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The Future of Arctic Shipping: Evaluating the Potential of Artic Shipping as an Alternative to Traditional Global Shipping Routes

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Table of Contents

List of Abbreviations:

EU – European Union

USA – United States of America

NWP – Northwestern Passage

NSR – Northern Sea Route

TSR – Transpolar Sea Route

SAR – Safety and Rescue

UNCLOS - United Nations Convention on the Law of the Sea

EEZ - Exclusive Economic Zone

IMO - International Maritime Organization

SOLAS - International Convention for the Safety of life at Sea 1974

MARPOL - International Convention for the Prevention of Pollution from Ships 1973/1978

UNCTAD - UN Trade and Development organisation

HS - Harmonized System

CES - Constant Elasticity of Substitution

OMR – Outward Multilateral Resistance

IMR – Inward Multilateral Resistance

PPML - Pseudo Poisson Maximum Likelihood estimator

DiD – Difference in Difference Analysis

ATT - Average effect of Treatment on the Treated

1 Introduction

1.1 Problem Statement

In the past 100 years, the use of non-renewable energy sources has led to a significant increase in the global temperature by about 1 degree Celsius (Dahlman, 2024). Whilst this seems like a small change, this slight increase of global temperature has had a catastrophic impact on the environment, driving seasonal temperature extremes, changing the habitat ranges for plants and animals, intensifying heavy rainfall, and reducing snow and ice covers. In fact, the northern hemisphere, especially the Arctic, is experiencing the largest temperature increases where the loss of reflective surfaces such as ice and snow amplify the rate of warming (Dahlman, 2024). This cycle of warming leads to a significant reduction of ice caps which further leads to increasing water levels and reduced habitats for the Arctic ecosystem. The earth changing at such as rapid pace has a plethora of effects on different industries, especially the global trade industry.

For every person alive today, the global shipping industry transports 1.5 tons of goods every year, with a total number of 11 billion tons (International Chamber of Shipping, 2019). Much of this trade is dominated by the transportation of raw materials, tankers trade, containerized cargo as well as other dry cargos (UNCTAD, 2021). In addition to this, trade between the European and Asian continents is consistently growing, as shown by the trade relationship between the European Union (EU) and China, being the largest trade relationship for both countries. The open relationship between East Asia and Europe also shows signs of growth in the coming decades, making shipping between the two locations as important as ever (European Commission, 2022). However, this relationship is only as strong as the shipping lanes that connect them. This increase in trade, not only between Europe and Asia, but on a global scale, applies pressures to global shipping chokepoints such as the Suez Canal, the Panama Canal and the Strait of Malacca. Whilst these are only small portions of a ships journey, they are the most important areas as they can lead to high levels of congestion, as well as dangers in the form of blockages or collisions (Lasserre & Pelletier, 2011). To ensure that these global trade chokepoints are never over pressured, new alternatives are being explored to ensure the continuation of global trade, and globalization (Humpert & Raspotnik, 2012).

Whilst the polar ice caps are now disappearing and global trade is continuously growing, new alternative shipping routes are opened in the form of the Northwest Passage (NWP), the Northern Sea Route (NSR) and the Transpolar Sea Route (TSR). These Arctic passages are shipping routes which open due to the melting of glacial ice caps, saving shipping companies time and fuel costs. Whilst these opportunities can help solve issues of congestions as well as supply chain management, there are significant geopolitical obstacles that need to be overcome first (Laulajainen, 2009). Due to the lucrative efficiency benefits that these Arctic passages provide, countries such as the United States of America (USA), Canada, Denmark, and Russia are in a constant debate over who has governance of these passages, blurring the future of these Arctic passages (Bennett et al., 2020). The geo-political discussion that these Arctic passages incur are based on maritime law, which is the global standard for governance of global shipping routes. Combining the aspects of efficiency gains through the NWP, NSR, and TSR Arctic passages, with the geo-political discussions between some of the world's largest economies, the following questions is raised:

"To what extent will Arctic shipping (NWP, NSR, and TSR) develop as an alternative to traditional global shipping trade in the next 100 years?"

