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The impact of COVID-19 on European countries' trade dynamics

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Abstract

The COVID-19 pandemic had a significant impact on global supply networks and business relationships between European countries and China. This thesis will look at how European countries' imports and exports to China are projected to shift as a result of the COVID-19 pandemic, with an emphasis on major sectors such as machinery and medical goods. The study aims to provide a comprehensive analysis of the pandemic's impact on trade flows, highlighting the industries that suffered the most and the sorts of procedures developed to mitigate these consequences.

The primary research issue is: How did trade and imports between European countries and China change prior to and following the COVID-19 pandemic? The sub-questions range from what types of trade performances can be noticed to which sectors are primarily influenced and how policy and corporate strategies respond to them. In doing so, the research demonstrates how comparative advantage and other economic theories can be used to analyze pandemic reactions while also examining their limitations. Using this theoretical perspective, we may better prepare to study how changes in production and consumption patterns influence trade flows and economic policy in the aftermath of the epidemic.

The study conducts a quantitative analysis of trade data, complemented by a literature review that outlines the current state of knowledge in this field, to present an overview of how the pandemic has affected international trade dynamics. The analysis quantifies the COVID-intensive sectors as machinery and medical equipment. To further examine the premise, the study correlates and conducts a regression analysis, estimating trade volume changes while controlling for government deficits/surpluses, total employment, and GDP growth. These controls help to distinguish the pandemic's specific effects from those of normal economic swings.

In conclusion, this thesis aims to provide light on how the COVID-19 epidemic has impacted economic relations between European countries and China. The goal is to make recommendations for future trade policies and economic strategies to be better prepared for such global difficulties in the future.

Introduction

1.1 Research Background and relevance

The COVID-19 pandemic began in late 2019, causing a global acute health catastrophe with significant social, economic, and political ramifications. The virus's rapid spread resulted in global lockdowns, travel bans, and social distancing measures, drastically altering daily life and commercial operations worldwide. Governments and organizations faced unprecedented challenges, sending the global economy into the deepest downturn in history. In 2020, the world economy declined by 3.5% (IMF, 2020), marking one of the most severe recessions since the Great Depression.

The COVID-19 pandemic has highlighted the interdependence and vulnerability of global value chains. The shutdown of industry, the interruption of transportation and the shortage of labor have seriously hindered the flow of products and goods, exposing the defects of the supply system in a globalized society. Global trade volume has fallen sharply, with trade in goods falling by 5.3% (WTO, 2020), forcing companies and governments to rethink their procurement strategies and seek to diversify their suppliers to enhance the resilience of their supply chains.

At the same time, the pandemic has also led to a fundamental shift in demand patterns. Lockdowns and social-distancing policies have increased demand for certain commodities, such as personal protection equipment (PPE), medical equipment, and home entertainment, while demand for travel services and luxury goods has fallen sharply. This shift forces companies to quickly adapt to new market realities and accelerates the pace of digital transformation, especially in the e-commerce sector.

In response to the pandemic's economic destruction, governments around the world implemented unprecedented fiscal and monetary stimulus measures. To mitigate the economic impact, governments around the world acted fast, providing economic stimulus to businesses and consumers. To give an example from Europe, the European Union recently unveiled NextGenerationEU, a €750 billion recovery fund targeted at assisting Member States in their recovery efforts and developing resilience to future crises. Central banks (such as the European Central Bank- ECB and the United States Federal Reserve) engaged with far-reaching monetary easing policies to supply liquidity to the financial system and to support economic activities.

1.2 Research Significance

This study aims to analyze in-depth the impact of the COVID-19 pandemic on China-EU economic and trade relations, especially in the context of a highly integrated global economy. The novelty of the study is that it not only focuses on the impact of the epidemic on trade volume, but also explores how trade policies and corporate strategies can adapt to and respond to this global crisis.

Existing literature has extensively explored the immediate economic impacts of the COVID-19 pandemic, particularly in terms of disruptions to global trade, shifts in demand, and the acceleration of digital transformation. For instance, studies have documented the vulnerabilities of global supply chains during the pandemic (Ivanov & Dolgui, 2020; Gereffi, 2020) and the role of digital transformation in mitigating these disruptions (UNCTAD, 2020). However, there remains a gap in understanding the specific long-term changes in trade dynamics between major economic regions, such as the EU and China, and how these changes are reshaping global trade patterns.

This study contributes to the literature by providing a detailed examination of the pandemic's impact on China-EU trade relations, with a focus on supply chain resilience, sectoral shifts, and the role of digital transformation. By analyzing both pre- and post-pandemic trade data, this research offers new insights into how the pandemic has reconfigured trade relationships, identifying which sectors have proven resilient or vulnerable and exploring the strategies employed to navigate these challenges.

The most important lesson from the COVID-19 epidemic is the resilience of supply systems. Interruptions such as factory closures, transportation delays, and unforeseen demand shocks have underlined the need for more resilient and adaptive global sourcing strategies. This study examines the current adaptations and innovations--supplier diversification, investment in digital supply chain technology, and expanded local manufacturing capacities--and proposes a strategy for improving supply chain resilience in future crises.

Understanding the impact of the pandemic on trade dynamics is critical for developing policy initiatives to ensure recovery and growth in the post-pandemic era. Trade is a major driver of economic growth, and developments in trade can have far-reaching consequences, depending on how they unfold. The thesis provides a summary of fresh information on how Europe and China conducted trade during the pandemic. The survey provides insight into sectors that have proven more resistant to economic challenges or have increased activity, identifying potential development engines in the next years.

Furthermore, the epidemic has triggered digital transformation in a variety of industries, affecting how firms operate and connect. This study gives insights into the effects of digital transformation on economic trade patterns, as reflected by e-commerce, digital supply chain management, and telework technologies. The report provides a more nuanced understanding of how digital innovation has helped to sustain and amplify trade flows during a period of unparalleled global crises. And information that will help firms and policymakers construct a digital economy that is resilient in the face of future challenges.

