CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of International Studies

UNIVESITY COLLEGE LONDON

School of Slavonic and East European Studies IMESS: Economics & Business

Master's Thesis

2024 **Chao Dan**

CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of International Studies

UNIVESITY COLLEGE LONDON

School of Slavonic and East European Studies IMESS: Economics & Business

Analysis of EU Enlargement on China-EU trade: Based on Gravity Model

Author of the Thesis: Chao Dan

Study programme: IMESS Economics & Business

Supervisor: prof. Vilém Semerák

Year of the defence: 2024

Declaration

1. I hereby declare that I have compiled this thesis using the listed literature and resources only.
2. I hereby declare that my thesis has not been used to gain any other academic title.
3. I fully agree to my work being used for study and scientific purposes.
4. During the preparation of this thesis, the author used DeepL (https://www.deepl.com) and ChatGPT 3.5 (Open AI, https://chat.openai.com) for translation purposes due to as a non-native English speaker. After using this tool/service, the author reviewed and edited the content as necessary and takes full responsibility for the content of the publication

In Prague on 30 July, 2024

Chao Dan

References

CHAO,Dan, *Analysis of EU Enlargement on China-EU trade: Based on Gravity Model.* Praha, 2023. s. Master's thesis (Mgr). Charles University, Faculty of Social Sciences, Institute of International Studies, Department of . School of Slavonic and East European Studies, Supervisor prof. Vilém Semerák

Length of the Thesis: 24533

Abstract

This study examines the impact of the European Union's eastward expansions on trade between the EU and China, leveraging bilateral trade panel data from 170 countries spanning 1996 to 2021. Utilizing fixed effects models and Poisson Pseudo-Maximum Likelihood (PPML) based on the gravity model, our analysis reveals that the EU's expansions have generally promoted trade both within the EU and with third-party countries. Moreover, China's accession to the WTO and improvements in EU institutional quality have positively influenced trade dynamics. Notably, the expansions have boosted overall trade flows between the EU and China. The analysis also highlights the role of indirect exports from the V4 (Visegrád Group) countries to China via advanced EU nations like Germany, within the framework of global value chains. Disaggregated sector-specific data reveal trade diversion effects particularly in the textiles and agriculture sectors post-EU enlargement. The study also highlights the EU's significant reliance on China for advanced technological components and materials critical to sectors like digital infrastructure, renewable energy, advanced manufacturing, and batteries. Finally, the varying impacts of different stages of EU expansion on China-EU trade are demonstrated.

Abstrakt

Tato studie zkoumá dopad východního rozšíření Evropské unie na obchod mezi EU a Čínou, využívajíc k analýze panelová data bilaterálního obchodu ze 170 zemí v období let 1996 až 2021. Při využití modelů s pevnými efekty a metody Poissonova pseudo-maximální pravděpodobnosti (PPML) založené na gravitačním modelu naše analýza odhaluje, že rozšíření EU obecně podporovalo obchod jak v rámci EU, tak s třetími zeměmi. Navíc přistoupení Číny k WTO a zlepšení institucionální kvality EU pozitivně ovlivnilo obchodní dynamiku. Zejména rozšíření podpořilo celkové obchodní toky mezi EU a Čínou. Analýza rovněž zdůrazňuje roli nepřímého exportu zemí V4 (Visegrádské skupiny) do Číny přes pokročilé státy EU, jako je Německo, v rámci globálních hodnotových řetězců. Disagregovaná data specifická pro jednotlivé sektory

odhalují efekty přesměrování obchodu, zejména v textilním a zemědělském sektoru po rozšíření EU. Studie také zdůrazňuje významnou závislost EU na Číně pro pokročilé technologické komponenty a materiály klíčové pro sektory jako digitální infrastruktura, obnovitelná energie, pokročilá výroba a baterie. Konečně jsou ukázány různé dopady jednotlivých fází rozšíření EU na obchod mezi Čínou a EU.

Keywords

Customs Union, EU enlargement, EU-China trade, Gravity Model, Trade Creation and Trade diversion, Trade dependence

Klíčová slova

Celní unie, rozšíření EU, obchod mezi EU a Čínou, gravitační model, tvorba a odklon obchodu, obchodní závislost

Title

Analysis of EU Enlargement on China-EU trade: Based on Gravity Model

Název práce

Analýza vlivu rozšíření EU na obchod mezi Čínou a EU: na základě gravitačního modelu

Acknowledgement

I would like to express my gratitude to my professor Vilém Semerák in the Charles University.I am deeply appreciative of his profound knowledge and scholarly excellence, which have been a continuous source of inspiration for me. His patient guidance and unwavering support were invaluable to me in the completion of my dissertation. Whenever I required assistance, he was consistently available to provide timely and insightful advice. I am deeply appreciative of his dedication and mentorship throughout this journey.

In addition, I would like to extend my sincere gratitude to Dr. Jiri Vykoukal for his assistance and constructive advice during the preparation of this thesis. His insights have been tremendously helpful.

Moreover, I would like to express my gratitude to UCL for providing exceptional academic support and an outstanding scholarly environment.

I would also like to thank my parents and friends for their support and encouragement during the writing of my thesis. Their belief in me has been a source of great motivation.

TABLE OF CONTENTS

Figure List

Table List

1.Introduction

So far, the European Union has undergone three eastward expansions. These expansions increased the EU's area, population, and economic output to various extents and elevated the EU from being China's third largest trading partner to its second largest. The second eastern expansion occurred in 2007 when Romania and Bulgaria officially became EU member states. The most recent, third eastern expansion took place in 2013 with Croatia joining the EU.

As a major trading nation, since establishing diplomatic relations with Europe in 1978, China's interactions with European countries have increasingly intensified. Following its eastward expansion, the EU's position as China's top trading partner has been solidified, and the importance of China-EU trade has grown significantly. However, the trade effects of the EU's eastward expansion have had various impacts on China-EU trade, both positive and negative. The EU is one of China's most important export markets, and this year marks the 20th anniversary of the EU's first eastward expansion, making it a worthy subject of detailed study to ascertain whether it has opened up larger markets or resulted in trade losses. This has significant practical implications for strengthening the economic and trade relations between China and the EU. Thus, the main purpose of this paper is to explore what has been the impact of the EU's eastward expansion on trade between China and Europe? Has it caused a loss of trade or has it led to a larger market?

The existing research gaps are significant. To date, there is a lack of systematic and comprehensive analyses on the impact of EU enlargement on China-EU trade relations. Moreover, as globalization progresses, it becomes crucial to analyze trade from the perspective of the global value chain—a perspective that is often overlooked in the existing literature. Therefore, this study aims to examine China-EU trade from the perspective of the global value chain, specifically assessing how the elevated position of the V4 countries within this chain influences their exports to China.

Furthermore, this study employs an extensive dataset, utilizing panel and trade data from 170 countries over the period from 1996 to 2021. The scope that is notably broader than that typically selected in existing literature. Also, this extensive period under examination will provide more complete and reliable results for the study. Additionally, this research incorporates institutional quality into the gravity model to explore whether the enhancement of institutional quality due to EU enlargement has facilitated an increase in trade flows.

This article employs the customs union theory proposed by Viner and the micro-founded gravity model developed by Anderson and Wincoop in 2003. According to Viner, the effects of a customs union can be delineated into trade creation and trade diversion. The gravity model will be employed to test the presence of trade creation and diversion effects stemming from EU enlargement. Beyond applying the gravity model to aggregated data, this study will also utilize disaggregated data to analyze the sector-specific trade effects of EU enlargement on China. In addition, the paper also uses the gravity model to examine the impact of different stages of EU enlargement on EU-China trade. Besides, the paper also discusses the trade dependence of the EU on China to assess the extent of economic interdependence between the two regions.

The remainder of this article is structured as follows: Section 2 discusses the background of EU enlargement and the recent challenges in China-EU trade. Section 3 is part of the literature review. It provides a comprehensive overview of two key theoretical frameworks: the theory of customs union and the gravity model of trade. Additionally, it examines existing literature on the impact of the EU's eastward expansion on EU-China trade . Section 4 presents a detailed descriptive analysis of trade within the EU and between the EU and China. It encompasses both overall trade patterns and sector-specific analyses to provide a comprehensive understanding of the trade dynamics. Section 5 describes the methodology-based model and the selected variables. Section 6 presents the empirical results and discussion. Section 7 offers an in-depth analysis, including strategic trade dependence analysis and the impact of different stages of EU enlargement on China-EU trade. Finally, Section 8 is part of conclusion

2. Backgrounds

2.1 Preparation for EU enlargement

The Eastern enlargement of the European Union (EU) essentially involved the gradual transplantation of the EU-15's institutional standards and behavioral norms into ten Central and Eastern European countries. In preparation for their accession, these countries aligned their political systems and economic development levels with those of the EU-15. This alignment was facilitated through the sequential signing of various treaties, including the Europe Agreements and the Accession Treaties. These treaties not only prepared these countries for EU membership but also led to an increase in bilateral trade volumes. The integration and Europeanization processes for new EU member states, such as Poland, Hungary, and Slovakia, were characterized by "anticipatory and adaptive Europeanization," where these states adapted to EU norms and policies prior to their official accession. These new member states were primarily "policy-takers" rather than "policy-makers," having initially limited influence on the EU's regulatory framework but were expected to implement extensive EU legislation (Goetz, 2004).

The relationship between the EU and these countries evolved over time, featuring intensive negotiations and stringent conditions for membership encapsulated by the Copenhagen criteria, which adopted in 1993, set comprehensive conditions for EU membership which encompass the maintenance of stable institutions that uphold democracy, legal standards, human rights, and minority protections. Additionally, candidate countries must possess a robust market economy capable of withstanding the internal market dynamics of the EU, as well as demonstrate a readiness to comply with the political, economic, and monetary policies of the union.

Beyond these legal stipulations, an informal acquis emerged—comprising norms and expectations not legally binding on the EU-15—against which candidate countries' readiness for membership was assessed. This assessment process involved the creation of detailed mechanisms for monitoring and evaluating the progress of these candidates as they worked toward meeting the accession criteria (Grabbe, 2002). Furthermore,

from 1991, these new EU member nations began forging institutionalized ties with the EU through the EU Association Agreement.

These agreements facilitated multifaceted cooperation spanning political, economic, and cultural exchanges and included significant trade liberalization in non-agricultural goods. They also mandated the adoption of substantial portions of EU rules and policies (Damis, 1998).

In addition, The Central European Free Trade Agreement (CEFTA), established initially in 1992 by Visegrád Four countries- Republic, Hungary, Poland, and Slovakia- in Central and Eastern Europe, aims to boost regional collaboration and economic growth through increased trade and the reduction of trade barriers among its members. However, the economic advantages expected from the agreement were not consistently achieved, largely due to ongoing political and economic challenges within the region, as noted by Dangerfield (Dangerfield, 2004). Over the years, nations such as Bulgaria and Romania also joined CEFTA, leveraging the agreement to bolster their EU accession process. Ultimately, CEFTA has played a significant role in promoting trade liberalization and preparing new EU members for successful integration into the broader European market

Moreover, the PHARE program, as one of the three primary pre-accession instruments along with ISPA and SAPARD, provided financial support to these new member states to achieve the objectives of the Europe Agreements. Post the 1993 EU Copenhagen Summit, the PHARE program was expanded to include investments in infrastructure to facilitate comprehensive and organic integration of these countries with the EU socially and economically. The program significantly boosted the economies of the Central and Eastern European countries and markedly improved their infrastructure conditions, narrowing the development gap with the EU-15 (Grabbe, 2002).

In general, the EU's strategy towards the new members was focused on ensuring that political, economic, and social adjustments necessary for membership were largely completed before accession, minimizing the impact on the existing EU structure and

policies and ensuring that these countries are well-prepared for the challenges of EU membership.

2.2 EU enlargement process

The European Union (EU), which included political, economic, and diplomatic aspects, is the pinnacle of regional integration. It originated from the European Communities. The evolution of the EU has been intricately associated with processes of expansion and intensification of integration. Throughout its history, the EU has undergone seven enlargements, growing from the original 6 to 28 member states. To date, the EU has carried out three significant eastern expansions.

In May 2004, the first eastward expansions took place, including eight countries in Central and Eastern Europe: Poland, Hungary, the Czech Republic, Slovakia, Estonia, Latvia, Lithuania, Slovenia, Cyprus, and Malta. This enlargement marked the most substantial expansion in the EU's history, from fifteen to twenty five countries. The political and historical significance of this enlargement was profound, as it ended the long-standing division of Europe caused by war, playing a critical role in the long-term achievement of peace and stability in the region. The second eastern expansion occurred in 2007, with Romania and Bulgaria joining the EU. The most recent expansion took place in 2013, when Croatia became a member. However, following the departure of the UK in 2020, the Union now comprises twenty-seven countries.

The interests of the EU and the nations of Central and Eastern Europe coincide with EU eastern expansion. From the EU's perspective, the region offers rich natural resources, high-quality labor, and geographical connection. The inclusion of these countries provides the EU with new sources of raw materials, a vast potential market, and an affordable labor force. Post-enlargement, the better allocation of resources and the development of scale economies enhance the EU's competitiveness internationally. Geopolitically, expanding eastward increases the EU's territory and serves as a buffer against Russian influence, enhancing the Union's autonomy from both the USA and Russia, thus securing its own safety and developmental interests. For the member

nations of Central and Eastern Europe, joining the EU entails having access to a single internal market as well as increased financial assistance and agricultural subsidies from the EU. Given that agriculture plays a significant role in the economies of many Central and Eastern European countries, some of these nations have strategically focused on leveraging the EU's Common Agricultural Policy (CAP). The CAP provides substantial support to their predominantly agricultural economic structures, facilitating modernization, increased productivity, and market access. This policy alignment is particularly evident in countries like Poland, where the agricultural sector constitutes a major component of the national economy (Richardson, 2006).

Figure 1 EU enlargement process

Year	New Member	Total number of member States
1973	United Kingdom, Denmark, Ireland	9
1981	Greece	10
1986	Portugal, Spain	12
1995	Finland, Sweden, Austria	15
2004	Poland, Hungary, Czech Republic, Slovakia, Cyprus, Malta, Slovenia, Estonia, Latvia, Lithuania	25
2007	Bulgaria, Romania	27
2013	Croatia	28

2.3 China-EU relation

2.3.1 EU's actions and perspective

Since the establishment of official relations in 1975, the European Community (EC) and the People's Republic of China (PRC) have progressively deepened their trade and economic ties. This relationship was initially formalized through a trade agreement signed in April 1978, followed by a textile agreement in 1979. The 1978 EU-China Trade Agreement was a significant achievement for both the European Community and China, marking the beginning of a long and evolving relationship. Besides, the 1978 agreement was subsequently replaced by the 1985 Trade and Economic Cooperation Agreement, which shifted the focus towards broader economic cooperation and investment targeted key sectors such as industry, mining, agriculture, science and technology, energy, transport, and communication (Colin,2010). Furthermore, the EC's

inclusion of China in the Generalised System of Preferences (GSP) scheme in 1980 markedly increased China's exports of industrial products to the EU, making China the principal beneficiary of the scheme, with over 30% of all EU preferential imports under GSP (Hu & Watkins, 1999).

However, in the 1990s, political tensions led to a significant setback in China-EU relations, impacting economic and trade exchanges to a notable extent. Consequently, the period from 1989 to 1994 marked a low ebb in the development of economic and trade relations between China and the EU. Subsequently, the landscape began to change positively in the fall of 1994 when Chinese President Jiang Zemin visited Europe, which effectively re-opened the doors to renewed economic and trade cooperation between China and the EU. In 2003, the European Union elevated its relationship with China to a new level, significantly enhancing their bilateral relations. In June 2003, the European Commission, in its first-ever security strategy report, designated China as a "strategic partner," placing it alongside the United States, Russia, Japan, and Canada (European Commission, 2003).

Over the past decades, the relationship has evolved into a strategically significant one for the global economy, especially with China's rise as a major economic force and the primary global manufacturing center in the late 20th century. China's accession to the WTO had an effect on the country's trade liberalization process and facilitated China's better integration into the global economy (Karkanis, 2018). Rumbaugh and Blancher propose that China accession into WTO would benefit to its trading partner, particularly through the liberalization of critical sectors such as agriculture and services. Enhancements in the predictability and transparency of China's business practices are anticipated to bolster confidence among foreign investors (Rumbaugh & Blancher, 2004). However, in 2016, the European Union introduced a new policy document regarding China. This document notably emphasized the mutual benefit in political and economic relations between the two parties, specifically highlighting the promotion of fair competition in various fields under the principles of "reciprocity" and equal participation. Despite its focus on reciprocity, the overall tone of the document

remained positive, ultimately describing China as "a comprehensive strategic partner of the EU"(European Commission, 2016).

Then in its 2019 policy document, where the European Commission for the first time categorized China as a partner, competitor, and rival, it was noted that "Europe is increasingly aware that the balance between the challenges and opportunities presented by China has shifted" (European Commission, 2019). It is important to note that the EU's tripartite positioning of China, or more precisely its threefold characterization of relations with China, has become a central tenet of its current and future policy towards China. This new understanding of China has resulted in EU policies exhibiting unprecedented characteristics of cooperation, competition, and confrontation.

In recent years, a series of measures adopted by the EU reflects a sense of competition, precaution, and protectionism towards China. A 465-page working document released by the European Commission in December 2017 identified major economic inefficiencies in China and offered "legitimacy" for the imposition of anti-dumping duties ion Chinese imports (European Commission, 2017). On April 11, 2019, the "EU Framework for the Screening of Foreign Investments" officially came into effect. Following the publication of the "White Paper on Foreign Subsidies Leveling the Playing Field" on June 17, 2020, the European Commission formally introduced a draft legislation on foreign government subsidies on May 5, 2021. The latter two legislations are primarily directed at China (European Commission, 2020).

Furthermore, in March 2021, the European Union, along with Canada, the United Kingdom, and the United States, primarily concerning sanctions related to human rights issues in Xinjiang. In response, China implemented countersanctions against the EU. Subsequently, the European Parliament froze the approval process for the Comprehensive Agreement on Investment (CAI), which had been under negotiation for seven years and underwent 35 rounds, between China and the EU in May 2021. What was once considered the cornerstone of EU-China economic and trade cooperation increasingly fell into the vortex of politicization (Mendes, 2023).

2.3.2 17+1 Initiative

Perspective of China

From the perspective of China, it has actively launched various policies to promote economic and trade relations and cooperation with the EU. For example, The Belt and Road Initiative, announced in 2013 by Chinese President Xi, is China's ambitious global development strategy that aims to enhance global trade and stimulate economic growth across Asia and beyond through development and investments in infrastructure projects such as roads, bridges, railways, and ports. Moreover, the 16+1 Initiative, now known as the 17+1 Initiative after Greece joined in 2019, is one of initiative under the BRI. However, the initiative saw a reduction in membership due to geopolitical tensions and dissatisfaction with the outcomes of the cooperation. Lithuania was the first to leave the group in May 2021.Following Lithuania's exit, Estonia and Latvia also withdrew from the initiative in August 2022, bringing the Initiative down to 14+1. That Initiative was preceded by the "12 measures plan," which had been introduced earlier by Chinese Prime Minister Wen Jiabao was designed to promote Chinese investments in Central and Eastern Europe (CEE) and enhance overall economic cooperation. The Belt and Road Initiative (BRI) aims to enhance cross-border infrastructure, thereby reducing trade barriers by reducing transportation costs across the vast region between China and Europe (Dell'Aguzzo & Diodato, 2022).

Perspective of EU

For the EU, the BRI presents both opportunities and challenges. According to Herrero and Xu, they suggest that landlocked EU countries can benefit from China's BRI policy because of lower transport costs (Herrero & Xu, 2017). Li, Bolton, and Westphal furthermore employ multiple regression analysis to explore the impacts of the Belt and Road Initiative (BRI) on China's trade relationships, particularly with European partners. The result illustrates that there are positive impacts of BRI on China's exports to Central Asia and Europe, particularly in manufactured goods, machinery, and miscellaneous manufactured articles. The impact on imports into China from these countries was not significant overall but showed positive trends in specific categories like food and live animals (Li et al., 2018). As the initiative progressed, the EU's perspective shifted toward a skepticism attitude. A primary concern among EU

institutions, certain member states, and business entities revolves around the sustainability of debt incurred by participating countries. Critics fear that these debts could lead to economic dependency on China, a scenario often described as "debt-trap diplomacy"(Pantucci, 2021; Dell'Aguzzo & Diodato, 2022). In addition, The BRI poses a competitive threat to European companies, as Chinese firms are often the primary beneficiaries in terms of project contracts, especially for state-owned ones. This situation makes it challenging for European firms to secure infrastructure deals. Besides, the formation of bilateral agreements under the BRI between China and individual EU states also threatens EU cohesion (Dell'Aguzzo & Diodato, 2022). Thus, while the BRI offers substantial infrastructure development opportunities, it presents significant challenges.

2.4 Methods of Trade Protection in the European Union and China

2.4.1Tariff Barriers

Upon accession to the European Union, new member states are required to adopt the EU's Common External Tariff (CET). This alignment process adjusts any pre-existing bilateral tariffs on Chinese goods to CET levels, potentially lowering tariffs for member states with previously higher tariffs or raising them for those with lower tariffs. This standardization seeks to simplify trade within the EU, yet simultaneously introduces new trade barriers for non-EU nations such as China (Sapir, 2001). In many cases, this alignment results in higher tariffs for Chinese goods in these new member states compared to the lower tariffs they may have had before joining the EU. Post-enlargement, the Eastern European countries were integrated into the EU's external trade policy framework. Before joining the EU in 2004, Poland applied a 2% tariff on imported Chinese electronics to stimulate trade and access to affordable products. However, upon accession to the EU, Poland was required to adopt the Common External Tariff (CET), which standardized tariffs across all member states. Consequently, the tariff on Chinese electronics in Poland increased to 5% (Delpech & Paugam, 2005). Besides, existing reciprocal trade agreements with China became

invalid, and many Chinese exports previously enjoying the Generalized System of Preferences (GSP) faced withdrawal from the GSP has had a negative impact on Chinese exports to the EU. With the eastward enlargement of the EU, more Central and Eastern European countries have joined the EU, which are themselves beneficiaries of the GSP. This has led to pressure for a reallocation of GSP resources, indirectly pushing for an adjustment of GSP policies to ensure equity and effectiveness in the allocation of its resources.Continuous graduation of certain sectors under the GSP's graduation mechanism began upon its implementation, culminating in the complete cessation of preferential treatment for China as of January 1, 2015. This decision followed the reclassification of China as a middle-upper income country for three consecutive years starting in 2013(EU Commission, 2015)

Moreover, there has been a notable increase in the implementation of anti-dumping duties (Lu et al., 2014). The EU's eastern enlargement has heightened internal protectionist measures, notably increasing the usage of anti-dumping and anti-subsidy actions against countries outside the EU to protect its industries from perceived unfair competition. (Durusoy et al., 2015). This is partly due to the new demands for market protection brought about by the newly acceded member states, but also due to the reorientation of the external trade policy of the EU as a whole. An illustrative example occurred when the EU imposed a provisional anti-dumping duty of 73% on ceramic tiles imported from China, citing that these products were being sold within the EU at prices lower than in China’s domestic market, which adversely affected comparable EU industries (EU Commission, 2011a). Therefore, a range of tariff barriers including normal tax tariffs as well as anti-dumping and anti-subsidy duties, continue to pose significant obstacles to EU-China trade.

2.4.2Non-tariff barriers

Non-tariff barriers (NTBs) cover a diverse array of quotas, subsidies, and regulatory measures including sanitary and phytosanitary (SPS) standards and technical trade barriers (TBTs). These barriers are typically more intricate and difficult to quantify compared to tariff barriers (Maskus & Wilson, 2001). The European Union makes extensive use of subsidies to bolster its agricultural sector as part of the Common

Agricultural Policy (CAP), which aims to promote the growth, productivity, and stability of agriculture within the EU through mechanisms such as direct payments and production quotas (Wickman, 2003).

In addition, EU is also progressively establishing non-tariff barriers. Most member states now favor the implementation of technical barriers that curtail the export of Chinese products to safeguard the interests of the newer member states. The EU imposes technical barriers on imports, primarily consisting of myriad, often updated technical regulations and standards that demand stringent compliance, including strict packaging, labeling, and labor protections. Additionally, environmental and health safeguards, known as "green barriers," enforce rigorous, extensive, and evolving standards. Collectively, these barriers significantly hinder the progress of trade between China and the EU (Lu et al., 2014). The technical trade barriers of the European Union are not only extensive but also strict in terms of technical standards. Besides having unified standards across the EU, each member state also has its own technical standards. The EU's ongoing arms embargo against China is maintained due to concerns over human rights abuses and potential security issues within China. Despite these concerns, some EU member states have recently debated whether to lift the embargo but face significant opposition from the US and Japan (Putten,2009).

Similarly, China implements a variety of subsidy strategies aimed at protecting and promoting its high and new technology industries. These subsidies are part of a broader approach to industrial policy that seeks to elevate sectors deemed strategically important for national economic development. Beyond subsidies, China also imposes a high amount of non-tariff barriers in terms of quotas and certification regulations, alongside currency exchange controls, as part of its arsenal of non-tariff measures (Imbruno, 2016).

2.5 China -EU Trade Overview

The development of trade between China and Europe

Trade between the EU and China can be divided into three main phases. The first phase was from 1978 to 1989, then from 1990 to 2002, and then from 2003 to the present.

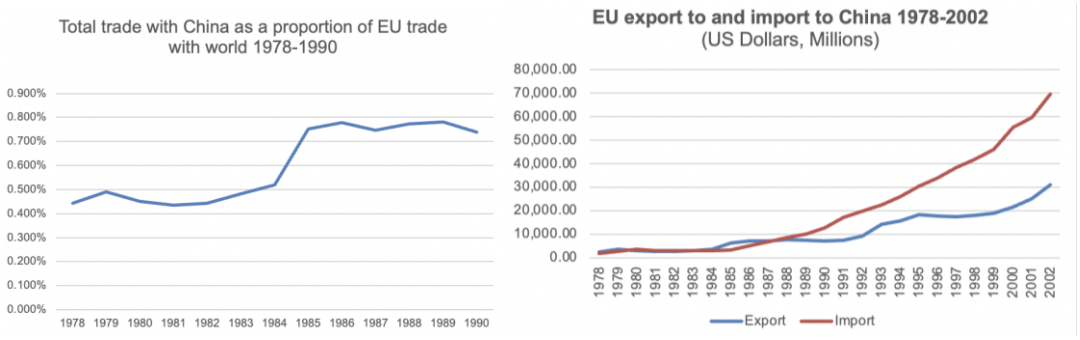
1)1978 to 1989 - Early Trade Development and European Protectionism

China established diplomatic relations with the European Economic Community (EEC) in 1975. By 1981, bilateral trade between China and EU had grown to $5,708.17 million, and by 1986, it had reached $12,157.5 million. The volume of China-EU trade nearly doubled every five years. Following the official establishment of relations in 1975, economic and trade relations developed more rapidly compared to the period before formal diplomatic ties were established. However, towards the end of the 1980s and the beginning of the 1990s, a significant portion of Chinese exports to the EU was subject to tariffs and non-tariff barriers (NTBs), and there was little China could do to influence these trade restrictions due to the protectionism of EU. For example, China's exports of textile and clothing products to the EU are subject to strict quota restrictions (Bieliński et al., 2019). In addition, China was a beneficiary of the EU's Generalised System of Preferences (GSP) during this period, which allowed a large number of products to enter the EU market at a price advantage, boosting the trade between China and the EU.

