions on trade is smaller than the same reductions in air and rail costs. For EU countries, especially landlocked countries, will benefit by 8% from trade value due to lower transport costs brought about by China's Belt and Road Initiative.

Kaczmarek and Jakóbowski (2015) examine the rationale behind for China's proposed and gradually enhanced regional cooperation framework with CEE countries. They contend that the primary drivers are the development of the euro zone crisis and the Chinese government's recognition the significance of some of these countries as European Union members. The emergence of this cross-regional growth mode is viewed as the result of the two parties overcoming ideological differences and realizing similar objectives. For one thing, the inclusion of CEE nations in this framework helps shift attention away from the regional debt problem and complements the Eastern countries' economic demands. For the other, it is advantageous for China to erase barriers posed by EU legislation and a lack of experience among Chinese firms. According to the authors, this development paradigm is pragmatic. The annual meeting of the 16+1 Forum has facilitated the development of bilateral relations and has facilitated the coordination of China's transnational projects with CEE countries. Fully respecting and paying close attention to the core interests and major concerns of all parties concerned, the establishment of the 16+1 cooperation mechanism is considered to be an attempt to effectively promote a new type of international relations between China and CEE countries (Ge, 2019; Kong, 2015; Liu, 2017).

Dumitrescu (2015) also argues in his research on the Belt and Road Initiative that, while the economic belt is the strategic focal point of China's diplomacy, it has demonstrated many benefits in terms of economic and trade growth, job creation, and fundamental social development in the nations along the path. Using China's investment in Romania and Serbia to upgrade transportation hub facilities and strengthen the two countries' logistics hub advantages in Central and Eastern Europe as examples, the author demonstrates that the majority of European countries benefit from Chinese direct investment in a variety of economic sectors.

Shang et al. (2016) evaluate the export performance of China and ten countries in Central and Eastern Europe between 2002 and 2011. They claim that although these nations began to integrate into the European economy in the early 1990s, these countries progressively adopted an "open to the East" foreign economic and trade strategy in response to Europe's projected moderate economic development. The authors' analysis of market share dynamics reveals that, with the exception of Romania, the CEE nations and China have increased their market shares in each other's marketplaces as their competitiveness in intermediate goods has increased. The reason why Romanian country is an outlier is due to its inflation rate has reached about 12%, which is twice the average inflation rate of the 10 countries in the region. Even though the article does not consider the role of foreign direct investment in the development of the bilateral trade pattern between China and CEE countries, it does reflect the growing share of bilateral trade in each other's regions. Similar findings have been made by other scholars. With the recent eastward expansion of nations in CEE region, and considering processing exports (PE) as a safe and effective path for industrialization, their PE trade with China has also become more frequent (Fernandes & Tang, 2018).

Cieřlik et al. (2016) analyze the transition of foreign trade in 10 post-socialist countries (current member states of the EU). In the early days of these countries' integrating into the EU, the trade volume of these countries increased rapidly due to the adoption of EU trade rules and the stable environment in the region. However, these intra-regional trade interests are to some extent substituted for trade with Asian and African countries, which is also considered a weakness of European integration. With the development of liberalization and integration within the EU, post-socialist countries have become more and more connected with Western European countries and have gradually participated in global value chain activities, making them increasingly attractive to foreign investors. A later research of Cieřlik (2020a) shows that these regions have high export potential for China, in particular, the electronics, textile industry and transportation ministries are most reliant on China for added value.

Yao (2016) divides CEE countries into three major sectors according to their geographical location and economic homogeneity: the three Baltic countries, the Visegrad group, and the Balkan countries. The author points out that between 2009 and 2014, China's trade and investment with CEE countries have grown significantly, but there are also many problems that restrict the development of bilateral trade, such as the prominent trade imbalance problem, the convenience of trade and investment still needs to be improved, and the lack of innovation in the cooperation model between the two sides. To this end, the paper puts forward

cooperation suggestions, including carrying out different industrial cooperation with different countries, strengthening logistics construction and improving the trade and investment environment. Other scholars also believe that increasing investment in infrastructure construction and achieving trade balance are the keys to deepening economic and trade cooperation between China and CEE nations (Jitaru & Pralea, 2016; Shen & Han, 2016).

Through a comparative analysis with other Visegrad countries, De Castro et al. (2017) point out that the Czech Republic's favorable geographical location, relatively cheap and well-educated labor force, industrial tradition, high-speed economic growth and stable political environment make the country's relationship of trade and investment with China strengthened. Their findings show that there is potential in Czech-Chinese trade and investment. Promoting mutually beneficial cooperation requires both governments to curb corruption, bridge cultural differences, deal with repatriation of profits, and reduce the occurrence of property rights misconduct. Pencea (2017) analyzes the relationship between Romania and China, and maintains that the trade imbalance will hinder the deepening of economic and trade exchanges between the two countries. Excessive trade deficits can exacerbate disappointment, dissatisfaction and distrust on the side of low relative net exporters. China should take clear actions to encourage Romania and other CEE countries to increase imports, further open up their markets, simplify procedures, technical requirements and cumbersome trade barriers.

Szunomár (2017) is another scholar who analyzes the country's economic and trade relations with China by taking a specific country as the research object. She argues that friendly political relations have brought opportunities for the healthy development of the economy and trade of both sides. Political exchanges, mainly represented by visits of high-level leaders, have contributed to the improvement of economic and cultural ties. With the promotion of the Belt and Road Initiative, Hungary, as a hub for Chinese products in the EU, has created an irresistible investment environment for China with its cooperative and open attitude, which has ushered in a new golden age for bilateral trade and investment relations. The findings of Szunomár (2018) also show that the 16+1 initiative provides a common platform for CEE countries and China, providing more and more connections for participating enterprises. By evaluating the correlation between bilateral political and economic relations between China and CEE countries, Matura (2019) also demonstrates the importance of political relations in China. He found that the quality of bilateral relations has a strong positive correlation with China's investment activities in CEE nations, while the strength of political relations within the EU is weakly related to the trade volumes of CEE countries.

With the development of China's foreign projects, more and more local scholars in CEE have adopted the dialectical method to analyze the relationship between China and CEE countries. Matura (2018) analyzes the media voice of the Belt and Road Initiative in Hungary and Slovakia. Based on the ChinfluenceCE Database, and selecting all Belt and Road and China-related news reported in these two countries from 2013 to the second quarter of 2017, the analysis found that the situation in the two countries was consistent. The anti-government media reported on the initiative negative, while pro-government media showed mostly positive sentiment. News sentiment has a significant impact on the public image of the country concerned. How the media portrays China has in turn influenced trade relations between China and CEE countries. Taking Serbia as an example, Pavličević (2018) also points out that two diametrically opposite domestic evaluations of China have had a significant impact on the economic and trade relations between China and Serbia. Later, some scholars used the method of cultural sociology to analyze and pointed out that the reason for this divisive evaluation of China was mainly due to the unique historical stage of communism it had experienced in the past (Turcsányi & Qiaoan, 2020). The disadvantage is that none of these authors quantitatively characterize the impact of different views on bilateral trade.

Local Chinese scholars prefer to use the corresponding trade index to analyze the competitiveness and complementarity of trade between China and CEE countries, in order to provide theoretical basis and practical development suggestions for deepening bilateral trade cooperation. For example, Xiao and Li (2019) employ the social network analysis method and the plate model to regard the trade relationship between China and CEE countries as a network as a whole, and each country as a node in the overall network. China's trade relations with countries in the CEE region and its dynamic changes. Combining the competitiveness index and complementarity index of trade, their research results show that, except for the isolated plates formed by Albania and Macedonia, the trade competition between China and the Central and Eastern European countries is fierce, but the overall complementarity is greater than the competition. Therefore, there is a large potential for economic and trade cooperation between China and the countries in CEE region. Deng and Li (2019) also came to the same research findings. They also maintain that the CEE countries that have joined the EU have an inhibitory effect on China's technology trade and resource and energy trade. To this end, the authors argue that China needs to optimize the trade environment, encourage the development of export-oriented industries, and handle the industrial competition relationship with CEE countries according to the value of the industrial competitiveness index and complementarity index to

avoid excessive competition. There is currently a crowding out effect between China and CEE countries in the textile and furniture fields, which aggravates the imbalance of the trade structure and is not conducive to the development of bilateral trade.(Stanojevic et al., 2020).

As the marginal contribution of academia to trade research between China and CEE countries or countries along the Belt and Road continues to decrease, Liu et al. (2020) turn to industry analysis. Through a dynamic network study on the competitiveness and complementarity of international agricultural trade along the Belt and Road, they found that Central and Eastern European countries, as an important supply region of agricultural products along the Belt and Road, trade with China, and their competition and complementarity network density has been increasing within the chosen time series, but complementarity still outweighs competitiveness. Carrying out trade in agricultural products can not only meet the basic needs of different types and quantities of agricultural products in different regions, but also avoid the high cost of purchasing specific agricultural products. Guo et al. (2021) point out that there are differences in agricultural resources, development conditions, and per capita product share between China and CEE countries, which make bilateral agricultural trade potential great. (Cieřlik, 2020b) uses an input-output model to analyze the changes in the export dependence of the electronics industry in CEE countries. As far as the industry is concerned, although the EU supply still dominates a majority of CEE nations, the increasing supply of electronic products in China directly compensates for the lesser supply in the EU, which means a closer trade ties between CEE region and China.

## 2.2 Analysis of factors affecting trade

Following a review of the research, it is discovered that the literature on the influencing variables of bilateral trade primarily classifies them into two categories: objective factors that will not change in the long run and human factors that will change in the short term. From the perspective of economics, their common essence is to directly or indirectly affect the demand or supply of trade in goods or services. The former is primarily concerned with economic size, population, geographical distance, the presence of a common border, language and so on. It is also commonly demonstrated by the majority of studies that these variables have a considerable impact on bilateral trade fluctuations (Fatima et al., 2019; Freeman & Lewis, 2021; Liu & Xiao, 2018; Mohmand et al., 2015; Ravishankar & Stack, 2014; Roy & Chatterjee, 2013).

In addition, scholars of world economics often introduce other relevant variables that will change in a short time according to research needs, such as free trade agreements (FTA), tariff levels, exchange rates, currency trade freedom, foreign direct investment, infrastructure levels, etc. For example, Guei et al. (2017) use a partial equilibrium WITS-SMART simulation model to evaluate the impact of a free trade agreement between South Africa and the EU. The results show that the FTA will produce trade creation and trade expansion effects, which will increase South Africa's imports and exports to the EU. Research by Qi and Zhang (2018) also shows that China and Australia can increase their GDP and exports by constructing an FTA. Constructing an FTA greatly reduces tariff costs and promotes trade liberalization (Jagdambe & Kannan, 2020; Russ & Swenson, 2019).

Exchange rate stability is considered a positive indicator in international trade by all economies. It is beneficial to increase investor trust and allow global market participants to make realistic business forecasts (Samuel, 2022). The theory of international finance shows that the depreciation of a country's exchange rate means that the value of the local currency falls, thereby increasing the cost of imports, which is not conducive to imports; but depreciation means that the price of domestic commodities is lower, which is conducive to exports. Conversely, the appreciation is good for imports and not good for exports. Marconi et al. (2021) examine the nexus between manufactured goods exports and domestic income elasticity of trade in 43 countries from 1995 to 2014 and discover that changes in real exchange rates are detrimental to exports, hence deteriorating the domestic production structure.

The business environment is generally considered to be the soft power of a country to attract foreign businessmen, while infrastructure is the hard power. Peng et al. (2020) find that the development of the financial market has a positive impact on China's import trade efficiency and a negative impact on China's export trade efficiency, while the burden of customs procedures has a significant negative impact on China's import and export trade efficiency. Cheng and Zhang (2017) empirical research suggests that China's outward foreign direct investment (OFDI) has a significant positive effect on exports. Karymshakov and Sulaimanova (2021) study the impact of infrastructure on trade in Central Asia, and their results showed that both the quality and quantity of infrastructure had a positive impact on trade flows, but this impact showed a decreasing trend. Infrastructure development promotes trade facilitation and reduces trade costs (Vidya & Taghizadeh-Hesary, 2021).

## 2.3 Research methods on trade potential

Trade potential, also known as trade efficiency, describes the difference between the actual foreign trade scale and the potential trade value of a research subject. In the existing literature, the empirical research methods on this topic mainly include the standard gravity model and the stochastic frontier analysis.

### 2.3.1 Standard gravity model

The Dutch economist Tinbergen (1962) and Finnish economist Pöyhönen (1963) are considered to be the first to introduce gravity models in physics into international trade research. Both utilize data in 1958, the former analyzes the world trade flows among 42 countries in the world, while the latter focuses on the trade data of 10 European countries. Although different forms are expressed by the two scholars, they both came to the same conclusion on the trade relationship of two countries, which is simply written as: the trade volume between the two countries the gross national product is positively correlated, while the distance is negatively correlated with the total trade values between country  $i$  and country  $j$ , which is generally shown in mathematical symbols as follows:

$$T_{ijt} = G \frac{Y_{it} \cdot Y_{jt}}{D_{ij}} \quad (1)$$

where  $T_{ijt}$  is the total bilateral foreign trade scale between country  $i$  and country  $j$  in period  $t$ ,  $G$  is a constant;  $Y_{it}$  and  $Y_{jt}$  represent the GNP of country  $i$  and country  $j$  in period  $t$ , respectively;  $D_{ij}$  represents the geographic distance between the objects under research.

As there are fewer factors are considered on the original gravity equation, and the objectivity and accuracy of explaining the trade potential is limited, more and more scholars continue to improve the connotation of this equation. For example, Linnemann (1966) introduced the population size as a factor affecting the change of trade flow into the gravity model. He argued that the number of populations of the importing country would affect the potential consumption demand, thereby restricting the bilateral trade change. Anderson (1979) proposed the concept of total trade expenditure, emphasizing that tariff barriers at different borders would increase trade expenditure. The scholar also pointed out that the gravity equation

has a Cobb-Douglas preference, and after taking logarithm, it is convenient to apply the ordinary least squares method. Besides, he regards trade potential as the ratio of actual trade to estimated trade. Bergstrand (1985) analyzed price and exchange rate factors and empirically concluded that they have a significant impact on aggregate trade flows. McCallum (1995) was concerned about the influence of the trade group, and maintained that the existence of a common border between the two sides of the trade has a decisive impact on the pattern of trade.

With the continuous improvement and improvement of scholars, the gravity model has gradually formed a complete research system, and has been widely used in the study of bilateral trade changes and the measurement of trade potential. Rahman (2010) employed this model to study the trade potential between Australia and its trading countries, and empirically concluded that Australia has great potential with Russia, Singapore, Argentina and other countries. Simwaka (2010) showed that the signing of free trade agreements would trigger a trade-creating effect, resulting in a higher trade potential value among member countries of the South African Development Community than the actual value. Li (2013) used a gravity model to study and found that the bilateral trade potential between China and Chile is large, and there is still a large room for expansion. Chen and Yang (2019) studied and found that the improvement of trade facilitation in the countries along the “Belt and Road” can significantly expand the trade flow between China and these nations.

However, it is worth noting that the standard gravity model has the following two limitations in estimating trade potential: First, since the estimation of parameters is based on regression, the actual trade volume may exceed the estimated potential value, which makes its explanatory power is not always reasonable; second, as the model assumes that the error term is completely random, the unobservable bilateral trade impediment factors are regarded as completely random error terms, which easily leads to a large deviation in the estimated results.