1.2 Sub-Questions

To answer the research question above, this thesis will subsequently answer significant sub-questions which will help structure the report and fully answer the research question. It is important to note that when referencing Arctic shipping routes, this thesis will concentrate on the 3 major shipping routes, the NWP, NSR and TSR. The sub questions consist of the following 5 questions:

1. What are the characteristics, operational challenges and opportunities associated with the usage of the Arctic shipping routes such as the NWP, NSR, and TSR?
2. How do geopolitical interests and tensions among Arctic and non-Arctic nations influence the development and accessibility of the NWP, NSR, and TSR?
3. What are the legal challenges and implications for maritime law as it pertains to the use of the Arctic Shipping Routes, particularly concerning sovereignty, environmental regulations, and rights of passage?
4. How will the introduction of the NWP, NSR, and TSR affect the spatial economy of the global trade industry, specifically in terms of changes in shipping distances, costs, and time?
5. What is the effect of Arctic shipping lanes on the trade volumes of countries that utilize Arctic shipping, in comparison to the countries who do not utilize Arctic shipping?

The first sub-question examines the current operational status of the Arctic passages, considering their specific characteristics as well as the possible opportunities that they offer. This will provide a deeper understanding of what the Arctic passages are, what they provide for society and who the stakeholders involved are. This sub question will be covered in the literature study in chapter 2.1 and 2.2.

Next it is important to evaluate the past, current and future geopolitical impacts that the Arctic passages will have on surrounding stakeholders. Due to the nature of their location, the NWP, NSR and TSR passages have multiple countries who lay claim on the rights to govern and control certain areas of the route. The impacts of these geopolitical tensions and interests will be discussed in chapter 2.3.

Furthermore, the governance of Arctic passages, especially the parts that do not fall under the law of a specific nation, is determined through maritime law. Whilst maritime law is constantly evolving, it is important to consider the perspective of international standards to evaluate the importance and future development of Arctic passages. The implications of maritime law on the Arctic shipping routes will be discussed in chapter 2.4.

Additionally, to analyse the effect of the Arctic passages on the global spatial economy, an optimization simulation will be run on global shipping lanes, to find out what the effect of Arctic shipping is on global trade. Changes to worldwide shipping distances, time and costs will be analysed and visualized in Chapters 3.2.1 and 4.1.

Finally, to fully round off the quantitative analysis of this study and analyse the true effects of Arctic shipping, econometric and statistical tests will be utilized in chapter 3.2.2 and 4.2. This will aim to support the theory-based results from chapter 4.1, whilst anchoring the analysis in empirical validity.

1.3 Relevance

1.3.1 Social Relevance

The development of Arctic Passages holds profound implications for social dynamics worldwide, influencing not merely the logistics of global trade but also the socioeconomic landscapes of stakeholder nations. The emergence of these routes as alternatives to traditional transcontinental passages like the Suez Canal or the Panama Canal redefines global shipping patterns, potentially alleviating congestion and reducing waiting times on existing routes (Lasserre & Pelletier, 2011). This efficiency gain is a benefit to global supply chains, yet it simultaneously intensifies social and political tensions among major world nations who stand to gain—or lose—significantly from these new maritime paths (Østerud & Hønneland, 2014). This thesis explores these social dimensions, emphasizing how the Arctic routes influence international relationships, disrupt local communities, and necessitate new, inclusive policy frameworks to manage the ecological, economic, and geopolitical stakes at play. As nations navigate these complex legal and strategic challenges, this research emphasises the need for cooperative governance structures that address not only the economic benefits but also the social equity and environmental sustainability of Arctic development. By examining these factors, this thesis aims to highlight the broader social relevance of the Arctic passages, advocating for policies that mitigate harm and foster international cooperation in the face of shifting global dynamics.