2)1990 to 2002 - Strengthening Trade Relations Amid Continued EU Protectionism

Between 1989 and 1991, for political reasons, the growth of trade between China and Europe began to slow down, with negative growth in 1990 and 1991, and an average annual growth rate of only 5.68 percent during this period. While the EU maintained certain protectionist measures, trade relations were increasingly driven by China’s growing economic prominence. During this phase, China's growing economic influence began to shift the balance, yet the EU maintained considerable leverage through protectionist policies. After 1991, the overall volume of trade flows between China and EU trade still showed an upward trend. Besides, the Uruguay Round, concluding in 1994, established the WTO, leading to widespread trade liberalization. China's 2001 WTO accession, a direct result of the Uruguay Round, significantly boosted its trade with the EU. The phase-out of the Multi-Fibre Arrangement (MFA) during the Round was expected to benefit China's textile exports, although concerns about new protective measures like anti-dumping duties remained (Hamilton & Whalley, 1995).

Figure 2 EU trade with China 1978-2002



Source: DOTS database, IMF

3) 2002 to now-Post-WTO Accession - Increased Politicization of EU-China Relations

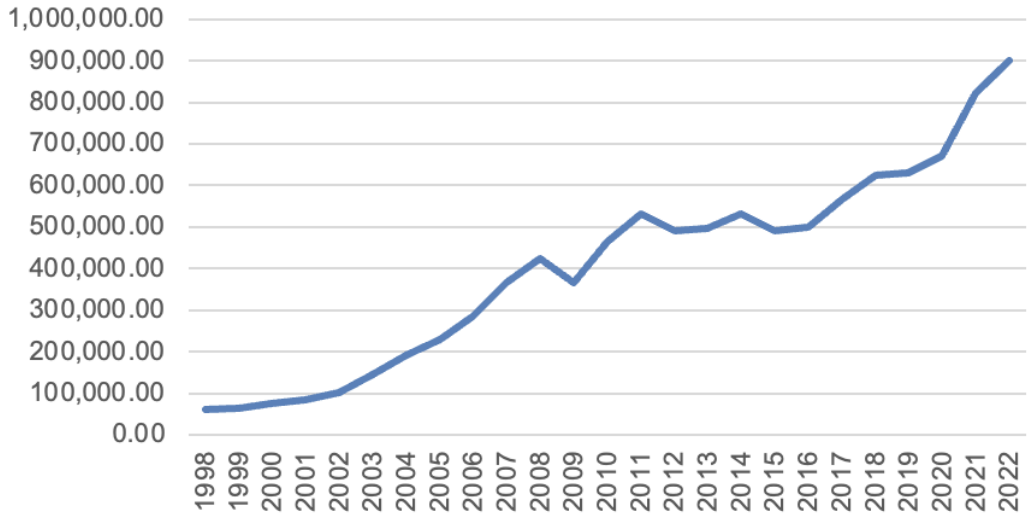
China's accession to the World Trade Organization (WTO) in 2001 marked a pivotal transformation in its trade relations with the European Union (EU). This event heralded a new era characterized by an increasing parity between the two economic powerhouses. This stage of the China-EU trade relationship is delineated by the mutual adaptation to WTO rules, escalating trade volumes, and a complex interplay of cooperation and contention within the legal frameworks established by the WTO.

Post-WTO accession, China experienced unprecedented economic growth, becoming one of the world's largest economies. According to the World Bank, China's GDP grew from approximately USD 1.33 trillion in 2001 to over USD 14.34 trillion by 2019, reflecting an average annual growth rate of about 9.52% during this period. Concurrently, the EU emerged as one of China's largest trading partners. The European Commission reports that by 2020, China surpassed the United States to become the EU's biggest trading partner, with bilateral trade in goods worth over €586 billion.

Moreover, this period also witnessed significant politicization of trade issues, where economic interests were increasingly influenced by broader geopolitical considerations. The EU's trade strategy began to reflect a dual approach towards China, aiming to balance the economic benefits of free trade with the need to protect its own market from perceived unfair competition. This strategy was evident in the imposition of trade defense instruments such as anti-dumping and countervailing duties. Notably,

the EU imposed significant anti-dumping duties on Chinese solar panels in 2013, which led to a major trade dispute resolved partially by negotiated settlement.

Figure 3Total trade volume between China and EU



3. Literature review

3.1 Theory of Customs Union

The framework of Customs Unions was proposed by Viner in 1950. He divided the trade effects of Customs Unions into trade creation and trade diversion (Viner,1950). Further Meade and Lipsey analyze the consequences of joining Regional Trade Agreements in terms of welfare effects. Lipsey introduced the Second Best Solution (SBS) in customs union creation (Meade,1955; Lipsey, 1957). Customs unions theory addresses the economic effects that arise when a group of countries agree to eliminate tariffs and adopt a common external tariff among themselves, forming a customs union.

3.1.1Static effects

Viner defines and illustrates the static effect of the customs union in terms of trade creation and trade diversion. Trade creation embodies a welfare increasing process in which trade between member countries becomes easier due to the removal of tariffs within the Union. In this situation the goods import from other countries which outside the Union will be replaced by importing from the union. In this situation, relatively inexpensive imports from Union member nations might take the position of commodities that were formerly produced at a greater cost domestically. Additionally,

trade creation allows the country to reallocate its resources toward producing goods that are more cost-effective and competitive. (Viner, 1950). Conversely, trade diversion is characterized by the substitution of cheaper goods from countries outside the EU with higher-priced goods from within the EU. This shift occurs because the customs union eliminates tariffs between member countries and imposes a common external tariff against non-member countries, making imports from member countries relatively cheaper despite their higher production costs compared to the other countries. In this situation, the shift in trade flows is detrimental to global economic welfare because it creates distortions in favor of internal producers and against external producers even though external producers are more competitive (Boronenko, 2017). In essence, trade creation denotes the expansion of trade volume that results from the removal of tariffs and non-tariff barriers among member countries. Trade diversion, however, signifies the realignment of trade flows, where trade among member countries supplants that between member countries and non-members following the formation of a customs union, leading to a reallocation of trade activities.

3.1.2Dynamic effects

Bela Balassa points out that the formation of a customs union can lead to several changes, including increased competition, economies of scale, enhanced capital formation, technological advancements, and improved terms of trade (Balassa, 1961). Expanding on Balassa's framework, Brada and Mendez delve deeper into the dynamics of customs unions, highlighting how integration not only boosts the growth rates of factor inputs like labor and capital—thereby enhancing output growth—but also accelerates technological progress. This acceleration in technological development ensures sustained output growth, independent of input growth rates (Brada & Mendez, 1988).The EU's eastward expansion exemplifies these effects through the free movement of goods, services, capital, and labor, facilitating significant west-to-east capital mobility and east-to-west labor migration. Post-enlargement investment from EU-15 into Central and Eastern Europe (CEE-10) in sectors such as energy, retail, automotive, banking, and telecoms has significantly enhanced the productivity and economic prosperity of the CEE-10 countries. This influx of technology, know-how,

and capital has been pivotal in boosting productivity. Furthermore, Balassa posits that customs unions stimulate economic growth by attracting external investment, thereby enriching the union's economic dynamics (Balassa, 1961). Supporting this, Baldwin and Seghezza demonstrate through the use of EU member state dummy variables that EU accession positively impacts technology spillovers, reinforcing the benefits of integration (Baldwin & Seghezza, 1996). Additionally, Brada and Mendez's 1988 panel regression analysis reveals a significant positive correlation between investment shares and EU membership, aligning with Balassa's observations (Brada & Mendez, 1988). Furthermore, the rate of return on capital may increase due to improvements in terms of trade. Savings will be encouraged, foreign direct investment will increase, and capital creation will be boosted as a result. This might boost output even further (Lejour et al., 2001).

Overall, EU enlargement has expanded the single market, allowing businesses to access a wider consumer base and scale up production, thereby reducing unit costs through economies of scale. This not only improves productivity but also increases the diversity of goods and services and leverages advanced production technologies effective at higher outputs. These interconnected dynamics underscore the profound impact of integration on fostering economic growth and technological progress within the EU (Papazoglou et al., 2006).

3.2 Trade Effects of EU Eastern Enlargement

3.2.1 Static Trade Effects of the EU Enlargement

Trade creation

There are many scholars who have studied the static trade effects of EU enlargement. Most of them believe that EU enlargement would bring not only trade creation but also trade diversion. Baldwin et al use a method of estimating the reduction of trade costs. They quantify that the trade costs between the new member states and the older EU member states had decreased by 10% (Baldwin et al., 1997). Keuschnigg and Kohler (2002) also use this method, but they found that a decrease in trade costs of

5% between the new and old member states' bloc after the EU's eastward expansion would be more appropriate (Keuschnigg & Kohler, 2002). This reduction in trade costs would facilitate intra-EU member States' trade transactions to create trade creation. The research findings by Nahuis indicate that the benefits of market integration of EU enlargement are unevenly distributed across sectors, with significant trade creation in areas like Agriculture, Textiles, and Food Processing due to lowered non-tariff barriers. (Nahuis, 2004).

In addition, according to the study conducted by Papazoglou, Pentecost and Marques in 2006, they employ a gravity model to analyze the effects of the 2004 EU enlargement on trade balances and patterns. They find that accession EU countries members experience a 25% increase in trade relative to their 2003 levels, indicating significant trade creation. (Papazoglou et al., 2006). Besides, Egger and Pfaffermayr analyze the trade effects of EU enlargement from 1960 to 2001, finding that the expansion of the EU initially generated significant trade creation effects. Their study also reveals that trade grew more rapidly between core and periphery countries, as well as among periphery countries, compared to trade among core countries (Egger & Pfaffermayr, 2013).

Trade diversion

The eastward expansion of the EU has impacts not only on member states but also on non-member countries. The expansion leads to an increase in the proportion of intra-regional trade, while reducing the dependency on external trade. As a result, non-EU member countries are affected by trade diversion effects and may lose some trade opportunities. Hiro Lee and Dominique van der Mensbrugghe believe that the trade diversion effects generated by the EU's eastward expansion do not have a significant economic impact on European countries outside the EU, but they have a greater impact on the low-income countries in ASEAN and China. This is because these countries have similar factor endowments and levels of economic development to the new EU member states, and there is a high substitutability in their exports to the EU, especially in industries such as food processing, clothing, textiles, raw material supply, primary product production, and transport equipment (Lee & Van Der Mensbrugghe, 2004).

Besides, the results of Papazoglou, Pentecost and Marques reveal that EU integration increases trade flows, with notable trade diversion from non-EU countries to EU members, particularly affecting exports to North America and the Far East. (Papazoglou et al., 2006)

Consequently, after the expansion, the ten new member countries, with their geographical advantages and the convenience of EU regulations, are likely to replace these countries to a large extent. The new member states have gained full EU membership status and have joined the unified EU market, which has greatly reduced trade costs, fostered the development of intra-EU trade, and reduced trade with economies outside the region, leading to trade diversion.

3.2.2 Dynamic effect trade effect of the EU enlargement-comparison of welfare gains in original and newly acceded EU member states

The positive effect of the EU's eastward expansion on economic welfare was predicted by Baldwin and other scholars in 1997(Baldwin et al, 1997). Then, many scholars utilize the computable general equilibrium model to assess the economic impacts of EU enlargement on Central and Eastern European countries. Scholars prefer to focus on the effects of joining the customs union, accessing the internal market, and labor mobility. Their findings indicate EU enlargement has brought more benefits to the new accession countries than to the old EU members. Lee and Van Der Mensbrugghe findings indicated that the expansion could raise the real income level of the new member states by 2% to 6.6%, while the income level of the original fifteen countries would only increase by 0.2% (Lejour et al., 2001; Lee & Van Der Mensbrugghe, 2004; Breuss, 2003). Furthermore, Rapacki and Próchniak (2009) employed neoclassical economic theory and endogenous growth models, along with cross-sectional data for regression and correlation analysis, and concluded that the eastward expansion of the EU significantly propelled economic growth in the new member states (Rapacki & Próchniak, 2009).

However, some scholars, such as Deardorff and Stern, contend that the EU's eastward expansion and the resulting integration would have a minimal long-term effect on growth. Employing a trade theory model based on economies of scale, they

demonstrated that the original fifteen EU member countries would benefit from the expansion due to increased returns from the enlargement of market size. In contrast, the gains for the new member states would be very limited. Although Deardorff and Stern's model provides an effective analytical framework for explaining the impact of economies of scale on manufacturing, they also acknowledge the limitations of their model's predictive capacity. Specifically, the model is somewhat simplified and does not fully take into account the economic diversity and complex interactions between member states, making it difficult to accurately predict how the economic welfare of the original fifteen and the ten new member countries will change after the EU's expansion (Deardorff & Stern, 2004).

3.3 Trade effects of EU enlargement on China

Scholars hold differing views on whether EU enlargement would cause trade diversion to China. The impact of the EU's eastward enlargement on China-EU economic and trade relations has two sides. Some scholars argue that EU enlargement will promote China-EU trade, while others contend that it will inhibit it.

3.3.1 EU enlargement will boost China-EU trade

Market Expansion and more investment opportunities

Several researchers believe that the expansion of the EU provides a market with greater consumer potential for China. This is due to the significant economic disparities between the newly acceded countries and the original fifteen. Specifically, Flemming suggested that integration has influenced investment and profitability factors that are closely tied to wage pressures (Flemming, 1987). In addition, Stanojevic and Qiu mention that the integration of Central and Eastern European Countries (CEEC) into the EU has led to a more unified and regulated market, enhancing trade volume and diversity of traded products with China (Stanojevic & Qiu, 2022). Hence, following the EU's eastward expansion, the reduction of internal tariffs and the elimination of trade barriers would inevitably increase the circulation of goods and broaden the levels of

consumption, providing Chinese enterprises with opportunities to expand their market in Europe (Yingrui, 2002).

Improve institutional quality

Anderson and Marcouiller find that countries with stronger institutions, capable of enforcing contracts and implementing transparent and impartial government policies, experience significantly higher trade volume (Anderson & Marcouiller, 2002). Then, Koukhartchouk and Maurel further explore how joining international institutions like the WTO and the EU influences trade patterns. They incorporate these variables that represent institutional quality into their analysis to assess the trade impacts on CEE countries (Koukhartchouk & Maurel, 2003). Moreover, based on the study of Hagemejer, Michałek and Svatko, their study also highlights the crucial role of economic institutions in shaping the outcomes of EU integration, suggesting that better institutional quality leads to more pronounced economic benefits (Hagemejer et al., 2021).

3.3.2 EU enlargement will inhibit China-EU trade

Trade diversion effect

Lee and Van Der Mensbrugghe's analysis indicates that the eastward expansion of the EU has an insignificant impact on East Asia, including China, despite China being a major direct competitor with East European producers. The sectors identified as potentially vulnerable to increased competition from Eastern Europe include textiles and apparel, where East Asia—China included—could encounter heightened competitive pressures (Lee & Van Der Mensbrugghe, 2004). However, some scholars believe that the EU's eastward expansion indeed have a negative impact on China-EU trade. This is mainly due to the fact that EU enlargement would bring trade diversion effects to third countries and thus reduced China's trade volume with EU. As tariff barriers within the European Union are eliminated, member states are likely to trade more goods and services with each other due to reduced costs and increased accessibility. Consequently, EU member states may increasingly source imports from within the Union instead of from external countries such as China. Besides, Akram and Rashid use a detailed fixed-effect gravity model to analyze import and export data

among EU countries from 1988 to 2008. They noted that the European Union significantly boosts trade interactions among its members. However, this intensification within the Union appears to come at a cost to external trade relations, evidenced by a concurrent decline in trade volumes with non-member nations (Akram & Rashid, 2016).

Protectionism policies

Anti-dumping duty

Durusoy et al review a lot of protectionism policies taken by EU. He concludes that the eastern enlargement of the European Union has intensified internal EU protectionism, leading to an increased use of anti-dumping and countervailing measures against non-member countries, thus generating more trade frictions (Durusoy et al., 2015). As new countries with potentially less developed economies join the EU, there is an increased focus on protecting these fragile economies from external competitive pressures, often resulting in increased protectionist measures. This is done to ensure that industries in newer member states are not overwhelmed by imports from non-EU countries, allowing them time to adjust and become competitive on a larger European scale. In addition, according to the "EU Commission Report on China in 2024", the reason for EU taken protectionism policy is that EU argues that certain Chinese industries benefit from state subsidies, leading to dumping practices where goods are sold below the cost of production, harming EU manufacturers. Besides, a more common reason for for protectionist policies of EU is to protect EU domestic industries, especially those at a disadvantage in international competition. These policies include tariffs, quotas, and other trade barriers designed to reduce the impact of imported products on the local market, thereby protecting jobs and the stability of supply chains . Additionally, the EU is concerned about the influence of the Chinese government in its economic operations, which can distort prices and competitive conditions in the global market, including the manipulation of raw material exports that affects their availability and pricing. The integration of new member states into the EU imposes stringent standards that can act as barriers.

Uprasen indicates that non-trade barriers (NTBs), including sanitary and phytosanitary measures, significantly affect China's exports to the EU, with varying

impacts across different product categories. For example, technical barriers to trade (TBTs) can both encourage and hamper exports depending on the product type (Uprasen, 2014). Chinese exporters incur considerable compliance costs due to the EU's rigorous technical standards and regulations, which require significant investments in testing, certification, and modifications to production processes. These stringent safety and quality standards have notably diminished Chinese agricultural exports to the EU (Yang et al., 2015). The complexity and diversity of these standards compromise the competitiveness of Chinese products. For instance, Yao (2021) highlights that Chinese tea exports are adversely impacted by global technical barriers, such as strict pesticide residue limits, leading to extensive testing, certification delays, and increased costs (Yao et al., 2021). Additionally, EU protectionist policies negatively impact China-EU trade relations, with internal EU protectionism further affecting trade (Tao & Ma, 2003).

Increase competition -Comparative Advantages Between China and EU

Qiu et al. employed a global trade analysis model along with the China Agricultural Decision Support System to investigate the agricultural trade dynamics between China and the Association of Southeast Asian Nations (ASEAN) (Qiu et al., 2007). Building on this foundation, He, Z. Huang, et al. (2016) utilized the Revealed Comparative Advantage (RCA) and Trade Complementarity Index (TCI) to analyze the competition and complementarity in agricultural trade between China and countries involved in the Belt and Road Initiative. Their findings indicated that while both competition and complementarity exist within these trade relationships, the aspect of complementarity is more pronounced. However, the findings of Yu and Qi propose that China holds a significant competitive edge in labor-intensive industries, though its agricultural products tend to be less competitive on the global stage. In contrast, countries like Poland and Lithuania showcase greater comparative advantages in agriculture than China, highlighting their stronger positions in this sector (Yu & Qi, 2015).

Additionally, the presence of numerous complementary agricultural goods between China and the Central and Eastern European (CEE) nations indicates substantial potential for commerce in agricultural products. These complementary relationships suggest that there are significant opportunities to enhance trade in this sector, benefiting

both China and the CEE countries (Yu & Qi, 2015). Besides, Langhammer and Schweickert discussed the impact of EU integration on the Asian countries. Their analysis demonstrates, through the calculation of trade overlap indices, that there is a growing trend of export competitiveness in the EU market between Asia and the 10 new member countries, posing challenges for trade relations with Asia (Langhammer & Schweickert, 2006).

3.4 Gravity Model of Trade

3.4.1 Initial gravity model

The concept of the gravitational model is inspired by Newtonian physics' law of gravitation, which posits that every pair of objects exerts a gravitational force on each other. This force is inversely proportional to the square of the distance between the centers of the objects and directly proportional to the product of their masses.

Mathematically, the gravitational force F can be expressed as:

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2},$$

Where F is the attractive force, M is the mass (mass i and mass j), D is the distance between the centers of the two objects and G is the universal gravitational constant

Similar to the gravitational attraction between two masses, trade interactions between two nations are influenced by their economic strength and inversely by their economic separation. The initial implementation of the gravity model in international trade was by Tinbergen in 1962 and Poyhonen in 1963. They demonstrated that trade flows between two nations (Fij) are inversely correlated with the distance (dij) between them geographically and directly correlated with their economic outputs (Yi, Yj). Specifically, More specifically, the exporting country's GDP shows its supply capabilities, whereas the importing country's GDP shows its demand capabilities.The geographical separation and associated transport costs act as impediments to their

bilateral trade. Then,by adding the population and the dummy variable of trade agreements, Linnemann expanded the gravity model(Linnemann, 1966). Moreover, in 1989 Bergstrand replaced the indicator of population size with per capita income (Bergstrand, 1989). In addition, with the boom in institutional economics in the last decade of this century, institutional quality factors were widely introduced into trade gravity models. For instance, Anderson and Marcouiller introduced a series of economic institutional variables to capture the impact of institutions on trade flows in 2002. The results of the study show that transaction costs are significantly correlated with non-security factors that impede international trade, and that a 10 per cent increase in a country's transparency and fairness index is associated with a 5 per cent increase in that country's import demand (Anderson & Marcouiller, 2002). In addition, Groot et al. (2004) introduce six institutional variables including voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. Their results show that the similarity between the two countries' regimes can increase trade flows between the two countries by 12 to 18 per cent, depending on imports and exports, a one-standard-deviation increase in the quality of regulation can increase trade flows between the two countries by 20 to 24 per cent, and a one-standard-deviation decrease in the level of corruption can increase trade volumes by 17 to 27 % (De Groot et al., 2004).

$$F_{ij} = G\frac{Y_i^{\beta_1} Y_j^{\beta_2}}{d_{ij}^{\beta_3}}$$

Initially, the theoretical background of the trade gravity model was imperfect, causing researchers to doubt its soundness. Under the presumptions of constant elasticity of substitution (CES) expenditures and product differentiation by place of origin, Anderson was the first economist to provide the theoretical economic backgrounds for the gravity equation based on the Armington assumption (Anderson,

1969). Anderson combined the product differentiation approach to derive the gravity equation, which explains the presence of the income variable in the model.

In addition, Bergstrand's study also expands the theoretical backgrounds of the gravity model of trade by connecting it with the concept of monopolistic competition, developed by Paul Krugman in 1980, to overcome the undesirable feature of Armington models (Bergstrand, 1989). Then, Deardorff found that the gravity model was compatible with several trade models, including the Ricardian model, the HO model, and growing returns to scales (Deardorff, 1998). Later, Eaton and Kortum derive the gravity model under the framework of Ricardian model (Eaton& Kortum, 2002). The gravity-type equation explains trade patterns by taking into account relative productivity disparities between nations in addition to the relative sizes and distances between economies. With further development of the theory, a version of the micro-foundation gravity model proposed by Anderson and Van Wincoop became the most popular model. They extend the scope of the model to include relative trade costs, multilateral trade-resistance (MTR) and border effects, which greatly improves the accuracy of the model and solves the famous McCallum border puzzle (Shahriar et al., 2019). Anderson and Van Wincoop argued that bilateral trade flows between two countries are influenced not just by the trade barriers that exist between them but also by the overall trade barriers that each faces with all other international trading partners. MTR captures external trade barrier effects that could skew bilateral trade flow assessments. Their approach involves using the CES utility framework to derive a theoretical gravity equation. Their concept also includes both tariff and non-tariff barriers, such as transport costs, political stability, and currency exchange strategies, that a country imposes or faces globally. It reflects the overall ease or difficulty of trading with the world rather than with a single partner (Andeson & Wincoop, 2003).

3.4.2 Micro-founded gravity model

The micro-founded gravity equation can be expressed as:

$$X_{ij} = \frac{Y_i Y_j}{Y}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma}$$

Y denotes world GDP

Yi and Yj the GDP of countries i and j respectively,

tij is the cost in j of importing goods from i

σ > 1 is the elasticity of substitution

πi and Pj represent exporter and importer ease of market access or country i's outward and country j's inward multilateral resistance terms

Expressed in the logarithmic form of the previous gravity model :

$$\ln X_{ij} = a_0 + a_1 \ln Y_i + a_2 \ln Y_j + a_3 \ln t_{ij} + a_4 \ln \Pi_i + a_5 \ln P_j + \varepsilon_{ij}$$

Where a0 is a constant, a3 = 1-σ and ε_{ij} is the error term.

However, there is a problem with multilateral resistance terms (MRTs) because they are difficult to observe. MRTs are typically computed through a complex iteration process that considers all bilateral barriers faced by countries. Nevertheless, because it necessitates the use of a non-linear least square (NLS) to produce an estimate, this approach is not commonly employed (Anderson & Wincoop, 2003).

Later, Baldwin and Taglioni contribute significantly to the refinement and applicability of the gravity model in international trade analysis. While acknowledging the fundamental correctness of the traditional gravity equation, they underscore its limitation in handling panel data. Their study introduces a generalized gravity equation capable of accommodating panel data, thereby enhancing the model's empirical relevance and analytical robustness. What is more, three common biases in calculating the gravity model for gold, silver, and bronze mistakes are identified by Baldwin and Taglioni. These correspond to the correlation of omitted variables with the trade-cost term, the incorrect adjustment of the exchange rate due to the use of a US aggregate

price index, and the inaccurate averaging of trade flows between partners (Baldwin & Taglioni, 2006).

Furthermore, Head and Mayer (2013) present a concise set of tools for estimating the gravity equation. While they outline several methods that align with the theoretical basis of the model, each method has its limitations. For instance, they discuss the use of "remoteness" as a proxy variable but dismiss it due to insufficient theoretical support. The most commonly adopted approach is the fixed effects method, which is robust and can produce unbiased results. However, when applying this method to panel data, the fixed effects must vary over time, as estimating a time-invariant coefficient becomes unfeasible due to perfect collinearity. Head and Mayer also explore other techniques such as iterative structural estimation, particularly the structurally iterated least squares (SILS) estimator, and ratio-type estimation. They emphasize the importance of employing a "toolkit approach" where these methods are used in conjunction to achieve unbiased estimates of coefficients.

Moreover, Feenstra proposes a method to handle the complexities of the gravity model estimation that simplifies the demanding computational needs of earlier approaches by Anderson and van Wincoop. His technique uses fixed effects for exporters and importers in cross-sectional analyses to effectively account for multilateral resistance terms—these are factors affecting a country's overall trading environment that are not directly measured. These exporter-time and importer-time fixed effects not only capture the complex multilateral resistance terms but also encompass variables that represent the economic size of countries and any other measurable or unmeasurable country-specific traits. This includes things like national policies, institutional characteristics, and exchange rates, which can all influence trade flows(Feenstra, 2015). Besides, Olivero and Yotov further refine this approach for use with panel data. They construct a dynamic gravity model and test different time lags. They find that gravity estimates using 3-, 4-, and 5-year lags yield similar results for the standard gravity variables flows (Olivero & Yotov, 2012). Building on this, incorporating pair-fixed effects along with exporter-time and importer-time fixed effects, as advocated by Egger and Nigai (2015) and Gómez-Herrera (2013), enhances

the precision in measuring bilateral trade costs. This method offers a clear advantage over conventional gravity models by accounting for unobserved heterogeneity and temporal dynamics in trade relationships (Egger & Nigai, 2015; Gómez-Herrera, 2013).

3.4.3 Problem of zero observations

A common issue with the gravity model is the occurrence of zero trade flows. There are several reasons why zero trade flows might appear in a dataset. One reason could be the complete absence of trade between two countries, resulting in accurate zero trade flows. Additionally, trade flows might be recorded as zero if the trade volume is too small to be captured, leading to false zero trade flows. Dealing with zero trade flows in a dataset is crucial, especially when logarithmic transformations are applied during the estimation process. Logarithms of zero are undefined, which poses a significant problem for variables like trade flows where zeros may exist.

There are several ways to deal with zero trade flow. One common method is to simply remove zero observations from the sample. While straightforward, this approach can compromise the model's robustness if zero observations constitute a significant portion of the data. More critically, omitting zero trade flows may result in the loss of valuable information that these observations signify about the absence of trade relationships. Silva and Tenreyro offered a different, more reliable approach, suggesting that the conventional log-linear Ordinary Least Squares (OLS) regression be replaced with the Poisson Pseudo Maximum Likelihood (PPML) estimator (Silva & Tenreyro, 2006). The PPML approach has the benefit of handling zero values in trade flow data in an efficient manner, which preserves the dataset integrity and enables a more precise estimation of the gravity model's coefficients. This approach has been further applied by studies such as Bobková (2012) and Arvis and Shepherd (2013), By employing PPML, researchers can ensure that the gravity model remains robust and informative, even in the presence of zero trade observations.