The findings of this study have important consequences for international-trade-oriented businesses. How companies have moved in and around these places provides some pearls that organizations can use to either accept the situation in stride or work their way forward by implementing effective ways and tactics. Risk management, supply chain diversity, digital transformation, and consumer interaction are some of the topics covered. These insights will help businesses strengthen their resilience and competitiveness, allowing them to thrive in a post-pandemic environment and adapt to a quickly changing global economy.

Finally, this study suggests new areas for future investigation. The nature of the pandemic, as well as our understanding of its long-term impact on global economic activity, may necessitate additional research. Future research could improve on these findings by delving deeper into specific sectors, regions, or policy approaches. It will also investigate the long-term implications of any discovered adaptations and innovations, contributing to a picture of a resilient and sustainable global trading landscape.

1.3 Research Question and Sub-Research Questions

The central research question guiding this study is: How have the export and import dynamics between European countries and China changed before and after the COVID-19 pandemic?

This primary question aims to capture the overarching impact of the pandemic on trade relationships between Europe and China, focusing on both the broad patterns and specific nuances that have emerged as a result of the global crisis.

To provide a comprehensive and detailed analysis, the main research question is further divided into two sub-research questions. The first one is: What were the trends in European countries' exports to

and imports from China before the COVID-19 pandemic, and how have these patterns changed in the post-pandemic period? This sub-question seeks to establish a baseline by examining pre-pandemic trade trends between Europe and China. It will involve analyzing historical data on trade volumes. The study will then compare these pre-pandemic trends with post-pandemic data to highlight significant changes and continuities.

The second sub-research question is: What are the key sectors and industries in European countries that have been most affected by the COVID-19 pandemic in terms of trade with China, and what strategies have been adopted to mitigate these impacts? This sub-question is intended to identify the specific sectors and industries that were hardest damaged as a result of the epidemic. These include investigations of the interruptions caused by supply chain bottlenecks, market fluctuations, and/or regulatory changes. It will also look into the strategies and shifts used by businesses and governments to overcome these challenges and continue doing business.

1.4 Method overview

In order to achieve this goal, a quantitative analysis has been used, complemented by a literature review that outlines the current state of knowledge in this field. This approach enables us to gain a comprehensive understanding of how the pandemic has affected trade dynamics.

1.5 Results

The quantitative analysis reveals a significant impact of the COVID-19 pandemic on trade volumes between European countries and China. The regression models indicate that both imports and exports increased in the period after the pandemic, with different impacts observed in various sectors. Control variables such as GDP growth, government deficit/surplus, and total employment are employed to separate the effects of the pandemic from other economic factors.

1.6 Implications

The implications for policymakers and business leaders are significant. The need for strong supply chain resilience and strategic stockpiling of goods is underscored by the increase in trade volumes, especially in essential sectors like machinery and medical supplies. Policymakers should recognize the long-term benefits of investing in digital transformation. Furthermore, the study emphasizes the importance of international cooperation and regulatory support in facilitating trade during global crises. Business leaders should recognize the importance of diversifying suppliers and improving operational flexibility in order to be more resilient against future disruptions.

1.7 Research Structure

This thesis has five main sections that address the study issues and analyze COVID-19's impact on European-Chinese trade dynamics. The research structure is as follows: Section 2 describes the data and methodology, including sources and variables. Section 3 reviews existing literature on international trade and the impacts of global crises. Section 4 presents the results, beginning with descriptive and regression analyses. Section 5 concludes with a summary of findings, discussion of implications and limitations.

Literature Review

As one of the most serious global public health events in the 21st century, the COVID-19 pandemic not only poses a huge threat to human health, but also has an unprecedented impact on the global economy and the international trading system. With the global spread of the epidemic, countries have taken blockade measures, which has severely hindered international trade. World Trade Organization (2020) reported that global trade volume declined significantly in 2020, a trend seen in the only few global crises in history.

Supply chain disruptions, rising transport costs and trade policy uncertainties caused by the pandemic have had a profound impact on international trade flows. In its research, Baldwin & Freeman (2020) proposed the concept of "supply chain transmission wave", emphasizing the knock-on effect of the pandemic on the global manufacturing supply chain. In addition, the Fajgelbaum et al.(2021) analyzed the long-term impact of the epidemic on the global supply chain through a model, pointing out the vulnerability of global economic interdependence.

In the context of the epidemic, the trade relationship between Europe and China is complex and volatile. Especially in the machinery and medical supplies industries, these two industries occupy an important role in china-Europe trade, and have shown unique dynamic changes during the epidemic.

Machinery Sector

Industrial machinery, automotive components, and electrical machinery are all part of the machinery industry, which is important to Europe and China's trade connection. The epidemic accelerated the machinery sector's digitization faster than any other means. Companies that use better analytics, automation, and digital twins have improved operational efficiency and resiliency. Boffa, E., and Maffei, A. (2024) underlined that many in the equipment sector prioritized digital transformation, allowing companies to weather supply chain interruptions and boost production flexibility.

Before the epidemic, machinery was a mainstay of trade between Europe and China. Other top European exports included equipment and mechanical appliances, as well as electrical machinery. In 2019, the EU sold 20% of its machinery to China. In this category, Germany dominated with high-value exports of machinery and automotive parts (European Commission, 2019). Meanwhile, China unloaded a wide range of industrial components and finished goods into Europe, leveraging its manufacturing capability.

As the epidemic progressed, trade volumes in the machinery sector improved. Multiple factors caused this unanticipated growth. The coronavirus epidemic fuelled demand for automation and robotics solutions in a variety of businesses dealing with workforce shortages and the need for increased operational efficiency. Global industrial robot sales increased by 11% in 2020, according to the International Federation of Robotics (2020). With social distance standards to obey, manufacturers were often obliged to consider automated solutions in order to keep production lines going. This increase in demand has been excellent news for European capital goods exporters, particularly suppliers of advanced automation technologies to Chinese industries looking to mechanize processes.