1.3.2 Scientific Relevance

As global warming progresses due to long-standing fossil fuel use, the emergence of new Arctic shipping routes presents a critical opportunity for a multidisciplinary research investigation. This thesis explores the development of the Arctic from a scientific perspective, integrating shipping economics, geopolitical disputes, and maritime law. This approach allows for a comprehensive understanding of how the Arctic's changing climate, driven by fossil fuel impacts, can be studied in tandem with the socio-economic and legal challenges posed by the opening of these new maritime pathways (Screen, 2010). Further, the technological advancements necessitated by Arctic development, such as improved predictive models for global trade and statistical testing of the effect of artic shipping on trade (Eguíluz, 2016), are thoroughly analysed to understand their potential and limitations within this complex framework. On the other hand, this scientific exploration also critically assesses the environmental risks associated with Arctic sea routes, including the potential destruction of environments and ecosystems, which are significant concerns given an increase in maritime traffic (Arrigo, 2015). By investigating these interlinked aspects, this thesis aims to provide new insights into how the Arctic region can be utilized and protected considering these emerging economic opportunities, offering a scientifically grounded blueprint for sustainable Arctic development. The combination of a qualitative approach (Chapter 2) as well as a quantitative approach (Chapter 4) will ensure that the results obtained from this research are valid and backed up through reliable sources and economic models. Furthermore, this research methodology allows for strong visual representation of the obtained data, assisting the thesis in representing the true impact of the Arctic sea routes.

2 Literature Study

2.1 Overview of Arctic Shipping Routes

The unique location and development of the Arctic Ocean presents multiple interesting characteristics, challenges, and opportunities which play important roles for the global shipping industry. The Arctic relates to the general regions surrounding the north pole, including the smallest and shallowest of the worlds five oceans, the Arctic Ocean (Ostenso, 2024). Additionally, the Arctic Ocean is surrounded by multiple economically developed nations such as Russia, Canada, USA, Greenland (Denmark), and Norway. In the late winter, the Arctic sea ice covers on average 15.5 million square kilometres of the Arctic Ocean, providing habitat to a full ecosystem of animals (National snow and Ice Data Center, 2020). However, due to climate change, and the subsequent warming of the earth, the Arctic ice caps are in danger of melting and decreasing to only a portion of what they were 50 years ago (Masters, 2012). This enormous change in Sea ice is illustrated in Figure 1 below.

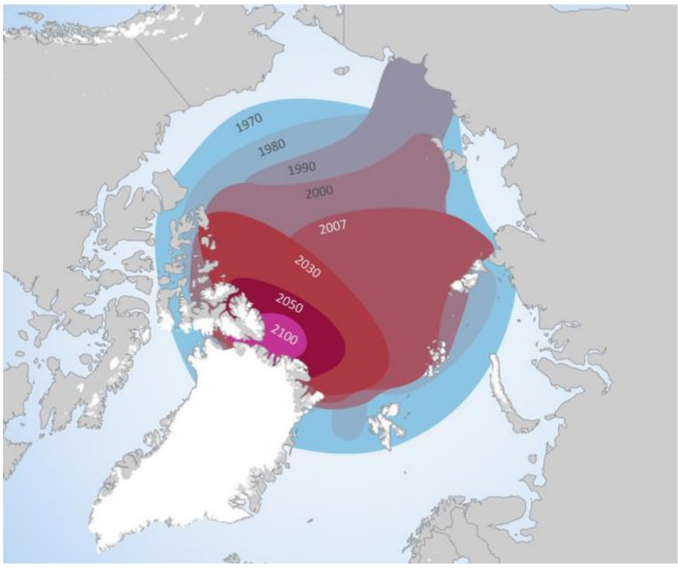

Figure 1. The Minimum extent Arctic Sea Ice Observations 1970-2007, and forecasts for 2030-2100 (Humpert & Raspotnik, 2012).

As can be seen in Figure 1, in the span of 130 years the majority of the Arctics Sea ice will have disappeared into the world's oceans. Whilst it is expected to see the Arctic ice caps change in size over several years, the long-term effects of global warming are clearly presenting themselves. This is because "multi-year ice", the oldest and thickest ice in the Arctic, is disappearing at a faster pace than the newer, thinner ice at the edges of the Arctic. This, in combination with a general rise in temperatures, results in a shorter ice-forming season, and therefore less Arctic sea ice (Comiso, 2012). However, the disappearance of Arctic sea ice leads to new opportunities in the Arctic in the form of hidden shipping routes, which were previously not possible or too dangerous to navigate. These include the North-West Passage, the Northern Sea Route, and the Transpolar Sea Route.