In summary, the empirical study of the gravity model has seen significant advancements in estimation methods, shifting from traditional cross-sectional analyses to more dynamic and robust panel data approaches. This enhancement allows for more precise econometric estimations and has led to its increased adoption in recent studies,

as evidenced by Christie (Christie, 2002). Moreover, the evolution of estimation techniques from pooled Ordinary Least Squares (OLS) to sophisticated fixed effects models, and further into Poisson Pseudo-Maximum Likelihood (PPML), Tobit, and Generalized Poisson Maximum Likelihood (GPML) methods, has been extensively tested. This progress has led to a more nuanced exploration of international trade flows, while also improving the accuracy of gravity models.

3.4.4 Gravity model used for industry-level studies

The gravity model is generally used to measure the variables affecting the total trade between two countries and the level of trade, but some scholars have also applied the model to the industry level. Bergstrand adapted the model to the industry level for the first time in 1989 based on the Heckscher-Ohlin 2*2*n model. He obtained a gravity model for the multi-industry world (where n stands for the number of countries), and this model takes into account intra-industry trade. The model was estimated using 1-digit SITC data from the 1960s and 1970s, and the results were consistent with expectations (Bergstrand, 1989). In addition, Nahuis has also used gravity modeling to study EU enlargement at the sectoral level. His focus is on the impact of the accession of the 10 new member states to the EU single market on different industries and countries (Nahuis, 2004).

Furthermore, Yulin and Guanghua conducted an in-depth analysis of bilateral agricultural trade flows and trade potential between China and 10 ASEAN countries. The results show that the bilateral agricultural trade flows between the two economies are affected by the size of the economy, the size of the country's population, the distance between the capitals of the two countries, and various trade institutional quality. Of these, the size of the economy and the quality of institutions have a significant impact on trade(Guanghua & Yulin, 2008). Xie also uses the gravity model to capture the effect of EU enlargement on China-EU agriculture trade. Her results show that the EU enlargement has a negative effect on China-EU agriculture trade (Xie, 2010).

3.5 Global Value Chain perspective

3.5.1 Global Value Chain functioning and its Main indicators

Global Value Chain functioning

The concept of the Global Value Chain (GVC) was first introduced by Porter in 1985. He described it as a series of value-adding activities associated with the production of goods and services in an integrated global process. These stages—encompassing product conception, design, production, sales, and services—are distributed across various countries, generating value-added activities for businesses involved (Porter, 1985). Building on Porter's foundational GVC theory, Kogut further developed the notion from an international strategic advantage perspective, proposing the "value-added chain" concept. Kogut argued that the value-added chain integrates various input factors and activities, such as technology, raw materials, and capital, culminating in the realization of commodity value through market transactions. Businesses can leverage their comparative advantages to engage in specific segments of the production chain and capture the corresponding value-added portions (Kogut, 1985).

Gereffi later coined "global commodity chains," describing the collective input and cooperation of various global economies in product development and sales, though initially overlooking the value-added aspect (Gereffi, 1999). By 2001, Gereffi and Kaplinsky refined GVCs as networks of cross-enterprise manufacturers engaged in close collaborations to realize product value, thus forming the foundational theoretical framework of GVCs (Gereffi & Kaplinsky, 2001). Global value chains (GVCs) are characterized by the fragmentation and segmentation of production across various phases, which are conducted in numerous locations around the world. This structure of production has notably increased the interconnection between nations

Main indicators of GVCs

There are two main indicators are used to measure the global value chain in terms of global value participation and global value positioning. The global value participation, which proposed by Koopman, Powers and Wang, uses to measure the position of country in the GVCs (Koopman et al., 2010). Global value chain

participation including GVC forward participation and GVC backward participation. GVC forward participation measures the value added by a country in producing intermediate goods and services that are then exported and used as inputs in other countries' production processes. Then the GVC forward participation can be divided into direct and indirect domestic value added. Direct domestic value added refers to the value a country adds directly through its exports used in other countries' production. Indirect domestic value added, on the other hand, indicates the proportion of a country's value added that is embedded in intermediate goods, which are then re-exported by a trading partner country (Borin & Mancini, 2015). Besides, GVC backward participation assesses the foreign value-added content in a country's exports, for example how much of the exports are actually originating from inputs imported from other countries. Global value chain participation calculated by summarizing these two components. The values range from 0 to 100. A higher value indicates a higher degree of participation by the country in the global value chain.

Furthermore, to evaluate a country's positioning within sector-specific Global Value Chains (GVCs), researchers employ an "upstreamness" measure, which measure the distance of a production sector from final consumer demand. Introduced and refined in studies by Fally (2012), and Antràs and Chor (2018), this index quantifies the number of production stages remaining until the goods or services of an industry reach the final consumers. Essentially, it reflects the "length" of the GVCs, indicating how far upstream a sector is in the overall production process.

3.5.2Regional value chain

A Regional Value Chain (RVC) is not a distinct classification of value chain; rather, it refers to the segmentation of the value creation processes predominantly within a specific region as opposed to globally. Baldwin (2013) observed that the production and specialized division of labor increasingly exhibit regional characteristics, with less prominence of global features. His findings indicate that the principal global value chains are centered around major economies such as the United States, Germany, China, and Japan. Peripheral countries strategically embed themselves into these chains, leveraging their comparative advantages, which leads to the formation of regional value

chains primarily situated around North America, Europe, and Japan (Baldwin, 2013). Further research by Schoar De Backer et al elucidates the significant relationship between trade policies and participation in global value chains, highlighting a pronounced regional aspect. Mechanisms such as free trade areas and customs unions within regions are intrinsically linked to the robustness of regional value chains and facilitate the expansion of rules of origin, enhancing the establishment and efficacy of these regional networks (De Backer et al, 2018).

Moreover, Morris provides a comparative analysis, demonstrating that regional value chains, such as those in apparel manufacturing led by South African retailers, are more conducive to fostering direct interactions between downstream manufacturers and regional suppliers compared to global value chains dominated by the United States. This regional orientation not only accelerates responses to market demands but also reduces production timelines and achieves cost efficiencies, underscoring the operational advantages of regional value chains over global ones (Morris, 2011).

3.5.3 Integration of Central and Eastern European Countries into EU Value Chains

Martínez-Zarzoso and others have pointed out that the accession of CEECs to the EU has had a positive and significant impact on the trade of intermediate and final goods. The analysis confirms that EU accession and the associated decrease in trade barriers have been pivotal in expanding trade, both in terms of variety and volume. (Martínez-Zarzoso et al., 2010). Besides, Kaplan indicates that the EU enlargement facilitated greater integration of the CEECs into EU value chains, particularly enhancing intra-CEEC trade more significantly than East-West trade. Besides, there was a notable increase in value-added exports from CEECs to other CEECs, particularly in services, which often involved lower-skilled activities. This suggests that enlargement led to specialization where CEECs engaged more in trade activities matching their labor market structures (Kaplan et al., 2018).

Additionally, Van Assche describes the ten CEECs as a "deep processing region" for the EU original 15 countries members, implying that these countries undertake production stages of lower added value or intermediate products within the EU's production network, while the production of finished or final products is more likely to be completed within the EU. Data shows that 70% of gross exports and 60% of imports of the CEECs are related to the EU original 15 countries members. This indicates that there are close economic and trade ties between the CEECs and the EU15 with the CEECs largely depending on the EU market and raw material supplies (Van Assche et al., 2012).

3.5.4 Shift in Manufacturing within the EU leading to the formation of the CE Manufacturing Core

Germany has not only maintained a substantial presence in the global value chain but has also driven economic growth within Europe by linking and integrating the peripheral production capacities of other countries in the region, thereby influencing both regional and global production and export trade. Germany has strategically utilized the geographic location, skilled labor, and cost advantages of Central and Eastern European countries (EU peripheral member states) to offshore and outsource low value-added segments of the manufacturing industry.

Within the core EU member states, there are typically two distinct outsourcing strategies: The first is often referred to as "vertical specialization." This strategy involves outsourcing the production of specific components within the manufacturing supply chain to other countries overseas, then importing the corresponding intermediate products, and ultimately completing the final production, assembly, and export in the home country. For example, in 1993, the German automaker Audi outsourced engine production to its Audi Hungary factory located in Győr, Hungary. This factory has become one of the world's largest engine suppliers. Some of the engines produced are then sent back to Audi's headquarters in Bavaria, Germany, where the final assembly and production of Audi cars are completed and then exported globally. The second strategy is known as "total offshoring," where the entire manufacturing base is relocated overseas. The entire production process is completed by the overseas company, and

products are exported directly to global markets. For instance, the French Renault automotive group has moved the production of several of its car models—the Clio series, Twingo series, and Smart Forfour series—to the Revoz factory in Novo Mesto, Slovenia, where the entire vehicles are produced and exported (Chiappini, 2012).

Stehrer and Stöllinger observe that manufacturing activities within the EU are increasingly concentrated around the Central European (CE) manufacturing core, centered on Germany, which includes Austria and the four Visegrád countries: the Czech Republic, Hungary, Poland, and Slovakia. A German-CE supply chain has emerged, specializing in manufacturing goods for export worldwide. They highlight the substantial growth in the contribution of Central European countries to the EU's value-added exports, noting an 8-percentage point increase that brought their share to 42.6% in 2011. This growth suggests that the CE manufacturing core has become increasingly crucial to the EU's manufacturing and export sectors (Stehrer & Stöllinger, 2015).

Furthermore, the concentration of manufacturing activities in Central European countries has resulted in a noticeable decline in the proportion of value-added exports from other EU member states, particularly those with higher incomes such as the Nordic and Benelux countries, as well as France and the United Kingdom. This trend indicates a redistribution of manufacturing capabilities within the EU, with Central European countries emerging as significant contributors at the expense of traditionally stronger economies (Stehrer & Stöllinger, 2015). In the process of globalization, the more EU core member states emphasize a strategy of "vertical specialization," the stronger their domestic manufacturing capabilities remain. This is reflected in the increased proportion of manufacturing value-added within their GDP, which, in turn, enhances their influence within the global value chain network. Conversely, the deindustrialization observed in some developed EU countries is primarily due to their greater reliance on a "total outsourcing" strategy rather than on "vertical specialization." This reliance has led to a weakening of their domestic manufacturing sectors (Celi et al., 2018).

3.5.5 CEE's increased participation in GVCs further facilitates trade between China and EU

As Central and Eastern European (CEE) countries increase their participation in global value chains (GVCs), it significantly enhances EU-China trade dynamics. The CEE nations have developed their manufacturing and processing capabilities through their integration into these chains, positioning themselves as pivotal links between China and the rest of the EU. According to Stöllinger, the engagement in GVCs has bolstered manufacturing in core Central European countries such as the Czech Republic, Hungary, Poland, and Slovakia. However, it has also accelerated the deindustrialization process in other EU member states (Stöllinger, 2016).Over the past two decades, the Czech Republic and its Visegrád counterparts have seen considerable foreign direct investment inflows and have become highly export-oriented. By 2015, exports accounted for 84% of GDP in the Czech Republic, over 90% in Hungary and Slovakia, and 50% in Poland, as per the World Bank. This shift reflects their deep integration into global value chains, analyzed by Gereffi & Fernandez-Stark (Gereffi & Fernandez-Stark, 2010).

The integration of the EU peripheral members into German value chains is likely to affect their influence in the GVC network, as Germany is at the center of the GVCs with a large number of upstream and downstream trading partners, and its output or input of value added has a significant impact on the production and export trade of other countries. Therefore, the integration of the EU periphery into the German value chain, which leads to a relatively greater overall global diffusion of the inputs and outputs of value added of the EU periphery, is likely to have an impact on the rest of the network through Germany's ability to expand in GVCs.

CEE countries typically occupy a midstream position in global supply chains. For example, CEE countries may import raw materials and components from China, process them, and then export the finished goods or immediate goods to Germany or other Western European countries, and subsequently to other international markets. This not only increases direct trade between CEE countries and China but also reinforces their role within the EU's internal production networks. A comprehensive analysis of trade panel data for a dozen CEE nations by Zhang et al. shows that a 10 percent increase in the acquisition of capital goods from China correlates with a 2.4

percent increase in the region's exports. This effect is more pronounced when considering both intermediate and capital goods procured from China, with a particular focus on domestic value-added in exports. The study confirms that sourcing from China significantly boosts the total exports of CEE nations and the domestic value created within these exports (Zhang et al., 2024).

Besides, according to Karkanis, the Czech Republic plays a crucial role in the global supply chain, acting as a conduit for Chinese value-added exports to Western markets. The Czech Republic imports parts and components, adds value through manufacturing or assembly, and then exports the finished or semi-finished goods (Karkanis, 2018). Additionally, De Castro highlights that nearly 80% of the Czech Republic's imports from China consist of intermediate products. A large portion of Chinese value-added (VA) is further processed in the Czech Republic and then used in exports to other countries. This demonstrates an indirect export pathway for Chinese exports to the EU. China may export components to the Czech Republic, where they are incorporated into finished goods. These goods are then exported again, potentially to Western markets, thus positioning the Czech Republic as a potential entry point for Chinese products into these markets (De Castro et al., 2017).

4. Current trade situation

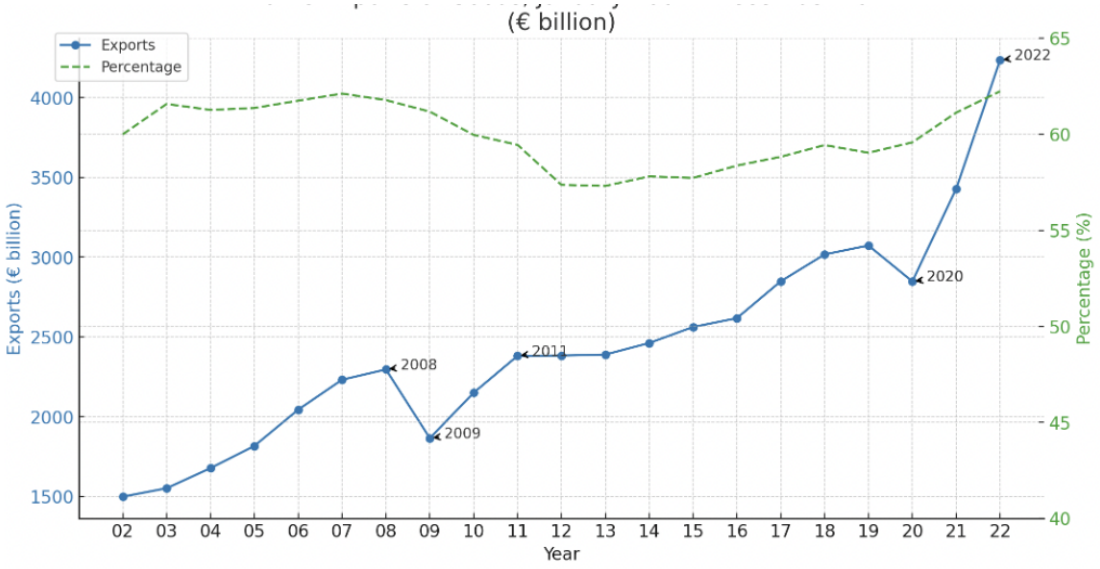
4.1 Current Intra EU trade

4.1.1Current situation of Intra EU trade

The trade between intra EU members is generally on an upward trend. Between January 2002 and December 2022 exports of goods increased (see Figure4). Between Jan 2002 and Dec 2022, exports of goods within the EU rose from €120 billion to €363 billion. In addition, intra-European Union export in goods accounts for about 62 % of total European Union trade between 2002 and 2022. Although there is a s ignificant drop in exports occurred from September 2008 to May 2009 due to the financial crisis, export values began to recover after the downturn. Then, the COVID-19 pandemic

caused a dramatic decrease in exports between February 2020 and April 2020. However, by December 2022, intra EU export levels had not only rebounded but also surpassed pre-pandemic figures. This may be due to the European Union relocating part of its production chain back to the EU after the Covid-19 pandemic. This move aims to avoid shortages of medical supplies caused by supply chain disruptions during global crises.

Figure 4 Intra EU exports of Goods, 2002-2022



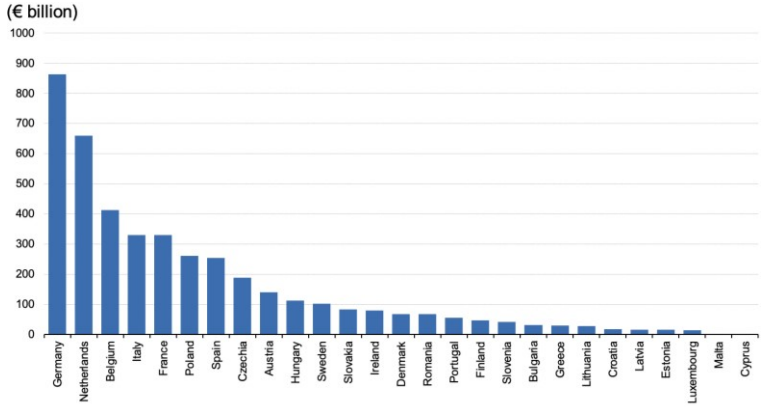
Source: Eurostat

Germany plays an important role in exporting goods to other EU member countries. Germany led with exports totaling €863 billion, while Cyprus had the lowest at just over €1 billion. Seven countries—Germany, the Netherlands, Belgium, Italy, France, Poland, and Spain—each exported goods worth over €200 billion to EU partners. Together, these countries represented 73% of the total intra-EU goods export value in 2022(see figure5). Besides, from 2002 to 2022, four countries experienced an average annual increase of over 10% in goods exports to EU partners. These countries included Latvia (11.9%), Lithuania (11.5%), Bulgaria (11.3%), and Poland (10.8%). Meanwhile, 13 out of the rest 23 Member States saw their exports grow at an annual rate of between 5% and 10%, and 10 countries had growth rates under 5%. Generally, Central Eastern Member States (CEE) exhibited higher growth rates (see Appendix 1).

This trend can be attributed to the economic integration and development of the CEE region within the EU. Post accession, these countries have benefited from

increased access to the larger EU market, substantial investment inflows, and the adoption of EU trade policies that enhance their export capabilities. The higher growth rates in these countries reflect their adaptation to the EU market and their successful exploitation of new trade opportunities.

Figure 5Exports of goods to other member states, 2022



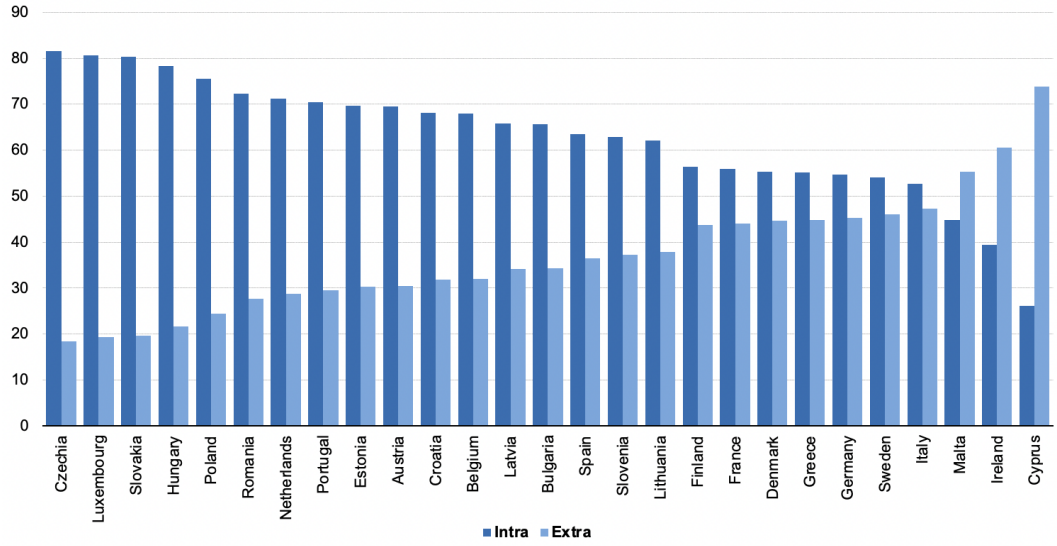
Source: Eurostat

In 2022, between 50% and 75% of exports from most Member States stayed within the EU, as shown in Figure 5. At the same time, Poland (76%), Hungary (78%), Slovakia (80%), Luxembourg (81%), and Czechia (82%) exceeded this range, with their shares of intra-EU exports surpassing 75%. On the other hand, Cyprus (26%), Ireland (39%), and Malta (45%) had less than half of their exports directed towards EU countries, which means they were more engaged in trade outside the EU. The data can largely be explained through the lens of regional value chains. Countries like Poland, Hungary, Slovakia and Czechia are deeply integrated into the regional value chains of the EU, which enhances their trade connectivity and economic interdependence with other EU nations. Conversely, Cyprus, Ireland, and Malta have lower percentages of intra-EU exports due to their unique economic orientations and geographic positions, which lead them to develop stronger trade relationships outside the EU. These countries might engage more with international markets that offer more favorable conditions for their specific exports or where historical and strategic partnerships exist, reducing their involvement in regional EU value chains.

Besides, the top trading partner is Germany, which ranks as the most frequent among the top three trading partners. Within the European Union (EU), the

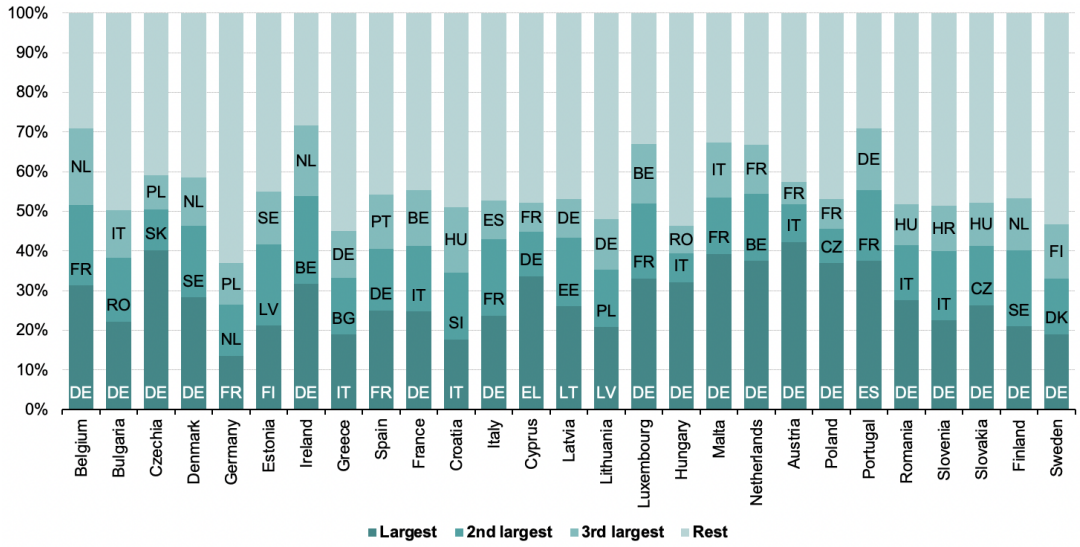
predominant mode of trade for nearly all member states involves exporting to another EU country Most EU member states' trade is concentrated within the EU, with Germany being a notable exception. In 2022, among the 27 EU member states, Germany was the most significant export market for 17 countries and ranked among the top three export markets for 22 member states. For instance, 40% of Czech exports are destined for Germany, followed by 29% to Austria, 28% to Hungary, and 27% to Poland(See figure 7). Additionally, Germany is the primary export market for Southern European countries like Italy, as well as Northern European countries like Finland and Sweden, and Western European countries such as the Netherlands. Even France, another leading economy within the EU, has Germany as its largest export market(see Appendix 2). This highlights the high degree of dependence of EU countries on Germany for trade. From a trade structure perspective, Germany predominantly imports industrial raw materials and intermediate products from other EU countries and exports primarily industrial finished products. This indicates that exports from other EU countries are often reprocessed in Germany, with some of these reprocessed goods being re-exported back to EU countries and others to non-EU countries. In this trade cycle, Germany plays the role of an integrator of industrial resources within the EU, positioning itself at the center of the EU's industrial supply chain (Martínez-Zarzoso et al., 2010).

Figure 6 Exports of goods: Intra EU and extra EU,2022(%)



Source: Eurostat

Figure 7 Main EU partners for exports of goods by member state, 2022 (share of total intra-EU exports of goods)



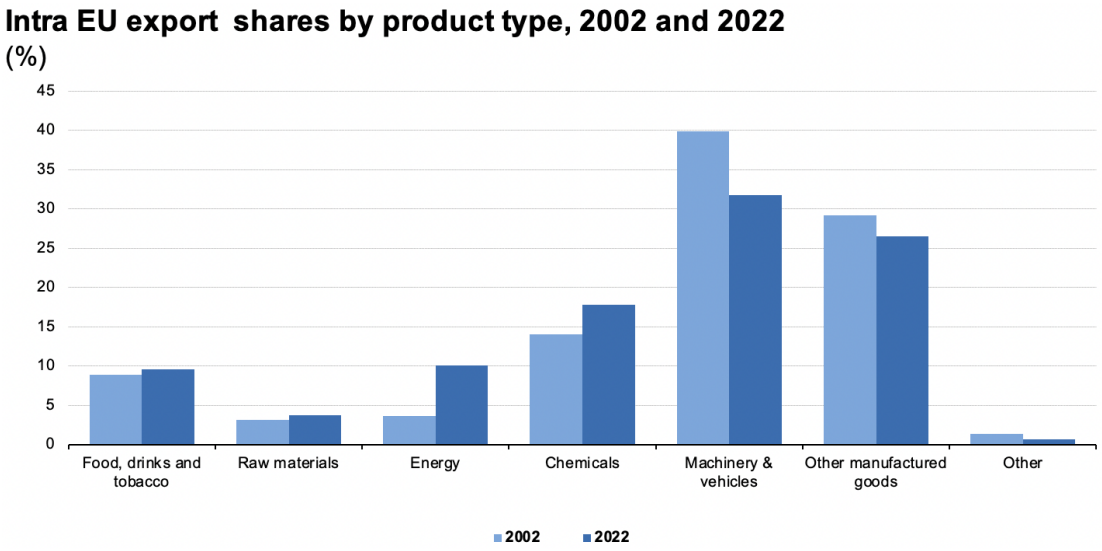
Source: Eurostat

4.1.2 Current Intra EU trade structure

Intra-EU exports are predominantly composed of machinery, vehicles, and other manufactured goods (See figure 8). In 2022, every member state has a higher share of manufactured goods compared to primary goods though the extent varied significantly. In Ireland, Czechia, and Slovakia, the share of manufactured goods was over eight times greater than that of primary goods. Conversely, Lithuania, Latvia, Cyprus, and Greece had ratios below two, at 2.0, 1.9, 1.6, and 1.5 respectively(see Appendix 3).

The reasons for these variations include differences in industrial capacity and economic specialization among Member States. Countries like Ireland, Czechia, and Slovakia have developed robust manufacturing sectors that produce high-value goods such as pharmaceuticals and automotive products, significantly boosting their manufactured goods exports. On the other hand, countries like Lithuania, Latvia, Cyprus, and Greece may rely more on agriculture and natural resources, leading to a lower ratio of manufactured to primary goods exports. This reflects the varying stages of industrial development and sectoral focus across the EU.

Figure 8 Intra EU export shares by product type, 2002 and 2022



Source: Eurostat

Moreover, for Visegrád Four (V4) countries, they have developed highly interdependent trade relationships, with substantial intra-regional trade. This is evident in the significant trade volumes among them. Their geographical closeness and economic similarities foster a conducive environment for robust trade relations. According to charts extracted from the OEC, the key Characteristics of V4 Trade focus on the Automotive Industry and Electronics and Machinery (see Appendix 4).