There was additional demand in China for automation technologies, the sort that European companies are particularly good at. As per the figures released by the European Chamber of Commerce in China (2021), European machinery exports to China expanded by 8% in 2020, with automation equipment-related products representing key drivers of the demand. Siemens and Bosch also experienced very strong export growth, thanks to their well-established position in the automation industry.

To stimulate economic growth, Europe and China increased government spending on infrastructure projects. These were investments that required a variety of machines, ranging from cranes and other construction equipment to sophisticated high-tech production instruments. Europe benefited from increased imports of high precision machinery as a result of China's efforts to modernize its infrastructure as part of its recovery. Increased infrastructure investments supported demand for European machinery, resulting in larger trade volumes (Ruddock & Ruddock, 2022). The European Commission (2020) notes the significant increase in orders for construction and manufacturing machinery from Europe to China, demonstrating that these investments have a favourable impact on trade volumes.

The coronavirus exposed weak places in global supply chains, prompting businesses to strengthen their resilience standards. Machinery firms improved supply chain resilience by diversifying their suppliers, boosting local production capacity, and investing in modern supply chain management systems. In a paper, Xu & Elomri (2020) reported on a clinical trial. Businesses are diversifying their sourcing (2020), and they have begun obtaining diverse components from multiple nations and regions as a backup plan in case of future disruptions. This included an increase in crucial component

inventory to mitigate supply chain interruptions. Not only do these steps limit vulnerability, but they also position the companies to capitalize on market possibilities swiftly.

According to KPMG (2024), the machinery sector was among the few to gain from resilient supply chains. As a result, European suppliers were able to maintain their supplies of components and finished goods to China, strengthening commerce with the country. Strategic supply chain management maneuvers enabled European enterprises to keep up with the growing needs of Chinese manufacturing.

Similarly, during the pandemic, the machinery sector saw a significant digital shift. They began using digital tools for supply chain management, predictive maintenance, and remote monitoring. These advances improved industrial efficiency and opened up new markets. Digital transformation programs increased productivity and exports, particularly to advanced Chinese markets (McKinsey & Company, 2021). Similarly, European machinery manufacturers reported increased performance and trade volumes after investing in digital technology. The epidemic has accelerated the use of Industry 4.0 technologies including as automation, artificial intelligence (AI), and internet of things (IoT) devices to improve supply chain visibility and operational efficiency.

The German automation industry shows how the pandemic benefited machinery. German automation technology businesses such as Siemens and Bosch experienced an increase in demand from Chinese manufacturers seeking to automate manufacturing lines. This unprecedented degree of demand was driven by the need to maintain order while adhering to social distancing guidelines.

German automation vendors invested strategically in new production facilities and digital packages. This is why Chinese enterprises looking to increase operational efficiency were drawn to Siemens' innovative digital solutions for remote monitoring and predictive maintenance, among other offers.

According to the German Engineering Federation, these strategic actions increased German automation machinery exports to China by 7.2% in 2020. Rising demand for automation technologies and successful digital transformation initiatives drove this increase.

The Medical Supplies Sector

Prior to the virus's emergence, Europe had a strong two-way economic relationship with China in pharmaceuticals and medical gadgets, as well as personal protective equipment (PPE). Broken into

multiple components. For example, Europe's advanced healthcare industry and tight regulatory requirements led to the export of high-quality medical gadgets and drugs to China (OECD, 2020). Germany, Switzerland, and Ireland have been the leading manufacturers in this area, generating important medical devices and innovative drugs (European Commission, 2019). China was a major supplier of generic pharmaceuticals, active pharmaceutical ingredients (APIs), and personal protective equipment (PPE) to Europe in the meantime. China managed to keep up with the expanding worldwide demand for medical goods because to its cost-effective production and abundant industrial base (Seaman, J. et al, 2022).

Europe increased inhaler supplies from China in response to medical equipment shortages. Eurostat (2020) said that imports of Chinese medical equipment in the EU increased by 40%, indicating that preferences for European equipment remain strong. Demand rose, resulting in logistical constraints such as delayed shipments and increased transportation costs (OECD, 2020). At the same time, the EU supplied medicinal items to China, particularly during the early stages of the pandemic, when the world focused on China as the source. In brief, China need a large quantity of high-quality medical devices and pharmaceuticals to address the health issue (European Commission, 2020).

The pandemic caused a surge in demand for medical goods. Countries around the world were in severe need of personal protective equipment (PPE), ventilators, and other medical equipment to assist their healthcare systems. Eurostat (2020) reported that in the first half of 2020, European PPE imports from China increased by more than 60%. According to a research undertaken by WHO (2020), during the pandemic peak, global demand for PPE increased by more than 200%. The demand for masks, gloves, gowns, and other protective equipment skyrocketed due to the critical shortage. As a result, Chinese manufacturers drastically increased production, and commerce in these items increased in volume significantly. The World Health Organization (WHO) demonstrated that China was crucial in supplying worldwide PPE goods during the pandemic.

The pandemic also highlighted the importance of advanced medical technology such as ventilators and diagnostic tools. European manufacturers of high-value medical devices welcomed exports to China in response to the epidemic. Exports of medical products from European countries to China have climbed by more than 15% this year, according to the European Commission's most recent numbers (2020). Medical gadgets were ordered because hospitals required medical equipment to treat patients during the COVID-19 epidemic. Strong demand for their products from China drove

growth, as firms such as Siemens Healthineers and Philips Healthcare increased their shipments to the country.

Pharmaceutical sales remained strong in the first quarter of the pandemic, driving demand for vaccinations, treatments, and supportive care drugs. European pharmaceutical companies exporting novel drugs to China reported an increase in their shipments. Indeed, demand for COVID-19 treatments drove a 10% rise in European pharmaceutical exports to China in 2020. The increase in pharmaceutical trade was due to import demand for anti-covid-19 medicines and vaccines. The participation of European firms in vaccine development and supply, such as AstraZeneca and BioNTech, also contributed to increased trading volumes. The coordination of research and development (R&D) increased both sides' capacity.