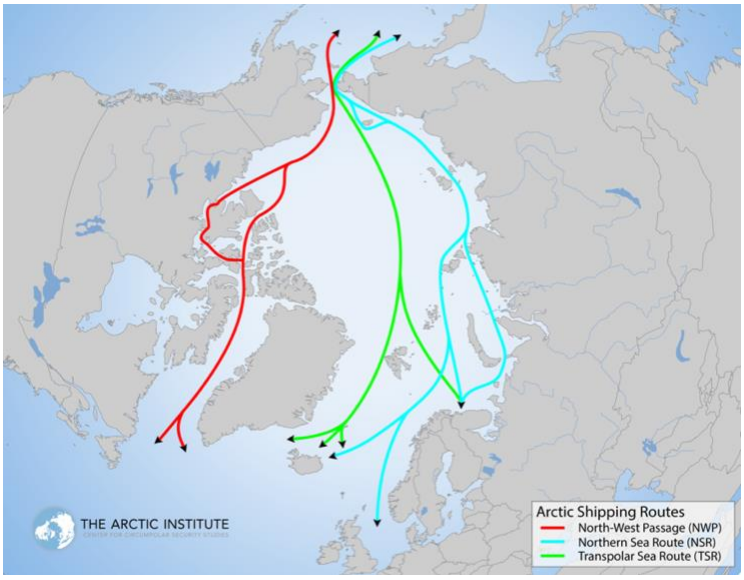

Figure 2. Map of Arctic Shipping Routes, North-West Passage, Northern Sea Route, and Transpolar Sea Route (Humpert, 2011).

2.1.1 North-West Passage

The NWP is a series of waterways that traverse the Arctic archipelagos of Canada, connecting the Atlantic and Pacific oceans. Historically sought by explorers as a direct route to Asia, the passage has long been hindered by dense ice. However, with the ongoing effects of climate change, the NWP has seen reduced ice coverage, making it more navigable during the summer months. This development could shorten maritime routes significantly, potentially altering global shipping patterns and reducing transit times between Atlantic and Pacific countries (Mahmoud et al., 2024).

2.1.2 Transpolar Sea Route

The TSR, in contrast, is a shipping lane that would theoretically run directly across the centre of the Arctic Ocean, passing close to the North Pole. This route is still largely theoretical, as it depends on future reductions in Arctic sea ice to become viable. The TSR would connect the Atlantic Ocean with the Pacific through waters north of both the Asian and North American continents. Like the NWP, the TSR could offer a shorter alternative to traditional routes such as the Suez and Panama Canals, promising significant changes in global shipping logistics if it becomes fully operational (Stephenson et al., 2020).

2.1.3 North Sea Route

The NSR is a shipping lane that runs along Russia's Arctic coast from the Kara Sea, along Siberia, to the Bering Strait. Like the NWP, the NSR has been historically difficult to navigate due to extensive ice coverage. Yet, with the progressive impacts of climate change, the ice along this route is diminishing, leading to increased navigability during extended periods of the year. This accessibility potentially transforms global shipping dynamics by providing a more direct route between Atlantic and Pacific ports. The large reduction in ice not only shortens transit distances but also cuts down shipping times and associated costs considerably. This shift could realign major global shipping routes, enhancing economic efficiency but also raising significant geopolitical and environmental considerations, especially in terms of Russian territorial waters and the delicate Arctic ecosystem (Makarov et al., 2022).

2.2 Operational Challenges and Opportunities of Arctic Shipping

2.2.1 Operational Challenges of Arctic Shipping

Whilst the reduction of Sea Ice does provide the possibility of new Arctic Passages, such as those mentioned above, these new opportunities carry significant challenges and dangers with them.