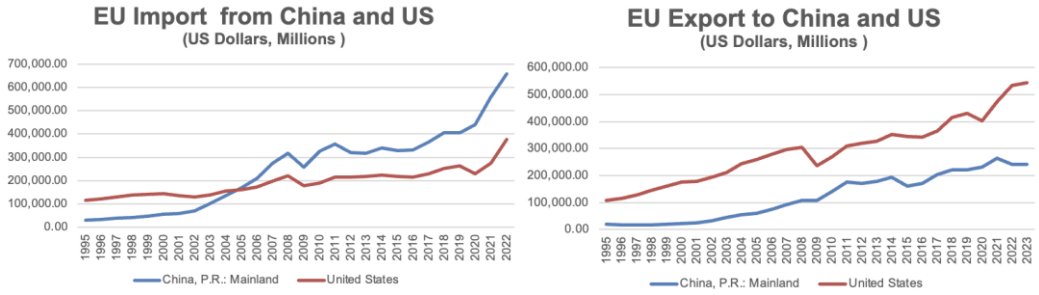
4.2 Current Situation of EU-China Trade

4.2.1Current EU-China trade

For the EU, China and the United States are the two most important trading partners (see Figure 9). The EU's trade with China has shown an overall upward trend. In 2005, the EU's imports from China surpassed those from the United States, making China the EU's largest source of imports. EU exports to China have also generally been on the rise. Figure 9 illustrates China's prominent role among the European Union's principal trade partners in the year 2023, highlighting its substantial involvement in both import and export markets. In terms of exports, China was the third-largest recipient of EU goods, accounting for 8.8% of the EU's external exports. This places China behind the United States, which led with 19.7%, and the United Kingdom, which accounted for

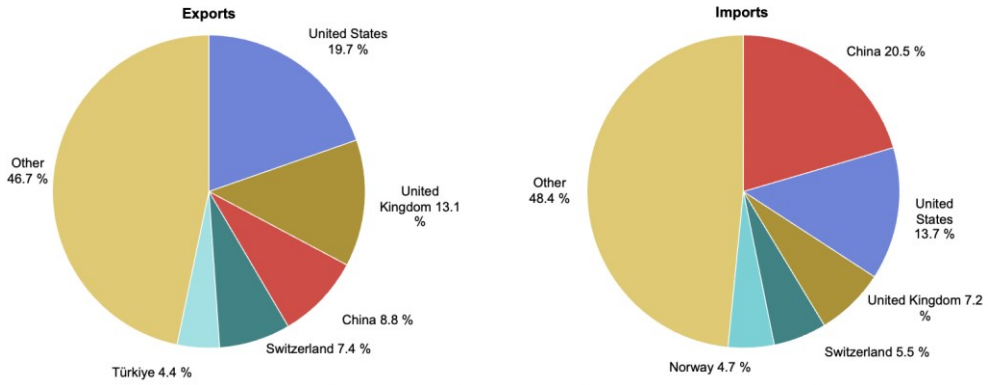
13.1% of the exports. China's position exceeded that of Switzerland and Türkiye, which comprised 7.4% and 4.4% of exports, respectively. Conversely, in the import sector, China emerged as the dominant supplier to the EU, constituting 20.5% of its total imports for the year, outpacing the United States (13.7%), the United Kingdom (7.2%), Switzerland (5.5%), and Norway (4.7%). This data clearly establishes China's critical role within the EU's trade framework, particularly as the foremost source of imports.

Figure 9 EU trade with China and US



Source: DOTS database, IMF

Figure 10 China among the EU's main partners for trade in goods, 2023(% share of extra-EU exports/imports)



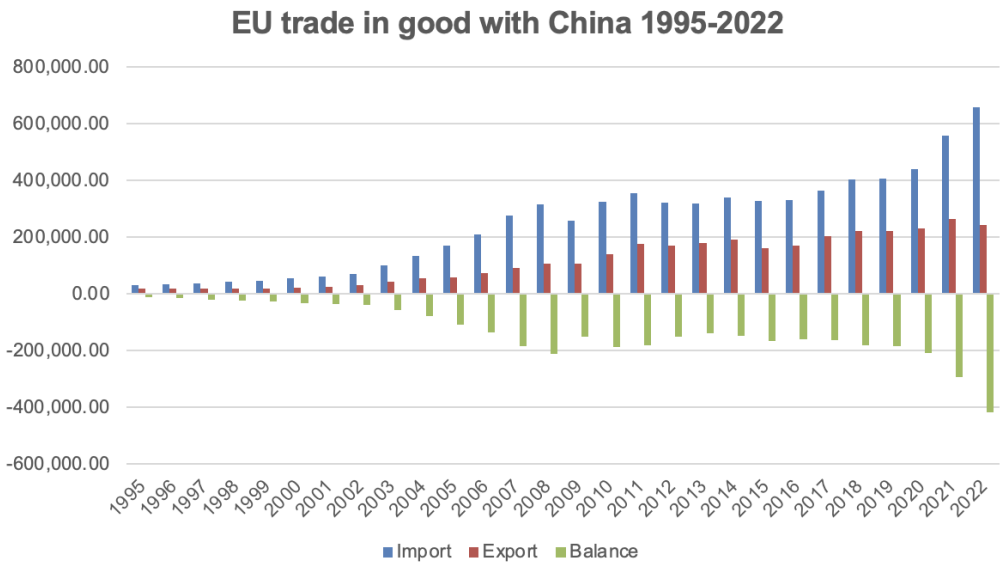
Source: Eurostat

Moreover, the trade relationship between China and the European Union (EU) from 1995 to 2022, as depicted in the provided chart, shows a dynamic and evolving economic interaction, characterized by a significant increase in trade volumes. In 2023, the value of goods import from China to EU already achieved 659.20billion euros while the value of good export to China achieved 242.49 billion euros. The green bar represents the difference between EU import and EU export to China. In recent decades,

the trend of increasing this indicated a huge trade deficit for the EU throughout the period. In 2022, the trade deficit stands at about -416.71 billion euros, reflecting higher imports from China compared to EU exports to China (See figure 111). However, the year 2022 presented a highly atypical macroeconomic landscape, marked by significant global events that reshaped trade dynamics extensively. The Ukraine crisis and the ongoing impacts of the COVID-19 pandemic were major disruptors, exerting profound effects on international trade flows. Specifically, the significant increase in China-EU trade in 2021 and 2022 can be primarily due to EU importing medical goods from China like mask. China effectively controlled the outbreak of the pandemic and took the lead in restoring full production, while other emerging economies experienced repeated outbreaks and stringent anti-epidemic measures that hampered their ability to supply products to the EU. As a result, China compensated for the reduction in exports to the EU from these countries. Regarding China's imports from the EU, as the first global production base to achieve comprehensive recovery, China was faced with substantial external demand from the global economic rebound. Consequently, in the process of expanding production, the demand for imported intermediate goods has increased. This has led to a significant but temporary increase in the trade deficit between China and the EU over the past two years. Moreover, during the COVID-19 pandemic, trade between China and the EU did not decrease, which indirectly reflects the high resilience of China-EU bilateral trade.

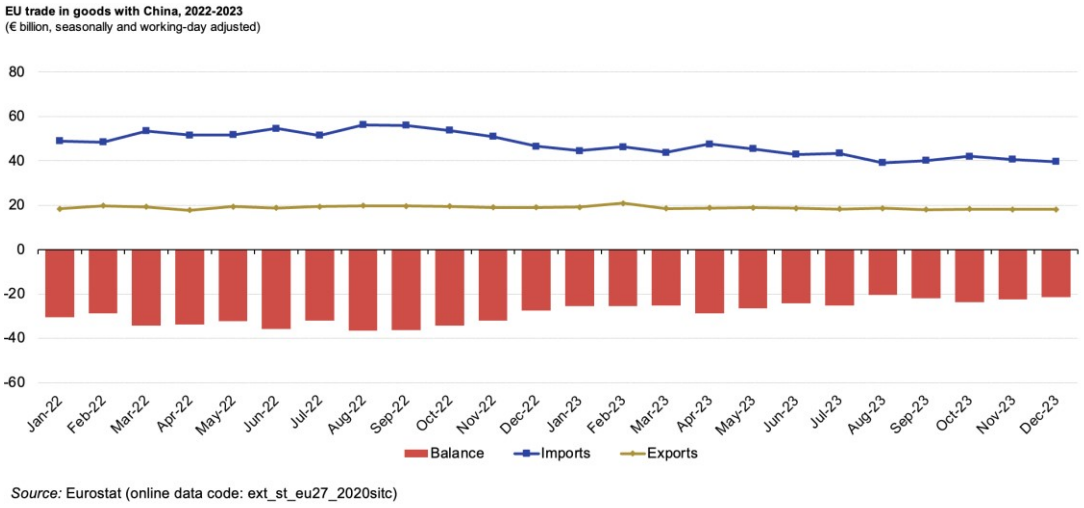
Recent data from Eurostat indicates a 27% reduction in the EU's trade deficit with China in 2023, suggesting the previous year's trade deficit figures were an anomaly (Eurostat, 2023). Although the EU's ongoing trade deficit with China often leads to trade frictions, it is not purely disadvantageous. As the relatively low-priced imported goods from China provide consumers in the European Union with more choices. Besides, intermediate products and raw materials from China aid in enhancing the productivity and international competitiveness of the EU's industrial manufacturing sector (Dadush et al., 2019). What is more, the substantial trade barriers imposed by China also contribute to the European Union's trade deficit.

Figure 11 EU trade in goods with China 1995-2022



Source: DOTS database, IMF

Figure 12 EU trade in goods with China, 2022-2023



Source: Eurostat

With regard to EU exports to China in 2023, Appendix 6 presents data on EU Member States' exports of goods to China. The Netherlands, Germany and Italy are the main exporters with €117bn, €95bn and €48m respectively. Germany is not only the EU's largest partner but also China's most important trading partner. Since 2016, China has been Germany's largest trading partner. In addition, it is worth noting that the Czech Republic has the highest share of imports from China as a percentage of its total imports from outside the EU, at 43.7 % according to Appendix 5, This means that China already

became a crucial trading partner for the Czech Republic. Besides, Estonia (30.2%), Slovenia (29.1%), and Poland (28.5%) Netherlands (25.7%), Hungary (25.0%), and Romania (20.8%) also exhibit a considerable reliance on Chinese imports, though slightly less than the highest tier.

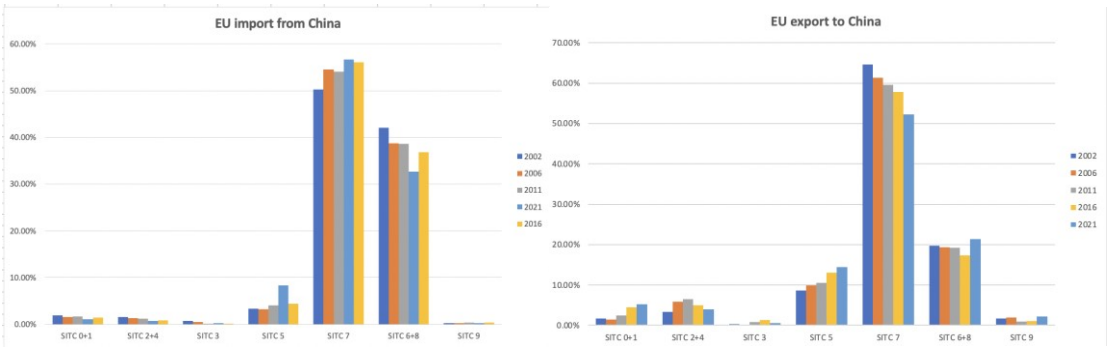
In general, CEE countries tend to show a higher percentage of dependence on imports from China compared to Western European countries. This could be attributed to different economic strategies, levels of industrial development, and trade policies. However, some Western countries still exhibit significant dependence on Chinese imports like Netherlands, reflecting the pervasive influence of China's manufacturing sector on the global market.

4.2.2 Current China-EU bilateral trade structure

Based on the Standard International Trade Classification (SITC), the trade patterns between the European Union (EU) and China can be analyzed through the distribution of import and export categories shown in the accompanying figure. The data indicates a significant concentration of trade in Category 7 of the SITC, which includes Machinery and Transport Equipment(see figure13). This category dominates both imports from and exports to China, highlighting a primary focus on industrially manufactured goods in the bilateral trade relationship. A more detailed analysis will be carried out using the Harmonised System (HS) classification to classify products more accurately as well as more easily.

Figure 13 EU trade with China (based on SITC classification)

SITC 0+1	Food, drink and tobacco
SITC 2+4	Raw materia
SITC 3	Energy
SITC 5	Chemicals products
SITC 7	Machinery and transport equipment
SITC 6+8	Other manufacuture goods
SITC 9	Commodities and transactions not classified elsewhere in the SITC



Source: UNCTAD

The analysis presents a detailed examination of the trade patterns in imports and exports between the European Union (EU) and China over the period from 2000 to 2021, utilizing the Harmonized System (HS) 92 classifications. The data reveals that the predominant categories of traded goods between the EU and China are concentrated in the sectors of Machinery and Transport Equipment, specifically classified under HS 84-85 and HS 86-89(see figure 14 ane 15). These sectors consistently dominate both import and export charts, underscoring their critical role in trade between China and the EU. The import and export of high-tech products have grown, indicating an increase in trade of value-added goods. The share of EU machinery imports from China increased from 35 % in 2000 to 51.6 % in 2021. This reflects China's upward movement in the global value chain, transitioning from basic manufacturing to more sophisticated, technology-intensive production. However, the share of imports from China for Optical, Photographic, Medical or Surgical Instruments drop from 4.72% in 2000 to 3.35% in 2021.

Moreover, textiles and footwear (HS 50-63, HS 64-67) have historically been integral to trade, particularly regarding the EU's imports from China. Although labor-intensive industries such as textiles and footwear continue to play a significant role, their relative contributions to the total trade volume have been diminishing. Specifically, the share of textiles in EU exports to China has decreased from 13.99% in 2000 to 7.42% in 2021, while the share for footwear has also declined, from 4.24% to 2.12% over the same period. This trend mirrors a broader global shift towards industries that necessitate increased capital investment. As China's manufacturing sector has evolved, there has been significant investment in technology and innovation. This shift has enabled

Chinese manufacturers to produce more technologically advanced and higher-value products and climbs up the global value chain, such as electronics and machinery, rather than focusing solely on labor-intensive goods like textiles and footwear. Many companies that once manufactured textiles and footwear in China. have relocated their production to other countries with lower labor costs, such as Vietnam, Bangladesh, and Cambodia. This relocation is part of a broader strategy to diversify production locations and reduce dependency on any single country, further contributing to the decline in China's share of textile and footwear exports. The decrease in the proportion of EU imports of textiles and footwear from China may also be due to the fact that the EU has many bilateral trade agreements with Vietnam like the Textiles and Clothing Agreement and Footwear Agreement, so the EU has decided to source these low value-added products from Vietnam instead of China (Duong, 2016). Furthermore, the steady import of Metals and Chemicals (HS 72-83, HS 28-38) goods highlights the EU's need for raw and intermediate materials essential for its industrial sectors. This suggests that the EU's manufacturing sectors are intertwined with global supply chains, relying on imports to feed into further stages of production and distribution within the region. In addition, it can also be observed that the share of vegetable imports, which are pertinent to the agricultural sector, experienced a steady decline following the expansion of the European Union. Specifically, this proportion dropped from 0.96% in 2000 to 0.47% in 2021. In addition, the importers of foodstuff (0.81% to 0.46%), Raw Hides and Skins, Leather, Furskins (4% to 1.06%), Live Animals, Animal Products(1% to 0.38%) also have declined compared to 2000.

From the perspective of EU export goods to China, significant sectors such as Machinery, Transport Equipment, and Chemicals or Allied Industries (HS 28-38) consistently hold substantial shares(see figure 15). These sectors reflect a strong EU focus on exporting advanced technology and capital-intensive products, which dovetail with China's robust demand for high-tech and infrastructure development inputs. Notably, the export share of Machinery decreased from 55.45% in 2000 to 33.16% in 2021. This is mainly due to China having developed its own machinery manufacturing capabilities, it may be relying less on EU imports. Conversely, the Transport Equipment

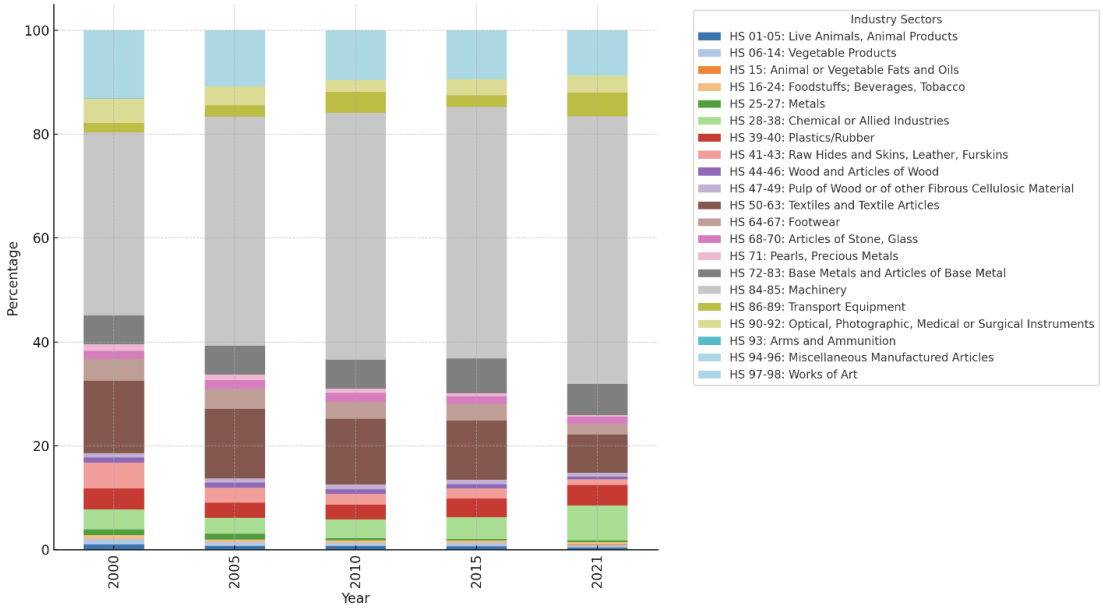
sector saw an increase from 9.53% to 19.16%. This shows that the EU's stronghold in high-value transport technologies. Besides, the Chemical sector grew from 7.83% to 12.56% over the same period. The chemical sector shows a relatively consistent share, illustrating the ongoing demand for chemical products, which are essential for a range of industries including manufacturing, pharmaceuticals, and agriculture. The export to China of sector Optical, Photographic, Medical or Surgical Instruments increase from 3.77% to 7.16%. The sector of Vegetable Products, representing agriculture agricultural sector, increases from 0.66% to 0.87%. Furthermore, the smallest trading goods between the EU and China include Live Animals and Animal Products (increasing from 0.98% to 3.7%), Animal or Vegetable Fats and Oils (increasing slightly from 0.66% to 0.87%), and Pulp of Wood or other Fibrous Cellulosic Material (decreasing from 1.96% to 1.44%), along with Foodstuffs (rising from 0.64% to 2.67%). These trends in EU exports to China are notably different from those observed in EU imports from China, where the trade volumes of these products have generally decreased. This divergence illustrates a certain level of complementarity in the EU-China trade relationship, where each entity tends to export more of what the other imports less, and vice versa. This complementarity is indicative of how both regions strategically balance their trade portfolios to optimize mutual economic benefits and address respective market demands.

In general, the trade relationship between China and the European Union has significantly evolved, shifting from labor-intensive to more capital- and technology-intensive industries. Concurrently, there's a decline in traditional sectors such as textiles. Additionally, the stable trade in intermediate goods like chemicals and base metals underscores a critical interdependency, essential for maintaining robust supply chains and supporting sustained industrial activity within the EU. It is important to note that while both China and the EU focus their exports on the machinery industry.

These demonstrate that trade between the EU and China predominantly occurs intra-industries (Lu et al., 2014). Besides, European countries produce electromechanical products with a higher capital intensity, primarily concentrating on high-end electromechanical products. In contrast, China often holds a comparative advantage in

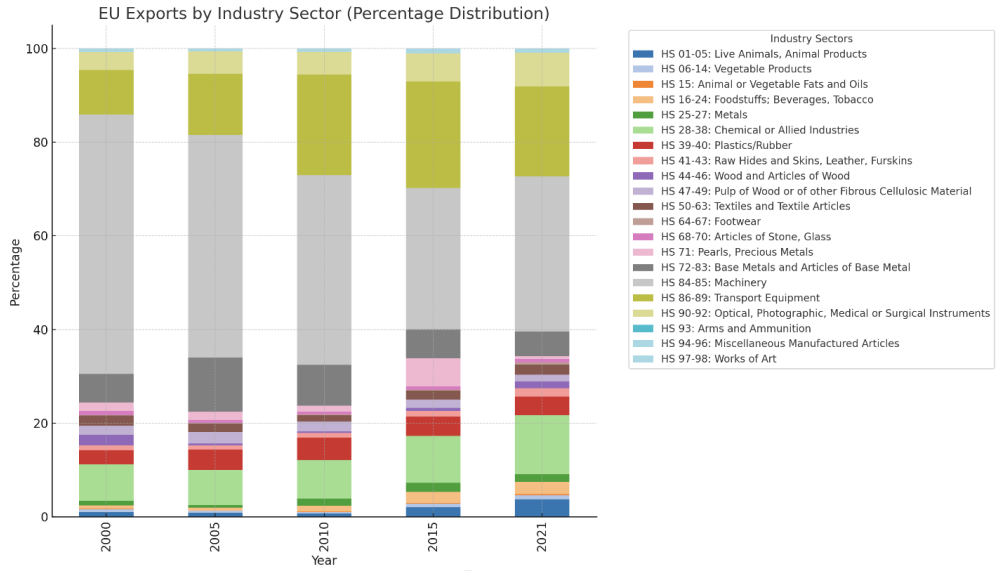
the export of cost-effective, mid-to-low-end electromechanical products. Consequently, China and the EU exhibit significant complementarity in the development of the electromechanical products industry.

Figure 14 EU imports from China by industry sector(percentage distribution)



Source: UN Comtrade data calculated by the author .The complete table, refer to Appendix 7.

Figure 15 EU Export to China by Industry Sector (percentage distribution)



Source: UN Comtrade data calculated by the author.For the complete table, refer to Appendix 8.

4.3Trade Dependency of EU on China

Overview

Figure 15 reveals a significant evolution in the trade relationship between the European Union (EU) and China over two decades, focusing on the seven most traded industry sectors. Notably, the dependency on Chinese machinery (HS 84-85) surged by 37.17 percentage points, from 9.03% to 46.20%, reflecting China's technological advancements and competitive manufacturing capabilities. Similarly, imports of miscellaneous manufactured articles (HS 94-96) experienced the highest increase, rising by 26.43 percentage points to 69.71%, indicating China's broad manufacturing diversity and its deep penetration into the European market. Additionally, the EU's trade dependence on imports from sectors such as Chemicals or Allied Industries, Metals Transport Equipment, Plastics/Rubber and optical instruments have also seen significant increases.

Figure 16 EU's Major Import Commodities' Dependence on China in 2000 and 2021 (EU Imports from China/Total Imports)

	2000	2021
HS 84-85: Machinery	9.03%	46.20%
HS 94-96: Miscellaneous Manufactured Articles	43.28%	69.71%
HS 50-63: Textiles and Textile Articles	16.77%	33.03%
HS 28-38: Chemical or Allied Industries	4.50%	13.24%
HS 72-83: Base Metals and Articles of Base Metal	8.27%	19.36%
HS 86-89: Transport Equipment	1.58%	14.67%
HS 39-40: Plastics/Rubber	12.06%	22.96%
HS 90-92: Optical, Photographic, Medical or Surgical Instruments	9.31%	14.11%

Source: UN Comrade, calculated by author

Manufacture Trade Dependence

According to the SITC classification of manufactured goods by the degree of manufacturing sophistication in the UNCTAD database, goods can be categorized into four groups: Labor-intensive and resource-intensive manufactures, Low-skill and technology-intensive manufactures, and Medium-skill and High-skill technology-intensive manufactures. This classification system allows for a detailed analysis of trade in manufactured goods.

Post-enlargement, some manufacturing capacities within the EU shifted to newer member states, attracted by lower labor costs compared to those in Western Europe. Despite this redistribution of manufacturing activities, the dependency on China for labor-intensive and resource-intensive goods continued to rise until 2010, after which a slight decrease was observed. This trend may reflect the EU's outsourcing to China for such products, complemented by a gradual shift towards more diversified sourcing strategies in response to escalating global trade tensions and heightened awareness of supply chain vulnerabilities. Besides, the Low-skill and technology-intensive manufactures exhibited a consistent increase in dependency, rising from 11.12% in 2000 to 27.80% in 2021. Prior to EU enlargement in 2000, the dependency on China for Labor-intensive and resource-intensive manufactures was higher than that for Medium-skill and High-skill technology-intensive manufactures.

For Medium-skill and technology-intensive manufactures, there was a marked increase from 8.55% in 2000 to 34.07% by 2021. This substantial rise in dependency indicates the EU's escalating procurement of more technologically advanced goods from China. In the domain of High-skill and technology-intensive manufactures, dependency intensified from 6.02% in 2000 to 30.60% in 2021, underscoring the EU's heavy reliance on China for high-tech manufacturing components and products especially the electronics. The EU, with its strong consumer market and high demand for high-tech products, relies on China's efficient and scalable manufacturing capabilities to meet its needs. The result of the figure aligns with the result of Zenglein, he mentioned the EU's strategic dependency on China, particularly pronounced in the electronics sector, stems not only from technological complexity but also from the complexities and costs associated with developing alternative supply chains (Zenglein, 2020). In addition, as noted by Tang, he points that China has become a critical player in global supply chains, especially in electronics and other high-tech industries. China often primarily serves as an assembly site in the high-tech electronics and electrical (E&E) sector. (Tang et al., 2024).

Figure 17 EU's Dependency on Chinese Manufactured Goods (EU's imports of manufactured goods from the China / EU's total imports)

	2000	2005	2010	2010	2021
MANUFACTURED GOODS BY DEGREE OF MANUFACTURING	9%	19%	28%	28%	32%
Labour-intensive and resource-intensive manufactures	18%	32%	42%	39%	38%
Low-skill and technology-intensive manufactures	11%	15%	25%	25%	28%
Medium-skill and technology-intensive manufactures	9%	15%	24%	26%	34%
Medium-skill: Electronics (excluding parts and components) (SITC 775)	37%	51%	62%	63%	66%
Medium-skill: Parts and components for electrical and electronic goods (SITC 772)	7%	16%	26%	32%	38%
Medium-skill: Other, excluding electronics	8%	14%	22%	24%	32%
High-skill and technology-intensive manufactures	6%	17%	26%	27%	31%
High-skill: Electronics (excluding parts and components) (SITC 751 + 752 + 761 + 762 + 763	10%	41%	58%	62%	67%
High-skill: Parts and components for electrical and electronic goods (SITC 759 + 764 + 776)	6%	22%	40%	45%	47%
High-skill: Other, excluding electronics	4%	5%	8%	10%	14%

Source: UNCTAD, calculated by author

In contrast, China's reliance on the EU for high-tech manufacturing goods is not particularly high. This is likely because the EU primarily exports low and medium technology manufactured products rather than high-tech items. Some ASEAN countries may act as intermediaries to export these goods to China. As previously mentioned, China serves primarily as an assembly hub for high-tech manufacturing goods, assembling components before exporting the final products. China's main imports from the EU are predominantly medium-tech products. Among these, medium-tech engineering goods, automotive products, and other high-tech items constitute the largest proportions (Tang et al., 2024)

Figure 18 China's Dependency on EU Manufactured Goods(China's imports of manufactured goods from the EU / China's total imports)

	2000	2005	2010	2015	2021
MANUFACTURED GOODS BY DEGREE OF MANUFACTURING	15%	13%	15%	15%	17%
Labour-intensive and resource-intensive manufactures	8%	11%	17%	19%	27%
Low-skill and technology-intensive manufactures	9%	15%	18%	23%	16%
Medium-skill and technology-intensive manufactures	23%	25%	29%	30%	33%
Medium-skill: Electronics (excluding parts and components) (SITC 775)	29%	28%	34%	34%	39%
Medium-skill: Parts and components for electrical and electronic goods (SITC 772)	19%	13%	14%	16%	19%
Medium-skill: Other, excluding electronics	24%	27%	31%	32%	35%
High-skill and technology-intensive manufactures	13%	7%	8%	9%	11%
High-skill: Electronics (excluding parts and components) (SITC 751 + 752 + 761 + 762 + 7	8%	5%	3%	3%	3%
High-skill: Parts and components for electrical and electronic goods (SITC 759 + 764 + 77	14%	4%	3%	2%	3%
High-skill: Other, excluding electronics	12%	11%	13%	17%	23%

Source: UNCTAD, calculated by author

5. Methodology and variable description

5.1 Methodology

The paper will use the gravity model to examine the trade effect of EU enlargement on China-EU trade. The gravity model can detect both trade creation and trade diversion of EU enlargement.