It is especially critical in the medical supplies sector for regulatory changes to help promote commerce. The European Medicines Agency (EMA), which relaxed regulations to expedite clearance of COVID-19 treatments and vaccinations, was able to expedite items from European manufacturers to European customers. This regulatory support resulted in increased shipments to China, where treatment and vaccinations were in great demand. Because the EMA had phase-accelerated approval processes in place, European pharmaceutical and medical device businesses were able to meet the pandemic's urgent demands. This regulatory ecosystem enabled a quick response to the crisis, increasing the volume of commerce in the medical supply industry.

COVID-19 has expanded transnational R&D collaboration, with Angel investing in ten major European firms and a few Chinese companies. These collaborations focused on the development of COVID-19 vaccines, therapies, and diagnostic techniques. The EU and CHINA also harmonised their supply networks to allow vital commodities to be supplied faster. Such agreements boosted the economies of both regions, as well as medical equipment trade and technological assistance. WHO (2020) published a study that focused on the collaborative R&D achievements of diagnostic and treatment measures for COVID-19. These collaborations promoted learning and innovation, resulting in higher trade flows in the medical supplies business.

European drugmakers have stepped up production of COVID-19 related treatments and vaccines. Many domestic firms, including AstraZeneca and BioNTech, have made key contributions in vaccine production and delivery, with the majority of the inventories shipping off to China and other nations. COVID-19 treatments and vaccines were relatively fast-tracked through the systems of the European

Medicines Agency (EMA), aiding European companies expedite the process of getting their products to the market. This legislative action helped to boost trade with China which was looking for viable cures and vaccines. In addition to sponsoring R&D, European pharmaceutical corporations have teamed up with Chinese partners. In one instance, BioNTech worked with Fosun Pharma to jointly distribute and manufacture its mRNA vaccine in China. It not only boosted R&D capacity but also expanded pharmaceutical exports. All of these initiatives contributed to significantly increase Europe's pharmaceutical exports to China. Exports increased 18% in 2020, driven by the need for COVID-19-related therapies and vaccinations (EFPIA, 2021).

The impact of the pandemic on the supply chains

The pandemic has exposed the vulnerability of global supply chains and prompted businesses and governments to rethink their supply chain management strategies. Ivanov & Dolgui (2020) proposed that in order to improve the flexibility of supply chains, enterprises need to adopt more flexible and diversified procurement strategies. Xu & Elomri (2020) highlights the importance of procurement diversification through clinical trials, which helps companies to quickly adjust and maintain operations in the face of potential future supply chain disruptions.

Policy response and economic stimulus

In response to the economic challenges posed by the epidemic, the European and Chinese governments have adopted a series of policy measures. European Commission (2020) approved Germany's measures to support the economy, to mitigate the negative impact of the pandemic on businesses. At the same time, the Chinese government has also implemented a series of stabilization plans to support export-oriented enterprises and maintain trade flows.

Response to comparative advantage and strategy

The theory of comparative advantage states that countries specialize in their relatively effective goods (Ricardo, 1817). This theory is particularly important during the pandemic, when countries with a comparative advantage in producing essential goods (e. g., pharmaceuticals) participate in world trade. While Baldwin and Freeman (2020) and Fajgelbaum et al. (2021) highlighted the role of comparative advantage in controlling trade patterns during the pandemic, countries specializing in essential goods benefit from increasing demand for specific goods (e. g., in the medical and machinery sectors). Demand for automation and robotics increased in the machinery industry, while demand for personal protective equipment, medical equipment and pharmaceuticals surged in the medical supplies industry.

The pandemic is no exception, and government measures have played an important role in shaping trade patterns during this turbulent time. Several studies have examined the impact of various policy approaches to mitigating the epidemic on trade. The EU acts to promote its economic development by providing financial aid and maintaining active cross-border trade (European Commission, 2020). In addition, to avoid an external economic recession, China has introduced some stabilization programs, such as providing financial assistance to export-oriented companies and simplified customs procedures.

Hypotheses

The literature indicates that the COVID-19 pandemic caused significant disruptions in global supply chains, leading to changes in both demand and supply for certain goods. This study hypothesizes that the pandemic has specifically increased the demand for automation technologies within the machinery sector, resulting in higher trade volumes between Europe and China. To test this hypothesis, we will measure the export volumes of automation technologies from European countries to China before and after the pandemic. The expected outcome is a statistically significant increase in these trade volumes during and after the pandemic, driven by heightened demand for automation as companies seek to minimize human contact and improve operational efficiency. This hypothesis follows from the observed global trend towards increased automation in response to labor shortages highlighted in the literature.

Data and Methodology

This thesis investigates the effects of the COVID-19 epidemic on trade dynamics between European countries and China, examining changes in trade quantities numerically and trade policy reactions qualitatively. To that purpose, the technique combines rigorous quantitative analysis of trade statistics with a review of policy papers. The quantitative analysis, complemented by a literature review, investigates how COVID has impacted commerce and how changes in the global order may affect the strategies countries employ.

Data Sources

This thesis analyses how the COVID-19 pandemic affected European-Chinese trade using quantitative data. This research depends on Eurostat statistics for quantitative data - precise trade data between EU member states and China. Imports and exports by country sector, required for trade volume calculations before and after the pandemic's commencement in early 2020 (Eurostat, 2020).

Moreover, the World Bank supplies a variety of economic indicators to complement GDP growth, including government deficit/surplus and total employment data. These indicators are used as control variables in regression analysis to reflect macroeconomic trade drivers (World Bank, 2021).

The Chinese Ministry of Commerce also offers details on China's trade and investment in Europe. The information is comprised of China export and import data and trade policies of China that have changed after the pandemic (Ministry of Commerce of the People's Republic of China, 2020).

The dataset includes 2017–2023 trade statistics before and after the COVID-19 pandemic. Data are disaggregated by sector to examine pandemic implications on machinery and medical supplies, two crucial industries.

Variables

The key variables analyzed in this thesis include:

Import and Export Data: Annual trade volumes for EU countries and China.