### 2.3.2 Stochastic frontier analysis

The stochastic frontier approach was originally used to study the productivity of enterprises. Frontier refers to the boundary of the envelope data at which the production outcome is optimal, and output below the production frontier level is considered inefficient and has growth potential. The frontier analysis focuses on the measurement of the degree of inefficiency and the analysis of the factors that contribute to inefficiency. In order to measure

the trade potential more accurately, Kalirajan and Shand (1999) incorporated the analysis into the standard gravity model, and obtained the stochastic frontier gravity model (Ravishankar & Stack, 2014). Different from the standard gravity model, this analysis decomposes the random disturbance term of the standard linear model into a random error term and a trade inefficiency term, which on the one hand facilitates avoiding the defects of the standard gravity model, and on the other hand helps analyze the factor leading to trade inefficiency. The expression for this analysis is:

$$T_{ijt} = f(x_{ijt}, \beta) \exp(v_{ijt} - u_{ijt}), u_{ijt} \geq 0 \quad (2)$$

After logarithm,

$$\ln T_{ijt} = \ln f(x_{ijt}, \beta) + v_{ijt} - u_{ijt}, u_{ijt} \geq 0 \quad (3)$$

where  $T_{ijt}$  represents the total bilateral trade between country i and country j in period t,  $x_{ijt}$  is the core factor affecting the dependent variable,  $\beta$  is the parameter vector to be estimated,  $v_{ijt}$  is the random interference term,  $u_{ijt}$  is the trade in-efficiency term that measures the impact of human factors on trade. Besides,  $v_{ijt}$  obeys zero mean, homoscedastic normal distribution, and is independent of  $u_{ijt}$ , which follows semi-normal distribution.

The trade potential refers to the optimal value of bilateral trade under the existing trade conditions when  $u_{ijt} = 0$ , that is, when the trade inefficiency term does not exist. The formula is expressed as:

$$T_{ijt}^* = f(x_{ijt}, \beta) \exp(v_{ijt}), \quad (4)$$

The  $T_{ijt}^*$  represents the trade potential of two countries i and j in period t. And further, trade efficiency (TE) can be written as:

$$TE_{ijt} = \frac{T_{ijt}}{T_{ijt}^*} = \exp(-u_{ijt}), u_{ijt} \geq 0 \quad (5)$$

The stochastic frontier model can be divided into two types: time-invariant and time-varying stochastic frontier approaches according to whether the trade non-efficiency term changes with time or not. The latter is mainly produced with the continuous development of technology and is more realistic. This thesis intends to adopt the time-varying stochastic frontier model proposed and applied to panel data analysis by Battese and Coelli (1992). Its inefficiency term has the following form:

$$u_{ijt} = \exp [-\eta(t - T)]u_{ij} \quad (6)$$

where  $\eta$  is a scalar parameter to be estimated, which refers to the trend of inefficiency factors changing with time,  $t$  represents the  $t$ -th year, and  $T$  represents the total number of periods.  $\eta=0$  means that the inefficiency factor does not change with time.  $\eta>0$  means that the non-efficiency factor decreases with time, and the efficiency increases, and vice versa, the efficiency decreases. However, the disadvantage is that this method can only estimate the average change trend of inefficiency factors (Battese & Coelli, 1995). To measure the actual technical efficiency and analyze the factors affecting the efficiency of each period, it is needed the trade inefficiency analysis model with the basic form is:

$$u_{ijt} = \delta \cdot z_{ij} + \varepsilon_{ij} \quad (7)$$

$z_{ij}$  represents various human factors that affect the non-efficiency term,  $\delta$  is the relevant unknown parameter, and  $\varepsilon_{ij}$  is the random interference term. The estimation method of model parameters usually puts the inefficiency term and the main influencing factors into the model for regression, which can be combined as:

$$\ln T_{ijt} = \ln f(x_{ijt}, \beta) + v_{ijt} - (\delta \cdot z_{ij} + \varepsilon_{ij}) \quad (8)$$

### 3. Characteristics and facts of bilateral trade between China and CEE countries

In recent years, China and CEE countries have had close trade activities and deepened trade cooperation. The framework of the "16+1" cooperation framework and the proposal of the "Belt and Road" initiative have brought new development opportunities for both parties and contributed to a significant result of economic and trade cooperation. In order to qualitatively describe the characteristics of bilateral trade between China and CEE countries, this part first discusses the current trade status from the perspectives of the total value and structural characteristics of bilateral trade between China and CEE countries. Then, it compares the current characteristics of foreign trade between China and CEE countries from three facets: export commodity structure, trade openness comparison, and terms of trade.

To summarize, there is a wealth of study on the factors and potential of bilateral trade, as well as mature theoretical systems and research methodologies that serve as a solid

foundation for the paper's theoretical explanation and empirical investigation. However, a systematic review of the current literature on China and CEE countries reveals that, first and foremost, most scholars' current research on China and CEE nations is primarily focused on the 16+1 or 17+1 cooperation frameworks, as well as bilateral trade between China and these countries in the context of the Belt and Road Initiative. Quantitative study on bilateral trade at the macroeconomic level is lacking. Second, while the competitiveness and complementarity index analysis method are widely used in research on bilateral trade between China and Central Eastern European countries, research on the influencing factors and potential of bilateral trade between China and countries of CEE region using the stochastic frontier gravity model is relatively scarce. Finally, when it comes to the factors impacting trade efficiency, the majority of studies employ relatively simple indicators, such as free trade agreements, infrastructure levels, and tariffs, as explanatory variables.

For the above limitations of the current literatures, this thesis performs research on bilateral trade between China and Central and Eastern European nations from a macroeconomic viewpoint, building on the prior researches. To begin with, the current state of bilateral trade between China and CEE countries is qualitatively analyzed using the trade index measurement method described previously; secondly, using the most recent data available for the research target countries from 2009 to 2020, the stochastic frontier gravity model is utilized to examine the primary influencing factors and trade efficiency of bilateral trade between China and CEE nations. Additionally, to better quantify the factors affecting current trade efficiency between China and Central Eastern European countries, comprehensive indicators covering political ties, cultural exchanges, economic exchanges, and business environment are incorporated as explanatory variables into the trade inefficiency model.

### 3.1 Trade scale analysis

#### 3.1.1 Changes in overall bilateral trade value and growth rate

Since the establishment of a socialist market economy in the 1990s, China has continuously improved its domestic business environment while encouraging enterprises to go global to enhance its international competitiveness. After officially becoming a member of the World Trade Organization in 2001, this country has gradually improved its trade relations with

other partners in the world in the common international trade rules, bringing common interests to itself and its partners<sup>2</sup>. On the one hand, the total export value of Chinese products has continued to increase, contributing a large number of manufactured products to various countries; on the other hand, with the massive opening of China's service sector - especially in the fields of distribution, telecommunications, education, banking and financial services , more and more foreign services began to pour into this emerging market (Garnaut et al., 2018).

The 17 CEE countries are located in the hinterland of Central Europe that have an advantageous geographical location, with Russia in the east and major EU member states in the west. They have maintained a long-term friendly political friendship and economic and trade cooperation with China. Since China gradually integrated into the world economic trend in the 21st century, the value of bilateral trade between China and CEE countries has been showing a trend of rapid expansion. As shown in Figure 3.1, in 2002, the bilateral trade value between China and CEE countries was 6.47 billion USD, and by 2020, this amount reached 104.65 billion USD. During these 18 years, the scale of trade between the two sides has increased by 98.18 billion USD, which means an expansion by 15.17 times (IMF, 2022).

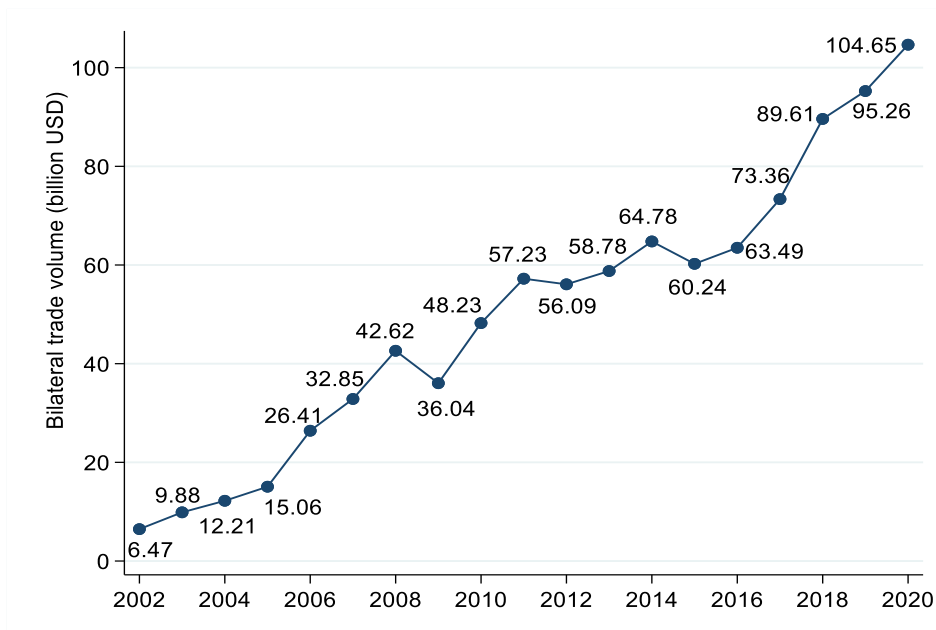


Figure 3.1. Total bilateral trade value between China and CEECs 2002-2020

Source: Author calculation from Direction of Trade Statistics, IMF.

<sup>2</sup> Note: China here refers to the P. R. China mainland, hence the data about China in this thesis does not include Hong Kong, Macau and Taiwan.

Judging from the data concerning the growth rate of total bilateral trade , during the 18 years from 2003 to 2020, the average growth rate of China's trade with CEE countries was 18.41%, while the rate between China and the world was 12.85%. A majority of years show that the growth rate of total trade value with CEE countries is higher than the growth rate of China's total bilateral trade with all partners in the world. From 2003 to 2008, both China's trade with the world and China's trade with CEE countries showed a positive growth rate, and the value was relatively large, almost maintaining above 20%. For example, the growth rate of China-CEECs is 52.70%, and China-world is 37.09%. The growth rate in 2009 was affected by the shrinking market demand and supply caused by the global financial crisis, hence both showed a negative trade growth ratio. The growth rate of China's trade with CEE countries that year was -15.43%, and the growth rate of China's trade with the world was -13.86% (IMF, 2022). Although the global economy continues to recover after the crisis, due to the European sovereign debt crisis and the subsequent refugee crisis triggered by the crisis in 2012, the political turmoil in many countries in European countries has affected the domestic economic environment, making the bilateral trade growth rate between China and Central and Eastern Europe reduce by 1.98%, which is lower than that of China and the world (See Figure 3.2).

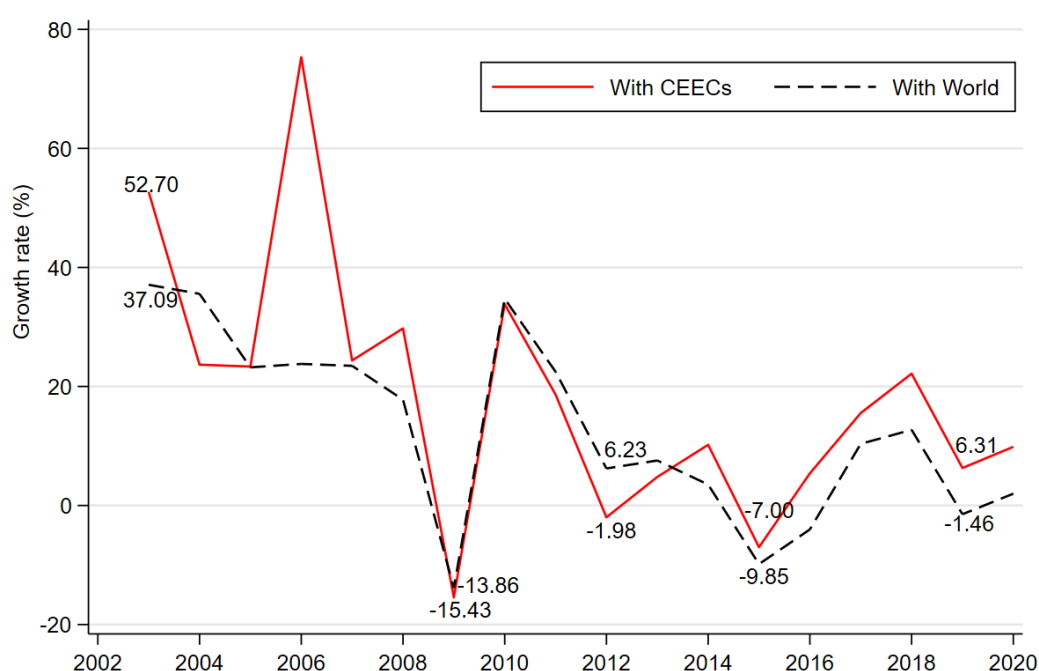


Figure 3.2 China's foreign bilateral trade growth rate with CEECs and with world 2003-2020

Source: Author calculation from Direction of Trade Statistics, IMF.

Note: The all-yearly growth rate values calculated by the author are listed in the Appendix 1.

Since 2014, the growth rate of bilateral trade between China and CEE countries has always been higher than the growth rate of China's overall foreign trade with world. Part of the reason is that after the establishment of the cooperation framework between China and CEE countries in 2012, leaders of the two sides have more frequent visits and more economic and trade exchange activities are launched. Song and Pavličević (2019) point out that relying on the cooperation framework between China and CEE countries, cooperation in the fields of investment and trade, finance, technological innovation, agriculture and forestry, and culture are deepened, which help increase the benefits of China and participating countries.

However, although China's import, export and bilateral trade value to CEE region has shown a trend of rapid increase, China has always been in a trade surplus from 2002 to 2020, and this value is gradually expanding, as is shown in the Figure 3.3.