Traditionally gravity mode can be outlined:

$$X_{ij} = GS_i M_j \emptyset_{ij}$$

Where M_i encapsulates all importer-specific factors that determine the total demand of the importing country j. Such factors typically include the GDP of the importing country. Similarly, $S_i$includes exporter-specific factors that represent the total supply capacity of the exporting country i, also in terms of its GDP. The variable G is a constant that does not vary with countries i and j. It may represent global factors like the overall level of world trade liberalization. Lastly, $\emptyset_{ij}$ denotes the ease with which exporter i can access the market of country j. This term is inversely related to the bilateral trade costs between the two countries

As mentioned in the previous section 3.4.1, the model of gravity was initially much criticized. Later, more and more scholars provide the model with the theoretical background. The micro-foundation gravity model developed by Anderson and Van Wincoop in 2003 has become the most prominent model in the field due to its advanced theoretical framework. Anderson and van Wincoop (2003) demonstrated that bilateral trade is influenced by relative trade costs and multilateral resistance factors.

The micro-foundation gravity equation can be expressed as:

$$X_{ij} = \frac{Y_i Y_j}{Y} \left(\frac{t_{ij}}{\pi_i P_j}\right)^{1-\sigma}$$

Y denotes world GDP

Y_i and Y_j represent the GDP of countries i and j respectively,

t_{ij} is the cost in j of importing a good from i

σ > 1 is the elasticity of substitution

π_i and P_j represent exporter and importer ease of market access or country i's outward and country j's inward multilateral resistance terms

Expressed in logarithmic form of previous gravitational model cross-section data:：

$$Ln\, X_{ij} = a_0 + a_1 LnY_i + a_2 LnY_j + a_3 Lnt_{ji} + a_4 Ln\pi_i + a_5 LnP_j + \varepsilon_{ij}$$

Where a0 is a constant, a3 = 1-σ and ε_{ij} is the error term.

The paper will use the micro-foundation gravity model, the model will be constructed according to this.

In empirical research, traditional pooled OLS models often inadequately address the heterogeneity inherent in time-specific and variable-specific factors, prompting researchers to pivot towards fixed-effect models for a more robust analysis of gravity equations as already mentioned in the previous literature reviews part of gravity model. This shift has been thoroughly discussed in previous literature reviews on gravity models, and is therefore only briefly described here. Feenstra employs fixed effects for exporters and importers to account for multilateral resistance terms, which affect a country's overall trading environment (Feenstra, 2015). Additionally, the incorporation of pair-fixed effects with the exporter-time and importer-time fixed effect, as advocated by Egger , Nigai and Gómez-Herrera, enhances the precision in measuring bilateral trade costs, providing a clear advantage over conventional gravity models. This study will implement these advanced fixed-effect models to investigate the trade effects of EU enlargement (Egger & Nigai, 2015; Gómez-Herrera, 2013).

Nevertheless, the fixed effect model cannot solve the problem of zero value in trade flow. Silva and Tenreyro in 2006 suggest using the Poisson Pseudo Maximum Likelihood (PPML) estimator to solve the problem of the zero trade. (Silva & Tenreyro, 2006). Moreover, in the presence of heteroskedasticity, this approach appears to yield more robust and consistent results than other econometric techniques. So, the paper will use the fixed effect and the PPLM estimator at the same time.

5.2 Description of the variables：

Distance

Havranek and Irsova (2015) highlight biases in using the great-circle formula for distance measurement, which Tamini et al. (2016) also note affects model outcomes due to methodological variations. Recent research favors more sophisticated distance measures. Mayer & Zignago (2011) introduce four types, including dis, discap, distw and distwces. The distw and distwces , with the preferred for their accuracy and less exaggerated border effects, as confirmed by Mayer & Zignago (2005). Among these two, scholars prefer to use the disw, I will algin with their choice to use the disw, which is a time-invariant variable (Mayer & Zignago, 2011; Karkanis, 2018 ;Zolin & Uprasen, 2018).

Institutional indicators

The paper will utilize the database of Worldwide Governance Indicators which was first proposed by Kaufmann in 2002 and has been updated to 2022 values, including six indicators of perceived institutional quality in terms of Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption. Each of these indicators represents various aspects of governance quality, encompassing the political process, the efficiency of the state apparatus and its policies and the overall success of governance (Kaufmann et al., 2002). Since these six indicators are highly correlated in order to avoid the multicollinearity, I will run the correlation test. Then I find that the correlation between expvr and exVrqi

is the lowest. So I will use regulatory quality (exrqr) and political stability and absence of violence (expvr) in the paper to represent the institutional quality.

	exVar	expvr	exger	exrqr	exrlr	exccr
exVar	**1.0000**					
expvr	**0.7061**	**1.0000**				
exger	**0.7751**	**0.7395**	**1.0000**			
exrqr	**0.7963**	**0.7038**	**0.9324**	**1.0000**		
exrlr	**0.8268**	**0.7995**	**0.9378**	**0.9146**	**1.0000**	
exccr	**0.7922**	**0.7975**	**0.9190**	**0.8751**	**0.9411**	**1.0000**

5.3 Model specification

Model 1(trade creation of EU enlargement)

$$Lnexport_{ij,t} = \alpha + \beta_1 Ln\, Disw_{ij,t} + \beta_2 Ln\, Y_{i,t} + \beta_3 Ln\, Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \varepsilon_{ij,t} \quad (1)$$

In Model 1, the variable $Lnexport_{ij,t}$ denotes the logarithm of the exports of country i to j at time t. The variable $Ln\, Dis_{ij,t}$ represents the logarithm of the population-weighted distance between the most populated cities in the respective countries. $Ln\, Y_{j,t}$ and $Ln\, Y_{i,t}$ are represented by the real GDP of countries i and j. $Contig_{ij}$ equals to 1 if countries are contiguous. $Comcol_{ij}$is 1 if countries share a common colonizer since 1945. Additionally, $langu_{ij}$ is a dummy variable that equals 1 if at least 9% of the population in both countries speak the same language, representing one of the cultural distances within the EU. Besides, the variable $EU_{ij,t}$ is equal to 1 if countries i and j are members of the EU at time t. The term $\varepsilon_{ij,t}$denotes the error term in the regression model.

Incorporating exporter time fixed effect and importer time fixed effect and pair fixed effect into the regression. So, the regression will be addressed following:

Fixed effect estimation:

$$Lnexport_{ij,t} = \alpha + \beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \gamma_i + \delta_j + \varphi_t + \varepsilon_{ij,t} \quad (2)$$

$$Lnexport_{ij,t} = \alpha + \beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \partial_{it} + \sigma_{jt} + \varepsilon_{ij,t} \quad (3)$$

$$Lnexport_{ij,t} = \alpha + \beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \omega_{ij} + \varphi_t + \varepsilon_{ij,t} \quad (4)$$

Variables ∂_{it} and σ_{jt} represent the exporter time fixed effect and importer time fixed effect. ω_{ij} represents the pair fixed effect. φ_t represents time fixed effect.

The specification of the gravity model for PPML can be represented in the following multiplicative form:

PPML estimation:

$$export_{ij,t} = exp\big(\beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \gamma_i + \delta_j + \varphi_t\big) * \varepsilon_{ij,t} \quad (5)$$

$$export_{ij,t} = \exp\big(\beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \partial_{it} + \sigma_{jt}\big) * \varepsilon_{ij,t} \quad (6)$$

$$export_{ij,t} = \exp\big(\beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \omega_{ij} + \varphi_t\big) * \varepsilon_{ij,t} \quad (7)$$

By incorporating the pair-fixed, importer-time fixed and exporter- time fixed effects in the PPML estimation together, the model can isolate all time-invariant factors

and accurately measure the impact of these time-varying variables on trade flows (Egger & Nigai,2015). So, the regression will be addressed:

$$export_{ij,t} = \exp\big(\beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \partial_{it} + \sigma_{jt} + \omega_{ij}\big) * \varepsilon_{ij,t} \quad (8)$$

Model 2 (trade creation and trade diversion effect of EU enlargement)

Previous models have not tested the effect of trade with third countries, so this model will attempt to test the effect of EU enlargement on trade with third countries and try to capture the trade diversion effect. On top of this, it will evaluate whether improvements in institutional quality can improve trade. In addition to the same variable as model1, model 2 introduces some variables to detect the trade diversion of associated with EU enlargement. Variable $Export\_to\_rest$ is a dummy variable, which equals 1 when the exporter is an EU member country and the importer is a non-member country. Similarly, the variable $import\_to\_rest$ will be included, which is also a dummy variable equal to 1 when the importer is an EU member country and the exporter is a non-member country. Besides, variables exrqr and expvr also will be added into the model2 to test whether the improvement of institutional quality will improve the trade flow between two countries. Variable exrqr represents the regulatory quality of the exporter country while expvr represents the political stability and absence of violence.

Moreover, according to Magee, he mentions a significant drawback of exporter-year and importer-year fixed effects is that they cannot use to include the trade diversion variables (Magee, 2008). This is mainly because exporter-time fixed effects control for all time-varying factors affecting a country's exports, while importer-time fixed effects control for all time-varying factors affecting a country's imports. The importer-time fixed effects, in particular, capture the overall change in a country's imports in a given year. This comprehensive control masks the specific effects of trade diversion, as it is not possible to separately identify the changes in intra-RTA imports and extra-RTA

imports. Thus, the following model will use the Country-Pair Fixed and country-specific effect.

$$Lnexport_{ij,t} = \alpha + \beta_1 Ln\, Disw_{ij,t} + \beta_2 Ln\, Y_{i,t} + \beta_3 Ln\, Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \beta_7 Export\_to\_rest_{ij,t} + \beta_8 Import\_to\_rest_{ij,t} + exrqr_i + expvr_i + \gamma_i + \delta_j + \varepsilon_{ij,t} \quad (9)$$

$$Lnexport_{ij,t} = \alpha + \beta_1 Ln\, Disw_{ij,t} + \beta_2 Ln\, Y_{i,t} + \beta_3 Ln\, Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \beta_7 Export\_to\_rest_{ij,t} + \beta_8 Import\_to\_rest_{ij,t} + exrqr_i + expvr_i + \omega_{ij} + \varphi_t + \varepsilon_{ij,t} \quad (10)$$

$$export_{ij,t} = \exp\big(\beta_1 Ln\, Disw_{ij,t} + \beta_2 Ln\, Y_{i,t} + \beta_3 Ln\, Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \beta_7 Export\_to\_restxport\_to\_rest_{ij,t} + \beta_8 Import\_to\_rest_{ij,t} + exrqr_i + expvr_i + \omega_{ij} + \varphi_t\big) * \varepsilon_{ij,t} \quad (11)$$

Model 3 (trade effect of EU enlargement on China)

Model 3 is designed to assess the trade impacts of EU enlargement on China, focusing particularly on the trade relationships between China and key EU member states, including Germany and the V4 countries (Czech Republic, Hungary, Poland, and Slovakia). The model will also explore changes in trade dynamics within the V4 group post-enlargement, examining how their EU integration influences internal trade patterns. Additionally, the model will incorporate the impact of China's accession to the WTO to provide a more comprehensive analysis of trade effects.

In Model 3, in addition to the variables included in Models 1 and 2, a dummy variable called $eu\_to\_china_{ij,t}$ is introduced to identify any trade diversion or trade

creation speciation between China and the EU following its expansion. The exporting nation is an EU member, while the receiving country is China, as shown by the variable equal to 1. Another dummy variable, $china\_to\_eu_{\ ij,t}$ equals 1 in the case when China is the exporter and the EU is the importer. Besides, $v4china_{\ ij,t}\ is$ a dummy variable, which is assigned a value of 1 when the exporting countries are the Visegrád Four (V4) countries, and the importer is China. Similarly, $Chinav4$ equals 1 when the exporter is China and the importer is a V4 country. Besides, variable $v4$ is used to analyze the intra-regional trade flows among the V4 countries. This variable aims to assess whether the enlargement of the European Union has enhanced the trade creation effect within these countries. When V4 equals 1, it represents that either the exporter or the importer belongs to the V4 countries. Moreover, $DEchina_{\ ij,t}$ is another dummy variable which equals 1 when the exporter is Germany and the importer is China. In addition, $WTO\_China_{\ ij,t}$ is a dummy variable to capture the accession of WTO of China on 11 December 2001. If the β7 coefficient is positive, it indicates that China's participation in the WTO has enhanced its trade relations with other nations, as membership in such international trade organizations typically reduces trading costs for all members involved.

$$\begin{aligned} export_{ij,t} = \exp(&\beta_1 Ln\ Dis_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} \\ &+ \beta_6 Comcol_{ij} + +\beta_7 WTO\_China_{\ ij,t} + \beta_8 EU_{ij,t} \\ &+ \beta_9 eu\_to\_china_{\ ij,t} + \beta_{10} china\_to\_eu_{\ ij,t} + \beta_{11} DEchina_{\ ij,t} \\ &+ \beta_{12} v4china_{\ ij,t} + \beta_{13} Chinav4_{\ ij,t} + \beta_{14} v4_{\ ij,t} + \omega_{ij} \\ &+ \varphi_t) * \varepsilon_{ij,t} \end{aligned} \quad (12)$$

$$\begin{aligned} export_{ij,t} = \exp(&\beta_1 Ln\ Dis_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} \\ &+ \beta_6 Comcol_{ij} + +\beta_7 WTO\_China_{\ ij,t} + +\beta_8 EU_{ij,t} \\ &+ \beta_9 eu\_to\_china_{\ ij,t} + \beta_{10} china\_to\_eu_{\ ij,t} + \beta_{11} DEchina_{\ ij,t} \\ &+ \beta_{12} v4china_{\ ij,t} + \beta_{13} Chinav4_{\ ij,t} + \beta_{14} v4_{\ ij,t} + \partial_{it} \\ &+ \sigma_{jt}) * \varepsilon_{ij,t} \end{aligned} \quad (13)$$

$$export_{ij,t} = \exp(\beta_1 Ln\ Dis_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_6 Comcol_{ij} + +\beta_7 WTO\_China_{ij,t} + \beta_8 EU_{ij,t} + \beta_9 eu\_to\_china_{ij,t} + \beta_{10} china\_to\_eu_{ij,t} + \beta_{11} DEchina_{ij,t} + \beta_{12} v4china_{ij,t} + \beta_{13} Chinav4_{ij,t} + \beta_{14} v4_{ij,t} + \partial_{it} + \sigma_{jt} + \omega_{ij}) * \varepsilon_{ij,t} \quad (14)$$

Equations (12), (13), and (14) all employ the Poisson Pseudo-Maximum Likelihood (PPML) estimation method. Equation (12) incorporates pair and time -fixed effects in terms of $\omega_{ij}\ and\ \varphi_t$. Equation (13) uses importer-year and exporter-year fixed effects ($\partial_{it}\ and\ \sigma_{jt}$), which account for time-varying factors specific to each importer and exporter, respectively. Equation (14) incorporates
a comprehensive set of fixed effects, including pair, importer-year, and exporter-year fixed effects in terms of ∂_{it} , $\sigma_{jt}\ and\ \omega_{ij}$. This specification ensures a more accurate assessment of the influence of trade policies and other variables of interest by providing a rigorous control for both time-varying country-specific impacts and time-invariant bilateral components.

Model 4 (incorporating FTAs)

Model 4 incorporates the variables eufta and chfta into the existing Equation (15) to evaluate the impact of Free Trade Agreements (FTAs) signed by the European Union (EU) and China with other countries. These inclusions allow for the isolation and measurement of the specific effects FTAs have on the trade performance of the EU and China respectively. In Equation (16), the variable eufta is a dummy variable that equals 1 when either the importer or the exporter is a member of the European Union (EU) and the other party is a country that has signed a free trade agreement (FTA) with the EU. Similarly, chfta is a dummy variable that equals 1 when either the importer or the exporter is China and the other party is a country that has signed an FTA with China. These two variables help to demonstrate the impact of such agreements on trade flows.

$$export_{ij,t} = \exp(\beta_1 Ln\ Dis_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_6 Comcol_{ij} + \beta_7 EU_{ij,t} + \beta_9 eu\_to\_china_{ij,t} + \beta_{10} china\_to\_eu_{ij,t} + \partial_{it} + \sigma_{jt} + \omega_{ij}) * \varepsilon_{ij,t} \quad (15)$$

$$export_{ij,t} = \exp(\beta_1 Ln\ Dis_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_6 Comcol_{ij} + \beta_7 EU_{ij,t} + \beta_9 eu\_to\_china_{ij,t} + \beta_{10} china\_to\_eu_{ij,t} + \beta_{11} eufta_{ij,t} + \beta_{12} chfta_{ij,t} + \partial_{it} + \sigma_{jt} + \omega_{ij}) * \varepsilon_{ij,t} \quad (16)$$

5.4 Data

My dataset covers 170 countries including data from 1996 to 2021.The nominal GDP data(*Yi, Yj*), expressed in current thousands US$, was acquired from the World Bank. Variable Export (*export*) is used to describe trade flows between the two countries in thousands of current US$ and is obtained from the CEPII gravity database. Besides, Variables related to trade costs—including contiguity, distance, linguistic commonality, and historical colonial links—as well as distance metrics(*Contig, langu, comcol, dis*), were derived from the CEPII gravity database. The institutional quality indicators(*exrar,expvr*) gain from the Worldwide Governance Indicators. In addition, the data for the dummy variables *eufta* and *chfta*, which are used to indicate the presence of FTAs signed by the EU and China with other countries, are obtained from the Design of Trade Agreements (DESTA) Database. Besides, Disaggregated trade data are gained from the BACI CEPII database and include export volumes for 21 sectors from 1996 to 2021.

6. Empirical results analysis

At first, the aggregated data will be subjected to analysis utilizing fixed time effects and a Poisson Pseudo-Maximum Likelihood (PPML) estimator to assess the trade impacts within the European Union. Subsequently, the potential trade diversion effects will be added to evaluate the comprehensive trade effects. The last stage involves

utilizing disaggregated data to explore sector-specific impacts within the top six trading industries.

6.1 Pre-Analysis test

The Wald test is conducted to test whether there is heteroskedasticity in my dataset. The result shows that there is the presence of heteroskedasticity. So robust standard errors will be used to address it. Besides, the Hausmann test also is conducted, the result shows that the panel data is more suitable to use fixed effect. In addition, the Variance Inflation Factors (VIF) also is conducted. The results show that the mean VIF for all variables is 1.18, which is well below the commonly accepted threshold of 5. Therefore, multicollinearity is not a concern in this case(All the results of these tests in the Appendix 9).

Moreover, the near zero trade flow in terms of the value of export less than 0.01 (10 dollars) accounts for 0.2 % of total export volume. In light of the near-zero trade flows and the presence of heteroskedasticity, the Poisson Pseudo-Maximum Likelihood (PPML) estimator also will be utilized to produce more reliable and consistent results (see Appendix 9).

6.2 Analyzing Trade Effects of the EU enlargement by aggregate date

6.2.1 Model 1(Trade effect within EU)

The results from columns one to four utilize fixed effects models, while columns five to eight apply the Poisson Pseudo-Maximum Likelihood (PPML) methodology. To start analyzing the outcomes under the fixed effects model.

The results in the first column indicate an inverse relationship between distance and export trade volume. As the distance increases by 1 % between each country, the trade flows between two countries would decrease 1.331%. Besides, Trade volume has a positive correlation with GDP. Column 2 concurrently controls time-specific and pair-specific effects by including fixed effects for each nation pair and year. This model

accommodates unobserved factors that vary across pairs and over time, such as changes in bilateral trade agreements or tariffs. The findings in the second column indicate that EU membership can notably enhance intra-EU trade by 35% (($e^{0.3}$ -1) × 100).

Furthermore, Column 3 includes the exporter-time fixed and importer-time fixed dummies to control for impacts that fluctuate over time and are unique to each exporter and importer. This means it accounts for changes over time that affect each country differently, such as domestic policy changes or economic conditions affecting export capacity or import demand. Similar geographic proximity, language, and historical links may considerably encourage bilateral trade, as the data demonstrate. Variables like contiguity, shared language, and common coloniser are significant and favourably affect trade. Interestingly, the EU dummy variable indicates a negative effect on trade flow in this model, contrasting with results in columns 1, 2, and 4. In the Column 4, this column considers fixed effects for both exporter-time and importer-time, as well as for each country pair, to control for time-varying effects specific to each exporter and importer and constant effects specific to each pair. It captures both time-varying and static unobserved heterogeneities across all dimensions. The results of the study show that the enlargement of the EU has led to trade creation within the EU member states and intra-EU trade has increased by 23.12% ($e^{0.208}$ -1) × 100.

Moreover, Columns 5 to 8 employ the Poisson Pseudo-Maximum Likelihood (PPML) method to address the challenges of near-zero trade flows and heteroscedasticity. In column 5 of Table 1, the analysis shows a negative correlation between distance and intra-EU trade, indicating that greater distance dampens trade volumes. Conversely, the GDPs of both exporter and importer countries exhibit a positive relationship with trade volumes, underscoring economic size as a critical driver of trade activity. Besides, the contiguity, common language, and common colonizer are also significant and positively influence trade within EU. The coefficient of dummy viable EU shows that the country's accession to the EU will increase trade flows by 0.26 % ($e^{0.0026}$ -1) × 100. Additionally, variables such as contiguity, common language, and shared colonial history are found to significantly and positively influence trade within the EU. However, this model only offers a rough summary and does not

take into account the most recent theoretical developments about the gravity model's fixed effects, which might lead to biased and unreliable conclusions.

The integration of pair-specific and time-specific fixed effects in Column 6 further suggests that a rise in trade volume is correlated with an increase in GDP. Additionally, this model demonstrates a significant boost in intra-EU trade by 48% ($e^{0.398}$ -1) × 100 following the accession to the EU.

In addition, column 7 includes exporter-time and importer-time fixed effects to account for time-varying economic conditions specific to each country. The results remain consistent with earlier findings, illustrating that geographical proximity, language similarity, and historical ties significantly boost trade, with specific increases within the EU by 57.14%(($e^{0.452}$ -1) × 100), 25.35%(($e^{0.226}$ -1) × 100) and 52.96%(($e^{0.425}$ -1) × 100) respectively. The result of the dummy variable EU shows that since EU enlargement, the trade can be improved by 26.36% (($e^{0.452}$ -1) × 100).

Finally, by including country-pair fixed effects in addition to the already-existing exporter-time and importer-time fixed effects, column 8 expands upon the preceding model. The result of column 8 is the most reliable one. This comprehensive model aims to mitigate potential endogeneity issues related to the EU by absorbing all trade-related costs and effectively isolating the impact of key variables. It confirms the positive influence of EU membership on trade, illustrating an 8% (($e^{0.0882}$ -1) × 100) increase in trade between member countries post-EU enlargement.

In summary, all results are as anticipated. Distance inversely correlates with trade volume, while the GDPs of the nation’s positively correlate with it. Additionally, trade volumes are positively associated with factors like contiguity, common language, and shared colonial history between countries. What is more, almost fixed effects models and PPML analyses indicate that the EU's eastern enlargement leads to trade creation within the EU unless the result of column 3.

Table 1 Result for Model 1

	(1) FE (t)	(2) FE (t, ij)	(3) FE (it, jt)	(4) FE (it, jt,ij)	(5) PPML	(6) PPML (ij,t)	(7) PPML (it,jt)	(8) PPML (it, jt, ij)
lndisw	-1.331***		-1.743***		-0.715***		-0.795***	
	(0.0166)		(0.0169)		(0.0092)		(0.0078)	
lnYi	1.258***	0.575***			0.800***	0.528***		
	(0.0050)	(0.0172)			(0.0033)	(0.0104)		
lnYj	0.961***	0.761***			0.782***	0.562***		
	(0.0052)	(0.0150)			(0.0049)	(0.0098)		
contig	1.047***		0.833***		0.539***		0.452***	
	(0.0877)		(0.0898)		(0.0247)		(0.0158)	
langu	0.823***		0.635***		0.455***		0.226***	
	(0.0345)		(0.0345)		(0.0182)		(0.0146)	
comcol	0.807***		0.902***		0.609***		0.425***	
	(0.0452)		(0.0413)		(0.0402)		(0.0289)	
eu	0.375***	0.309***	-1.099***	0.208***	0.0226	0.398***	0.234***	0.0882**
	(0.0505)	(0.0276)	(0.0605)	(0.0379)	(0.0192)	(0.0201)	(0.0194)	(0.0173)
_cons	-35.67***	-25.23***	22.51***	7.609***	-22.68***	-14.16***	22.39***	16.42***
	(0.251)	(0.564)	(0.150)	(0.0007)	(0.192)	(0.376)	(0.0692)	(0.0038)
Time-Fixed	YES	YES	NO	NO	NO	YES	NO	NO
Country-Pair Fixed	NO	YES	NO	YES	NO	YES	NO	YES
Exporter-Time Fixed	NO	NO	YES	YES	NO	NO	YES	YES
Importer-Time Fixed	NO	NO	YES	YES	NO	NO	YES	YES

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2.2 Model 2

Model 2 expands on the previous model 1 by including variables designed to capture the trade diversion effects associated with EU enlargement(see Table2). Additionally, the variables exrqr and expvr have been introduced to assess whether improvement in the institutional quality of exporting countries facilitates increased trade flows with their principal trading partners.The model's findings, which are shown in Columns 1 and 2 and take into consideration temporal variables as well as impacts unique to each countries, confirm that trade flows are significantly impacted by GDP, proximity, contiguity, shared language, and shared colonial history. Column 1 shows that trade between EU member states decreases after EU accession but the result is not significant. Conversely, the coefficients for export_rest and importer_from_rest are both positive and statistically significant at the 1% level, suggesting that there is a trade creation between EU and non-member countries. Importantly, no evidence of trade diversion effects is found. However, when adjusting for fixed effects related to country pairs and time, Column 2 exhibits a negative coefficient for importer_from_rest, suggesting the presence of trade diversion following EU enlargement.

Furthermore, Column 1 confirms a positive correlation between institutional quality and trade flows. Specifically, an enhancement in regulatory quality (exrqr) by one unit correlates with an approximate 1.25% increase in export volume, a finding strongly supported by its high statistical significance. Similarly, a one-unit improvement in political stability and absence of violence (expvr) is associated with a roughly 0.4% increase in export volumes, underscoring the critical role of political stability in facilitating export activities. These results are corroborated by the findings presented in Column 2.