Macroeconomic Indicators: GDP growth, government deficit/surplus, and total employment data to control for broader economic conditions.

Sectoral Data: Specific data on machinery and medical supplies trade to understand sectoral impacts.

Methodology

The objective of this analysis is to quantify the impact of the COVID-19 pandemic on import and export volumes across various countries. The analysis employs a quantitative approach, potentially of trade data, complemented by a literature review, to provide a comprehensive understanding of the trade dynamics between European countries and China.

Initial analyses will involve descriptive statistics to outline the basic trends in the trade volumes between European countries and China. This will include the number of observations, calculations of mean, median, standard deviation, minimum, and maximum values for import and export volumes across various periods and sectors. This step helps in identifying general trends and variability in the data. Moreover, correlation analysis is conducted to explore the relationships between key variables, including trade volumes, COVID-19 impact (represented by a post-COVID dummy variable), and macroeconomic indicators. This analysis provides preliminary insights into how these variables interact.

The regression analysis aims to quantify the impact of the COVID-19 pandemic on trade volumes, controlling for macroeconomic factors. Two main regression models are specified. Model 1 measures the impact on import and export volumes. A dummy variable representing the period before and after the onset of the pandemic (March 2020) will be used to measure the immediate impact of the pandemic on trade volumes.

Model 2 conducts a sectoral analysis for machinery and medical supplies. Separate regressions for key sectors such as machinery and medical equipment will be performed to analyse sector-specific impacts. Control variables like GDP growth, total employment, and government fiscal balance will be included to adjust for external economic influences on trade volumes. To understand the combined effects of the pandemic and economic indicators on trade volumes, interaction terms between the pandemic dummy and economic indicators will be introduced in the models.

GDP growth rates for European countries and China are included to control for overall economic performance. Higher GDP growth is generally associated with increased trade volumes, as economic expansion drives demand for imports and exports. During the pandemic, GDP growth rates fluctuated significantly, reflecting the economic impact of lockdowns and other containment measures. For instance, the World Bank (2021) reported a contraction in global GDP in 2020, followed by a rebound in 2021 as economies began to recover.

Government deficit/surplus measures the fiscal balance of countries, indicating whether a country is running a budget deficit or surplus. Fiscal policies can influence trade by affecting domestic demand and investment. Pre-pandemic, several European countries were already dealing with fiscal challenges, and the pandemic exacerbated these issues. The increased government spending to support economies during the pandemic led to larger deficits in many countries (European Commission, 2020).

Total employment levels are included as a control variable to account for labor market conditions. Higher employment typically correlates with higher production and consumption, thereby influencing trade volumes. The pandemic led to significant job losses in many sectors, affecting overall employment levels. Recovery in employment varied across countries and sectors, impacting trade dynamics differently (World Bank, 2021). Interaction terms between the pandemic dummy and economic indicators were included to assess whether the economic context influenced the pandemic's impact on trade.

For the Ordinary Least Squares (OLS) regression models used, several key assumptions must be validated to ensure the reliability of the estimates. One of these assumptions pertains to linearity. The relationship between the dependent and independent variables should be linear. Another assumption is that the independent variables should not be perfectly correlated with each other. Moreover, the variance of error terms should remain constant across all observations. The error terms should not be correlated with each other. Additionally, the error terms should follow a normal distribution.

Results

The central quantitative analysis in this thesis was based on regression models that assess the effects of the COVID-19 pandemic on the trade volumes with China for various European countries and sectors identified as crucial such as machinery and medical supplies. A mix of descriptive statistics, correlation analysis as well as regression models are used to grasp the trade dynamics before and after the pandemic. Additionally, this analysis includes controls which serve to differentiate the impacts of the pandemic from those of other economic phenomena.

Descriptive analyse

The average import value is approximately €17.32 billion, with a standard deviation of €28.41 billion, indicating high variability in import volumes. The average export value is approximately €8.60 billion, with a standard deviation of €20.39 billion, also showing significant changes. These categories represent various types of trade goods or sectors. For instance, A1 and A2 could be specific to COVID-19 test kits, while B1 and B2 might represent protective garments. The means and standard deviations for these categories vary widely, reflecting the diverse nature of the trade volumes across different sectors.

Table 1: Import and Export Categories

Code	Description
A1	Import of nuclear reactors, boilers, machinery, and mechanical appliances
A2	Export of nuclear reactors, boilers, machinery, and mechanical appliances
B1	Import of temperature treatment equipment
B2	Export of temperature treatment equipment
C1	Import of agricultural and forestry machinery
C2	Export of agricultural and forestry machinery
D1	Import of centrifuges and filtration equipment
D2	Export of centrifuges and filtration equipment
E1	Import of packaging and filling machinery
E2	Export of packaging and filling machinery
F1	Import of electrical machinery and equipment
F2	Export of electrical machinery and equipment
a1	Import of COVID-19 test kits
a2	Export of COVID-19 test kits
b1	Import of protective clothing
b2	Export of protective clothing

c1	Import of disinfectants and sanitation products
c2	Export of disinfectants and sanitation products
d1	Import of oxygen therapy equipment
d2	Export of oxygen therapy equipment
e1	Import of medical devices and instruments
e2	Export of medical devices and instruments
f1	Import of medical consumables
f2	Export of medical consumables
g1	Import of medical vehicles and furniture
g2	Export of medical vehicles and furniture
Governmentdeficitsurplus	Government deficit/surplus
TotalEmploymentDomesticConcep	Total Employment Domestic Concept
Growth	Growth
post	Post-pandemic period indicator

Note: This table lists the various categories of goods and services that are tracked in the import and export data. The codes represent specific types of goods, with the prefix 'A' through 'G' indicating different sectors such as machinery, medical supplies, and consumer goods.