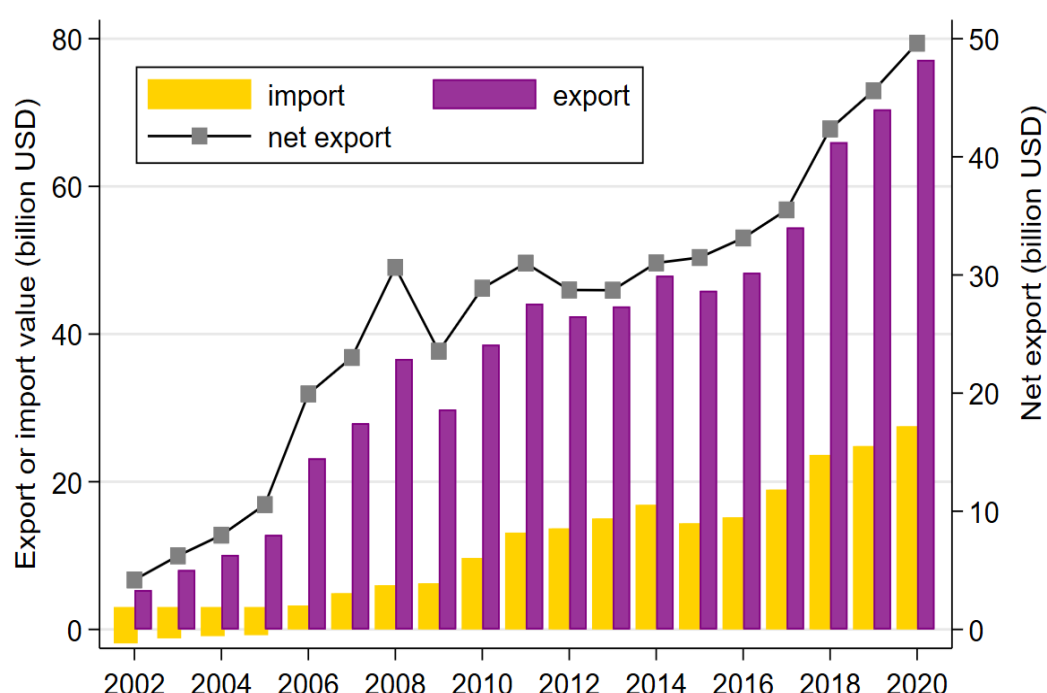


Figure 3.3 Trade values between China (reporting country) and CEECs 2002-2020

Source: Author calculation from Direction of Trade Statistics, IMF.

According to the data released by IMF (2022), in 2002, China exported 5.33 billion USD to CEE region, and imported 1.14 billion USD from these countries, with a net export value of 4.19 billion USD, while by 2020, the total import value of CEE countries from China was 7.713 billion USD, with the export value to China 27.52 billion USD, meaning the CEE countries' trade deficit with China climbed to 49.62 billion USD. During these 19 years, the

average annual growth rate of China's exports to CEE countries was 16%, while the average annual growth rate of exports from these nations to China was relatively higher at 19.36%. China's average annual growth rate in this bilateral trade was the trade surplus was 26.65 billion USD. This means that in the bilateral trade between China and CEE countries, both sides have gained trade benefits, yet still a large trade imbalance.

### 3.1.2 Bilateral trade value analysis by country

The members of the Visegrad Group, which is also known as V4 (Poland, Hungary, Slovakia and the Czech Republic), are not only the countries with the largest economic aggregates in the Central and Eastern Europe, but also the trading partners with the largest share of bilateral trade between China and the CEE countries over the years. According to the data from 2002 to 2020, except for 2006, which was hit by the global oil crisis, the total import of V4 countries to China accounted for about 65% of the total import of CEE countries to China, and the proportion of exports to China was nearly in recent years, it has remained above 70% (IMF, 2022). The high proportion of imports and exports has kept the proportion of total bilateral trade between V4 and China at a high level (as shown in Figure 3.4).

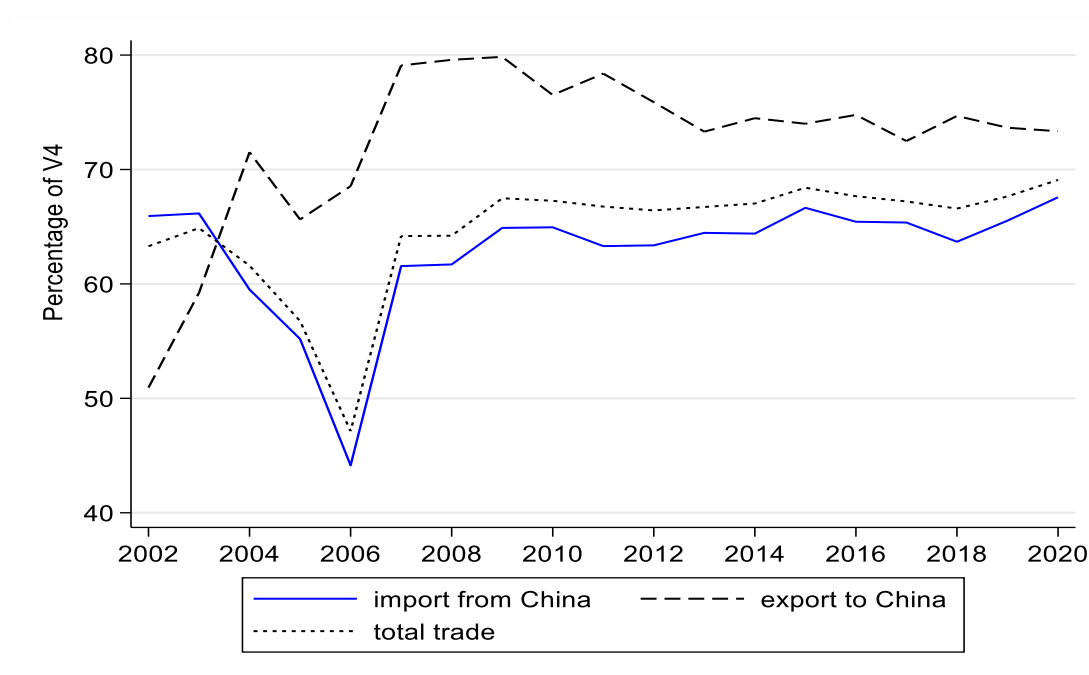


Figure 3.4 Trade proportion of V4 accounting for the proportion of CEECs 2002-2020

Source: Author calculation from Direction of Trade Statistics, IMF.

In 2020, with CEE countries as the reporting countries, in their bilateral trade relations with China, the top five countries in terms of total trade value are Poland, Czech, Hungary, Slovak and Greece. The total trade value of these five countries with China accounts for 76.56% of the total trade value of CEE region with China. Compared to the 2019 statistics, this ranking has not changed, and the proportion of the top five trading partners is still high at 76.53% (see Appendix 2). Table 3.1 reflects the trade between CEE countries and China in 2020. As China's largest trading partner that year, Poland's exports to China amounted to 4.32 billion US dollars, accounting for 15.71% of the total exports from China in CEE countries; imports from China were 2.786 billion US dollars, accounting for the total exports of the region from China. The scale of bilateral trade with China was US\$3.218 billion, accounting for 30.75% of the bilateral trade between China and CEE countries (IMF, 2022).

Table 3.1. Bilateral trade values between CEE region and China by country in 2020

|             | Values (billion USD) |        |             | Values by CEE region (%) |        |             |
|-------------|----------------------|--------|-------------|--------------------------|--------|-------------|
|             | Import               | Export | Total trade | Import                   | Export | Total trade |
| Poland      | 27.86                | 4.32   | 32.18       | 36.12                    | 15.71  | 30.75       |
| Czech       | 13.78                | 5.14   | 18.92       | 17.87                    | 18.69  | 18.08       |
| Hungary     | 7.43                 | 4.28   | 11.71       | 9.63                     | 15.57  | 11.19       |
| Slovak      | 3.05                 | 6.43   | 9.48        | 3.95                     | 23.38  | 9.06        |
| Greece      | 7.04                 | 0.77   | 7.81        | 9.13                     | 2.81   | 7.47        |
| Romania     | 5.14                 | 2.64   | 7.78        | 6.67                     | 9.59   | 7.44        |
| Slovenia    | 3.45                 | 0.51   | 3.96        | 4.48                     | 1.85   | 3.79        |
| Bulgaria    | 1.55                 | 1.37   | 2.91        | 2.00                     | 4.97   | 2.79        |
| Lithuania   | 1.80                 | 0.49   | 2.29        | 2.34                     | 1.77   | 2.19        |
| Serbia      | 1.63                 | 0.50   | 2.13        | 2.12                     | 1.81   | 2.04        |
| Croatia     | 1.57                 | 0.14   | 1.71        | 2.03                     | 0.51   | 1.63        |
| Latvia      | 1.05                 | 0.20   | 1.25        | 1.36                     | 0.73   | 1.19        |
| Estonia     | 0.86                 | 0.28   | 1.14        | 1.12                     | 1.02   | 1.09        |
| Albania     | 0.57                 | 0.08   | 0.65        | 0.74                     | 0.29   | 0.62        |
| North       |                      |        |             |                          |        |             |
| Macedonia   | 0.11                 | 0.23   | 0.34        | 0.14                     | 0.83   | 0.32        |
| Bosnia and  |                      |        |             |                          |        |             |
| Herzegovina | 0.12                 | 0.07   | 0.19        | 0.16                     | 0.26   | 0.18        |
| Montenegro  | 0.11                 | 0.06   | 0.17        | 0.15                     | 0.21   | 0.16        |

Source: Author calculation from Direction of Trade Statistics, IMF.

## 3.2 Decomposition of merchandise trade structure

The structure of international trade is the essential reflection of the trade pattern, and its analysis is a core field of international trade theory and empirical research (Fan et al., 2006). Trade commodity structure refers to the proportion of the trade value of various merchandises in a country or region in the total trade value. This part analyzes the trade commodity structure between CEE countries and China based on the 4th revision of the Standard International Trade Classification (SITC) that are commonly adopted by countries.

The SITC system divides products into 10 categories according to the raw materials produced and their degree of manufacture (as shown in Table 3.2). Among them, categories 0-4 are primary products with low added value, and categories 5-9 are industrial manufactured products with relatively high added value (United Nations, 2006).

Table 3.2 Standard International Trade Classification (SITC), Revision 4

| Code | Commodity category                              | Code | Commodity category                   |
|------|-------------------------------------------------|------|--------------------------------------|
| 0    | Food and live animals                           | 5    | Chemicals and related products       |
| 1    | Beverages and tobacco                           | 6    | Manufactured chief material goods    |
| 2    | Crude materials, inedible, except fuels         | 7    | Machinery and transport equipment    |
| 3    | Mineral fuels, lubricants and related materials | 8    | Miscellaneous manufactured articles  |
| 4    | Flora and fauna oils, fats and waxes            | 9    | Not classified elsewhere in the SITC |

Source: Department of Economic and Social Affairs, United Nations

### 3.2.1 Total commodity structure analysis

From the perspective of trade categories, from 2016 to 2020, the trade export structure between from CEE region to China was relatively stable (see Figure 5). The category of commodities that accounted for the largest proportion of exports to China was machinery and transportation equipment (SITC7), which accounted for more than 60% in many years. Others larger export categories also include manufactured goods by raw materials (SITC6), miscellaneous products (SITC8), non-edible raw materials (SITC2), and chemicals and related products (SITC5). The remaining product categories exported to China are relatively less.

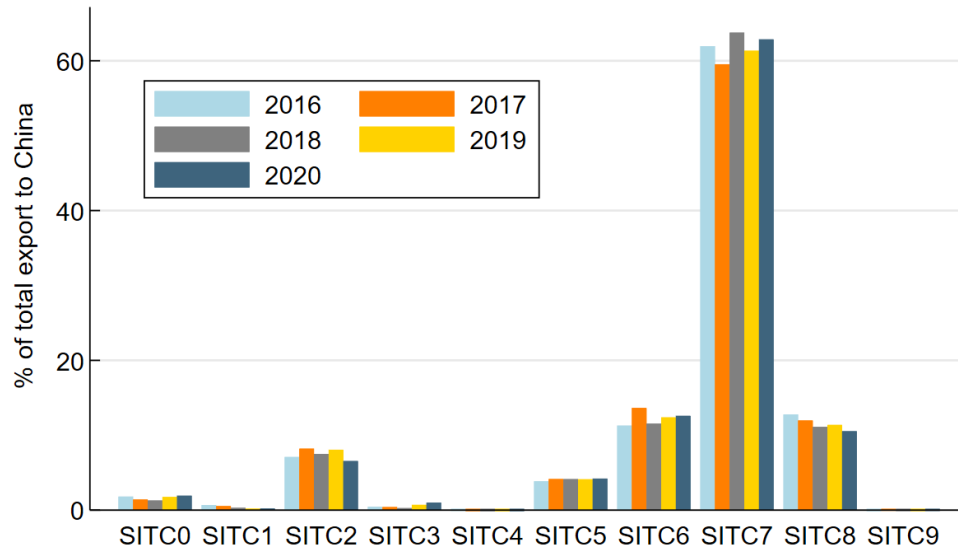


Figure 3.5 CEE countries total goods export to China by categories

Source: Author calculation from UNCTAD Database.

From the perspective of the value-added content contained in commodity categories, the products exported from Central and Eastern European countries to China are mainly industrial products with high added-value content (SITC5+SITC6+SITC7+SITC8+SITC9), and primary products with low added-value content (SITC0+SITC1+SITC2+SITC3+SITC4) also contribute to a certain amount of export, but the proportion is small. After sorting out the data, it is found that in the past five years, the proportion of high value-added product exports in the total exports of CEE countries to China has stabilized at about 98%, while the proportion of other products is only about 2%. This reflects the imbalance in the overall export structure of CEE countries (UNCTAD, 2022).

The product structure of CEE nations imported from China was also steady during this period. Figure 3.6 reflects commodity exports from China to CEE countries from 2016 to 2020. During the selected five years, machinery and transportation equipment (SITC7) was the largest product category imported from these countries to China, and its proportion was stable at around 53% over the five years. Other imported products with a relatively large proportion included miscellaneous products (SITC8), manufactured products by raw material (SITC6), chemicals and related products (SITC5). In terms of added value, the products imported by CEE countries from China are still mainly manufactured products with high added values, of which the proportion to the total regional import from China has been stable at around 98% that is reflected in the Appendix Exhibit 4 (UNCTAD, 2022).

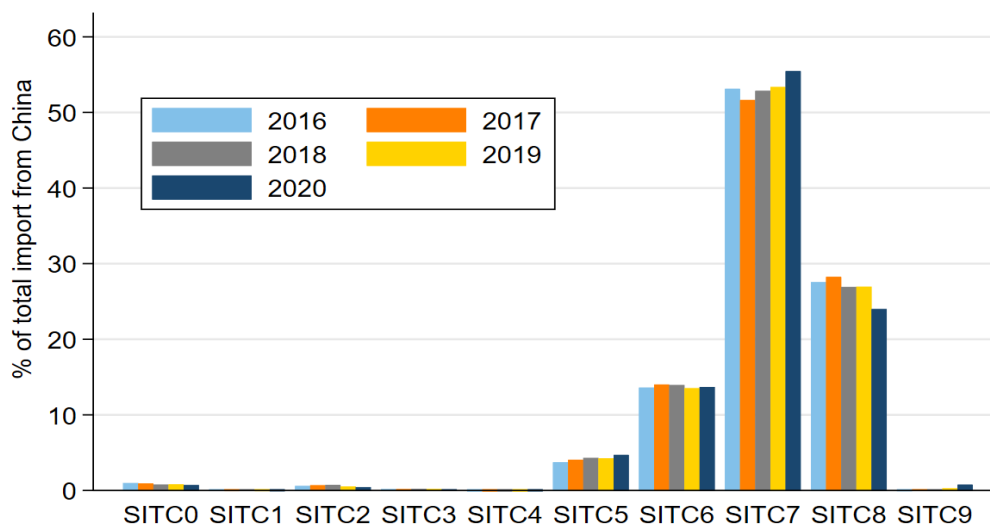


Figure 3.6 CEE countries total goods import from China by categories

Source: Author calculation from UNCTAD Database.