Then, the Poisson Pseudo-Maximum Likelihood (PPML) method is also utilized. According to the results in Column 3, exports of the member states to the rest of the world increased 34.17% and imports from the rest of the world increased by 5 % after the eastern enlargement of the EU. The result in Column 3 show that following the EU's eastern expansion, exports from member states to the rest of the world climbed by 34.17%

(($e^{0.294}$ -1) × 100)) and imports from the rest of the world increased by 5% (($e^{0.05}$ -1) × 100)

Similar results are observed in Column 4, which employs country-pair fixed effects. It shows that export trade creation is greater than import trade creation following the EU enlargement. Moreover, the coefficient for the EU dummy variable in Column 3 and 4 indicates that joining the EU boosts trade between member countries by 79.67%% (($e^{0.586}$ -1) × 100 and 73.15% (($e^{0.549}$ -1) × 100) separately, a figure substantially higher than those reported in Table 1. This suggests a more pronounced trade-promoting effect on intra-bloc trade when external trade is also considered. Additionally, the impact of intra-trade creation surpasses that of extra-trade effects, indicating that the elimination of tariffs between EU member countries offers greater incentives for trade amongst themselves compared to trading with external countries.

Overall, these findings suggest that the establishment of a customs union following the EU's eastern enlargement would lead to a significant increase in trade flows within the EU and between the EU and other global markets. Besides, there is a positive relationship between the quality of EU institutions and trade flow.

Table 2 Result of Mode 2

	(1) FE (t)	(2) FE (ij,t)	(3) PPML (i,j,t)	(4) PPML (ij,t)
lndisw	-1.328***		-0.791***	
	(0.0168)		(0.00818)	
lnYi	1.203***	0.547***	0.562***	0.564***
	(0.00591)	(0.0175)	(0.0221)	(0.0112)
lnYj	0.976***	0.764***	0.578***	0.586***
	(0.00544)	(0.0150)	(0.0200)	(0.0100)
contig	1.303***		0.462***	
	(0.0869)		(0.0162)	
langu	0.785***		0.220***	
	(0.0343)		(0.0150)	
comcol	0.867***		0.431***	
	(0.0442)		(0.0302)	
eu	-0.0614	0.380***	0.586***	0.549***
	(0.0560)	(0.0354)	(0.0384)	(0.0226)
export_rest	0.128***	0.402***	0.294***	0.331***
	(0.0294)	(0.0283)	(0.0357)	(0.0184)
importer_from _rest	0.200***	-0.192***	0.0558*	0.0664***
	(0.0354)	(0.0378)	(0.0240)	(0.0181)
exrqr	0.0125***	0.00712***	-0.000768	-0.00117*
	(0.000672)	(0.000658)	(0.00113)	(0.000509)
expvr	0.00412***	0.000646	-0.000671	-0.000448
	(0.000560)	(0.000452)	(0.000643)	(0.000309)
_cons	-35.58***	-25.04***	-9.482***	-15.68***
	(0.249)	(0.565)	(0.730)	(0.385)
N	547631	546360	547631	546360
Time-Fixed	YES	YES	YES	YES
Country-Pair Fixed	NO	YES	NO	YES
Exporter, Importer-Fixed	NO	NO	YES	NO

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2.3 Model 3 (trade effect of EU enlargement on China and V4)

In assessing the trade dynamics between the European Union (EU) and China, Model 3 aims to elucidate the impact of EU enlargement on these trade relations. Column 3 has the most reliable results. However, the other variables in column 3 are absorbed, so we need to combine columns 1 and 2 to see the overall results.

According to the findings in columns 1 and 2 of table 3, a robust positive correlation exists between GDP and export volume, while a negative relationship between distance and trade flow aligns with traditional gravity model expectations. Besides, it also corroborates the widely held view that geographical proximity, shared language, and historical ties are strong promoters of bilateral trade.

Column 1 particularly highlights the positive influence of China's accession to the World Trade Organization (WTO) on its trade interactions. The coefficient of *wto_china* reveals that trade flows are approximately 71.9% (($e^{0.542}$ -1) × 100) higher when China engages under WTO conditions than when it does not, emphasizing the significant boost in trade due to China's integration into the global trade system. Further examination reveals the effects of the EU enlargement on trade flows between the EU and China. The coefficient for euchina indicates a 105.85% (($e^{0.722}$ -1) × 100) increase in EU exports to China post-enlargement, suggesting a creation of exports. Besides, the chinaeu coefficient shows an increase of 22.87%% (($e^{0.206}$ -1) × 100) in EU importing from China since the enlargement, underscoring the growing importance of Chinese goods in the European market and testifying the import trade creation, likely driven by China's competitive pricing and the EU's market demand.

Furthermore, according to the results presented in Column 2 of table 3, which account for the time-varying economic conditions unique to each nation by including importer- and exporter-time fixed effects. The result of column 2 also presents a substantial positive impact of the variable *DEChina*, where the trade flow involving Germany as the exporter and China as the importer more than doubles, increasing by 145% (($e^{0.900}$ -1) × 100). The coefficient for DEChina is larger than the EU suggesting that Germany is the primary exporter within the EU to China. In contrast, the coefficient of v4china is negative, indicating a significant decrease in exports from v4 countries

(the Czech Republic, Hungary, Poland, and Slovakia) to China following their accession to the EU. The observed 48.3% % (($e^{0.727}$ -1) × 100) decrease in exports suggests a reorientation of v4 countries' trade priorities or a realignment of trade policies post-EU accession. Besides, the variable *v4* shows that there is a significant increase of trade flow between the intra V4 countries since the EU enlargement. The trade within v4 countries increase 129% (($e^{0.829}$ -1) × 100). Besides, the variable chinav4 indicates that since the EU enlargement, V4 countries have increased their imports from China, although this result is not statistically significant.

In Column 3, which utilizes importer-time, exporter-time, and pair fixed effects, variables other than *eu*, *euchina*, and *chinaeu* are effectively absorbed into the model. This analytical approach reveals that post-EU enlargement, there is a trade creation effect within the EU, quantified as a 9.12% (($e^{0.0912}$ -1) × 100)) increase in trade volumes. The coefficient for euchina robustly demonstrates a 22.38%(($e^{0.202}$ -1) × 100)) increase in EU exports to China following the enlargement. Furthermore, the variable chinaeu indicates an increase in the EU's imports from China. However, this increase does not reach statistical significance.

In conclusion, following the European Union's (EU) enlargement, there has been an increase in exports from the EU to China, along with a continued rise in imports from China. Furthermore, Germany, as the EU's principal trading partner with China, has observed an increase in its exports to China. In contrast, the Visegrád Four countries—comprising the Czech Republic, Hungary, Poland, and Slovakia—have experienced a decrease in their exports to China after their accession to the EU. However, trade flows within the V4 have significantly increased. Additionally, China's accession to the World Trade Organization (WTO) has further facilitated trade between these nations.

Interpretation of Trade Dynamics Involving V4 Countries, Germany, and China

The relative decline in exports from the Visegrád Four (V4) countries to China can be attributed to the fact that these countries primarily process imported raw materials

or semi-finished goods into intermediate products, which are not typically exported back to China. Consequently, there are few products left that the V4 can directly export to China.

To be more specially, the observed trade patterns involving the V4 countries, Germany, and China suggest a sophisticated interdependency that can be attributed to the value-added processes in the global supply chain. Specifically, the V4 countries have been noted to import raw materials or semi-finished goods from China, which they then process into intermediate products. This stage of processing typically involves significant value addition within the V4 economies, leveraging their technological capabilities and cost-efficient labor markets. Following this intermediary stage, these products are often exported to Germany, Austria, and the Netherlands instead of China, for further processing and completion. Subsequently, the finished goods that are completed and processed might be exported to markets such as China. Alternatively, these goods could be also exported to other third-party countries (Baldwin, 2013). Building upon this understanding of the V4's role in the value chain, we can further explore their specific contributions to international trade.

Table 3 Result of Mode 3

	(1) PPML (ij,t)	(2) PPML (it,jt)	(3) PPML (it,jt,ij)
lndisw		-0.790***	
		(0.00778)	
lnYi	0.528***		
	(0.0104)		
lnYj	0.562***		
	(0.00987)		
contig		0.452***	
		(0.0155)	
langu		0.220***	
		(0.0144)	
comcol		0.409***	
		(0.0291)	
wto_china	0.542***		
	(0.0409)		
eu	0.382***	0.332***	0.0912***
	(0.0191)	(0.0198)	(0.0165)
euchina	0.722***	-0.267***	0.202*
	(0.0904)	(0.0377)	(0.0950)
chinaeu	0.206*	0.293***	0.00722
	(0.0959)	(0.0351)	(0.0744)
DEChina		0.900***	
		(0.0342)	
v4		0.829***	
		(0.0431)	
chinav4		0.0185	
		(0.0446)	
v4china		-0.692***	
		(0.0693)	
_cons	-14.18***	22.32***	16.42***
	(0.376)	(0.0685)	(0.00454)
N	550239	551491	550239
Time-Fixed	YES	NO	NO
Country-Pair Fixed	YES	NO	YES
Exporter-Time Fixed	NO	YES	YES
Importer-Time Fixed	NO	YES	YES

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Perspective of Global value China of V4 countries export to China

Shifting our focus to the broader context of global trade dynamics, let's delve deeper into the specific role of the V4 countries within the international market. As mentioned previously, the V4 countries are integral to global manufacturing supply chains, focusing mainly on producing intermediary goods. Typically, these goods are completed in other countries before the final products are exported to China. Thus, a more accurate assessment of the V4 countries' economic engagement with China should consider not only the final products directly exported to China, but also the intermediary goods that are completed in other countries and subsequently re-exported to China to gain a comprehensive view of their trade relations.

According to the OECD TiVA database, a value chain analysis reveals that when considering only the final products exported to China, the export volumes from the Visegrád Four (V4) countries appear quite limited. Specifically, exports from the Czech Republic to China constitute only 1.32% of its total exports, Hungary 1.44%, Poland 1.24%, and Slovakia 2.72 % according to the traditional cross border statistic Trade (see Table 4). However, adopting a global value chain perspective reveals an increase in these exports. It does reveal how much of the immediate product (in terms of value-added) produced in the v4 countries that were absorbed by China through the way of indirect trade. The value-added by origin and destination is calculated by tracing the value contributed by each country to the final product, calculated by the value-added exports from country (each v4 countries) to China/The total value-added exports of country (each v4 countries). In a detailed analysis of value-added exports from the Visegrád Four (V4) countries to China within specific sectors, substantial increases are observed in the sectors of Equipment and Motor Vehicles, Trailers, and Semi-Trailers. The analysis is sector-specific, as indicated by Sector of Origin: 19 and 20. This means the value-added is being calculated for a specific industry or sector within each country. Specifically, in the machinery and equipment sector, the Czech Republic's exports to China account for 5.62%, while Hungary contributes a higher figure of 6.29%. Poland and Slovakia contribute 3.93% and 5.65%, respectively. Even more notable are the increases in the sector of Motor Vehicles, Trailers, and Semi-Trailers, where the Czech

Republic’s exports stand at 4.58%, Hungary's at 6.78%, Poland's at 3.76%, and Slovakia's at an impressive 17.96%(see Table 4). This underscores the Slovak automotive industry's significant growth and its rising prominence on the global stage. The significant growth of the Slovak automotive industry and its rising prominence on the global stage are underscored by current market trends. Additionally, this phenomenon illustrates the high demand for vehicles produced in Slovakia, particularly in the Chinese market.

Furthermore, data from Table 5 corroborate the enhancement of global value chain participation following the EU enlargement, aligning with Kaplan who emphasizes the positive impact of this enlargement on Central and Eastern European countries (Kaplan,2018). This increase in global value chain involvement has facilitated deeper economic integration and technological upgrading within these regions to significantly bolster manufacturing capabilities in core Central European countries such as the Czech Republic, Hungary, Poland, and Slovakia (Stöllinger, 2016).

Thus, despite appearing as a minor trade partner in bilateral trade statistics, China emerges as a crucial market for the V4 countries. This analysis underscores the importance of considering integrated value chains to fully appreciate the economic interdependencies between the V4 countries and China.

Table 4 V4 countries direct and indirect exports to China in 2020

	Czech Republic	Hungary	Poland	Slovakia
Total Value added	2.23%	2.53%	1.64%	3.25%
Sector 19: Machinery and equipment	5.62%	6.29%	3.93%	5.65%
Sector20: Motor vehicles, trailers and semi-trailers	4.58%	6.78%	3.76%	17.96%
Traditional Bilateral Trade	1.32%	1.44%	1.24%	2.72%

Source: OECD TiVA database& DOTS database IMF, calculated by ICIO command

Table 5 Global value chain participation (GVC-backward + GVC-forward) of V4 in 2000 and 2020

	Czech Republic	Hungary	Poland	Slovakia
2000	44.73	54.76	42.01	50.66
2020	54.70	58.85	48.66	61.98

Source: OECD TiVA database, calculated by ICIO command

6.2.4 Model 4: (incorporate the FTA)

According to Table 6, the Free Trade Agreement (FTA) variables are added to the existing regression model. Column 1 presents the results without including the eufta and chfta variables, while Column 2 shows the results after incorporating these variables, along with exporter-time, importer-time, and pair fixed effects. After adding the FTA variables, the coefficient for the *eu* variable increases from 0.0912 to 0.156, indicating that the trade creation effect within the EU since its enlargement has risen

significantly from 9.5% (($e^{0.0912}$ -1) × 100) to 16.9% (($e^{0.156}$ -1) × 100). Similarly, the coefficient for *euchina* increases from 0.202 to 0.212, suggesting that since the EU enlargement the EU's exports to China have grown from 22.3% (($e^{0.202}$ -1) × 100) to 23.6% (($e^{0.212}$ -1) × 100), reflecting a modest enhancement in trade flows due to FTAs. Although the coefficient for *chinaeu* increases from 0.00722 to 0.0172, it remains statistically insignificant, implying that the inclusion of FTA variables does not significantly alter the trade flows from China to the EU. Overall, these results demonstrate a notable increase in the trade creation effect within the EU following its enlargement and a modest improvement in EU-China trade, while the impact on China-EU trade remains negligible. Moreover, the positive coefficients of eufta and chfta testify to the trade creation effects in regions where the EU and China have signed trade agreements with other countries.

The changes in coefficients primarily result from the inclusion of the *eufta* and *chfta* variables, which control for the impact of the EU's and China's external FTAs, respectively. By incorporating *eufta*, the model removes external influences from the *eu* variable, allowing the *eu* coefficient to more accurately reflect the trade-promoting effect within the EU. Similarly, the increased coefficients for the *euchina* and *chinaeu* variables reflect a more precise direct trade relationship between China and the EU, as *eufta* ensures these variables are not affected by the EU's FTAs with other countries. Additionally, when *chfta* is included, it controls for the impact of China's FTAs with other countries, further refining the analysis of trade flows involving China. Thus, the inclusion of these variables provides a more nuanced understanding of how FTAs impact trade flows, offering clearer insights into the effectiveness of these agreements in promoting trade between the EU and China.

Table 6 Result of model 4

	(1)	(2)
	PPML (it,jt,ij)	**PPML (it,jt,ij)**
eu	0.0912***	0.156***
	(0.0165)	(0.0203)
euchina	0.202*	0.212*
	(0.0950)	(0.0947)
chinaeu	0.00722	0.0172
	(0.0744)	(0.0742)
eufta		0.0674***
		(0.0121)
chfta		0.0249
		(0.0363)
_cons	16.42***	16.40***
	(0.00454)	(0.00594)
N	550239	550239
Time-Fixed	NO	NO
Country-Pair Fixed	YES	YES
Exporter-Time Fixed	YES	YES
Importer-Time Fixed	YES	YES

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.3 Disaggregated analysis

In addition to the aggregated, I will also employ the disaggregated data to conduct a gravity model analysis to examine the impact of EU enlargement on eight specific sectors in China-EU trade. These sectors, identified through the HS 92 classification, represent the most significant goods exchanged between the two entities. This classification identifies 8 key industries which include Textiles, Machinery, Optical

Photographic and Medical Instruments, Agriculture, Miscellaneous Manufactured Articles, Chemicals, Plastics/Rubber, and Transport Equipment which in Table 7 and Table 8.I will utilize the Poisson Pseudo Maximum Likelihood (PPML) technique to analyze the impact, while also accounting for pair and fixed to control for omitted variables and any unobserved, time-invariant characteristics of country pairs. The regression specification is as follows.

$$export_{ij,t} = \exp(\beta_1 Ln\ Dis_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \beta_7 china\_to\_eu_{ij,t} + \beta_8 eu\_to\_china_{ij,t} + \omega_{ij} + \varphi_t) * \varepsilon_{ij,t} \quad (14)$$

According to the result presented in table 7, the customs union exhibits varied impacts across different sectors. The elimination of tariffs between member countries has led to trade creation in all eight sectors. However, the trade creation effect within EU in the textile sector is deemed insignificant. Furthermore, for the Textile industry, there has been a 13% decrease in imports from China since the EU's enlargement while the result is not significant. Nevertheless, as evidenced by Table 8, the EU has increased its textile imports from other parts of the world post-enlargement This trend suggests that the EU is actively seeking to diversify its supply chain in order to reduce its dependence on Chinese textile suppliers. Such diversification efforts include sourcing from other low-cost countries, such as Vietnam. In addition, this shift is largely to the lifting of textile quotas on January 1, 2005, which initially led to a surge in textile exports from developing countries to the EU. However, the revision of the Generalised Preferential Treatment (GPT) by the European Commission in October 2005 has created new barriers to the export of Chinese textiles. Tariffs have risen from the current average of 9 % to 12 %. (EU commission,2005) This explains why the EU's imports of textiles from the rest of the world have increased but imports from China have decreased.

Notably, the Agricultural sector demonstrates the most significant trade creation effect within the EU, increasing by 110%. There is also evidence of trade diversion

between China and the EU in the Agriculture sector, which decreased by 30% following the EU enlargement. Moreover, EU imports of agricultural products from the global market also have decreased by 10%. This reduction is primarily attributed to the implementation of the Common Agricultural Policy (CAP) within the EU. By subsidizing local production, the EU can rely less on imports, which leads to a decrease in agricultural imports from non-member countries, including China. Besides, the EU has strict agricultural standards relating to health, safety, and environmental impact. New regulations or changes in enforcement intensity after enlargement can impact imports if external suppliers find it challenging to meet these standards. On top of that both in China and the EU, the tariffs on agricultural products are a bit higher than the tariffs on non-agricultural products.

Additionally, the Machinery and Transport Equipment sector recorded the second and third highest trade increases within the EU, at 62.41% and 60.95% respectively. This is due to the elevated position of CEE countries, especially the Visegrád Four (V4), in the supply chain and their increased participation in the global value chain have improved their manufacturing capabilities. Furthermore, EU imports from China have increased, with imports of Optical Photographic and Medical Instruments rising by 192%. Additionally, the products showing the largest increase in imports from China are Transport Equipment and Machinery. This corroborates the descriptive analysis presented in the previous section. It indicates that despite the strengthening manufacturing capabilities within the CEE countries of the EU, the Union still heavily relies on Chinese manufacturing.

Moreover, EU imports of chemical goods from China have increased by 26%, while imports from the rest of the world have decreased by 3.6%. Since the enlargement of the European Union, the volume of intra-European Union trade in chemical products has increased by 32.84%. The creation of trade within the EU exceeds that of import growth from China. This discrepancy is primarily attributed to technical barriers to trade arising from stringent EU regulations, notably the Regulation on the Registration, Evaluation, and Authorisation of Chemicals (REACH) proposed by EU 15 (Zeitlin, 2015). Despite the EU's relatively weak chemical production capacity, these regulations

have created significant compliance costs for non-EU exporters, making it difficult for them to meet the standards required to enter the EU market.

In the Plastics and Rubber sector, while the EU has experienced trade creation within its borders, it has also increased imports from China in terms of 44.62%. However, the internal trade creation within the EU surpasses the import growth from China. This phenomenon illustrates that the elimination of tariffs has encouraged the EU to source these raw materials locally due to reduced transportation costs.

In summary, EU enlargement has led to trade diversion from China in the sectors of agriculture and textiles. The impact on other industries has primarily been to promote both imports and exports, particularly evident in the Machinery, Optical, Photographic, Medical instruments, and Transport equipment sectors.

Table 7 Trade effects on China Disaggregated Data

	Textile	Machinery	Optical, Photographic, Medical Instruments	Agriculature	Miscellaneous Manufactured Articles	Chemical	Plastics/Rubber	Transport Equipment
eu	0.0554	0.485***	0.372***	0.746***	0.415***	0.284***	0.449***	0.476***
	-0.0286	-0.029	-0.0331	-0.0285	-0.0355	-0.0192	-0.0267	-0.0353
chinaeu	-0.123	0.533***	1.072***	-0.268***	0.446***	0.237*	0.369***	0.850***
	-0.146	-0.155	-0.131	-0.0797	-0.111	-0.0935	-0.109	-0.171
euchina	1.041***	0.925***	1.280***	0.689***	1.648***	-0.0175	1.268***	1.196***
	-0.129	-0.19	-0.185	-0.143	-0.227	-0.176	-0.149	-0.289
_cons	-16.09***	-20.27***	-18.82***	-10.94***	-23.29***	-13.05***	-18.70***	-21.92***
	-0.761	-0.69	-1.236	-0.425	-1.014	-0.459	-0.489	-0.75
N	377210	421563	314491	411692	313711	348181	338715	304820

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8 Trade effects on Disaggregated Data (whole word)

	Textile	**Machinery**	**Optical, Photographic, Medical Instruments**	**Agriculature**	**Miscellaneous Manufactured Articles**	**Chemical**	**Plastics/Rubber**	**Transport Equipment**
eu	0.223***	0.874***	0.801***	0.848***	0.680***	0.411***	0.698***	0.657***
	-0.0362	-0.0398	-0.0495	-0.0303	-0.0436	-0.0273	-0.0308	-0.0463
export_rest	0.104***	0.578***	0.658***	0.304***	0.479***	0.207***	0.388***	0.439***
	-0.0307	-0.0313	-0.0413	-0.03	-0.0342	-0.0259	-0.0271	-0.0362
importer_from_rest	0.277***	0.223***	0.201***	-0.102***	0.195***	-0.0359	0.0581*	-0.03
	-0.0319	-0.0313	-0.0546	-0.0247	-0.0355	-0.0264	-0.0244	-0.0332
_cons	-16.07***	-20.39***	-19.05***	-10.93***	-23.39***	-13.08***	-18.73***	-21.84***
	-0.758	-0.689	-1.232	-0.424	-1.013	-0.459	-0.487	-0.75
N	377210	421563	314491	411692	313711	348181	338715	304820

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7. Extension Analysis

7.1 Extension sector analysis

Based on the comprehensive analysis previously conducted regarding the EU's trade dependency on China, it has been observed that the highest dependencies are concentrated within the Harmonized System (HS) categories 94-96, as well as HS 84-85. By utilizing the six-digit classification within the HS, more detailed data can be obtained.

According to Rogers, strategic dependence is identified when the following conditions are met: the EU is a net importer of a good, over 50 percent of the EU's imports of that good come from China, and China dominates more than 30 percent of the global market for that good (Rogers et al., 2020). Based on this definition, we gain the data from the BACI CEPII database, the following graph is the result of the top ten products that are strategically dependent on China. From the data of 2021, it is evident that within the HS84-85 product classification, the European Union's largest imports from China are categorized under HS847193, which includes data processing machinery: storage units, whether or not presented with the rest of a system. The dependency of the EU on China for these products stands at 51.57%, indicating that nearly half of these imports are sourced from China (see table 9). The second largest import category from China for the EU is classified under HS54140, which pertains to electrical apparatus: photosensitive devices, including photovoltaic cells and light emitting diodes, with a dependency rate of 57.37% on China, reflecting the EU's substantial reliance on China for components critical to renewable energy technologies (see Table 9). Besides, traditional manufacturing, the EU's reliance on China for optical devices, appliances, and instruments is also notably high. This trade dependence on China for such products increased from 57.58% in 2015 to 81.29% in 2021.

The significant reliance on China for these categories is largely due to the relatively slow development of cutting-edge industries in the EU compared to the United States

and emerging market countries represented by China. For instance, in the renewable energy sector, the EU's photovoltaic industry, once a global leader, has significantly declined, while China's photovoltaic industry now accounts for more than half of the global market share. China's photovoltaic industry benefits from a large production scale, a complete supply chain capable of responding quickly to market demand, government policy incentives such as electricity price policies significant government funding on photovoltaic industry (Zhao et al., 2013). This lays the foundation for China to become a global leader in the photovoltaic industry. In contrast, the EU's photovoltaic manufacturing industry is smaller in scale and struggles to compete with China's production capabilities. Moreover, data processing machinery represents a significant portion of global Information and Communication Technology (ICT) products. Concerns about policy are particularly warranted for the electronics sector, where the EU's market share has declined more significantly than in overall manufacturing (Marschinski & Martínez-Turégano, 2020). According to research data from the European Commission's Joint Research Centre (JRC) on the world's top 2500 companies by R&D investment, the EU's investment in ICT industry R&D is significantly lower than the global average. Chinese companies invest almost twice as much in R&D for ICT services and 42% more in the ICT producers sector than their EU counterparts. As a direct consequence of this shortfall, the European Union relies heavily on importing these essential technological components from China and US , which has established a more robust infrastructure for ICT production through substantial R&D investment (Grassano et al., 2021).

Table 9 Trade strategic dependence of EU on China

year	hs6	Trade volumn	EU27_imp	EU import share from China	China globalmarket share	description
2021	847193	1159601.875	15.58%	51.57	74.30	Data processing machinery: storage units, whether or not presented with the rest of a system
2021	854140	403642.375	5.42%	57.37	48.39	Electrical apparatus: photosensitive, including photovoltaic cells, whether or not assembled in modules or made up into panels, light emitting diodes
2021	940540	156274.3906	2.10%	51.33	64.18	Lamps and light fittings: electric, n.e.s. in heading no. 9405
2021	901380	131992.7813	1.77%	81.30	57.30	Optical devices, appliances and instruments: n.e.s. in heading no. 9013 (including liquid crystal devices)
2021	950691	106146.5156	1.43%	52.11	63.20	Athletics and gymnastics equipment
2021	860900	83786.85938	1.13%	62.49	66.23	Containers: (including containers for transport of fluids) specially designed and equipped for carriage by one or more modes of transport
2021	940171	75982.10938	1.02%	55.79	66.90	Seats: with metal frames, upholstered, (excluding medical, surgical, dental, veterinary or barber furniture)
2021	940179	63148.39063	0.85%	57.59	69.80	Seats: with metal frames, not upholstered, (excluding medical, surgical, dental, veterinary or barber furniture)
2021	901910	59808.98047	0.80%	52.11	64.65	Mechano-therapy appliances: massage apparatus and psychological aptitude-testing apparatus
2021	420212	55145.78125	0.74%	57.60	69.98	Cases and containers: trunks, suit-cases, vanity-cases, executive-cases, brief-cases, school satchels and similar containers, with outer surface of plastics or of textile materials
2021	940130	47460.71484	0.64%	51.64	64.81	Seats: swivel with variable height adjustment, excluding medical, surgical, dental, veterinary or barber furniture

In addition, It is important to note Germany's significant trade dependence on China for cells and batteries, which are essential components in vehicle production.

Germany's reliance on Chinese batteries has reached 54%, with imports totaling $171.49 billion(see Appendix 1). This underscores that despite hosting leading electric vehicle manufacturers, the EU's vulnerability lies in its reliance on China for the critical components like power batteries used in electric vehicles. According to the European Commission, the challenges associated with battery production in the EU are complex and span the entire value chain. The EU's manufacturing capacity for lithium-ion cells is relatively limited compared to other regions such as Asia and the U.S., affecting the entire battery production process from cell to pack manufacturing. Moreover, the EU faces challenges in securing a stable and sufficient supply of critical raw materials necessary for battery production, such as lithium, cobalt, and nickel. This dependence on imported materials poses a strategic vulnerability for the EU (European Commission. Joint Research Centre., 2016).

These reflect the EU's significant reliance on China for advanced technological components and materials, particularly in sectors integral to digital infrastructure, renewable energy, advanced manufacturing and battery.