Firstly, the Arctic sea ice has not completely disappeared yet, and new ice will consistently keep on forming, leading to smaller icebergs and icefields appearing, proving a significant danger for ships that have not been designed to handle icy conditions. Additionally, ships that are exposed to Arctic conditions must endure severe weather conditions such as icing from sea spray, wind chill, and polar lows (Det Norske Veritas, 2010). These weather conditions lead to an increased demand for ship maintenance, as well as rougher sea conditions for navigation and the ship-crew. For many shipping vessels, the default measure is to hire ice breaker class vessels which are designed to break a path open for smaller vessels that do not have the necessary modifications to do so. This however carries hiring costs, highlighted in Figure 3 and Table 1 (Cariou et al., 2021).

Figure 3. Current Ice Breaker Zones of the NSR (Cariou et al., 2021)

Table 1. NSR fees [in US Dollars (USD)] as a function of the number of zones with icebreaker assistance (adapted from Cariou et al., 2021)

Class	Season	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
1A	**Summer/ Fall [USD]**	191,127	229,345	267,572	305,799	344,026	382,245	382,245
	Winter/Spring [USD]	477,812	573,371	668,930	764,498	860,057	955,625	955,625

Another possibility for shipping firms is to build ice class ships whose main purpose is navigating areas of the world where the cold climate would usually present an issue for regular ships. However, the building costs of ice class vessels, designed to navigate icy seas, are often 10-20% higher than the building costs of regular shipping vessels (Furuichi & Otsuka, 2012). In addition to higher building costs, ice class ships are heavier and less fuel efficient than normal shipping vessels. This is due to their additional cold climate equipment and reinforced hulls, which puts a larger strain on fuel efficiency and maintenance costs. A study conducted by Solakivi et al. in 2019 revealed that the operation of Ice class ships in open waters increases operational costs by approximately 9% compared to other vessels under review.

Finally, the remoteness of the Arctic and the subsequent implications for Safety and Rescue (SAR), in combination with limited reliability for weather forecasting as well as the lack of port infrastructure, make the Arctic a very dangerous region for humans to work (Det Norske Veritas, 2010). Currently, there is a significant lack of suitable port infrastructure in place to ensure that vessels carrying cargo can make a safe return to harbour in cases of necessary repairs. In addition to this, due to the low number of vessels currently in circulation around the Arctic Ocean, SAR stations are missing throughout vital points of Arctic shipping routes (Buixadé et al., 2014). However, developments in the usage of the NSR in the past 20 years has shown significant improvements to this issue. The Russian government is currently identifying and developing the necessary infrastructure to ensure that safe passage through the NSR is possible, as seen in Figure 4.

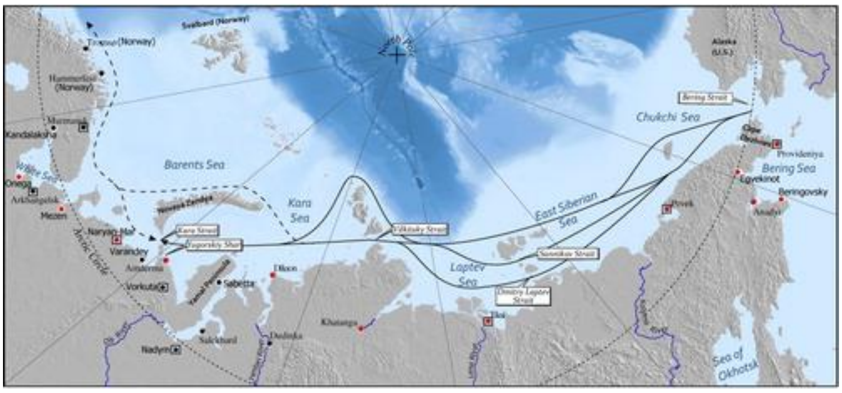

Figure 4. Map of the Russian and Norwegian Arctic coasts, showing the NSR (solid line) and its extension to the Northeastern Sea Route (dotted line). Settlements in red have been identified by the Russian Government as having port facilities in a state of disrepair. Planned SAR stations are also identified with a square (Buixadé et al., 2014).