Further research found that the bilateral foreign commodity trade between CEE countries and China is dominated by the trade in manufactured goods with relatively high added value (total SITC5+6+7+8+9), which can be reflected in the Table 3.3. For example, under the SITC system, the exports of manufactured goods from CEE region to China account for about 90% of the total merchandise trade scale, while the trade scale of primary products (total SITC0+1+2+3+4) is only 10%. From the point of view of goods imported from China, the scale of manufactured products is even higher, reaching 98% (UNCTAD, 2022). On the one hand, this reflects that in bilateral trade, both sides pay more and more attention to the added value of products, on the other hand, it also shows that the structure of bilateral trade in goods between CEE nations has been facing a highly unbalanced development from 2016 to 2020.

Table 3.3 CEECs merchandise export and import with China in % under SITC 2016-2020

|      | Total SITC0+1+2+3+4 |        | Total SITC5+6+7+8+9 |        |
|------|---------------------|--------|---------------------|--------|
|      | Export              | Import | Export              | Import |
| 2016 | 10.10               | 1.87   | 89.90               | 98.13  |
| 2017 | 10.61               | 1.89   | 89.39               | 98.11  |
| 2018 | 9.38                | 1.88   | 90.62               | 98.12  |
| 2019 | 10.74               | 1.63   | 89.26               | 98.37  |
| 2020 | 9.73                | 1.37   | 90.27               | 98.63  |

Source: Author calculation from UNCTAD Database.

As for the reasons why industrial manufactured goods with relatively high added value are the main product types in the bilateral commodity trade between CEE countries and China, this thesis believes that the following four facets can be listed: First, although China has a large domestic land area, it has a large population. While the demand for primary products, such as agricultural products, is relatively small, it is also vulnerable to the impact of trade policies of partner countries. Second, since China joined the World Trade Organization, the domestic industrial structure has been gradually upgraded, and low value-added products, such as the clothing industry, have gradually shifted to countries in Southeast Asia with relatively lower labor costs. Coupled with the influence of domestic policies, the proportion of China's foreign manufactured goods has been increasing. Third, CEE region has a good land factor endowment and abundant supply of primary commodities; fourth, CEE countries have unique geographical advantages, and are influenced by the technological spillover effects of developed European industrial countries, which has helped form a leading industrial manufacturing advantage. Ambroziak (2018) have introduced Germany's role in the promotion of global value chains in 10 Central and Eastern European countries. By absorbing foreign direct investment, these countries have gradually upgraded their industries and increased value-added trade.

### 3.2.2 Merchandise structure comparison by country

Among the CEE countries' commodity exports to China, the four Visegrad countries are still the top four nations in the region's merchandise exports to China (as shown in the Table 3.4). Among them, Slovakia has the largest export value, reaching 6431.4 million US dollars, accounting for 23.4% of the scale of CEE region. In terms of its products exported to China, the commodity with the largest trade value is machinery and transportation equipment (SITC7) with the largest trade value of US\$6,191.1 million, accounting for 96.21% of all the country's merchandise exports to China. The Czech Republic, Poland and Hungary, the largest exports to China are also machinery and transport equipment (SITC7), accounting for 66.73%, 45.89%, and 73.43% of their exports to China, respectively. However, the commodity structure exported by these countries is more diversified, with a larger proportion of chemicals and related products (SITC5) and finished products classified as raw materials (SITC6) (UNCTAD, 2022).

In addition, there are differences in the commodity export structure of these countries. Not all countries export to China with high value-added trade. For example, Montenegro,

Albania and Latvia mainly export primary products in 2020. The relatively low value-added products (SITC0+1+2+3+4) accounted for 97.87%, 74.83% and 65.42%, respectively (UNCTAD, 2022). The reason for this high proportion is mainly because these countries export large quantities of non-edible raw materials (SITC2) to China.

Table 3.4 CEECs commodity export to China under SITC in million USD in 2020

|                           | SITC0 | SITC1 | SITC2 | SITC3 | SITC4 | SITC5 | SITC6  | SITC7  | SITC8 | SITC9 |
|---------------------------|-------|-------|-------|-------|-------|-------|--------|--------|-------|-------|
| Albania                   | 0.2   | 0.1   | 59.4  | 0.0   | 0.0   | 0.0   | 4.8    | 0.7    | 14.4  | 0.2   |
| Bosnia and<br>Herzegovina | 0.0   | 0.2   | 23.7  | 0.0   | 0.0   | 0.9   | 4.6    | 17.1   | 26.0  | 0.1   |
| Bulgaria                  | 82.5  | 1.3   | 138.4 | 0.0   | 3.8   | 31.2  | 753.2  | 189.3  | 167.9 | 1.7   |
| Croatia                   | 0.7   | 0.1   | 36.1  | 0.0   | 0.0   | 6.4   | 14.5   | 67.7   | 13.2  | 0.2   |
| Czech                     | 43.5  | 12.3  | 559.1 | 0.2   | 0.0   | 134.4 | 338.6  | 3425.0 | 617.7 | 1.8   |
| Estonia                   | 22.1  | 0.5   | 41.5  | 11.5  | 0.0   | 4.9   | 24.0   | 122.6  | 54.1  | 0.3   |
| Greece                    | 11.9  | 2.1   | 289.5 | 48.4  | 1.9   | 291.8 | 21.0   | 89.8   | 15.9  | 0.8   |
| Hungary                   | 16.6  | 6.3   | 23.6  | 0.0   | 0.1   | 200.1 | 300.1  | 3144.0 | 589.0 | 1.8   |
| Latvia                    | 8.6   | 0.9   | 83.0  | 38.6  | 0.0   | 10.4  | 17.1   | 28.8   | 12.7  | 0.4   |
| Lithuania                 | 109.8 | 2.6   | 43.8  | 10.4  | 0.0   | 55.8  | 111.0  | 44.4   | 108.9 | 0.8   |
| Montenegro                | 0.0   | 1.4   | 54.8  | 0.0   | 0.0   | 0.0   | 0.0    | 0.5    | 0.7   | 0.0   |
| North<br>Macedonia        | 0.1   | 1.6   | 37.9  | 0.0   | 0.0   | 24.5  | 116.5  | 42.0   | 4.5   | 0.1   |
| Poland                    | 215.7 | 24.4  | 165.4 | 124.1 | 0.1   | 274.8 | 1094.0 | 1982.6 | 434.1 | 4.8   |
| Romania                   | 2.4   | 1.1   | 124.3 | 42.8  | 3.1   | 68.4  | 215.3  | 1544.4 | 632.9 | 3.5   |
| Serbia                    | 7.2   | 2.8   | 45.0  | 0.1   | 0.8   | 8.6   | 322.1  | 93.3   | 17.5  | 0.2   |
| Slovak                    | 0.5   | 0.5   | 40.3  | 0.0   | 0.0   | 15.2  | 58.6   | 6191.1 | 124.4 | 0.8   |
| Slovenia                  | 7.5   | 0.9   | 35.9  | 0.0   | 0.0   | 32.1  | 67.1   | 301.4  | 63.1  | 0.5   |
| Total                     | 529   | 59    | 1802  | 276   | 10    | 1159  | 3463   | 17285  | 2897  | 18    |

Source: Author calculation from UNCTAD Database.

Table 3.5 depicts the commodity structure of 17 CEE countries imported FROM China in 2020. Different from the export structure of the same year, these countries imported manufactured goods with relatively high added value to China. Except for Croatia's primary products imported from China, which accounted for 26.59% of the country's total imports from China, the proportion of primary products imported by other countries was all below 4%. In terms of imported commodities, all countries have high demand for China's machinery and transportation equipment (SITC7), miscellaneous products (SITC8), and finished products by raw materials (SITC6). Using these goods that has a certain technological content as raw

materials for continued production or assembly and then exporting to other western European countries has become a major economic development model for major economies in CEE region (Ambroziak, 2018).

Table 3.5 CEECs merchandise import from China under SITC in million USD in 2020

|                           | SITC0 | SITC1 | SITC2 | SITC3 | SITC4 | SITC5  | SITC6  | SITC7   | SITC8  | SITC9 |
|---------------------------|-------|-------|-------|-------|-------|--------|--------|---------|--------|-------|
| Albania                   | 9.5   | 0.8   | 1.4   | 0.0   | 0.3   | 37.2   | 200.7  | 171.1   | 148.6  | 1.5   |
| Bosnia and<br>Herzegovina | 2.4   | 0.0   | 0.7   | 0.0   | 0.0   | 5.7    | 37.7   | 44.6    | 27.9   | 1.0   |
| Bulgaria                  | 33.5  | 4.0   | 24.2  | 0.2   | 19.3  | 120.7  | 310.3  | 708.7   | 315.8  | 10.6  |
| Croatia                   | 0.7   | 0.1   | 36.1  | 0.0   | 0.0   | 6.4    | 14.5   | 67.7    | 13.2   | 0.2   |
| Czech                     | 46.2  | 0.2   | 18.6  | 0.1   | 1.2   | 174.6  | 859.8  | 11297.8 | 1252.0 | 87.9  |
| Estonia                   | 13.8  | 2.1   | 3.7   | 0.5   | 0.0   | 40.5   | 168.4  | 500.9   | 122.5  | 11.6  |
| Greece                    | 54.1  | 8.2   | 13.1  | 59.3  | 1.9   | 246.7  | 1061.0 | 2601.7  | 2966.4 | 23.9  |
| Hungary                   | 18.3  | 0.9   | 6.9   | 0.1   | 0.0   | 361.8  | 592.5  | 4464.5  | 1885.5 | 74.2  |
| Latvia                    | 15.9  | 4.1   | 4.9   | 1.4   | 0.1   | 123.0  | 202.0  | 447.5   | 213.6  | 39.7  |
| Lithuania                 | 49.8  | 3.0   | 9.5   | 0.2   | 0.3   | 194.3  | 468.4  | 688.4   | 368.6  | 25.5  |
| Montenegro                | 0.9   | 2.0   | 0.8   | 0.4   | 0.0   | 21.4   | 31.1   | 32.0    | 18.9   | 5.7   |
| North<br>Macedonia        | 1.3   | 0.0   | 1.1   | 0.0   | 0.0   | 14.0   | 27.7   | 91.8    | 20.0   | 1.0   |
| Poland                    | 206.4 | 9.1   | 112.4 | 24.6  | 1.3   | 1417.7 | 3796.3 | 13065.0 | 7903.0 | 199.8 |
| Romania                   | 44.9  | 2.6   | 56.5  | 0.4   | 2.8   | 202.9  | 1090.6 | 2635.3  | 1056.1 | 34.4  |
| Serbia                    | 5.8   | 0.1   | 3.7   | 0.1   | 0.4   | 96.3   | 374.4  | 852.7   | 286.6  | 4.4   |
| Slovak                    | 5.3   | 0.7   | 3.4   | 0.0   | 0.0   | 42.4   | 263.4  | 2150.1  | 526.3  | 41.5  |
| Slovenia                  | 25.2  | 0.6   | 32.4  | 0.3   | 0.3   | 401.2  | 703.1  | 1518.1  | 756.4  | 14.7  |
| Total                     | 534   | 38    | 329   | 88    | 28    | 3507   | 10202  | 41338   | 17882  | 578   |

Source: Author calculation from UNCTAD Database.

### 3.3 Key indices measuring trade

In order to deeply analyze the competition and complementarity of related merchandise trade between China and CEE countries, this thesis employ some data to figure out two indicators: trade intensity index and revealed comparative advantage index. The original data are from Direction of Trade Statistics, IMF, and UNCTAD Databa.

### 3.3.1. Trade intensity index

Introduced by Brown (1947), trade intensity index (TII) is widely used to measure the interdependence of two countries in terms of trade. The index is expressed by the formula as:

$$TII_{ij} = (X_{ij}/X_{it})/(X_{wj}/X_{wt}) \quad (9)$$

where  $TII_{ij}$  denotes the degree of trade intensity between country i and country j,  $X_{ij}$  expresses the export values of country i to country j,  $X_{it}$  suggests the export values of country i to the world,  $X_{wj}$  is world export values to country j, and  $X_{wt}$  represents the total world export values (World Bank, 2022).

This formula measures the importance of a country's products to a trading partner country by its relative market share in the import market of the trading partner country. Generally,  $TII_{ij} > 1$  means that country i is more important to country j in bilateral trade, and the larger the value, the more products exported by country i can meet the market demand of country j; on the contrary,  $TII_{ij} < 1$  shows that in the bilateral trade, the goods of country i are not closely related to the market demand of country j, hence the trade relationship is loose.

Through the calculation of relevant trade data (IMF, 2022), it is found that between 2011 and 2020, the trade intensity index of a majority of CEE countries on China is quite stable, and the values either of the total CEE region or specific country are all between 0 and 0.3. Although these numbers are less than 1, which means that these countries' trade ties with China are not very close, at the same time these indices are all greater than zero, suggesting that the trade relations between the nations in CEE region and China are not alienated (as shown in Table 3.6). There is still considerable potential for improvement between these countries and the world's largest developing country to sublimate their trade relations.

In addition, after comparing the figures of countries (See Table 3.6), it is also reflected that during this decade, there are five countries whose trade intensity index (TII) on China is higher than the regional average: Bulgaria, Slovak, Hungary, North Macedonia and Poland. This shows that products from these areas are generally more popular with Chinese consumers than those from other CEE countries. And it is also worth noting that the apparent TII almost IN all CEE countries has gradually increased between 2011 and 2020. This reflects the strengthening of the industrial competitiveness of these countries.

Table 3.6 Trade intensity index of CEE countries on China 2011-2020

| Country                   | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Average |
|---------------------------|------|------|------|------|------|------|------|------|------|------|---------|
| Albania                   | 0.09 | 0.10 | 0.20 | 0.14 | 0.09 | 0.09 | 0.11 | 0.07 | 0.08 | 0.06 | 0.10    |
| Bosnia and<br>Herzegovina | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01    |
| Bulgaria                  | 0.12 | 0.21 | 0.24 | 0.18 | 0.15 | 0.12 | 0.16 | 0.17 | 0.18 | 0.21 | 0.17    |
| Croatia                   | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.03 | 0.02 | 0.03    |
| Czech                     | 0.10 | 0.11 | 0.12 | 0.11 | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 | 0.11 | 0.11    |
| Estonia                   | 0.12 | 0.05 | 0.05 | 0.07 | 0.06 | 0.07 | 0.09 | 0.08 | 0.07 | 0.10 | 0.07    |
| Greece                    | 0.06 | 0.07 | 0.07 | 0.05 | 0.04 | 0.05 | 0.07 | 0.12 | 0.11 | 0.12 | 0.07    |
| Hungary                   | 0.16 | 0.17 | 0.17 | 0.15 | 0.11 | 0.12 | 0.12 | 0.11 | 0.10 | 0.11 | 0.13    |
| Latvia                    | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.04    |
| Lithuania                 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.04 | 0.05 | 0.05 | 0.07 | 0.08 | 0.04    |
| Montenegro                | 0.00 | 0.02 | 0.02 | 0.01 | 0.03 | 0.06 | 0.02 | 0.05 | 0.06 | 0.07 | 0.03    |
| North<br>Macedonia        | 0.20 | 0.24 | 0.15 | 0.11 | 0.18 | 0.05 | 0.06 | 0.06 | 0.14 | 0.17 | 0.14    |
| Poland                    | 0.07 | 0.07 | 0.08 | 0.08 | 0.07 | 0.06 | 0.07 | 0.06 | 0.08 | 0.09 | 0.07    |
| Romania                   | 0.07 | 0.06 | 0.08 | 0.08 | 0.06 | 0.07 | 0.07 | 0.06 | 0.05 | 0.06 | 0.06    |
| Serbia                    | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.10 | 0.11 | 0.03    |
| Slovak                    | 0.24 | 0.19 | 0.22 | 0.18 | 0.11 | 0.12 | 0.13 | 0.13 | 0.16 | 0.20 | 0.17    |
| Slovenia                  | 0.04 | 0.06 | 0.06 | 0.07 | 0.08 | 0.12 | 0.13 | 0.11 | 0.08 | 0.09 | 0.08    |
| Total CEECs               | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.13 | 0.11    |

Source: Author calculation from Direction of Trade Statistics, IMF.