7.2 Impact of Different Phases of EU Enlargement on China-EU Trade

Model 5 utilizes ceu dummy variables to analyze the impact of EU enlargements on China-EU trade, each reflecting specific accession phases. For every ceu dummy variable, the exporter is China and importer is different EU countries.

$$export_{ij,t} = \exp\big(\beta_1 Ln\ Disw_{ij,t} + \beta_2 Ln\ Y_{i,t} + \beta_3 Ln\ Y_{j,t} + \beta_4 Contig_{ij} + \beta_5 langu_{ij} + \beta_5 Comcol_{ij} + \beta_6 EU_{ij,t} + \beta_6 ceu_{ij,t} + \partial_{it} + \sigma_{jt} + \omega_{ij}\big) * \varepsilon_{ij,t}$$

ceu15: When the exporting country is China and the importing country is the 15 EU member states, the dummy variable ceu15 equals 1. The variable is utilized to assess the trade interactions between China and the EU's original 15 member states during the

period from 1996 to 2006. It aims to quantify the trade implications before and after the EU's 2004 enlargement.

ceu25: Captures trade between China (exporter) and the EU25, which includes the initial 15 members plus ten new entrants—Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia (importers) from 2004 to 2006. This period focuses on the immediate impacts of the 2004 enlargement

ceu27: This variable where exporter is China and importer is EU27 countries which plus Bulgaria and Romania, from 2007 to 2012, assessing the effects of their accession.

ceu28: This variable where exporter is China and importer is EU28 countries which plus Croatia, ranging from 2013 to 2019, evaluating the impact of the latest EU expansion.

ceu27_uk: Reflects trade post-Brexit from 2020 to 2021, excluding the UK to isolate the effects of its departure. The variable where exporter is China, importer is EU 27 which excluding UK.

chcee: Evaluates trade between China (exporter) and the ten Central and Eastern European countries—Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia (importers) that joined the EU in 2004, specifically examining the period from 2004 to 2008.

The analysis of the ceu dummy variables reveals nuanced insights into the trade relationships between China and the European Union across different phases of EU enlargement. According to column 1 of Table 10, the ceu15 variable indicates a decrease in imports from China by the original 15 EU members post-2004 enlargement, likely due to a shift in trade preferences towards new EU members, which strengthens intra-EU trade linkages and reduces dependence on external imports to cause the trade diversion effect on China. According to result of column 2, the ceu25 variable shows a non-significant increase in imports from China post-2004, suggesting that while new member states with less developed production capacities continued to rely on Chinese

goods. Besides, the coefficient of ceu27 shows that there is a significant increase in imports from China by 11.18% following the accession of Bulgaria and Romania in 2007.

The result of column 4 indicates a decrease in EU imports from China between 2013 and 2019 after Croatia's accession, suggesting the presence of a trade diversion effect. Post-Brexit, the ceu27_uk variable suggests a potential trade diversion effect although this result is not statistically significant. Croatia's smaller market size and more developed economy might not have offered significant new opportunities for Chinese exports. Additionally, the EU's increasing focus on developing internal supply chains and promoting intra-EU trade to foster economic resilience could have contributed to reduced reliance on Chinese imports. In addition, the European Union (EU) is likely to have adopted a diversification strategy due to supply chain risk considerations. This includes signing free trade agreements (FTAs) with other countries, such as South Korea, to reduce dependence on a single country. At the same time, the Chinese government has made strong efforts to develop its domestic market and encourage domestic consumption and production, which may lead to a reduction in exports of certain products. In addition, the implementation of the Belt and Road Initiative may have boosted bilateral trade. Chinese companies investing in factories in Europe can produce goods directly for the EU market, thus reducing the need for direct imports from China.

Furthermore, the results in the column 6 show a significant reduction in imports from China by the cee10 countries, which joined theEU in 2004, amounting to a 12.74% decrease (($e^{0.106}$ -1) × 100) from 2004 to 2008. This may be because of the removal of tariffs within the EU, leading the cee10 countries to favor trading within the EU rather than with external member countries.

Table 10 Result of Impact of Different Phases of EU Enlargement on China-EU Trade

	(1)	(2)	(3)	(4)	(5)	(6)
	PPML	**PPML**	**PPML**	**PPML**	**PPML**	**PPML**
	(it,jt,ij)	**(it,jt,ij)**	**(it,jt,ij)**	**(it,jt,ij)**	**(it,jt,ij)**	**(it,jt,ij)**
eu	0.0899***	0.0899***	0.0911***	0.0878***	0.0898***	0.0891***
	(0.0162)	(0.0162)	(0.0162)	(0.0163)	(0.0162)	(0.0163)
ceu15	-0.0151					
	(0.0251)					
ceu25		0.0203				
		(0.0293)				
ceu27			0.106***			
			(0.0169)			
ceu28				-0.0873***		
				(0.0158)		
ceu27_uk					-0.00248	
					(0.0344)	
chcee						-0.120**
						(0.0377)
_cons	16.42***	16.42***	16.42***	16.42***	16.42***	16.42***
	(0.00364)	(0.00364)	(0.00364)	(0.00364)	(0.00365)	(0.00364)
N	550239	550239	550239	550239	550239	550239

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

8. Conclusion

This study examines the effects of EU enlargement on EU-China trade relations by analyzing data from 170 countries spanning 1996 to 2021, using both aggregate data and disaggregate data -specific sector trade data. The gravity model, augmented with

Fixed Effects Model (FEM) and Poisson Pseudo-Maximum Likelihood (PPML) estimation, serves as the analytical framework. The aggregated results underscore the significant trade-enhancing impacts of the EU customs union, evident in increased trade among member states and with non-member countries. Furthermore, the findings suggest that EU enlargement has fostered trade creation rather than trade diversion in EU-China trade dynamics.

The disaggregated analysis of the top eight industries indicates that EU enlargement resulted in trade diversion from China in the agriculture and textiles sectors. Conversely, in sectors such as Machinery, Optical, Photographic, Medical Instruments, and Transport Equipment, there was a noticeable trade creation effect, suggesting that EU enlargement has positively influenced trade flows between the EU and China in these industries. Furthermore, the impact of various phases of EU enlargement on trade with China was also assessed.

To be more specific, the detailed key findings are the following:

- The trade relationship between China and the European Union has significantly evolved from labor-intensive industries to more capital- and technology-intensive sectors, with a concurrent decline in traditional sectors such as textiles. The data reveals that the predominant categories of traded goods between the EU and China are concentrated in the sectors of Machinery and Transport Equipment, specifically classified under HS 84-85 and HS 86-89.
- Analysis of aggregated data shows that the trade creation effects of EU enlargement are evident both within the EU and with other country members outside the EU. This indicates that the EU and its enlarged member states are intensifying their mutual trade relationships and increasingly engaging with the wider global market. Moreover, in the long term, there has been no significant trade diversion effect from China to the EU, and this finding becomes even more pronounced after

including variables related to free trade agreements between China and the EU. So, the EU's eastward expansion has boosted trade between China and Europe as a whole and led to a larger market.

- Various phases of EU enlargement have distinctly impacted trade relations with China. After the enlargement, the original 15 EU countries saw a reduction in imports from China, indicative of a trade diversion effect. In the initial four years following the EU's first expansion in 2004, the ten new member states also reduced their imports from China. However, for the EU as a whole, imports from China generally increased after the first two phases of EU enlargement. Contrarily, the 2013 accession of Croatia led to a decrease in EU imports from China, suggesting a trade diversion effect.
- Improvements in the institutional quality of new member states, along with China's accession to the WTO, have positively influenced China-European trade volumes. This aligns with Hagemejer's findings in 2021, suggesting that accession into the EU allows governments of new member countries to focus more on economic development and to accelerate the pace of catching up with the older member states, thereby offering more trade and investment opportunities for Chinese businesses (Hagemejer, 2021).
- According to empirical results from model 3, post-EU enlargement, Germany's exports to China increased by 145%. Additionally, while model 3 shows a 48.3% decrease in exports from V4 countries to China post-enlargement, data from Table 4 indicate that V4 countries export indirectly to China through developed countries such as Germany and Italy. The trade creation effect among V4 countries has increased by 129% since EU enlargement. Moreover, the trade value added between V4 and China exceeds the total bilateral traditional trade flow, demonstrating that V4 countries export indirectly to China through other developed EU countries.

- Disaggregated data analysis reveals a trade diversion effect from China in agriculture (decrease 30%) and textiles(decrease 13%), consistent with scholar Xie's viewpoint and previous description analysis. The trade diversion in agriculture is partially due to countries like Poland and Lithuania showcasing greater comparative advantages in agriculture than China, highlighting their stronger positions in this sector and the implementation of the EU's Common Agricultural Policy (Yu & Qi, 2015; Xie, 2010). The trade diversion in textiles indicates that the EU may be seeking to diversify its supply chain to reduce its reliance on Chinese textile supplies, potentially turning to other low-cost countries like Vietnam. Besides, this is also possible due to the graduation of textile sectors under the GSP's graduation scheme. The trade creation effect is detected in other sectors such as Machinery (62.46% increase), Optical Photographic and Medical Instruments (192% increase), Miscellaneous Manufactured Articles (56.2% increase), Chemicals (26% increase), Plastics/Rubber (44.62% increase), and Transport Equipment (60.95% increase).
- The EU's significant strategic reliance on China for advanced technological components and materials, particularly in sectors integral to digital infrastructure, renewable energy, advanced manufacturing, and batteries, is primarily due to the EU's weaker capabilities in producing high-tech products. This is exemplified by Germany's considerable strategic dependence on China for cells and batteries, with a dependency rate of 54%.

References

Akram, M., & Rashid, Dr. A. (2016). Trade Creation and Diversion Effects of the European Union. *Pakistan Journal of Applied Economics*, *Special Issue*.

Anderson, J. E. (1979). A Theoretical Foundation for the Gravity Equation. *The American Economic Review*, *69*(1), 106–116.

Anderson, J. E., & Marcouiller, D. (2002). Insecurity and the Pattern of Trade: An Empirical Investigation. *The Review of Economics and Statistics*, *84*(2), 342–352. https://doi.org/10.1162/003465302317411587

Anderson, J. E., & van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. *American Economic Review*, *93*(1), 170–192. https://doi.org/10.1257/000282803321455214

Anderson, J. E., & van Wincoop, E. (2004). Trade Costs. *Journal of Economic Literature*, *42*(3), 691–751. https://doi.org/10.1257/0022051042177649

Andreosso-O'Callaghan, B. (2007). Complementarity and Rivalry in EU?China Economic Relations in the Twenty-First Century. *European Foreign Affairs Review*, *12*(1). https://kluwerlawonline.com/api/Product/CitationPDFURL?file=Journals\EERR\EERR2007003.pdf

Antràs, P., & Chor, D. (2018). *World Trade Evolution: Growth, Productivity and Employment* (pp. 126–194). Taylor & Francis Group.

Baier, S. L., & Bergstrand, J. H. (2004). Economic determinants of free trade agreements. *Journal of International Economics*, *64*(1), 29–63. https://doi.org/10.1016/S0022-1996(03)00079-5

Balassa, B. (1961). TOWARDS A THEORY OF ECONOMIC INTEGRATIONa. *Kyklos*, *14*(1), 1–17. https://doi.org/10.1111/j.1467-6435.1961.tb02365.x

Baldwin, R. (2012). *Global Supply Chains: Why They Emerged, Why They Matter, and Where They Are Going*.

Baldwin, R. E., Francois, J. F., & Portes, R. (1997). The costs and benefits of eastern enlargement: The impact on the EU and central Europe. *Economic Policy*, *12*(24), 125–176. https://doi.org/10.1111/1468-0327.00018

Baldwin, R., & Lopez-Gonzalez, J. (2013). Supply-Chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses. *NBER Working Papers*, Article 18957. https://ideas.repec.org//p/nbr/nberwo/18957.html

Baldwin, R., & Seghezza, E. (1996). *Growth and European Integration: Towards an Empirical Assessment* (CEPR Discussion Paper 1393). C.E.P.R. Discussion Papers. https://econpapers.repec.org/paper/cprceprdp/1393.htm

Baldwin, R., & Taglioni, D. (2006). *Gravity For Dummies And Dummies For Gravity Equations*. https://doi.org/10.3386/w12516

Bergstrand, J. H. (1989). The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade. *The Review of Economics and Statistics*, *71*(1), 143–153. https://doi.org/10.2307/1928061

Bieliński, T., Markiewicz, M., & Oziewicz, E. (2019). Do Central and Eastern Europe Countries Play a Role in the Belt and Road Initiative? The Case of Chinese OFDI into the CEE–16 Countries. *Comparative Economic Research*, *22*, 7–22. https://doi.org/10.2478/cer-2019-0009

Borin, A., & Mancini, M. (2015). Follow the value added: Bilateral gross export accounting. *Temi Di Discussione (Economic Working Papers)*, Article 1026. https://ideas.repec.org//p/bdi/wptemi/td_1026_15.html

Boronenko, V. (2017). *Why Supporting Instruments of the „Small Busines Act" are not Widely Used by the European SMEs? The Case of Latvia.*

Brada, J. C., & Mendez, J. A. (1988). An Estimate of the Dynamic Effects of Economic Integration. *The Review of Economics and Statistics*, *70*(1), 163–168. https://doi.org/10.2307/1928166

Celi, G., Ginzburg, A., Guarascio, D., & Simonazzi, A. (2018). *Crisis in the European Monetary Union. A Core-Periphery Perspective*. https://doi.org/10.4324/9781315542966

Chen, H., Luo, C., Renard, M.-F., & Sun, S. (2022). EU-China trade and intra-EU trade: Substitute or complementary? *Journal of Economic Surveys*, *36*(3), 558–585. https://doi.org/10.1111/joes.12471

Chiappini, R. (2012). Offshoring and Export Performance in the European Automotive Industry. *Competition & Change*, *16*(4), 323–342. https://doi.org/10.1179/1024529412Z.00000000020

Christie, E. (2002). Potential trade in south-east Europe: A gravity model approach. *SEER - South-East Europe Review for Labour and Social Affairs*, *04*, 81–101.

Colin, B. (2010) 'Obstacles in upgrading the 1985 trade and economic cooperation agreement between the EU and China', EU–China Observer, (3), pp. 9-13.

Dadush, U., Domínguez-Jiménez, M., & Gao, T. (2019). *The State of China-European Union Economic Relations*. Bruegel. https://www.jstor.org/stable/resrep28517

Damis, J. (1998). Morocco's 1995 association agreement with the European Union. *The Journal of North African Studies*, *3*(4), 91–112. https://doi.org/10.1080/13629389808718345

DANGERFIELD, M. (2004). CEFTA: Between the CMEA and the European Union. *Journal of European Integration*, *26*(3), 309–338. https://doi.org/10.1080/0703633042000261652

De Backer, K., De Lombaerde, P., & Iapadre, L. (2018). Analyzing Global and Regional Value Chains. *International Economics*, *153*, 3–10. https://doi.org/10.1016/j.inteco.2018.01.003

De Castro, T., Vlckova, J., & Hnát, P. (2017). Trade and investment relations between the Czech Republic and China: The Czech Republic as a gateway to the EU? *Society and Economy*, *39*, 481–499. https://doi.org/10.1556/204.2017.39.4.2

De Groot, H. L. F., Linders, G.-J., Rietveld, P., & Subramanian, U. (2004). The Institutional Determinants of Bilateral Trade Patterns. *Kyklos*, *57*(1), 103–123. https://doi.org/10.1111/j.0023-5962.2004.00245.x

Deardorff, A. (1998). Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In *The Regionalization of the World Economy* (pp. 7–32). University of Chicago Press. https://www.nber.org/books-and-chapters/regionalization-world-economy/determinants-bilateral-trade-does-gravity-work-neoclassical-world

Deardorff, A. V., & Stern, R. M. (2004). EU Expansion and EU Growth. In A. V. Deardorff (Ed.), *The Past, Present and Future of the European Union* (pp. 74–102). Palgrave Macmillan UK. https://doi.org/10.1057/9780230522862_5

Dell'Aguzzo, L., & Diodato, E. (2022). *The Belt and Road Initiative: An Opportunity or a Threat for the European Union?* https://doi.org/10.23827/BDL_2022_9

Delpech, R., & Paugam, J.-M. (2005). The European Union's Trade Policy. *Politique etrangere*, *4*, 743–754.

Duong, N. B. (2016). *Vietnam-EU Free Trade Agreement: Impact and Policy Implications for Vietnam* (SSRN Scholarly Paper 2802488). https://doi.org/10.2139/ssrn.2802488

Durusoy, S., Sica, E., & Beyhan, Z. (2015). Economic Crisis and Protectionism Policies: The Case of the EU Countries. *International Journal of Humanities and Social Science*, *5*(6).

Egger, P. H., & Nigai, S. (2015). Structural gravity with dummies only: Constrained ANOVA-type estimation of gravity models. *Journal of International Economics*, *97*(1), 86–99. https://doi.org/10.1016/j.jinteco.2015.05.004

Egger, P. H., & Pfaffermayr, M. (2013). The Pure Effects of European Integration on Intra-EU Core and Periphery Trade. *The World Economy*, *36*(6), 701–712. https://doi.org/10.1111/twec.12065

European Commission. Joint Research Centre. (2016). *Lithium ion battery value chain and related opportunities for Europe.* https://doi.org/10.2760/6060

European Commission. (2019, March). EU-China: A strategic outlook. Retrieved from https://ec.europa.eu/info/sites/info/files/communication-eu-china-a-strategic-outlook.pdf

European Commission. (2006, October). Commission Working Document Accompanying COM (2006) 631 final: Closer partners, growing responsibilities - A policy paper on EU-China trade and investment: Competition and Partnership. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/2c65b426-2484-459d-a60d-8847e8765a5d/language-en

European Commission. (2017, December). Commission Staff Working Document On Significant Distortions in the Economy of the People's Republic of China for the Purposes of Trade Defence Investigations. Retrieved from https://trade.ec.europa.eu/doclib/docs

Evenett, S. J. (2010). *China-EU solar panel trade dispute: Rhetoric versus reality*. CEPR. https://cepr.org/voxeu/columns/china-eu-solar-panel-trade-dispute-rhetoric-versus-reality

Feenstra, R. C. (2015a). *Advanced International Trade: Theory and Evidence - Second Edition*. Princeton University Press.

Feenstra, R. C. (2015b). *Advanced International Trade: Theory and Evidence - Second Edition* (2nd ed.). Princeton University Press. https://www.perlego.com/book/738769/advanced-international-trade-theory-and-evidence-second-edition-pdf

Flemming, J. S. (1987). The Economics of Worldwide Stagflation: A Review. *Oxford Economic Papers*, *39*(1), 223–232.

Gereffi, G. (1999). International trade and industrial upgrading in the apparel commodity chain. *Journal of International Economics*, *48*(1), 37–70. https://doi.org/10.1016/S0022-1996(98)00075-0

Gereffi, G., & Fernandez-Stark, K. (2010). *The Offshore Services Value Chain: Developing Countries and the Crisis* (SSRN Scholarly Paper 1585041). https://papers.ssrn.com/abstract=1585041

Gereffi, G., & Kaplinsky, R. (2001). The Value of Value Chains: Spreading the Gains from Globalisation. In *Special issue of the IDS Bulletin* (Vol. 32).

Gómez-Herrera, E. (2013). Comparing alternative methods to estimate gravity models of bilateral trade. *Empirical Economics*, *44*(3), 1087–1111.

Grabbe, H. (2002). European Union Conditionality and the 'Acquis Communautaire'. *International Political Science Review / Revue Internationale de Science Politique*, *23*(3), 249–268.

Grassano, N., Hernandez Guevara, H., Fako, P., Tuebke, A., Amoroso, S., Georgakaki, A., ... & Panzica, R. (2021). The 2021 eu industrial r&d investment scoreboard. *EUR*.

Guanghua, Lin, Y., Zhao. (2008). Research on the Economic and Trade Development of China-ASEAN Countries. *World Economic Research*, *12*, 92–100. https://doi.org/10.12677/WER.2023.122010

Hagemejer, J., Michałek, J. J., & Svatko, P. (2021). Economic impact of the EU Eastern enlargement on New Member States revisited: The role of economic institutions. *Central European Economic Journal*, *8*(55), 126–143. https://doi.org/10.2478/ceej-2021-0008

Hamilton, C., & Whalley, J. (1995). Evaluating the Impact of the Uruguay Round Results on Developing Countries. *The World Economy*, *18*(1), 31–49. https://doi.org/10.1111/j.1467-9701.1995.tb00200.x

Havranek, T., & Irsova, Z. (2017). Do Borders Really Slash Trade? A Meta-Analysis. *IMF Economic Review*, *65*(2), 365–396.

Head, K., & Mayer, T. (2014). *Gravity Equations: Workhorse,Toolkit, and Cookbook* (pp. 131–195) [Handbook of International Economics]. Elsevier. https://econpapers.repec.org/bookchap/eeeintchp/4-131.htm

Herrero, A. G., & Xu, J. (2017). China's Belt and Road Initiative: Can Europe Expect Trade Gains? *China & World Economy*, *25*(6), 84–99. https://doi.org/10.1111/cwe.12222

Hu, X., & Watkins, D. (1999). The evolution of trade relationships between China and the EU since the 1980s. *European Business Review*, *99*(3), 154–161. https://doi.org/10.1108/09555349910271055

Imbruno, M. (2016). China and WTO liberalization: Imports, tariffs and non-tariff barriers. *China Economic Review*, *38*, 222–237. https://doi.org/10.1016/j.chieco.2016.02.001

Kaplan, L. C., Kohl, T., & Martínez-Zarzoso, I. (2018). Supply-chain trade and labor market outcomes: The case of the 2004 European Union enlargement. *Review of International Economics*, *26*(2), 481–506. https://doi.org/10.1111/roie.12339

Karkanis, D. (2018). EU-China Trade: Geography and Institutions from 2001 to 2015. *Journal of Economic Integration*, *33*(1), 1158–1175.

Kaufmann, D., Kraay, A., & Zoido-Lobatón, P. (2002). *Governance Matters II: Updated Indicators for 2000-01*. World Bank Publications.

Keuschnigg, C., & Kohler, W. (2002). Eastern Enlargement of the EU: How Much Is It Worth for Austria? *Review of International Economics*, *10*(2), 324–342. https://doi.org/10.1111/1467-9396.00335

Kogut, B. (1985). Designing Global Strategies: Comparative and Competitive Value-Added Chains. *Sloan Management Review (Pre-1986)*, *26*(4), 15.

Koopman, R., Powers, W., Wang, Z., & Wei, S.-J. (2010). Give Credit Where Credit is Due: Tracing Value Added in Global Production Chains. *NBER Working Paper Series*. https://doi.org/10.3386/w16426

Koukhartchouk, O., & Maurel, M. (2003). Accession to the WTO and EU Enlargement: What Potential for Trade Increase? *C.E.P.R. Discussion Papers, CEPR Discussion Papers*.

Langhammer, R., & Schweickert, R. (2006). *EU Integration and its Implications for Asian Economies – What we Know and What Not*.

Lee, H., & Van Der Mensbrugghe, D. (2004). EU enlargement and its impacts on East Asia. *Journal of Asian Economics*, *14*(6), 843–860. https://doi.org/10.1016/j.asieco.2003.09.001

Lejour, A., De Mooij, R. A., & Nahuis, R. (2001). *EU Enlargement: Economic Implications for Countries and Industries* (SSRN Scholarly Paper 287847). https://doi.org/10.2139/ssrn.287847

Li, Y., Bolton, K., & Westphal, T. (2018). The effect of the New Silk Road railways on aggregate trade volumes between China and Europe. *Journal of Chinese Economic and Business Studies*, *16*(3), 275–292. https://doi.org/10.1080/14765284.2018.1453720

Lipsey, R. G. (1957). The Theory of Customs Unions: Trade Diversion and Welfare. *Economica*, *24*(93), 40–46. https://doi.org/10.2307/2551626

Lu, Z., Yan, T., & Deng, X. (2014). EU-China Economic Relations: Interactions and Barriers. *Review of European Studies*, *6*. https://doi.org/10.5539/res.v6n4p12

Magee, C. S. P. (2008a). New measures of trade creation and trade diversion. *Journal of International Economics*, *75*(2), 349–362.

Mancini, M., Montalbano, P., Nenci, S., & Vurchio, D. (2024). Positioning in Global Value Chains: World Map and Indicators, a New Dataset Available for GVC Analyses. *The World Bank Economic Review*, lhae005. https://doi.org/10.1093/wber/lhae005

Mao, H., & Xiong, L. (2022). Is Bilateral Value Added in Trade between China and EU Countries Efficient? *China & World Economy*, *30*(3), 210–238. https://doi.org/10.1111/cwe.12424

Marschinski R., & Martínez-Turégano D. (2020). THE EU'S SHRINKING SHARE IN GLOBAL MANUFACTURING: A VALUE CHAIN DECOMPOSITION ANALYSIS. *National Institute Economic Review*, *252*, R19–R32. https://doi.org/10.1017/nie.2020.18

Martínez-Zarzoso, I., Voicu, A., & Vidovic, M. (2010). CEECs Integration into Regional and Global Production Networks. *Inma Martinez-Zarzoso*.

Mayer, T., & Head, K. (2002). Illusory Border Effects: Distance Mismeasurement Inflates Estimates of Home Bias in Trade. *Working Papers*, Article 2002–01. https://ideas.repec.org//p/cii/cepidt/2002-01.html

Mayer, T., & Zignago, S. (2011). *Notes on CEPII's Distances Measures: The GeoDist Database* (SSRN Scholarly Paper 1994531). https://doi.org/10.2139/ssrn.1994531

Meade, J. E. (James E. (1995). The theory of customs unions. *(No Title)*. Retrieved 28 April 2024, from https://cir.nii.ac.jp/crid/1130282272761465856

Mendes, C. A. (2023). PERSPECTIVES ON THE SUSPENSION OF THE EU-CHINA COMPREHENSIVE AGREEMENT ON INVESTMENT. *Janus*, *14*(1, TD1), Article 1, TD1. https://doi.org/10.26619/1647-7251.DT0123.3

Morris, M., Staritz, C., & Barnes, J. (2011). Value chain dynamics, local embeddedness, and upgrading in the clothing sectors of Lesotho and Swaziland. *International Journal of Technological Learning, Innovation and Development*, *4*, 96–119. https://doi.org/10.1504/IJTLID.2011.041901

Nahuis, R. (2004). One size fits all?: Accession to the internal market; an industry-level assessment of EU enlargement. *Journal of Policy Modeling*, *26*(5), 571–586.

Olivero, M. P., & Yotov, Y. V. (2012). Dynamic gravity: Endogenous country size and asset accumulation. *Canadian Journal of Economics/Revue Canadienne d'économique*, *45*(1), 64–92. https://doi.org/10.1111/j.1540-5982.2011.01687.x

Pantucci, R. (2021). The Many Faces of China's Belt and Road Initiative. *Current History*, *120*, 28–34. https://doi.org/10.1525/curh.2021.120.822.28

Papazoglou, C., Pentecost, E. J., & Marques, H. (2006). A Gravity Model Forecast of the Potential Trade Effects of EU Enlargement: Lessons from 2004 and Path-dependency in Integration. *The World Economy*, *29*(8), 1077–1089. https://doi.org/10.1111/j.1467-9701.2006.00834.x

Porter Michael, E. (1985). Competitive advantage: creating and sustaining superior performance. *New York*.

Qiu, H., Yang, J., Huang, J., & Chen, R. (2007). Impact of China-ASEAN Free Trade Area on China's International Agricultural Trade and Its Regional Development. *China & World Economy*, *15*(5), 77–90. https://doi.org/10.1111/j.1749-124X.2007.00083.x

Rapacki, R., & Próchniak, M. (2009). The EU enlargement and economic growth in the CEE new member countries. *European Economy - Economic Papers 2008 - 2015*, Article 367. https://ideas.repec.org//p/euf/ecopap/0367.html

Richardson, J. (2006). *European Union: Power and Policy-Making*. Routledge.