The development of Russian SAR stations, as well as possible future developments of SAR stations on the NWP, will also create the possibility for SAR support along the TSR route.

Whilst Arctic shipping still faces a lot of challenges, which could deter the usage of the Arctic shipping lanes, all these challenges can be overcome through time, investment and technological development, which will ensure a safer Arctic for all.

2.2.2 Opportunities for Arctic Shipping

Whilst the Arctic presents many challenging weather conditions, as well as dangerous working conditions for ship crew, the opening of new Arctic passages provides strong economic benefits in terms of reduced shipping distances, times, and costs. With the continued warming of Arctic temperatures, the ice-free period throughout the Arctics main shipping lanes is expected to grow from 30 days in 2010, to 120 days by 2050 (Borgerson, 2009). This increase is ice-free period means that more ships can now travel through Arctic shipping lanes, creating multiple benefits.

The first benefit is the reduction of travel time and distance for ships, increasing supply chain efficiency, and extending shelf life for perishable goods, leading to a reduction of food waste. This is well represented between Rotterdam and multiple major Asian ports in Table 2:

Table 2. Sailing distances between Asian Ports and Rotterdam via the Suez Canal and TSR (Humpert & Raspotnik, 2012)

Port of Origin	**Port of Destination**	**Distance in nautical miles**		**Days at see at 17 knots**		**Distance savings in %**
		via Suez Canal	via TSR	via Suez Canal	via TSR	
Tokyo	**Rotterdam**	11,192	6,600	27.4	16.1	-41
Shanghai	**Rotterdam**	10,525	7,200	25.8	17.6	-32
Hong-Kong	**Rotterdam**	9,748	8,000	23.9	19.6	-18
Singapore	**Rotterdam**	8,288	9,300	20.3	22.7	12

Additionally, the decreased distance allows firms to adopt a super-slow sailing strategy. Super slow sailing involves a ship decreasing its average speed significantly during shipping, resulting in a possible 100% increase in energy efficiency. For example, a ship travelling from Rotterdam to Tokyo, can reduce its speed by 40% going over the Arctic in compared to using the Suez Canal, and still arrive at the same time (Schøyen & Bråthen, 2011). This results in a significant reduction of greenhouse gases, as well as fuel costs for shipping companies. The adoption of super-slow sailing has saved shipping giant Maersk more than $100 Million US Dollars (USD) since it adapted its ships to super-slow sailing in 2007 (Vidal, 2010).

The availability of Arctic shipping routes will also reduce the amount of congestive pressure on vital choke points in supply chains, such as the Suez Canal (17228 vessels per year), the Panama Canal (14323 vessels per year), and the Strait of Malacca (60000 vessels per year) (PricewaterhouseCoopers, 2011). Due to the high quantity of vessels passing through these bottlenecks, blockages and accidental collisions can stall world trade for weeks, creating massive, unexpected costs and time delays. One example of this was realized in March of 2021, when the container ship the “Ever Given”, ran aground in the Suez Canal. The Ever Given ran aground in a vital one-way navigational section of the Suez Canal, blocking around 430 ships from passing through the Suez Canal, and redirecting hundreds more around the southern tip of Africa. For an entire week, the blockage stopped around 3% of global trade, whilst every additional day of the blockage cost global trade around $9 billion USD (Notteboom et al., 2024).

Whilst these kinds of blockages are not a regular occurrence, the dangers of blockages as well as the negative effects of congestion are clear. The Arctic sea routes provide a cost-effective alternative which does not suffer from the same congestive pressure, whilst simultaneously avoiding the risk of blockages and accidental collisions.

2.3 Geopolitical Stakes in the Arctic region

Chapter 2.3 will discuss the geopolitical tensions and interests that are and have been in political discourse surrounding the Arctic, whilst chapter 2.4 will go into further detail discussing the governance of the Arctic.