### 3.3.2 Revealed comparative advantage index

In the theory of international trade, comparative advantage is the premise for countries with different levels of factor endowment and productivity to carry out trade. So as to analyze whether a specific type of merchandise of a certain country or region has a comparative advantage in the international market or not, Balassa (1965) proposed revealed comparative advantage (RCA) index. The index can be expressed by the formula as:

$$RCA_i^k = (X_i^k / X_i) / (X_w^k / X_w) \quad (10)$$

where  $RCA_i^k$  denotes the revealed comparative advantage of product k in country i,  $X_i^k$  and  $X_i$  represent the export values of merchandise k and the total export values in country i, respectively.  $X_w^k$  suggests the export value of goods k in the world, and  $X_w$  is the total export values in the world.

The RCA index is widely used for it is comparably easy to collect and to measure, and any level of disaggregation can be calculated by RCA index (Bacchetta et al., 2012; Grančay & Dudáš, 2019). The numerator of the index reflects the proportion of the export values of a type of product in the country's total exports, and the denominator describes the proportion of the export of the same type of product in the world market to the world's total exports. In general, if  $RCA_i^k > 2.5$ , it means that the product k of country i is extremely competitive; if it is between 1.25 and 2.5, it means that the product is highly competitive; if it is between 0.8 and 1.25, it means it has moderate competitiveness; if it is less than 0.8, it indicates a weak competitive advantage.

Using the merchandise trade data released by UNCTAD (2022) of China and 17 countries in CEE region, this part calculates the average value of the RCA index of the research subjects from 2016 to 2020 under the system of SITC Revision 4, under which commodities are commonly divided into different categories based on the abundance of factor endowments attached. The first five categories of primary finished products are all resource-intensive, SITC5 and SITC7 represent capital-intensive manufactured goods, and SITC6 and SITC8 are capital-intensive.

Table 3.7 reflects the competitiveness of the 18 countries' products in the world market as measured by their RCA indices. In general, there is no necessary link between a country's comparative advantage in a certain category of export products and the country's total exports. For example, the Visegrad countries, the largest exporter, does not always have the highest RCA index for many products. There are differences in the comparative advantages of export products of various countries.

In terms of resource-intensive commodities, the RCA index values of all kinds of products exported by China is lower than 0.8, suggesting a weak competitiveness in the international market. However, the RCA indices of CEE countries in these product categories are larger than those of China, which reflects they have more comparative advantages than China in the related products. Especially Bulgaria, Croatia, Estonia, Greece, Latvia, Lithuania,

Montenegro, these countries comparably have a larger RCA index over 1.25 for resource-intensive products, meaning their products are highly competitive in the international market.

As for capital-intensive products, neither CEE countries nor China have a competitive advantage. When comparing labor-intensive products, the conclusion is complicated. Some CEE countries have greater comparative advantages than China, such as Bulgaria, Croatia, Latvia and other countries that have a larger RCA index of finished products classified by raw materials (SITC6), while meanwhile these countries are less competitive than China in exports of miscellaneous products (SITC8).

Table 3.7 Average RCA index under SITC in China and CEECs in 2016-2020

|                           | Resource intensive |       |       |       |       | Capital intensive |       | Labor intensive |       |
|---------------------------|--------------------|-------|-------|-------|-------|-------------------|-------|-----------------|-------|
|                           | SITC0              | SITC1 | SITC2 | SITC3 | SITC4 | SITC5             | SITC7 | SITC6           | SITC8 |
| Albania                   | 1.21               | 0.56  | 1.64  | 0.83  | 0.11  | 0.10              | 0.12  | 1.12            | 3.55  |
| Bosnia and<br>Herzegovina | 0.88               | 0.83  | 2.50  | 0.72  | 2.41  | 0.67              | 0.44  | 1.92            | 2.41  |
| Bulgaria                  | 1.67               | 1.52  | 1.75  | 0.82  | 2.00  | 0.88              | 0.61  | 1.80            | 1.11  |
| China                     | 0.41               | 0.17  | 0.17  | 0.15  | 0.08  | 0.55              | 1.32  | 1.35            | 1.95  |
| Croatia                   | 1.64               | 2.23  | 1.93  | 0.93  | 0.83  | 1.17              | 0.66  | 1.36            | 1.24  |
| Czech                     | 0.49               | 0.98  | 0.56  | 0.16  | 0.43  | 0.54              | 1.60  | 1.19            | 1.04  |
| Estonia                   | 1.17               | 1.20  | 2.16  | 1.04  | 1.44  | 0.53              | 0.86  | 1.15            | 1.28  |
| Greece                    | 2.29               | 2.86  | 1.11  | 2.74  | 3.53  | 1.03              | 0.26  | 1.26            | 0.61  |
| Hungary                   | 0.99               | 0.62  | 0.46  | 0.20  | 0.97  | 0.98              | 1.55  | 0.82            | 0.74  |
| Latvia                    | 2.03               | 5.84  | 3.62  | 0.46  | 0.28  | 0.76              | 0.64  | 1.49            | 0.82  |
| Lithuania                 | 2.01               | 4.19  | 1.35  | 1.18  | 0.59  | 1.33              | 0.56  | 0.93            | 1.37  |
| Montenegro                | 1.09               | 6.77  | 5.95  | 1.64  | 0.29  | 0.57              | 0.28  | 2.12            | 0.35  |
| North<br>Macedonia        | 0.85               | 4.09  | 1.29  | 0.15  | 0.31  | 2.06              | 0.90  | 1.02            | 1.21  |
| Poland                    | 1.67               | 2.22  | 0.54  | 0.22  | 0.31  | 0.80              | 1.04  | 1.50            | 1.41  |
| Romania                   | 0.99               | 1.91  | 0.99  | 0.33  | 0.54  | 0.38              | 1.30  | 1.31            | 1.24  |
| Serbia                    | 2.09               | 3.72  | 0.90  | 0.25  | 2.04  | 0.81              | 0.78  | 1.88            | 1.08  |
| Slovak                    | 0.48               | 0.18  | 0.48  | 0.27  | 0.20  | 0.37              | 1.70  | 1.31            | 0.77  |
| Slovenia                  | 0.49               | 0.42  | 0.71  | 0.36  | 0.16  | 1.42              | 0.87  | 1.31            | 0.74  |

Source: Author calculation from UNCTAD Databa.

In addition, in order to analyze the yearly dynamic changes of the comparative advantages between China and the CEE countries, the top five nations of CEE region with the largest trade values with China, which are the Czech Republic, Greece, Hungary, Poland and Slovakia, are representatively selected. The import and export value of these five countries with China in 2020 account for 76.55% of the total export value of CEE countries to China (as shown in Table 3.1). Under the SITC system, the changes in the comparative advantages of each export product between China and the five CEE countries from 2016 to 2020 are dynamically depicted (see Figure 3.7).

Judging from China's data, in the past five years, the RCA index of the first five categories of products under the SITC system was below 0.5, and the RCA index of the next three categories of manufactured products were all above 1.25. The product category with the highest index level is SITC8. This shows that China's products in the international market are still mainly labor-intensive, but at the same time, the export of capital-intensive products also has comparative advantages, especially SITC7 products. In addition, during this period, the export competitiveness of the following three types of products in China, SITC0, SITC1, and SITC8, is gradually decreasing, while the international competitiveness of SITC3, SITC4, SITC6, and SITC7 is gradually improving as a whole. The reasons for this phenomenon are, on the one hand is attributed to the adjustment of China's industrial policy, and the government's stricter control of resource-based industries to achieve sustainable development of resources; on the other hand, with the rising labor costs in China, and the impact of the epidemic on the shutdown of factories has affected the competitiveness of labor-intensive industries and related merchandises.

From the data of the five major trading powers in CEE region from 2016 to 2020, the RCA indices of Greece and Poland in SITC0 and SITC1 products are relatively large, around 2.0, which shows that the two types of goods from these countries are very competitive in the international market and can complement the related merchandises in China. The comparative advantage of Greece's SITC3 products is also relatively large, with the RCA index exceeding 2.5. Hungary's RCA index value for SITC7 products is the largest among the five countries. In general, under the SITC system, China and its main trading partners in CEE countries have strong complementarity in the first five types of resource-intensive primary products, while the capital and labor endowments in the followed four types of high value-added industrial products are comparable, meaning they are more competitive with each other.

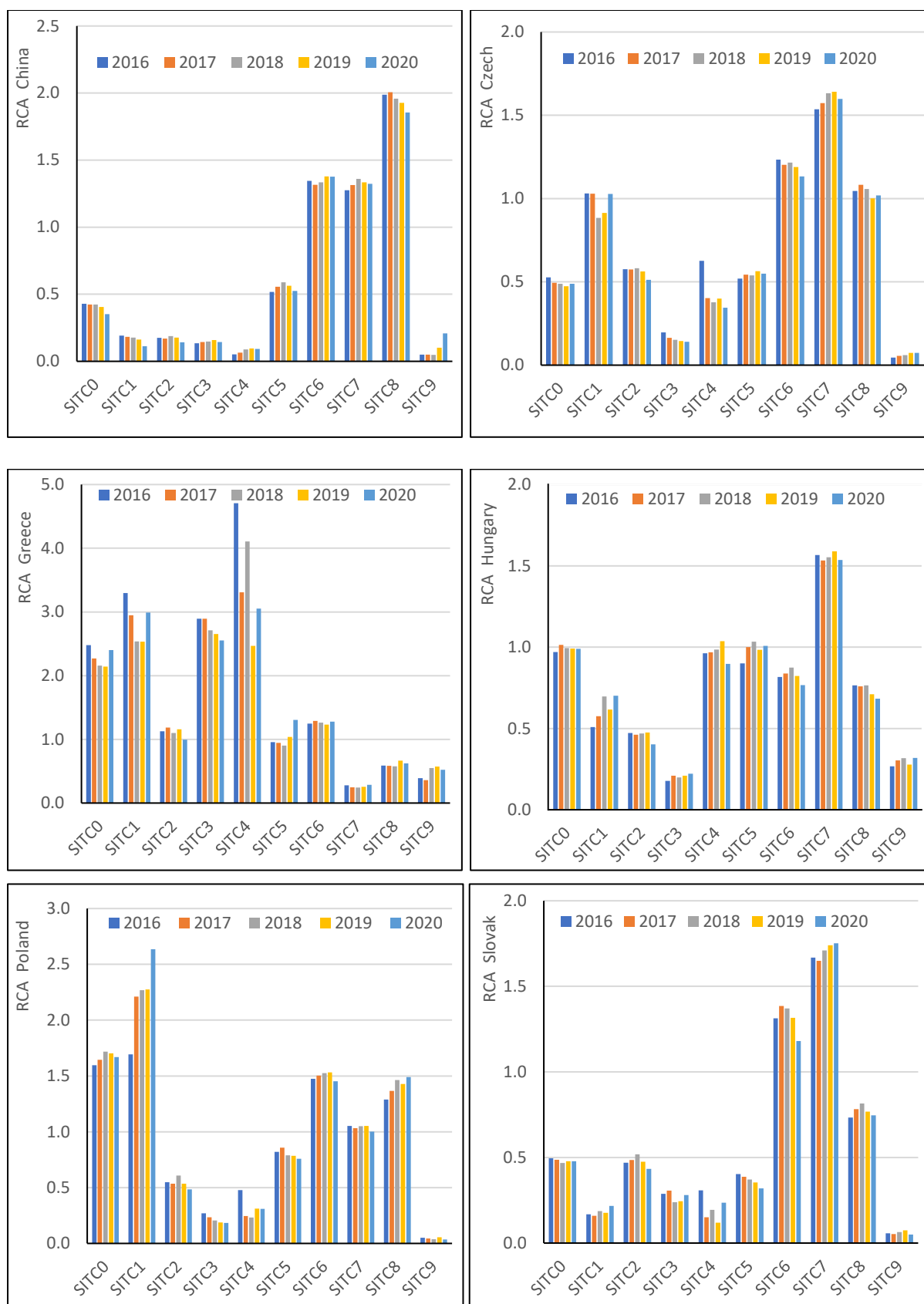


Figure 3.7 RCA Index for China and its major trading partners in CEE region 2016-2020

Source: Author calculation from UNITAD Database.

## 4. Model settings and data sources

### 4.1 Model settings

On the basis of sorting out relevant references, combined with research needs, the thesis introduces natural factors that are difficult to change in a short time, such as economic scale, population, and distance, into the stochastic frontier gravity model, while the human factors that can change in a short period of time, for instance, political connections, cultural exchanges, investment factors, infrastructure level and business environment, are incorporated into the trade inefficiency model. So as to improve the accuracy of the regression results, this part intends to analyze from three perspectives, which include the export and import values of China to CEE countries, as well as the bilateral trade scales between the east nation and the west. The models are set as follows:

$$\begin{aligned} \ln BT_{ijt} = & \alpha_0 + \alpha_1 \ln GDPC_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln POPC_{it} \\ & + \alpha_4 \ln POP_{jt} + \alpha_5 \ln WDIS_{ij} + v_{ijt} - u_{ijt} \end{aligned} \quad (11)$$

$$\begin{aligned} \ln CEX_{ijt} = & \alpha_0 + \alpha_1 \ln GDPC_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln POPC_{it} \\ & + \alpha_4 \ln POP_{jt} + \alpha_5 \ln WDIS_{ij} + v_{ijt} - u_{ijt} \end{aligned} \quad (12)$$

$$\begin{aligned} \ln CIM_{ijt} = & \alpha_0 + \alpha_1 \ln GDPC_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln POPC_{it} \\ & + \alpha_4 \ln POP_{jt} + \alpha_5 \ln WDIS_{ij} + v_{ijt} - u_{ijt} \end{aligned} \quad (13)$$

Among them, the trade inefficiency model is assumed to be:

$$\begin{aligned} u_{ijt} = & \beta_0 + \beta_1 PVIS_{ijt} + \beta_2 EU_{jt} + \beta_3 YCIM_{jt} + \beta_4 \ln IFDI_{jt} \\ & + \beta_5 CRE_{it} + \beta_6 TRDOM_{jt} + \beta_7 INDOM_{jt} + \varepsilon_{ijt} \end{aligned} \quad (14)$$

For the explained variables of the models,  $BT_{ijt}$  represents the total bilateral trade between China and CEE countries in year t,  $CEX_{ijt}$  is the trade values of China's exports to a certain CEE country j, and  $CIM_{ijt}$  refers to the numbers of China's imports from a CEE country j, which also reflects the latter's export to the former. In order to smooth the data and reduce the problems of multicollinearity and heteroskedasticity that may exist in the model, take the logarithm of the variables with large values.