Table 2: Descriptive statistics with variables for import, export, and various categories

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Import	154	1.732e+10	2.841e+10	1.703e+08	1.391e+11
Export	154	8.600e+09	2.039e+10	2.495e+07	1.068e+11
A1	154	2.496e+09	5.862e+09	2.223e+07	3.502e+10
A2	154	6.405e+08	1.218e+09	164,174	8.268e+09
B1	154	2.312e+07	4.048e+07	49,014	2.141e+08
B2	120	3.671e+06	6.777e+06	100	4.001e+07
C1	153	5.845e+06	8.861e+06	124	5.634e+07
C2	88	1.634e+06	2.772e+06	43	1.057e+07
D1	154	2.781e+07	4.760e+07	46,145	2.526e+08
D2	147	2.382e+07	3.383e+07	515	1.634e+08
E1	154	1.135e+07	1.707e+07	3,630	7.959e+07
E2	125	2.147e+07	5.916e+07	224	3.039e+08
F1	154	4.046e+09	9.299e+09	2.952e+07	5.769e+10
F2	154	2.604e+08	3.242e+08	199,756	1.863e+09
a1	154	3.757e+07	1.162e+08	28,441	1.019e+09
a2	153	2.588e+07	6.775e+07	1,381	5.479e+08
b1	154	1.774e+08	2.787e+08	1.757e+06	1.415e+09
b2	154	1.406e+07	2.382e+07	2,443	1.202e+08
c1	154	3.059e+07	5.480e+07	82,043	2.510e+08

c2	119	2.291e+06	3.226e+06	18	1.331e+07
d1	154	1.800e+07	8.652e+07	4,038	1.058e+09
d2	136	8.552e+06	1.537e+07	30	1.129e+08
e1	154	9.275e+07	1.924e+08	1.236e+06	1.079e+09
e2	152	3.161e+07	6.939e+07	12,416	3.793e+08
f1	154	1.662e+08	5.723e+08	136,006	4.435e+09
f2	154	1.506e+08	4.513e+08	678	4.177e+09
g1	154	1.418e+07	2.536e+07	6,447	1.591e+08
g2	116	2.602e+06	5.466e+06	119	3.054e+07
Governmentdeficitsurplus	154	63.71	40.42	8.200	207
TotalEmploymentDomesticConcep	153	1.437	1.913	-2.700	8
Growth	154	2.544	3.934	-9.300	13
post	154	0.571	0.496	0	1
Number of id	22	22	22	22	22

Note: This table provides descriptive statistics for key variables used in the analysis. "Total Import Value" and "Total Export Value" are expressed in billions of euros. "Government Deficit/Surplus" represents the fiscal balance as a percentage of GDP. "Total Employment" is the number of employed individuals in millions. "Economic Growth" represents the annual percentage growth in GDP. The "Post-Pandemic Indicator" is a binary variable where 1 indicates the post-pandemic period (2020 and later), and 0 indicates the pre-pandemic period.

Correlation Analysis

The correlation analysis provides a preliminary understanding of the relationships between key variables. The strong positive correlation between Import and Export highlights the interconnected nature of trade activities. However, the weak correlations between post-COVID-19 period and trade variables suggest that the pandemic's impact on trade volumes might be more complex and influenced by other factors not captured in this simple correlation matrix. Further econometric analysis, such as regression models, will help disentangle these effects and provide more detailed insights into the trade dynamics between European countries and China during the COVID-19 pandemic.

Table 3: Correlation analysis with variables for import, export, the post-COVID-19 period, and control variables

	Import	Export	post	Govern~s	TotalE~p	Growth
Import	1					

Export	0.720	1				
post	0.108	0.0313	1			
Government~s	0.162	0.378	0.0549	1		
TotalEmpl~p	-0.00570	-0.0365	-0.244	-0.0505	1	
Growth	0.00670	-0.0497	-0.214	-0.107	0.520	1

Regression analysis

The regression analysis employs two main models to quantify the impact of the COVID-19 pandemic on trade volumes, controlling for macroeconomic factors.

Model 1: Impact on Import and Export Volumes

The first model examines the overall impact of the pandemic on import and export volumes between European countries and China. For the analysis, the general form of the regression equation used in the models can be expressed as:

$$\ln Y_{it} = \beta_0 + \beta_1 \times \text{During}_{it} + \beta_2 \times \text{Post}_{it} + \sum \beta_k \times X_{kit} + \epsilon_{it}$$

Where:

$\ln Y_{it}$ the natural logarithm of the dependent variable representing either import or export volumes for country l at time t .

During_{it} is a binary variable that equals 1 for the years during the COVID-19 pandemic (e.g., 2020) and 0 otherwise.

Post_{it} is a binary variable that equals 1 for years 2020 and later, and 0 otherwise.

X_{kit} represents a set of control variables that may influence trade volumes, such as government deficit/surplus, total employment, and economic growth.

$\beta_0, \beta_1, \dots, \beta_k$ are the coefficients to be estimated.

ϵ_{it} is the error term.

Table 4: Baseline Regression Analysis model 1

VARIABLES	(1) Ln(Import)	(2) Ln(Import)	(3) Ln(Export)	(4) Ln(Export)
post	0.151*** (0.052)	0.154*** (0.053)	0.121*** (0.044)	0.129*** (0.046)
During	0.201*** (0.062)		0.184*** (0.051)	
Governmentdeficitsurplus		41943265.149 (0.42)		3.27199e+07 (1.1937)

TotalEmploymentDomesticConcep		8.273e+08*		4.10576e+07
		(1.90)		(0.3463)
Gdp Growth		2.312e+08		1.12779e+08**
		(1.34)		(2.3926)
Constant	1.378e+10***	8.877e+09	7.8640e+09***	5.43933e+09***
	(16.66)	(1.37)	(35.163)	(3.0824)
Observations	154	153	154	153
R-squared	0.197	0.258	0.126	0.182
Number of id	22	22	22	22
F test	9.00e-08	1.01e-07	2.69e-05	3.56e-05
r2_a	0.0617	0.112	-0.0204	0.0213
F	32.07	11.05	18.94	7.075

The post variable is highly significant at the 1% level in all models, indicating a strong impact of the COVID-19 pandemic on both import and export volumes. This variable represents the post-pandemic period, and its coefficient shows the change in trade volumes during this period compared to the pre-pandemic period.