Rogers, J., Foxall, A., Henderson, M., & Armstrong, S. (2020). *Breaking the China Supply Chain: How the 'five Eyes' Can Decouple from Strategic Dependency*. Henry Jackson Society.

Rumbaugh, T., & Blancher, N. (2004). *China: International Trade and WTO Accession*.

Shahriar, S., Qian, L., Kea, S., & Abdullahi, N. M. (2019a). The gravity model of trade: A theoretical perspective. *Review of Innovation and Competitiveness*, *5*(1), 21–42. https://doi.org/10.32728/ric.2019.51/2

Silva, J. M. C. S., & Tenreyro, S. (2006). The Log of Gravity. *The Review of Economics and Statistics*, *88*(4), 641–658. https://doi.org/10.1162/rest.88.4.641

Stanojević, S., & Qiu, B. (2022). A study on the impact of EU membership on Sino-CEEC trade in the context of the 17+1 cooperation mechanism. *International Review*, *1–2*, 60–64. https://doi.org/10.5937/intrev2202069S

Stehrer, R., & Stöllinger, R. (2015). *The Central European Manufacturin Core: What is Driving Regional Production Sharing?* (Research Report 2014/15-02). FIW-Research Reports. https://www.econstor.eu/handle/10419/121234

Stöllinger, R. (2016). Structural change and global value chains in the EU. *Empirica*, *43*(4), 801–829. https://doi.org/10.1007/s10663-016-9349-z

Sun, L., & Reed, M. R. (2010). Impacts of Free Trade Agreements on Agricultural Trade Creation and Trade Diversion. *American Journal of Agricultural Economics*, *92*(5), 1351–1363. https://doi.org/10.1093/ajae/aaq076

Wickman, K. (2003). Whither the European Agricultural Policy? A Viable Reform of the CAP in the Context of an Enlarged EU and the Doha Development Round. Stockholm, Sweden: Timbro.

Taglioni, D., & Winkler, D. (2016). *Making Global Value Chains Work for Development* [World Bank Publications - Books]. The World Bank Group. https://econpapers.repec.org/bookchap/wbkwbpubs/24426.htm

Tang, C., Rosland, A., Li, J., & Yasmeen, R. (2024). The comparison of bilateral trade between China and ASEAN, China and EU: From the aspect of trade structure, trade complementarity and structural gravity model of trade. *Applied Economics*, *56*(9), 1077–1089. https://doi.org/10.1080/00036846.2023.2174940

Tao Ma, X., sun. (2003). *The Impact of the EU's Eastern Enlargement on Sino-European Economic and Trade Relations*. https://www.cqvip.com/qk/96001x/200310/8515053.html

Tinbergen, J. (1962). Shaping the world economy; suggestions for an international economic policy.

Uprasen, U. (2014a). The Impact of Non-Tariff Barriers in the European Union on China's Exports. *Palgrave Macmillan Books*, 141–164.

Uprasen, U. (2014b). The Impact of Non-Tariff Barriers in the European Union on China's Exports. In B. Andreosso-O'Callaghan, J. Jaussaud, & M. B. Zolin (Eds.), *Economic*

Integration in Asia: Towards the Delineation of a Sustainable Path (pp. 141–164). Palgrave Macmillan UK. https://doi.org/10.1057/9781137432933_8

Vercio, L. L., Amador, K., Bannister, J. J., Crites, S., Gutierrez, A., MacDonald, M. E., Moore, J., Mouches, P., Rajashekar, D., Schimert, S., Subbanna, N., Tuladhar, A., Wang, N., Wilms, M., Winder, A., & Forkert, N. D. (2020). Supervised machine learning tools: A tutorial for clinicians. *Journal of Neural Engineering*, *17*(6), 062001. https://doi.org/10.1088/1741-2552/abbff2

Viner, J. (2014). *The Customs Union Issue*. OUP USA.

Xie, J. (2010). *Empirical Analysis of China—Eastern Europe Agricultural Trade: Gravity Model Approach*.

XY. KONG, The Trade Effects of the EU-Turkey Customs Union: Based on the Gravity Model. p. Mater thesis. Charles University, Fakulty of Social Sciences, Institut of International Studies, Supervisot prof. Petr Jeřábek

Yang, Z., Shen, Q., & Yang, G. (2015). *Impacts of EU Technical Barriers to Trade upon Export of Chinese Agricultural Products and Countermeasures*. 27–31. https://doi.org/10.2991/ichssr-15.2015.7

Yao, Y., Zhou, Y., & Zhu, J. (2021, January 1). *Research On Technical Barriers to Trade in Chinese Exports*. https://doi.org/10.2991/assehr.k.210121.139

Yu, C., & Qi, C. (2015). Research on the Complementarity and Comparative Advantages of Agricultural Product Trade between China and CEE Countries—Taking Poland, Romania, Czech Republic, Lithuania and Bulgaria as Examples. *Journal of Service Science and Management*, *8*(2), Article 2. https://doi.org/10.4236/jssm.2015.82022

Zeitlin, J. (2015). *Extending Experimentalist Governance?: The European Union and Transnational Regulation*. Oxford University Press.

Zenglein, M. J. (2020). *MAPPING AND RECALIBRATING EUROPE'S ECONOMIC INTERDEPENDENCE WITH CHINA*.

Zhang, H., & Ding, Y. (2024). The impact of global value chain restructuring on the product structure of China-EU exports. *Journal of Asian Economics*, *91*, 101708. https://doi.org/10.1016/j.asieco.2024.101708

Zhao, Z., Zhang, S.-Y., Hubbard, B., & Yao, X. (2013). The emergence of the solar photovoltaic power industry in China. *Renewable and Sustainable Energy Reviews*, *21*, 229–236. https://doi.org/10.1016/j.rser.2012.12.066

Zolin, M. B., & Uprasen, U. (2018). Trade creation and diversion: Effects of EU enlargement on agricultural and food products and selected Asian countries. *Asia Europe Journal*, *16*(4), 351–373. https://doi.org/10.1007/s10308-018-0508-7

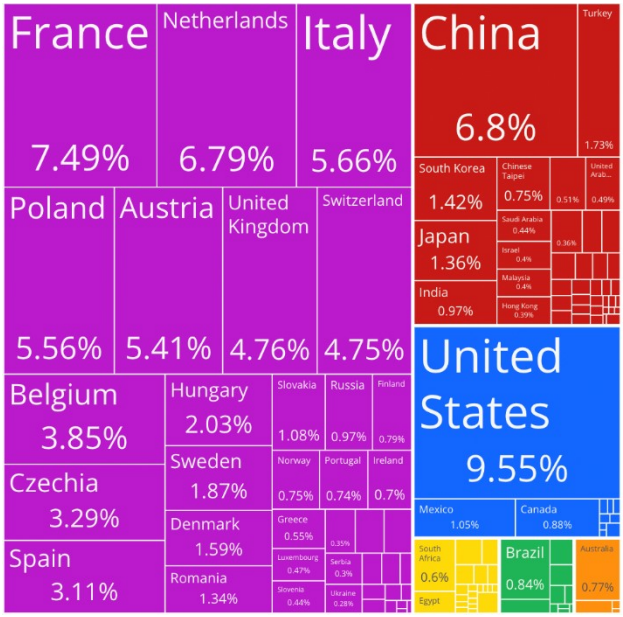
Appendix List

Appendix 1 Exports of goods to other member states, 2002 and 2022

Exports of goods to other Member States, 2002 and 2022
(€ billion and %)

	2002	2022	Annual average growth rate
Latvia	2	15	11.9%
Lithuania	3	28	11.5%
Bulgaria	4	32	11.3%
Poland	34	260	10.8%
Romania	10	67	9.9%
Slovakia	14	83	9.5%
Czechia	33	188	9.1%
Cyprus	0	1	8.9%
Estonia	3	15	8.6%
Slovenia	8	42	8.4%
Croatia	3	17	8.2%
Greece	7	30	7.6%
Hungary	30	113	6.9%
Netherlands	182	660	6.6%
Spain	87	253	5.5%
Portugal	20	55	5.3%
Belgium	152	413	5.1%
Germany	363	863	4.4%
Austria	60	140	4.4%
Sweden	44	102	4.3%
Italy	148	330	4.1%
Ireland	39	80	3.6%
Finland	25	46	3.2%
Denmark	37	68	3.1%
Malta	1	1	2.9%
France	196	330	2.6%
Luxembourg	9	13	2.1%

Appendix 2 Export destination of Germany 2022



Source: OEC database

Appendix 3 Intra EU exports of goods by product type, 2002-2022(%)

Intra EU exports of goods by product type, 2002 - 2022

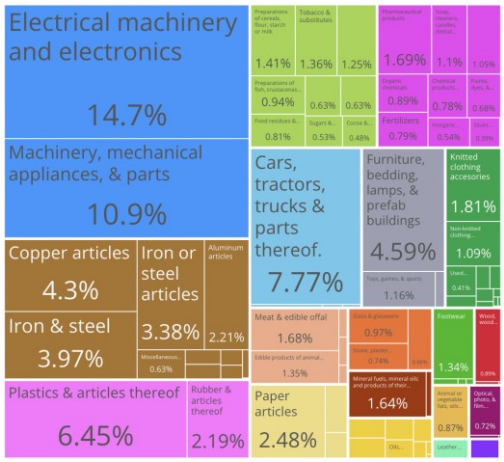
(%)

	Primary goods		Manufactured goods		Ratio manufactured to primary goods,2022
	2002	2022	2002	2022	
Ireland	6	9	91	90	9.8
Czechia	10	10	90	90	8.7
Slovakia	13	10	86	89	8.6
Luxembourg	9	13	90	85	6.5
Malta	2	13	98	86	6.5
Hungary	10	14	89	86	6.3
Slovenia	5	14	95	86	6.2
Romania	12	14	87	86	6.1
Germany	10	14	87	85	6.1
Italy	10	15	88	85	5.8
Austria	12	15	87	83	5.4
Poland	15	17	85	83	5.0
EU	16	19	83	80	4.1
France	16	21	84	78	3.8
Finland	13	21	86	78	3.7
Portugal	12	21	88	78	3.7
Belgium	17	22	82	77	3.5
Sweden	14	24	84	76	3.1
Bulgaria	21	25	77	75	3.0
Spain	21	26	78	73	2.8
Denmark	30	30	66	70	2.3
Netherlands	31	30	69	70	2.3
Croatia	21	32	79	68	2.2
Estonia	19	32	81	66	2.0
Lithuania	32	33	68	67	2.0
Latvia	31	35	69	65	1.9
Cyprus	38	38	61	62	1.6
Greece	35	39	63	59	1.5

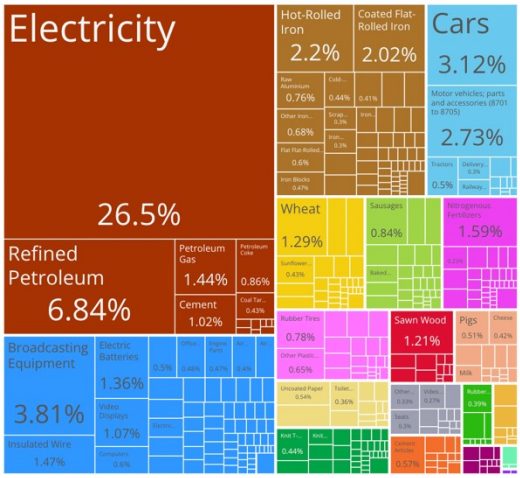
Source: Eurostat (8)

Appendix 4 V4 trade flows

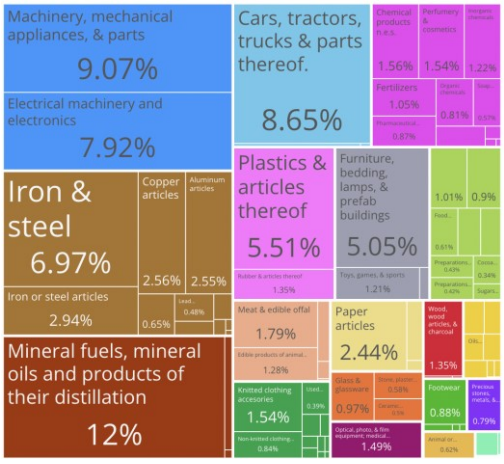
Poland export to Hungary



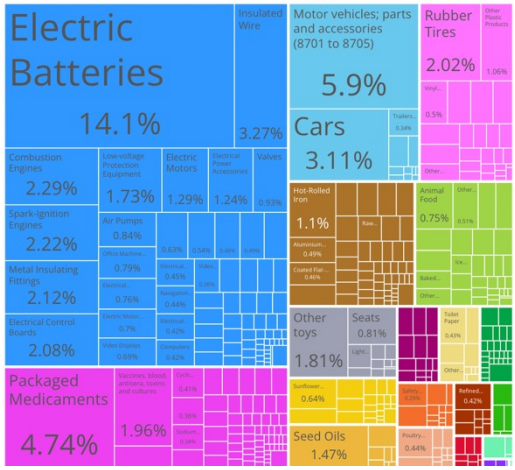
Slovakia export to Hungary



Poland export to Czech Republic.



Slovakia export to Hungary



Source: OEC Database

Appendix 5 EU imports of goods from China, 2023

EU imports of goods from China, 2023

	€ million	% of China in extra EU imports
Netherlands	116,942	25.7
Germany	94,525	20.0
Italy	47,589	18.7
France	42,023	16.3
Spain	36,677	18.9
Poland	31,684	28.5
Belgium	30,826	16.1
Czechia	25,401	43.7
Hungary	11,043	25.0
Slovenia	9,867	29.1
Sweden	9,580	16.5
Ireland	8,591	10.4
Denmark	7,413	17.6
Austria	7,107	13.9
Greece	6,901	17.0
Romania	6,754	20.8
Portugal	5,221	19.5
Slovakia	4,311	20.0
Finland	3,140	14.0
Bulgaria	2,663	13.4
Lithuania	1,710	12.8
Croatia	1,298	13.4
Estonia	948	30.2
Latvia	869	18.1
Cyprus	758	13.2
Malta	356	12.4
Luxembourg	213	9.1

Source: Eurostat

Appendix 6 EU exports of goods to China, 2023

EU exports of goods to China, 2023

	€ million	% of China in extra EU exports
Germany	97,303	13.6
France	25,017	9.3
Netherlands	22,299	8.5
Italy	19,172	6.3
Ireland	8,875	7.9
Belgium	8,259	4.8
Spain	7,579	5.3
Sweden	6,697	8.1
Denmark	5,337	10.0
Austria	5,060	8.0
Finland	3,554	10.8
Poland	3,078	3.4
Slovakia	2,874	11.7
Czechia	2,438	5.6
Hungary	1,543	4.9
Bulgaria	1,017	6.3
Romania	856	3.4
Portugal	769	3.3
Slovenia	394	1.4
Greece	385	1.8
Estonia	253	5.3
Luxembourg	228	7.0
Latvia	185	2.5
Lithuania	146	0.9
Croatia	79	1.0
Malta	37	2.5
Cyprus	26	0.8

Source: Eurostat

Appendix 7 EU import from China HS classfication

Section	ExactSection	2000	2000(%)	2005	2005(%)	2010	2010(%)	2015	2015(%)	2021	2021(%)
I	HS 01-05: Live Animals, Animal Products	683384116	1.02%	1445700091	0.72%	2635979126	0.70%	2458820814	0.63%	2122730405	0.38%
II	HS 06-14: Vegetable Products	641853007	0.96%	1336811061	0.67%	2217087215	0.59%	2530324373	0.65%	2638663375	0.47%
III	HS 15: Animal or Vegetable Fats and Oils	18001981	0.03%	43355631	0.02%	46615143.11	0.01%	103358954.5	0.03%	883569270.8	0.16%
IV	HS 16-24: Foodstuffs; Beverages, Tobacco	540473448	0.81%	1025311158	0.51%	1858366021	0.50%	1875907879	0.48%	2585284263	0.46%
V	HS 25-27: Metals	700143374	1.05%	2193314616	1.10%	1362469430	0.36%	964189599.9	0.25%	1872582567	0.34%
VI	HS 28-38: Chemical or Allied Industries	2613324338	3.91%	6274343328	3.14%	13737913830	3.67%	16340887046	4.20%	37204853082	6.66%
VII	HS 39-40: Plastics/Rubber	2630214545	3.93%	5631043232	2.82%	10443374482	2.79%	13715270050	3.53%	22216991424	3.98%
VIII	HS 41-43: Raw Hides and Skins, Leather, Furskins	3344521367	5.00%	5789964867	2.90%	7975396128	2.13%	7852720355	2.02%	5947200989	1.06%
IX	HS 44-46: Wood and Articles of Wood	711470450	1.06%	2069048836	1.04%	3215410415	0.86%	3084823909	0.79%	3154067717	0.56%
X	HS 47-49: Pulp of Wood or of other Fibrous Cellulosic Material	524588708	0.78%	1556660279	0.78%	3261085434	0.87%	3455732618	0.89%	3733546315	0.67%
XI	HS 50-63: Textiles and Textile Articles	9363579312	13.99%	26651609730	13.34%	47710749869	12.73%	44049616711	11.33%	41432858060	7.42%
XII	HS 64-67: Footwear	2834967036	4.24%	7723436291	3.87%	12202311411	3.26%	12796927470	3.29%	11839530966	2.12%
XIII	HS 68-70: Articles of Stone, Glass	973468356	1.45%	3443009437	1.72%	6382091207	1.70%	5500251488	1.42%	7199417172	1.29%
XIV	HS 71: Pearls, Precious Metals	824757568	1.23%	2028576615	1.02%	2826255416	0.75%	2257785284	0.58%	1888579811	0.34%
XV	HS 72-83: Base Metals and Articles of Base Metal	3750212942	5.60%	11197030182	5.61%	21013383605	5.61%	26021100196	6.69%	33442758429	5.99%
XVI	HS 84-85: Machinery	23611911752	35.29%	87999100656	44.06%	1.77931E+11	47.49%	1.88328E+11	48.45%	2.88163E+11	51.60%
XVII	HS 86-89: Transport Equipment	1164436001	1.74%	4461642331	2.23%	15203047915	4.06%	8611191731	2.22%	25235453241	4.52%
XVIII	HS 90-92: Optical, Photographic, Medical or Surgical Instruments	3160196002	4.72%	7249971588	3.63%	8897173031	2.37%	12092633536	3.11%	18688415984	3.35%
XIX	HS 93: Arms and Ammunition	2342260	0.00%	14298034	0.01%	45285036.63	0.01%	61112359.88	0.02%	84206600.94	0.02%
XX	HS 94-96: Miscellaneous Manufactured Articles	8722126831	13.03%	21203462907	10.62%	34833729839	9.30%	35929878256	9.24%	48119783963	8.62%
XXI	HS 97-98: Works of Art	97401934	0.15%	376793683	0.19%	905309331.4	0.24%	675083583.4	0.17%	560992349.7	0.10%

Appendix 8 EU export to China based on HS classification

Section	**ExactSection**	2000	2000	2005	2005	2010	2010	2015	2015	2021	2021
I	HS 01-05: Live Animals, Animal Products	228155422	0.98%	523511399	0.83%	1066677980	0.72%	3756843726	2.01%	9638394872	3.70%
II	HS 06-14: Vegetable Products	153741734	0.66%	236026473	0.37%	392100651.1	0.26%	1436802328	0.77%	2262784614	0.87%
III	HS 15: Animal or Vegetable Fats and Oils	22215124	0.10%	32669160	0.05%	115552766.3	0.08%	308151867.5	0.17%	634866477.7	0.24%
IV	HS 16-24: Foodstuffs; Beverages, Tobacco	148558856	0.64%	428005229	0.68%	1891199205	1.27%	4373618922	2.34%	6940266640	2.67%
V	HS 25-27: Metals	234067328	1.01%	371069239	0.59%	2312837690	1.56%	3662190846	1.96%	4297092317	1.65%
VI	HS 28-38: Chemical or Allied Industries	1820603008	7.83%	4683766312	7.41%	12238641319	8.24%	18632119720	9.99%	32715848967	12.56%
VII	HS 39-40: Plastics/Rubber	700640786	3.01%	2756398200	4.36%	7041929575	4.74%	7646579514	4.10%	10411262127	4.00%
VIII	HS 41-43: Raw Hides and Skins, Leather, Furskins	230420069	0.99%	591468221	0.94%	1464214285	0.99%	2421054259	1.30%	4563929181	1.75%
IX	HS 44-46: Wood and Articles of Wood	529610242	2.28%	277882575	0.44%	494971056.5	0.33%	1077775576	0.58%	3761893670	1.44%
X	HS 47-49: Pulp of Wood or of other Fibrous Cellulosic Material	455978414	1.96%	1534895575	2.43%	3079114224	2.07%	3377540811	1.81%	3760225596	1.44%
XI	HS 50-63: Textiles and Textile Articles	499926867	2.15%	1173446145	1.86%	2180689113	1.47%	3516250750	1.88%	5665478799	2.18%
XII	HS 64-67: Footwear	13843465	0.06%	55954759	0.09%	160987534.1	0.11%	457602713.7	0.25%	1025046174	0.39%
XIII	HS 68-70: Articles of Stone, Glass	226693225	0.98%	397465410	0.63%	970687539	0.65%	1195077792	0.64%	1935916948	0.74%
XIV	HS 71: Pearls, Precious Metals	403783925	1.74%	1107462364	1.75%	1803211322	1.21%	11280996945	6.05%	1703501165	0.65%
XV	HS 72-83: Base Metals and Articles of Base Metal	1410917931	6.07%	7296780129	11.54%	13017932182	8.76%	11620758958	6.23%	13734081942	5.27%
XVI	HS 84-85: Machinery	12888616136	55.45%	30117096340	47.62%	60147294438	40.48%	56198302218	30.12%	86341284998	33.16%
XVII	HS 86-89: Transport Equipment	2214179398	9.53%	8229067358	13.01%	31853182853	21.44%	42359358506	22.70%	49882851905	19.16%
XVIII	HS 90-92: Optical, Photographic, Medical or Surgical Instruments	877369398	3.77%	3028375109	4.79%	7255486651	4.88%	11400055716	6.11%	18650394663	7.16%
XIX	HS 93: Arms and Ammunition	1304873	0.01%	5199925	0.01%	23104645.7	0.02%	8640076.005	0.00%	7163760.692	0.00%
XX	HS 94-96: Miscellaneous Manufactured Articles	177752527	0.76%	378845159	0.60%	999321528.7	0.67%	1751775487	0.94%	2375013355	0.91%
XXI	HS 97-98: Works of Art	4057524	0.02%	14240129	0.02%	78688711.42	0.05%	93406821.91	0.05%	66546121.91	0.03%

Appendix 9 Pre-analysis test

Wald Test for heteroskedasicity

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (32651)  = 3.1e+08
Prob>chi2 =      0.0000
```

Hausman Test

```
    chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            = 8420.11
Prob > chi2 =  0.0000
(V_b-V_B is not positive definite)

.
end of do-file
```

VIF Test

Variable	VIF	1/VIF
lndisw	1.29	0.776360
lnYj	1.22	0.821227
lnYi	1.21	0.829258
comcol	1.19	0.842376
importer_f~t	1.18	0.848257
export_rest	1.17	0.853443
eu	1.17	0.857520
contig	1.16	0.859997
langu	1.15	0.866123
wto_china	1.04	0.956993
Mean VIF	1.18	

Appendix 10 Near zero flow

near_zero_trade	Freq.	Percent	Cum.
0	728,563	99.80	99.80
1	1,482	0.20	100.00
Total	730,045	100.00	

Appendix 11 Germany trade dependence of China's machinery

year	hs6	DE_imp	trade	DE_imp_fro	X_role_glob	description
2021	844712	1	2867.698	88.73	42.31	Knitting machines: circular, with cylinder diameter exceeding 165mm
2021	841911	1	44836.1563	87.14	24.78	Heaters: instantaneous gas water heaters, for domestic or other purposes
2021	852739	1	51281.5273	78.26	53.25	Radio-broadcast receivers: n.e.s. in heading no. 8527, other than with sound recording, reproducing apparatus or clock, including apparatus capable of receiving radio-telephony
2021	854519	1	34896.9219	75.82	60.94	Carbon electrodes: with or without metal, of a kind used for other than furnaces
2021	851672	1	88634.4844	72.86	84.94	Electro-thermic appliances: toasters, of a kind used for domestic purposes
2021	850511	1	455306	72.56	59.26	Magnets: permanent magnets and articles intended to become permanent magnets after magnetisation, of metal
2021	852732	1	24788.7715	71.02	69.12	Radio broadcast receivers: n.e.s. in heading no. 8527, combined with a clock, including apparatus capable of receiving radio-telephony or radio-telegraphy
2021	840731	1	539.893005	70.97	55.58	Engines: reciprocating piston engines, of a kind used for the propulsion of vehicles of chapter 87, of a cylinder capacity not exceeding 50cc
2021	845959	1	3234.62402	70.39	44.34	Machine-tools: for milling by removing metal, knee-type, other than numerically controlled
2021	848020	1	16786.5918	69.13	41.61	Mould bases: for metal, metal carbides, glass, mineral materials, rubber or plastics
2021	847193	1	12025807	68.54	74.30	Data processing machinery: storage units, whether or not presented with the rest of a system
2021	842541	1	67209.8828	65.54	37.64	Jacks: built-in jacking systems of a type used in garages, for raising vehicles
2021	845929	1	21657.2676	65.41	40.10	Machine-tools: for drilling by removing metal, other than numerically controlled
2021	854121	1	150898.188	59.98	50.12	Electrical apparatus: transistors, (other than photosensitive), with a dissipation rate of less than 1W
2021	851650	1	185345.609	59.77	70.83	Ovens: microwave, of a kind used for domestic purposes
2021	841013	1	674.151978	58.08	41.47	Turbines: hydraulic turbines and water wheels, of a power exceeding 10000kW
2021	851310	1	142940.141	57.69	78.80	Lamps: portable, electric, designed to function by their own source of energy (excluding lighting equipment of heading no. 8512)
2021	841451	1	117544.984	57.31	78.51	Fans: table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output not exceeding 125W
2021	851210	1	57511.4531	57.01	54.62	Lighting or visual signalling equipment: electrical, of a kind used on bicycles, excluding articles of heading no. 8539
2021	842381	1	21318.2266	56.01	33.63	Weighing machines: having a maximum weighing capacity not exceeding 30kg (excluding balances of a sensitivity of 5cg or better)
2021	851539	1	41450.9805	55.30	58.13	Welding machines and apparatus: for arc (including plasma arc) welding of metals, other than fully or partly automatic, whether or not capable of cutting
2021	850611	1	171490.938	54.00	47.70	Cells and batteries: primary, of an external volume not exceeding 300cm3, manganese dioxide
2021	851822	1	352907.813	53.55	53.31	Loudspeakers: multiple, mounted in the same enclosure
2021	851821	1	171423.109	52.86	60.08	Loudspeakers: single, mounted in their enclosures
2021	846591	1	186610.672	52.72	36.14	Machine-tools: sawing machines, for working wood, cork, bone, hard rubber, hard plastics or similar hard materials
2021	851629	1	161578.984	52.08	58.96	Heating apparatus: electric soil heating apparatus and space heating apparatus (excluding storage heating radiators)
2021	850910	1	771482.5	51.61	50.25	Electro-mechanical domestic appliances: vacuum cleaners with self-contained electric motor
2021	842310	1	88454.625	51.53	75.71	Weighing machines: personal (including baby scales) and household scales
2021	845939	1	3955.052	50.59	22.31	Machine-tools: for boring-milling by removing metal, other than numerically controlled
2021	843061	1	25570.4375	50.50	22.22	Machinery: for tamping or compacting, not self-propelled
2021	853400	1	1230698.13	50.15	49.65	Circuits: printed