In addition,  $\alpha$  and  $\beta$  are coefficients to be estimated,  $v_{ijt}$  is a random interference term, which satisfies the regression model assumptions.  $u_{ijt}$  refers to the inefficiency term that is independent from  $v_{ijt}$ , and  $\varepsilon_{ijt}$  is the random error term. In stochastic frontier models, the first five explanatory variables are extracted from the traditional gravity model, which describe as:

$GDP_{C_{it}}$  and  $GDP_{jt}$  is the gross domestic product of China and its trading partners in CEE region in year t, respectively. Economic conditions are a prerequisite for consumption. The stronger a country's economic strength is, the better its domestic economic development is, and the level of households' consumption is also generally high. The impact mechanism of economic conditions on trade is mainly manifested in two aspects. One is that economic development requires a large number of imported commodities and raw materials, and the other is that high income levels enable residents to pursue higher-quality and more diversified foreign products. The coefficients of these two variables are gauged to be positive. The traditional gravity model uses GDP to represent the economic factors affecting a country's foreign trade, although there are more and more scholars also select the per capita GDP variable to analyze trade changes (Khayat, 2019; Kiran et al., 2021). In order to avoid complete collinearity with population variables, this dissertation still selects GDP rather than per capita GDP.

$POPC_{it}$  suggests the population size of China in year t, and  $POP_{jt}$  represents the population of its trading countries. The size affects both demand and supply of goods. For example, when a country's production level cannot meet the needs of a large domestic population, it will expand imports, which helps to increase import trade; but at the same time, the size of the population also means abundant labor resources, which helps to enhance the domestic supply capacity, after realizing the surplus of products, it turns to promote exports. Hence, the preliminary projected effect of demographic factors on trade is uncertain.

WDIS is the weighted geographic distance between China and CEE countries. Different from the simple geographic distance that considers the geographic distance between the capitals of the two countries, the weighted geographic distance analyzes the distance between the cities having the largest population in the two countries, and uses the population proportion as the weight in the calculation. This distance represents the transportation cost of trade transactions. The greater the distance, the higher the associated transportation costs. As the political function of the capital is more prominent, choosing a city with a large population to reflect the cost of trade transactions is more and more suitable for analyzing international trade flows (Mayer & Zignago, 2011). The effect of distance on trade is reckoned to be negative.

In terms of the inefficiency model with  $u_{ijt}$  regarded as the dependent variable, its independent variables selected are illustrated as the following:

$PVIS_{ijt}$  refers to the presence or absence of visits by state leaders between China and CEE countries  $j$  in year  $t$ . Due to the limited data, it is set as a dummy variable. In a certain year, there is a visit by the leaders of both parties, which is marked as 1, otherwise it is registered as 0. Representing major diplomatic activities of the country, the foreign visit of a country's leader is usually accompanied by a large number of government officials and entrepreneurs. During the period, while enhancing mutual political trust and security assistance, various economic and trade cooperation agreements are often signed with the visited country to promote economic reciprocity. Since the China-CEEC cooperation framework was proposed in 2012, the exchange of political visits between the two countries has increased compared with the past. The coefficient for this variable is expected to be positive. In collecting statistical data, this thesis adopts the conceptual definition approach of Kastner and Saunders (2012), which locks the scope of Chinese leaders as the state president and the premier of the State Council, while foreign leaders select the head of state and government prime minister accordingly.

$EU_{jt}$  is another dummy variable indicating whether CEE country  $j$  is a member of the EU in year  $t$ , 1 means yes and 0 means no. Due to the close transportation distance between EU member states, transportation costs are reduced; at the same time, as a customs union, the deepening of economic integration of EU facilitates trade among the internal member states. Moreover, the economic organization has signed many free trade agreements with other countries, which facilitates EU member states and agreement partners to trade with less trade costs. These paths further replace China and reduce bilateral trade with China. Previous research indicates that the signing of free trade agreements has a trade-creating effect, which simultaneously increase imports and exports between partner countries (Guei et al., 2017; Lateef et al., 2018; Qi & Zhang, 2018).

$YCI_{jt}$  denotes to the cumulative number of years of existence of all Confucius Institutes opened in each CEE country  $j$  until year  $t$ . Although this variable is newly created by the author of the dissertation, some evidence can still be found in the existing literature. Language and culture, as a link between informal institutions for exchanges and cooperation, have an increasingly prominent impact on international trade. Bilateral trade grows when a portion of the population in both countries speaks the same language (Melitz, 2008). Canadian scholars (Gurevich et al., 2021) also pointed out that language diversity would affect the exchange cost

of a country's foreign trade through the study of the cultural change of his home country, and greater language similarity can promote a country to enhance international trade. Confucius Institutes are symbols of Chinese culture with distinctive characteristics and play an important role in stimulating the influence of cultural soft power. Through Chinese teaching, holding cultural activities, and developing study abroad programs in China, Confucius Institutes have deepened the understanding of Chinese language and culture in the host country, provided a platform for cultural exchanges, mutual learning, integration and innovation for people from different cultural backgrounds, and enhanced China's trust and cooperation with countries where Confucius Institutes are established. The more years a country's Confucius Institutes have been established, the greater the effect on trade promotion with China is reckoned to be. In addition, considering that the number of Confucius Institutes is related to the population of the country, this thesis treats this variable as follows: divide the cumulative number of years of all Confucius Institutes existing in a country by the total population of the country, and multiply by 1 million . The processed variable is denoted as  $YCIM_{jt}$ . Their quantitative relationship can be expressed as:

$$YCIM_{jt} = (YCI_{jt}/POP_{jt}) * 1000000 \quad (15)$$

Where  $YCIM_{jt}$  represents the cumulative number of years of existence of Confucius Institutes per million population, and  $POP_{jt}$  is the total population of country j in the same year t.

$IFDI_{jt}$  represents the stock amount of inward foreign direct investment (IFDI) from China but absorbed by CEE country j in year t. Although it is the nature of multinational corporations to become international, since China's entry into the WTO in 2001, the government has encouraged enterprises to go global, and China's outward FDI has gradually increased steadily. Szunomár (2018) pointed out that the investment of Chinese multinational enterprises in the CEE region mainly flows to the manufacturing and service industries, and the main motivations for acquiring overseas companies are to facilitate access to important technologies, successful brands and new distribution channels. These have facilitated the cross-border flow of capital, products and labor, and facilitated the flow of bilateral trade. The business transactions of enterprises investing abroad are still inextricably linked with the companies in their home countries. A number of studies have demonstrated that FDI has complementary effects on bilateral trade (Jana et al., 2020; Xiong & Sun, 2021). The coefficient of this variable is inferred to be positive.

$CRE_{it}$  is the number of China-Europe railway express (CRE) opened in year  $t$ . Due to the incompleteness of the data of some countries in CEE region in terms of aviation, railway, logistics performance, etc., this variable is used as a surrogate variable for bilateral trade infrastructure, which will cause a certain measurement bias, but in face of data missing is an option. As a logistics channel for trade between China and countries along the Belt and Road, the CRE runs according to fixed trains, routes, schedules and full timetables. The more the number, the more conducive to trade. Since its opening in 2011, the number of trains, routes and types of goods have gradually increased, and the scale of operation has expanded rapidly, improving the hardware facilities for foreign trade in countries along the route. From 2016 to 2021, the annual number of CRE increased from 1,702 to 15,183, with an average annual growth rate of 55%; the categories of transported goods have expanded to more than 50,000 types of auto parts and vehicles, chemicals, electromechanical, and grain; annual transportation The value of goods increased from 8 billion US dollars to 74.9 billion US dollars, an increase of 9 times, and its proportion in the total trade volume between China and Europe increased from 1.5% to 8% (China-CEEC, 2022). CRE not only improves the transportation capacity of China's trade exports, but also provides a lot of help for many small and medium-sized Central and Eastern European enterprises to enter the Chinese market (Yang et al., 2020). The variable is expected to have a positive effect on trade.

$TRDOM_{jt}$  and  $INDOM_{jt}$  refer to the trade freedom and investment freedom of CEE countries  $j$  in year  $t$ , respectively. These two indicators are utilized to measure the openness and freedom of a country's market economy and business environment (Miller et al., 2022). Trade freedom reflects the extent to which a country's government restricts domestic market players from participating in international trade through tariffs, export volumes, trade quotas or trade bans, as well as activities such as licensing, standards, or other regulatory activities. A free and open investment climate means that individuals and businesses are free to decide how capital is used and how it flows, through which the financial system in a country in which savings, credit, and payments function efficiently is reflected. The higher the index scores, the freer the corresponding indicators. Generally, a good business environment is an important manifestation of a country's economic soft power and helps to promote the development of bilateral trade. The coefficients for these three variables are estimated to be positive.

## 4.2 Data sources

Before the data analysis, this part explains the variable selected in the model and data sources, which are shown in Table 4.1 below:

Table 4.1 Model variables selection and data sources

| Category              | Model                             | Code         | Brief denotation                                                                       | Source                                    |
|-----------------------|-----------------------------------|--------------|----------------------------------------------------------------------------------------|-------------------------------------------|
| Dependent variables   |                                   | <i>BT</i>    | Bilateral trade                                                                        | Self-calculation: $CEX_{ijt} + CIM_{ijt}$ |
|                       |                                   | <i>CEX</i>   | China export to CEEC                                                                   | Direction of Trade Statistics, IMF        |
|                       |                                   | <i>CIM</i>   | CEEC export to China                                                                   | Direction of Trade Statistics, IMF        |
| Independent variables | Stochastic frontier gravity model | <i>GDPC</i>  | GDP in China                                                                           | World Development Indicators              |
|                       |                                   | <i>GDP</i>   | GDP in CEEC                                                                            | World Development Indicators              |
|                       |                                   | <i>POPC</i>  | Population in China                                                                    | World Development Indicators              |
|                       |                                   | <i>POP</i>   | Population in CEEC                                                                     | World Development Indicators              |
|                       |                                   | <i>WDIS</i>  | Weighted distance from China to CEEC                                                   | CEPII Dataset                             |
|                       | Trade inefficiency model          | <i>PVIS</i>  | Political visits <sup>3</sup>                                                          | China's Diplomacy Yearbook                |
|                       |                                   | <i>EU</i>    | EU member <sup>4</sup>                                                                 | EU Country profiles                       |
|                       |                                   | <i>YCIM</i>  | Cumulative number of years of existence of Confucius Institutes per million population | Dig Mandarin Dataset                      |
|                       |                                   | <i>IFDI</i>  | CEEC FDI from China                                                                    | MOFCOM, China                             |
|                       |                                   | <i>CRE</i>   | China-Europe railway express                                                           | Rail Freight Dataset                      |
|                       |                                   | <i>TRDOM</i> | Trade freedom                                                                          | Heritage Foundation                       |
|                       |                                   | <i>INDOM</i> | Investment freedom                                                                     | Heritage Foundation                       |

Source: Own construction.

<sup>3</sup> and <sup>4</sup> are two dummy variables, while the others are numerical variables.

## 5. Data analysis and discussion

### 5.1 Descriptive statistics

On the basis of the preceding review, 17 countries in Central and Eastern Europe are chosen as research subjects for the purpose of analyzing the determinants and potential of their bilateral trade with China. Table 5.1 summarizes the descriptive statistics for the selected variables from 2009 to 2020. Each variable has 204 observations. The data in the table demonstrate that there are significant differences between Central and Eastern Europe countries and China in terms of import and export values, total trade values, economic scale, population size, geographical distance, political connection, cultural exchange, the amount of inward FDI, the proxy transportation infrastructure, and business environment, which can be inferred through the varied mean values and standard deviation (Std.Dev.).

Table 5.1 Descriptive statistics of model variables

| Variable       | Obs | Mean  | Std.Dev. | Min   | Max   |
|----------------|-----|-------|----------|-------|-------|
| <i>Ln BT</i>   | 204 | 14.36 | 1.26     | 11.68 | 17.22 |
| <i>Ln CEX</i>  | 204 | 14.18 | 1.24     | 11.68 | 17.10 |
| <i>Ln CIM</i>  | 204 | 12.16 | 1.91     | 4.89  | 15.04 |
| <i>Ln GDPC</i> | 204 | 29.92 | 0.32     | 8.25  | 9.25  |
| <i>Ln GDP</i>  | 204 | 24.70 | 1.22     | 29.26 | 30.32 |
| <i>Ln POPC</i> | 204 | 21.04 | 0.02     | 22.12 | 27.11 |
| <i>Ln POP</i>  | 204 | 15.35 | 1        | 13.33 | 17.46 |
| <i>Ln WDIS</i> | 204 | 8.94  | 0.05     | 8.82  | 9     |
| <i>PVIS</i>    | 204 | 0.50  | 0.50     | 0     | 1     |
| <i>EU</i>      | 204 | 0.69  | 0.47     | 0     | 1     |
| <i>YCIM</i>    | 204 | 1.62  | 1.56     | 0     | 8.26  |
| <i>YCI</i>     | 204 | 9.50  | 10.99    | 0     | 63    |
| <i>Ln IFDI</i> | 204 | 10.04 | 2.14     | 5.30  | 14    |
| <i>CRE</i>     | 204 | 2804  | 3937     | 0     | 12406 |
| <i>TRDOM</i>   | 204 | 85.64 | 2.96     | 75.20 | 88.40 |
| <i>INDOM</i>   | 204 | 70.98 | 9.88     | 40    | 90    |

Source: Own construction based on Stata 16.0. The tables below are the same.

## 5.2 Correlation analysis

Relevance is what makes research meaningful. In order to test the correlation between the explanatory variables and the explained variables, a preliminary test of the correlation analysis is carried out by constructing a correlation coefficient matrix, which is shown in Table 5.2, and the following findings are found: First, the weighted geographical distance is only significantly correlated with China's imports to CEE countries (*CIM*), the correlation between China's exports and bilateral trade is not significant; secondly, the cumulative annual number of Confucius Institutes per million population of the countries in CEE region (*YCIM*) is only significantly correlated with China's imports to these countries. The statistical significance of the cumulative annual number of Confucius Institutes (*YCI*) is better because it is significantly correlated with China's imports, exports, and bilateral trade to CEE countries. To this end, the following analysis uses *YCI*. This still has some plausibility. Although the number of Confucius Institutes in CEE countries is different, the trade volume is also different. Third, other variables selected in this dissertation are significantly correlated with the explained variables, among which the GDP and population, as well as the inward FDI in the CEE nations are strongly corrected with the export, import, and bilateral trade values, regarding China as reporting country and CEE countries as its trading partners.

## 5.3 Stochastic frontier gravity model analysis of factors

### 5.3.1 Hypothesis test

In order to ensure the correctness of the function form of the stochastic frontier gravity model, this part first uses the likelihood ratio statistic to test the applicability of the model. The null hypothesis ( $H_0$ ) and the alternative hypothesis ( $H_1$ ) of the model are:

$H_0: u_{ijt} = 0$ . The trade inefficiency term is significantly absent.

$H_0: u_{ijt} \neq 0$ . The trade inefficiency term exists significantly.

Table 5.3 below shows the output of each model by Stata 16.0. Since the p-values are all 0.000, which is less than 0.01, the p-value approach indicates that the null hypothesis is rejected, which means that the trade non-efficiency term significantly should be included.