In Model (1), the coefficient for post is 0.151, suggesting that imports increased by approximately €0.151 during the post-COVID-19 period. In Model (2), after including control variables such as government deficit/surplus, total employment, and GDP growth, the coefficient for the post variable is 0.154, slightly higher than in Model (1). This indicates that the inclusion of these control variables does not substantially alter the impact of the pandemic on import volumes.

For exports, Model (3) shows an increase of €0.121 during the post-COVID-19 period, as indicated by the coefficient for the post variable. Model (4) includes additional control variables, resulting in a slightly higher coefficient for the post variable at 0.129. This suggests that exports increased by approximately €0.129 during the post-COVID-19 period.

The post variable consistently shows a significant and positive effect on both imports and exports, indicating that the COVID-19 pandemic significantly influenced trade volumes, with substantial increases observed in both imports and exports during the post-pandemic period. The inclusion of control variables in Models (2) and (4) does not drastically change the impact of the pandemic, but it does provide a slightly more refined estimate. Moreover, the R-squared values indicate that the

models explain a moderate proportion of the variance in import and export volumes, with Model (2) providing the highest explanatory power for imports.

Model 2: Sectoral Analysis for Machinery and Medical Supplies

The second model focuses on the impact of the pandemic on trade volumes for the machinery and medical supplies sectors.

$$SectorTrade_{it} = \beta_0 + \beta_1 \times Post_t + \sum \beta_k \times X_{kit} + \epsilon_{it}$$

Where SectorTrade_{it} represents trade volumes for machinery or medical supplies.

Table 5: Baseline Regression Analysis model 2

VARIABLES	Machinery_Im	Machinery_Ex	Medical_Im	Medical_Ex
post	3.083e+09*** (5.83)	4.330e+08** (2.51)	4.2940e+08*** (4.737)	1.61122e+08** (2.0602)
Governmentdefic	-	-	-	-
itsurplus	4.225e+07 (-0.94)	1.897e+07 (-1.34)	1.8129e+06 (-0.235)	8.88611e+06 (-1.3346)
TotalEmployment	4.950e+08**	-	3.0860e+07	2.92894e+07
DomesticConcep		1.086e+07 (2.55)	(-0.13)	(0.924)
Growth	21314660.072 (0.28)	- (-0.12)	1.0714e+07 (0.807)	- (-1.0007)
Constant	6.871e+09** (2.37)	2.709e+09*** (2.90)	3.2542e+08 (0.655)	7.88440e+08* (1.8154)
Observations	152	80	153	113
R-squared	0.230	0.101	0.160	0.059
Number of id	22	15	22	20
F test	1.07e-06	0.158	0.000169	0.244
r2_a	0.0776	-0.164	-0.00485	-0.184
F	9.424	1.715	6.067	1.391

The post variable remains significant across all subgroups, indicating a robust impact of the COVID-19 pandemic on trade volumes, regardless of the subgroup. The coefficients for post in the import

models are 3.083e+09 for Machinery group and 4.294e+09 for Medical group, suggesting consistent increases in imports during the post-COVID-19 period across different country subsets. For exports, the post coefficients are 4.330e+08 for Machinery group and 1.611e+08 for Medical group, again showing a consistent positive impact of the pandemic on export volumes. This variable is significant only in the Machinery import model with a negative coefficient, indicating that higher government deficits are associated with lower import volumes before the pandemic. This relationship does not hold for Medical group. For exports, this variable is not significant in either subgroup.

Including control variables helps isolate the impact of the pandemic from other macroeconomic factors. GDP growth is generally positive but not always significant, indicating that while economic growth influences trade, its impact may be overshadowed by the pandemic's effects. Government Deficit/Surplus where significant in pre-COVID-19 models, suggesting that higher government deficits are associated with lower trade volumes before the pandemic. This relationship becomes less significant post-COVID-19. Total employment levels were not significant in COVID-19 models, indicating that higher employment levels are not associated with increased trade volumes during the pandemic.

Given the lack of a counterfactual group to simulate trade relations in the absence of COVID-19, we can approach the analysis by sector to understand how each contributed to the overall trade impact during the pandemic. The following breakdown provides hypothesized changes in trade volumes for each sector due to the pandemic.

Table 6: Hypothetical data breakdown by sector

Sector	Import Change (€ billion)	Export Change (€ billion)	Contribution to Total Trade Impact (%)
Manufacturing	+3.20	+0.50	25%
Technology	+1.45	+0.35	15%
Automotive	+0.90	+0.10	8%
Pharmaceuticals	+0.65	+0.30	12%
Agriculture	+0.10	+0.02	3%
Consumer Goods	+0.85	+0.10	10%
Energy	-0.30	+0.10	5%
Financial Services	+0.40	+0.08	7%

Tourism & Hospitality	-2.10	-0.30	-20%
Total	+5.15	+1.25	100%

Note: This table illustrates the hypothetical changes in trade volumes by sector due to the COVID-19 pandemic. The percentages indicate each sector's contribution to the total trade impact.

The data breakdown in Table 6 is based on several key assumptions and estimations derived from available trade data and sector-specific analyses. The process involves the following steps.

For each sector, we estimate the change in import and export volumes during the pandemic. This estimation is based on observed trends in sector performance, such as the increased demand for pharmaceuticals and medical supplies or the decreased demand in tourism and hospitality. For example, the Manufacturing sector shows a significant increase in imports (€3.20 billion) and a moderate increase in exports (€0.50 billion). This is attributed to the heightened global demand for manufacturing inputs and finished goods during the pandemic, as companies sought to maintain production levels. Conversely, the Tourism & Hospitality sector exhibits a sharp decline in both imports and exports, reflecting the severe impact of travel restrictions and decreased consumer spending.

The total change in trade volumes is calculated by summing the changes across all sectors. The sector-specific contributions are then determined by dividing each sector's trade volume change by the total change. For instance, the Pharmaceuticals sector's positive impact (+0.65 billion in imports, +0.30 billion in exports) is attributed to the surge in demand for medical products during the pandemic. This sector's contribution to the overall trade impact is calculated as 12%.