Table 5.2 Correlation coefficient matrix between variables

|                | <i>Ln BT</i> | <i>Ln CEX</i> | <i>Ln CIM</i> | <i>Ln PGDPC</i> | <i>Ln PGDP</i> | <i>Ln POPC</i> | <i>Ln POP</i> | <i>Ln WDIS</i> | <i>PVIS</i> | <i>EU</i> | <i>YCIM</i> | <i>YCI</i> | <i>Ln IFDI</i> | <i>CRE</i> | <i>TRDOM</i> | <i>INDOM</i> |
|----------------|--------------|---------------|---------------|-----------------|----------------|----------------|---------------|----------------|-------------|-----------|-------------|------------|----------------|------------|--------------|--------------|
| <i>Ln BT</i>   | 1            |               |               |                 |                |                |               |                |             |           |             |            |                |            |              |              |
| <i>Ln CEX</i>  | 0.995***     | 1             |               |                 |                |                |               |                |             |           |             |            |                |            |              |              |
| <i>Ln CIM</i>  | 0.858***     | 0.814***      | 1             |                 |                |                |               |                |             |           |             |            |                |            |              |              |
| <i>Ln GDPC</i> | 0.169**      | 0.156**       | 0.253***      | 1               |                |                |               |                |             |           |             |            |                |            |              |              |
| <i>Ln GDP</i>  | 0.931***     | 0.931***      | 0.802***      | 0.042*          | 1              |                |               |                |             |           |             |            |                |            |              |              |
| <i>Ln POPC</i> | 0.166**      | 0.154**       | 0.241***      | 0.976***        | 0.043*         | 1              |               |                |             |           |             |            |                |            |              |              |
| <i>Ln POP</i>  | 0.843***     | 0.851***      | 0.658***      | -0.0120         | 0.173**        | -0.0120        | 1             |                |             |           |             |            |                |            |              |              |
| <i>Ln WDIS</i> | 0.0380       | 0.0630        | -0.141**      | 0               | -0.308***      | 0              | 0.0940        | 1              |             |           |             |            |                |            |              |              |
| <i>PVIS</i>    | 0.200***     | 0.198***      | 0.170**       | 0.225***        | 0.0900         | 0.213***       | 0.210***      | 0.0380         | 1           |           |             |            |                |            |              |              |
| <i>EU</i>      | 0.580***     | 0.543***      | 0.729***      | 0.0510          | 0.808***       | 0.0510         | 0.401***      | -0.467***      | 0.0990      | 1         |             |            |                |            |              |              |
| <i>YCIM</i>    | 0.0190       | -0.0120       | 0.200***      | 0.661***        | 0.302***       | 0.702***       | -0.262***     | -0.349***      | 0.158**     | 0.197***  | 1           |            |                |            |              |              |
| <i>YCI</i>     | 0.672***     | 0.670***      | 0.570***      | 0.469***        | 0.200***       | 0.495***       | 0.645***      | -0.125*        | 0.257***    | 0.343***  | 0.256***    | 1          |                |            |              |              |
| <i>Ln IFDI</i> | 0.803***     | 0.793***      | 0.716***      | 0.392***        | 0.303***       | 0.402***       | 0.715***      | 0.0870         | 0.251***    | 0.432***  | 0.197***    | 0.668***   | 1              |            |              |              |
| <i>CRE</i>     | 0.153**      | 0.146**       | 0.189***      | 0.726***        | 0.136*         | 0.811***       | -0.0100       | 0              | 0.175**     | 0.0300    | 0.670***    | 0.460***   | 0.348***       | 1          |              |              |
| <i>TRDOM</i>   | 0.217***     | 0.187***      | 0.417***      | 0.159**         | 0.359***       | 0.130*         | 0.0460        | -0.300***      | -0.122*     | 0.505***  | 0.164**     | 0.132*     | 0.170**        | -0.0120    | 1            |              |
| <i>INDOM</i>   | 0.151**      | 0.137*        | 0.313***      | 0.345***        | 0.407***       | 0.315***       | -0.0840       | -0.593***      | 0.0660      | 0.426***  | 0.464***    | 0.188***   | 0.189***       | 0.190***   | 0.472***     | 1            |

Note: \*, \*\*, \*\*\* represents the significance level at 0.1, 0.05, 0.01, respectively.

Table 5.3 Regression results of stochastic frontier gravity model

|                | (1)<br><i>Ln BT</i>   | (2)<br><i>Ln CEX</i>  | (3)<br><i>Ln CIM</i> |
|----------------|-----------------------|-----------------------|----------------------|
| <i>Ln GDPC</i> | 0.500**<br>(2.34)     | 0.159**<br>(2.00)     | 1.577***<br>(5.65)   |
| <i>Ln GDP</i>  | 1.175***<br>(7.69)    | 1.378***<br>(23.11)   | 1.010***<br>(4.38)   |
| <i>Ln POPC</i> | -11.876***<br>(-2.89) | -6.783***<br>(-94.76) | -7.601**<br>(-2.34)  |
| <i>Ln POP</i>  | -0.422***<br>(-2.95)  | -0.595***<br>(-4.81)  | 0.279<br>(1.04)      |
| <i>Ln WDIS</i> | -2.937***<br>(-3.02)  | -2.601***<br>(-3.58)  | -5.040**<br>(-2.20)  |
| <i>PVIS</i>    | -0.001<br>(-0.02)     | -0.002<br>(-0.07)     | -0.080<br>(-1.04)    |
| <i>EU</i>      | -0.628***<br>(-4.19)  | -0.997***<br>(-5.02)  | 1.582***<br>(4.43)   |
| <i>YCI</i>     | 0.013***<br>(2.51)    | 0.015***<br>(4.03)    | 0.031***<br>(3.54)   |
| <i>Ln IFDI</i> | 0.134***<br>(5.14)    | 0.126***<br>(6.23)    | 0.156***<br>(2.76)   |
| <i>CRE</i>     | 0.000***<br>(2.91)    | 0.000***<br>(2.73)    | 0.000<br>(1.27)      |
| <i>TRDOM</i>   | 0.031**<br>(2.55)     | 0.029**<br>(2.28)     | 0.076**<br>(2.73)    |
| <i>INDOM</i>   | 0.012**<br>(2.20)     | 0.012***<br>(3.47)    | 0.014<br>(1.31)      |
| _cons          | 205.585**<br>(1.98)   | 101.231**<br>(1.17)   | 102.320<br>(0.46)    |
| sigma_u        | 0.654***<br>(4.91)    | 0.556***<br>(5.14)    | 1.578***<br>(5.23)   |
| sigma_v        | 0.178***<br>(19.18)   | 0.174***<br>(17.55)   | 0.483***<br>(19.32)  |
| Mu_cons        | 0.369<br>(1.11)       | -1.164<br>(-0.20)     | -3.951<br>(-0.65)    |
| Log likelihood | 31.913                | 36.672                | -171.942             |
| Prob>chi2      | 0.000                 | 0.000                 | 0.000                |
| N              | 204                   | 204                   | 204                  |

Note: t statistics in parentheses. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

Source: Own creation according to Stata 16.0 regression output.

### 5.3.2 Analysis of regression results

Table 5.3 reflects the parameter estimates for each model. In this stochastic frontier gravity model, except for the degree of political connection (*PVIS*) of the dummy variable, the signs of the coefficients of other explanatory variables are consistent with the expected signs of the theory, which confirms the overall robustness of the experimental results.

In the bilateral trade model (1) between China and CEE countries, the partial regression coefficient indicates that demographic factors, weighted geographical distance and EU membership have an inhibitory effect on trade, and other factors that pass the significance level test can promote the development of bilateral trade. Holding other factors remain unchanged, the effect of each variable on trade is explained as follows:

For every 1% increase in China's GDP, bilateral trade will increase by 0.5% on average; the GDP trade elasticity of CEE countries is 1.175, which contributes more to bilateral trade than China's GDP changes. For every 1% increase in China's population, bilateral trade decreases by 11.876% on average, while the reverse impact of population changes in CEE countries on bilateral trade changes is only 0.422%. For every 1% increase in weighted geographic distance, bilateral trade decreases by an average of 2.937%. EU membership will reduce bilateral trade by an average of 1.8739 (=exp (0.628)) million US dollars. Although the cumulative annual number of Confucius Institutes has a small contribution to bilateral trade with a promoting effect on trade of 1.0131 million UD dollars when there are one more year exitance of the Confucius Institutes. The average bilateral trade elasticity of inward FDI in CEE countries is 0.134. For each increase of 1 point in trade freedom and investment freedom indices, the bilateral trade between China and CEE countries will increase by an average of 1.0315 (=exp (0.031)) and 1.0121 (=exp (0.012)) million US dollars, respectively.

With regards to the model of China's exports to CEE countries (2), the partial regression coefficient indicates that demographic factors, weighted geographical distance, and EU membership effect trade negatively, and other factors which pass the significance level test can promote bilateral trade development. Assuming all other factors are unchanged, the effects of each variable on trade are explained as follows:

Exports from China to CEE countries increase by 0.159% for every 1% increase in China's GDP; the trade elasticity of exports from CEE countries to China's GDP is 1.378, which

has a significant impact on China's exports. The average reduction in China's exports to CEE partner countries is 6.783% for every 1% increase in its population. Comparatively, the reverse effect of population changes in CEE countries on China's export trade changes is only 0.595%. Exports from China to the CEE region decrease by approximately 2.601% for every 1% increase in weighted geographical distance. A membership in the European Union will result in China's exports to CEE countries declining by an average of 2.7101 ( $=\exp(0.997)$ ) million US dollars. Confucius Institutes are beneficial to China's exports to countries in the Central and Eastern Europe region, and consequently, they have a positive effect on export with 1.0151 ( $=\exp(0.015)$ ) million US dollar when one more year existed. China's FDI in CEE countries can also boost Chinese exports to the region. In these regions, China's OFDI contributes, on average, to 0.126% of its exports. China's exports to CEE countries will increase by an average of 1.0294 ( $=\exp(0.029)$ ) and 1.0121 ( $=\exp(0.012)$ ) million dollars for every point increase in the trade freedom and investment freedom indicators in CEE countries, respectively.

In the model of CEE countries exporting to China (3), except for the dummy variable of political ties reflected by the exchange of visits of senior leaders, effect of the population size of CEE countries and the investment freedom index of these countries on their exports to China are not significant. Under the condition that other factors remain unchanged, the effect of each variable passing the significance level test on trade is explained as follows:

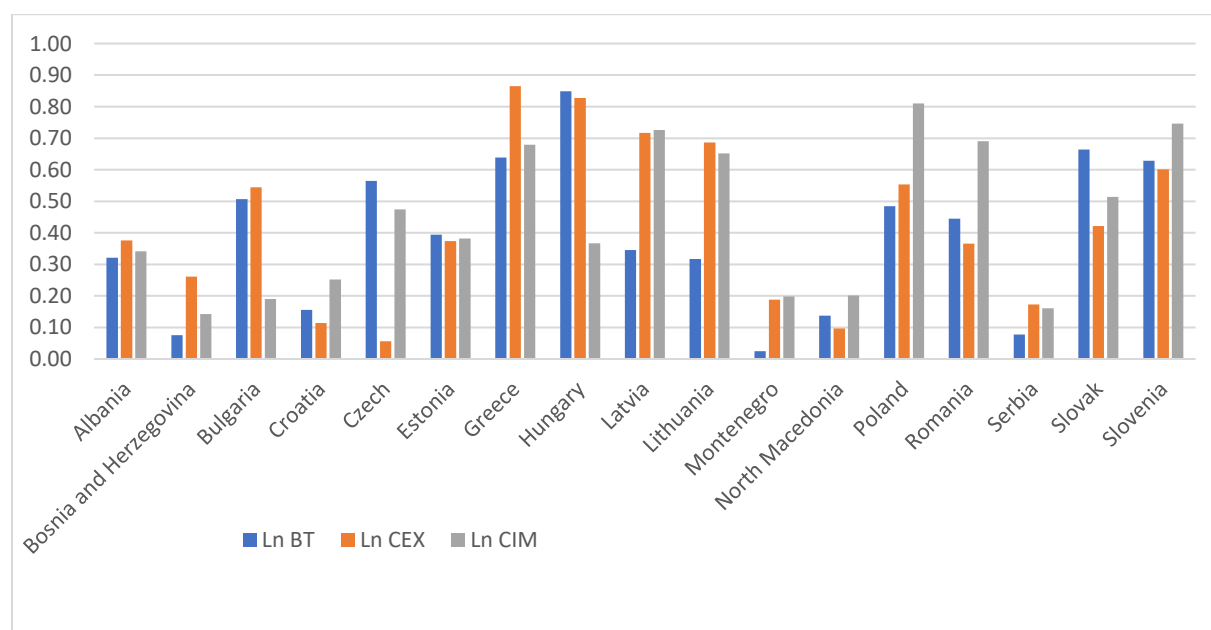
For every 1% increase in China's GDP, China's import trade from CEE countries will increase by 1.577% on average; the trade elasticity of CEE countries' GDP to China's exports to China is 1.010. This comparison shows that CEE countries' exports are mainly driven by demand. Every 1% increase in China's population reduces China's imports from CEE partner countries by an average of 7.601%. For every 1% increase in weighted geographic distance, China's trade value of imports from the CEE region will decrease by an average of 5.040%. EU membership will reduce CEE countries export trade to China by an average of 4.8647 ( $=\exp(1.582)$ ) million US dollars. The cumulative annual number of Confucius Institutes is beneficial to the export of CEE countries to China, and the effect is that the export trade will increase 1.0315 ( $=\exp(0.031)$ ) million US dollars when the existed year adds 1. China's outward FDI in CEE countries can also promote exports from these countries or regions to China. For every 1% increase in China's OFDI in these regions, the average increase in the export trade values of CEE countries to China can pull China from CEE countries by 0.156%. Each increase of 1 point in the trade freedom and freedom index of CEE countries will lead to an increase of 1.0790 ( $=\exp(0.076)$ ) million US dollars in China's import from the CEE countries.

The impact of bilateral high-level visits (*PVIS*) on trade was not significant. One of the reasons behind this is that word processing methods can be inappropriate. Due to the lack of bilateral diplomatic yearbook data database, when citing this indicator, the paper set it as a dummy variable based on the statistical results reported on the official website of the Chinese Ministry of Foreign Affairs, which makes the trend of this variable too flat. Further analysis of the trade effect of this variable is necessary when data are available.

## 5.4 Calculation of trade potential

Trade efficiency (TE) can be obtained according to the formula  $TE_{ijt} = \exp(-u_{ijt})$  and based on the estimation results of the trade inefficiency model. The larger the value, the higher the trade efficiency, which means that the trade barriers between China and CEE countries are smaller; on the contrary, the lower the trade efficiency and the more trade barriers. Figure 5.4 depicts the average trade efficiency between China and 17 countries in the CEE region during 2009-2020.

Figure 5.4 Average trade efficiency between China and CEE countries 2009-2020



Source: Own construction based on the inefficiency model output results in Stata 16.0.

According to Figure 5.4, it can also be found that the average trade efficiency between most CEE countries and China is between 0.3 and 0.8, which is a medium level of trade

development. This shows that there is still some resistance in the import and export trade between China and CEE countries. From the national level, the import trade efficiency, export trade efficiency and bilateral trade efficiency of the four Visegrad countries are generally higher than those of other countries. Less trade barriers benefit from the fact that these countries are at the forefront of regional development, have high levels of trade freedom, and have formed relatively complete infrastructure.

In addition, based on the results of the stochastic frontier gravity model, it is further suggested that China and all the 17 CEE countries still have large trade potential and trade space that can be expanded, which is shown in Table 5.1.

Table 5.1 Estimated trade potential of China and CEE countries in 2020 (unit: million USD)

|                        | Actual trade |       |       | Trade potential |       |       | Trade space to be expanded |      |      |
|------------------------|--------------|-------|-------|-----------------|-------|-------|----------------------------|------|------|
|                        | LnBT         | LnCEX | LnCIM | Ln BT           | LnCEX | LnCIM | BT                         | CEX  | CIM  |
| Albania                | 13.29        | 13.20 | 10.82 | 14.21           | 13.67 | 12.57 | 2.91                       | 2.82 | 3.20 |
| Bosnia and Herzegovina | 13.60        | 13.58 | 9.63  | 14.34           | 13.77 | 12.85 | 2.87                       | 2.76 | 3.80 |
| Bulgaria               | 14.86        | 14.40 | 13.87 | 15.35           | 14.95 | 14.11 | 2.81                       | 2.82 | 2.77 |
| Croatia                | 14.11        | 14.03 | 11.49 | 15.36           | 14.95 | 14.53 | 2.97                       | 2.90 | 3.54 |
| Czech                  | 16.90        | 16.77 | 14.74 | 16.81           | 16.62 | 16.25 | 2.70                       | 2.69 | 3.01 |
| Estonia                | 13.94        | 13.66 | 12.55 | 14.58           | 14.12 | 13.47 | 2.84                       | 2.81 | 2.93 |
| Greece                 | 15.48        | 15.27 | 13.80 | 16.14           | 15.87 | 15.04 | 2.84                       | 2.83 | 2.97 |
| Hungary                | 16.32        | 16.16 | 14.37 | 16.46           | 16.22 | 14.78 | 2.74                       | 2.73 | 2.80 |
| Latvia                 | 13.73        | 13.50 | 12.15 | 14.64           | 14.16 | 13.75 | 2.90                       | 2.86 | 3.10 |
| Lithuania              | 14.35        | 14.11 | 12.79 | 15.07           | 14.68 | 14.07 | 2.86                       | 2.83 | 3.00 |
| Montenegro             | 12.52        | 12.43 | 10.14 | 13.53           | 12.77 | 11.78 | 2.95                       | 2.79 | 3.20 |
| North Macedonia        | 13.55        | 13.30 | 12.01 | 14.06           | 13.46 | 12.30 | 2.82                       | 2.75 | 2.79 |
| Poland                 | 17.22        | 17.10 | 15.04 | 17.67           | 17.49 | 15.67 | 2.79                       | 2.78 | 2.83 |
| Romania                | 15.69        | 15.57 | 13.51 | 16.60           | 16.40 | 14.99 | 2.88                       | 2.87 | 3.03 |
| Serbia                 | 14.58        | 14.39 | 12.83 | 15.42           | 14.98 | 13.91 | 2.88                       | 2.83 | 2.96 |
| Slovak                 | 15.53        | 14.97 | 14.67 | 15.92           | 15.63 | 14.59 | 2.79                       | 2.84 | 2.70 |
| Slovenia               | 14.91        | 14.72 | 13.15 | 15.45           | 15.08 | 14.02 | 2.82                       | 2.79 | 2.90 |

Source: Own construction based on the stochastic frontier model output.

## 6. Conclusion

### 6.1 Main research findings

In the analysis of influencing factors and trade potential calculation of bilateral trade between China and Central and Eastern European countries, this dissertation takes 17 CEE countries as research samples, and conducts research based on national-level trade data released by international organizations such as IMF and UNCTAD. Research. After sorting out the relevant literature, this dissertation analyses the characteristics of trade between China and Central and Eastern European countries from 2009 to 2020. Taking bilateral trade scale, trade structure, trade competitiveness and complementarity as research points, it constructs a stochastic frontier gravity. The model introduces the trade non-efficiency term, takes the economic scale, population, and weighted geographical distance as the core variables, and uses bilateral political connections, EU regional economic organizations, the cumulative annual number of Confucius Institutes, the number of China-Europe railway express, China's foreign direct investment in CEE countries, trade freedom and investment freedom are the variables of trade non-efficiency. Through empirical research, the influencing factors and trade potential of China's trade with 17 countries in CEE region are estimated. The main findings are as follows:

In the feature analysis part of bilateral trade between China and CEE countries, the dissertation finds that the current trade scale between China and CE countries is increasing, but China has been in a trade surplus for a long time, while CEE countries always export less than imports. In terms of trade structure, the trade between these countries is dominated by manufactured products with high added value, while primary products with lower added value make less contribution to bilateral trade. From the analysis of the competitiveness and complementarity of trade, China and CEE countries are more competitive in terms of manufactured products, while primary products have obvious complementarity.

The dissertation uses the time-varying stochastic frontier gravity model to analyze the influencing factors of bilateral trade between China and CEE countries. The study finds that the economic scale level of China and CEE countries, the cumulative number of Confucius in the year, China's foreign direct investment in CEE countries and the Trade freedom has a very significant effect on the total trade volume between the two sides, while demographic factors and weighted geographical distance have a significant inhibitory effect on trade. Although the

China Railway Express has passed the significance test of the model, its trade effect is almost zero, although in addition, the hypothesis test of the model shows that it is appropriate to introduce inefficiency terms in the model.

In addition, this dissertation estimates the trade efficiency and trade potential between China and Central and Eastern European countries through the model. Although the current trade efficiency between China and CEE countries is at a low level, there is a certain trade potential to be expanded with these 17 countries in Central and Eastern Europe.

## 6.2 Policy recommendations

According to the above research findings, in order to promote the close communication and interaction between China and CEE countries and realize the healthy development of the main body of trade activities, the thesis, combined with the previous random frontier empirical analysis results, put forward the following countermeasures and suggestions:

First, adjust the structure of import and export commodities and optimize the balance of trade and investment. The reason why China currently has a long-term trade surplus with Central and Eastern European countries is that on the one hand, the products with a large export share between China and these countries are not very different from the factor endowments of domestic enterprises, resulting in intensified market competition and gradual differentiation.

Second, intensifying cultural exchanges. The establishment of Confucius Institutes in CEE countries helps strengthen cultural exchanges with the host countries, promote multicultural communication, facilitate in-depth understanding of the cultural customs of trading partner countries, clarify local policies and laws, and facilitate the development of trade and investment activities. Avoid adverse events caused by cultural and language differences.

Third, optimize the domestic business environment and improve the logistics infrastructure. The impact of geographic distance on bilateral trade is significant. Gradually improving the infrastructure and improving the level of logistics will help reduce logistics costs. A good business environment can attract more multinational companies to go out of the domestic market and provide products and services in other countries.

## 6.3 Research limitations and future directions

Since the establishment of the China-CEEC cooperation framework in 2012, political, economic, trade and cultural exchanges between China and CEE countries have become more frequent. In order to measure the influence of the degree of political connection, this paper selects the dummy variable of bilateral high-level mutual visits in the absence of bilateral diplomatic data. The downside is that this indicator fails to significantly account for its impact on bilateral trade. And a future research direction is to quantify the degree of bilateral political correlation as much as possible, and simply setting it as a dummy variable will easily lead to large estimation errors. Another research direction is to examine the impact of cross-border population movements and the number of tourists on the country's import and export trade.

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## Appendix

Exhibit 1 Bilateral trade of China-CEECs and China-world

| Year | Trade of China-CEECs |              |            |             |                 | Trade of China-world |                  |
|------|----------------------|--------------|------------|-------------|-----------------|----------------------|------------------|
|      | Export value         | Import value | Net export | Trade value | Growth rate (%) | Trade value          | Growth rate ( %) |
| 2002 | 5.33                 | 1.14         | 4.19       | 6.47        | -               | 621.19               | -                |
| 2003 | 8.05                 | 1.82         | 6.23       | 9.88        | 52.70           | 851.60               | 37.09            |
| 2004 | 10.09                | 2.12         | 7.98       | 12.21       | 23.66           | 1154.46              | 35.56            |
| 2005 | 12.81                | 2.25         | 10.56      | 15.06       | 23.34           | 1422.42              | 23.21            |
| 2006 | 23.17                | 3.24         | 19.93      | 26.41       | 75.31           | 1760.81              | 23.79            |
| 2007 | 27.93                | 4.91         | 23.02      | 32.85       | 24.37           | 2174.09              | 23.47            |
| 2008 | 36.63                | 5.98         | 30.65      | 42.62       | 9.75            | 2560.78              | 17.79            |
| 2009 | 29.79                | 6.25         | 23.55      | 36.04       | -15.43          | 2205.94              | -13.86           |
| 2010 | 38.56                | 9.68         | 28.88      | 48.23       | 33.83           | 2972.35              | 34.74            |
| 2011 | 44.12                | 13.11        | 31.00      | 57.23       | 18.65           | 3640.71              | 22.49            |
| 2012 | 42.41                | 13.68        | 28.73      | 56.09       | -1.98           | 3867.44              | 6.23             |
| 2013 | 43.74                | 15.03        | 28.71      | 58.78       | 4.79            | 4159.96              | 7.56             |
| 2014 | 47.90                | 16.88        | 31.02      | 64.78       | 10.20           | 4306.33              | 3.52             |
| 2015 | 45.86                | 14.38        | 31.48      | 60.24       | -7.00           | 3882.30              | -9.85            |
| 2016 | 48.31                | 15.18        | 33.13      | 63.49       | 5.40            | 3726.06              | -4.02            |
| 2017 | 54.43                | 18.93        | 35.51      | 73.36       | 15.53           | 4112.22              | 10.36            |
| 2018 | 65.98                | 23.63        | 42.36      | 89.61       | 22.15           | 4635.36              | 12.72            |
| 2019 | 70.43                | 24.83        | 45.60      | 95.26       | 6.31            | 4567.50              | -1.46            |
| 2020 | 77.13                | 27.52        | 49.62      | 104.65      | 9.86            | 4658.28              | 1.99             |

Source: Direction of Trade Statistics, IMF; calculation of the author.

Note: The statistics in the Exhibit are based on the reporting country of China. Value unit of the trade indicators is in billion USD.

Exhibit 2 Bilateral trade indicators between CEE region and China by country in 2019

|             | Value (billion USD) |        |             | Value by CEE region (%) |        |             |
|-------------|---------------------|--------|-------------|-------------------------|--------|-------------|
|             | Import              | Export | Total trade | Import                  | Export | Total trade |
| Poland      | 23.91               | 3.94   | 27.85       | 33.94                   | 15.88  | 29.24       |
| Czech       | 12.91               | 4.63   | 17.54       | 18.33                   | 18.64  | 18.41       |
| Hungary     | 6.44                | 3.75   | 10.19       | 9.14                    | 15.09  | 10.69       |
| Slovak      | 2.89                | 5.97   | 8.86        | 4.11                    | 24.03  | 9.30        |
| Greece      | 7.74                | 0.73   | 8.47        | 10.99                   | 2.92   | 8.89        |
| Romania     | 4.56                | 2.32   | 6.89        | 6.48                    | 9.36   | 7.23        |
| Slovenia    | 3.40                | 0.52   | 3.92        | 4.83                    | 2.08   | 4.12        |
| Bulgaria    | 1.55                | 1.16   | 2.71        | 2.20                    | 4.68   | 2.84        |
| Lithuania   | 1.68                | 0.44   | 2.12        | 2.39                    | 1.76   | 2.22        |
| Croatia     | 1.03                | 0.36   | 1.39        | 1.46                    | 1.46   | 1.46        |
| Serbia      | 1.39                | 0.15   | 1.53        | 1.97                    | 0.59   | 1.61        |
| Latvia      | 1.08                | 0.20   | 1.27        | 1.53                    | 0.79   | 1.34        |
| Estonia     | 0.92                | 0.30   | 1.22        | 1.30                    | 1.21   | 1.28        |
| Albania     | 0.60                | 0.10   | 0.70        | 0.85                    | 0.42   | 0.74        |
| North       |                     |        |             |                         |        |             |
| Macedonia   | 0.11                | 0.15   | 0.26        | 0.16                    | 0.60   | 0.27        |
| Bosnia and  |                     |        |             |                         |        |             |
| Herzegovina | 0.11                | 0.08   | 0.19        | 0.16                    | 0.31   | 0.20        |
| Montenegro  | 0.11                | 0.04   | 0.16        | 0.16                    | 0.17   | 0.16        |

Source: Direction of Trade Statistics, IMF; calculation of the author.

Exhibit 3 CEE region merchandise export to China in % under SITC 2016-2020

|               | 2016  | 2017  | 2018  | 2019  | 2020  |
|---------------|-------|-------|-------|-------|-------|
| SITC0         | 1.81  | 1.42  | 1.29  | 1.75  | 1.92  |
| SITC1         | 0.68  | 0.54  | 0.31  | 0.19  | 0.21  |
| SITC2         | 7.10  | 8.21  | 7.50  | 8.07  | 6.55  |
| SITC3         | 0.45  | 0.41  | 0.27  | 0.71  | 1.00  |
| SITC4         | 0.08  | 0.03  | 0.02  | 0.02  | 0.04  |
| SITC0+1+2+3+4 | 10.10 | 10.61 | 9.38  | 10.74 | 9.73  |
| SITC5         | 3.85  | 4.15  | 4.14  | 4.12  | 4.22  |
| SITC6         | 11.28 | 13.64 | 11.55 | 12.38 | 12.59 |
| SITC7         | 61.95 | 59.54 | 63.76 | 61.34 | 62.86 |
| SITC8         | 12.78 | 11.97 | 11.11 | 11.38 | 10.54 |
| SITC          | 0.03  | 0.09  | 0.06  | 0.04  | 0.07  |
| SITC5+6+7+8+9 | 89.90 | 89.39 | 90.62 | 89.26 | 90.27 |

Source: UNCTAD Database, calculation of the author.

Exhibit 4 CEE region merchandise import from China in % under SITC 2016-2020

|               | 2016  | 2017  | 2018  | 2019  | 2020  |
|---------------|-------|-------|-------|-------|-------|
| SITC0         | 0.98  | 0.92  | 0.78  | 0.80  | 0.72  |
| SITC1         | 0.11  | 0.10  | 0.11  | 0.08  | 0.05  |
| SITC2         | 0.60  | 0.69  | 0.75  | 0.53  | 0.44  |
| SITC3         | 0.17  | 0.17  | 0.22  | 0.19  | 0.12  |
| SITC4         | 0.02  | 0.02  | 0.02  | 0.01  | 0.04  |
| SITC0+1+2+3+4 | 1.87  | 1.89  | 1.88  | 1.63  | 1.37  |
| SITC5         | 3.73  | 4.07  | 4.30  | 4.25  | 4.71  |
| SITC6         | 13.61 | 14.01 | 13.94 | 13.53 | 13.69 |
| SITC7         | 53.14 | 51.65 | 52.86 | 53.37 | 55.47 |
| SITC7         | 27.57 | 28.26 | 26.92 | 26.95 | 23.99 |
| SITC8         | 0.07  | 0.12  | 0.10  | 0.28  | 0.77  |
| SITC5+6+7+8+9 | 98.13 | 98.11 | 98.12 | 98.37 | 98.63 |

Source: UNCTAD Database, calculation of the author.