The breakdown assumes that sectors with increased demand (e.g., Pharmaceuticals, Consumer Goods) saw corresponding increases in trade volumes, while sectors severely affected by the pandemic (e.g., Tourism & Hospitality) experienced declines. The estimates also account for global supply chain disruptions, shifts in consumer behavior, and government interventions during the pandemic, which influenced sector-specific trade dynamics. After estimating the contributions of each sector, the percentages are adjusted to ensure that they sum to 100%, correcting for any rounding errors or discrepancies in the data.

This breakdown allows us to see which sectors were most affected by the pandemic. For instance, sectors such as manufacturing and technology shows resilience or even expansion, whereas tourism and hospitality experienced significant downturns.



Figure 1: trade volumes for three sectors from 2017 to 2023, where ID 1 represents Agriculture, ID 2 represents Consumer Goods, and ID 3 represents Financial Services.

Additionally, Figure 1 has been created to display the trade volumes for three sectors from 2017 to 2023. The similarity among these sectors is that their export trade volumes were low in the pandemic year 2020. Specifically, Agriculture showed its lowest volume in 2020, while Consumer Goods and Financial Services showed their lowest volumes in 2022. However, the sectors differ in their levels of sensitivity to the pandemic. Consumer Goods showed more dynamic changes compared to Sector 3.

Conclusion

This thesis has explored the profound impact of the COVID-19 pandemic on trade dynamics between European countries and China, focusing on overall trade volumes and specific sectors such as machinery and medical supplies. Through a meticulous approach combining quantitative regression analysis with a literature review of policy documents and sector-specific analyses, this study has generated several significant findings and insights.

The regression analysis provides strong evidence of the COVID-19 pandemic's widespread impact on trade behaviour between European countries and China. Once again, the regression models concluded that the number of imports and exports from European countries to China increased significantly, and not just after the pandemic. The increase in trade volumes indicates the region's trade lanes' resilience and adaptability in the face of international instability caused by the pandemic.

Detailed sectoral studies revealed that the results were sector-specific. The machinery industry has seen an increase in automation and digital technologies as a result of the global trend toward resilience and efficiency in manufacturing. On the other hand, the medical sector saw a surge in demand for life-saving healthcare supplies such as PPE and medical devices, indicating a global health emergency and supply chain restrictions that necessitated strategic fortification.

GDP growth, government budget balances, and total employment were used as control variables to help put the pandemic's influence on trade into context. The fact that the linked control variables were significant in different models suggests that, while macroeconomic factors influence commerce, their effects are clearly conditional and can shift after the epidemic. For example, in post-pandemic models, such modelling may place less emphasis on government deficits because the pandemic has a greater influence on trade dynamics.

The outbreak has had immediate short-term effects on trade, including disruptions in supply chains and dramatic changes in demand. Over time, however, long-term effects begin to emerge, involving a reassessment of supply chains and adjustment of trade patterns. In the short term, the trade volume has experienced sharp fluctuations, especially in the machinery and medical supplies industries. In the long term, the pandemic has accelerated the digital transformation, facilitating investment in automation and remote work technologies, which could permanently alter trade processes.

Governments and international organisations meanwhile took a broad range of policy measures to try to prevent trade disruption and aid economic recovery. These responses ranged from various Government fiscal stimulus packages, changes in regulations, and global cooperation to ensure that goods and services could continue to flow even when commodity supply-chains were disrupted. Machinery and medical supplies companies in particular readjusted their business strategies by implementing digital transformations, diversifying production locations, and increasing production capacity. In doing so, these strategic responses not only addressed the immediate shock, but also built the foundation for their industries to bounce back.

Discussion

These findings offered substantial support for Ricardo's theory of comparative advantage, which explains trade patterns during a crisis. Countries that specialized in sectors where they had a comparative advantage—Europe in high-tech manufacturing, China in low-cost medical supplies—were able to act as pivots, keeping global trade moving.

This includes emphasizing the long-term consequences of COVID-19-induced adjustments in global supply chain trade patterns that are projected in the future, as well as sustainability problems, implications for digital transformation, and a possible configuration of geopolitical standpoints/wars to come. Cross-sectional studies conducted across many locations and industries will assist determine how universal and context-specific responses to global health problems are.

Limitations

This thesis has valuable insights, although several areas are constrained. Because the study is based on publicly available trade data, such as that from Eurostat and the Chinese Ministry of Commerce, its conclusions are only as accurate, comprehensive, and up to date as those data sets. Trade figures have been vigorously revised, and initial amounts may alter significantly. This corpus of work could be improved by including both real-time data sources and bigger amounts of data to represent the dynamic nature of trade flow fluctuations.

Moreover, the findings are mostly applicable to the EU and China, and they may not represent intricacies in the trading relationships of other parts or countries with the rest of the globe. The regional scope of pandemic reactions and economic structures limits the generalizability of conclusions drawn from this study.

The study will focus on the pharmaceutical and consumer electronics sectors. As a result, omitting the other industries, training trade patterns between European countries and China. You could possibly have investigated several sectors and discovered intriguing trade impact patterns or characteristics.

Furthermore, while the study included a number of economic variables as controls, it failed to account for other potentially significant aspects such as political stability, foreign relations, and sectoral policies. These elements have the potential to improve our understanding of trade dynamics.

The study is also limited to the early stages of the pandemic and the period immediately following. The latter, for various trends and strategy adaption results, are not the focus of this thesis in terms of long-run implications.

In conclusion, this thesis illuminates how the COVID-19 pandemic reshaped trade relations between European countries and China, revealing both challenges and opportunities across different sectors. By integrating quantitative analyses with qualitative insights, the study provides a nuanced understanding of adaptive strategies and policy responses that underpin resilient global trade systems. Moving forward, leveraging these insights will be crucial for fostering sustainable economic recovery and enhancing international cooperation amidst ongoing global uncertainties.

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