2.3.1 Direct Stakeholder Nations

The Arctic circle has had some significant variability of political tensions in the past 50 years. The Cold war saw heavy Arctic militarization between the USA and Russia, including the construction of new military ports and the deployment of naval warships throughout the Arctic circle. The post-cold war period of the early 1990's, after the collapse of the Soviet Union, saw clear improvements in geopolitics around the Arctic. Nations shared a universal focus on research into climate change, Arctic research cooperation and economic interests. This cooperation was further institutionalized through the Arctic council, the Conference of Parliamentarians of the Arctic region, the Northern Forum, and other associations. The cooperative focus on science throughout the Arctic has led to new political interests and friction for Arctic nations, such as natural resource mining, questions of jurisdiction and prospects of new shipping routes (Østerud & Hønneland, 2014).

An increase of scientific presence in the Arctic, combined with the effects of Climate change, makes the mining for natural resources such as oil and natural gas in the Arctic a beneficial economic interest. The value of these natural resources, hidden below polar ice, are invaluable for many nations, hence political discourse on the topic is constantly occurring (Petrov et al., 2018). Whilst the borders of who has access to which resources in the Arctic is blurred, the main developmental factors become clear. The demand of the sea routes that navigate the Arctic are a derived demand from the demand of mining operations in the Arctic (Kaiser et al., 2023). If mining operations in the Arctic become a viable and economically profitable option, nations will not hesitate to start operating in the Arctic, which subsequently creates demand for navigable sea routes such as the NWP, NSR and TSR. The increased demand into these sea routes will aid in the development of the technological and social requirements to make Arctic shipping a viable and reliable shipping alternative (Ocean Conservancy, 2017).

The development of human presence in the Arctic comes together with political tensions between nations. The Arctic contains an estimated 22% of the worlds undiscovered natural resources, much of which is located underneath disputed international waters (Brutschin & Schubert, 2016). The current effects of climate change are raising demand for human presence in the Arctic, mostly due to new trade routes and resource mining. With this increase of economic interest, the demand for militarisation also grows. In his paper on Russian militarization in the Arctic, Åtland (2011) recognized that the growing economic significance of the Arctic, in addition with jurisdictional issues, may lead to an increase of military activity in the Arctic. However, Åtland also concludes that this is not necessarily a security priority for Russia now as they have more pressing military matters. This is further supported by the Russia-Ukraine conflict currently occurring, depleting many of Russia's resources (Favaro & Williams, 2023). On the other hand, other Authors such as Tayloe (2015), fear that Russia's military power, as well as its focus to "demonstrate that Russia retains its great power status and still has world-class military capabilities" sets the Arctic as a high stakes power play between the liberal, western order and a revisionist Russia.

Whilst the political interests and tensions in the Arctic have negative externalities, such as the effects on the Arctic ecosystem due to increased ship traffic, as well as social effects due to increased militarisation, they all lead to the further development of Arctic shipping routes and Arctic shipping technology.

2.3.2 In-Direct Stakeholder Nations

Whilst most of the world's nations are not directly involved in the development of the Arctic, mostly due to geographical location, there are many who have economic and political interests in the Arctic.

China is the world largest exporter of goods with $3714.25 Billion USD of goods exported in 2022 (Matthes, 2024). This makes them a large player in global trade. However, China's geographic location means that the nation relies on waterways such as the Panama Canal, Suez Canal, and the Strait of Malacca for global shipping routes, creating a strategic vulnerability. The development of Arctic shipping routes provides a new alternative for China to diversify its portfolio of trade routes (Humpert & Raspotnik, 2012). The Chinese and Russian governments have both shown clear intention of working together to ensure strong development in the Arctic, providing China with quicker and more secure shipping lanes (Brutschin & Schubert, 2016). Additionally, China's diversification of trade routes also allows it to address the "Malacca Strait Dilemma" which former President Hu described as a strategic vulnerability due to the lack of control for China. The involvement of China in the Arctic also raises significant interest for the EU, as Arctic shipping routes allows for up to 40% reduction in travel distance between Europe and East-Asia, strengthening the trade relationship between both European economies and East-Asian economies (Humpert & Raspotnik, 2012). Finally, the global trend of "geography of places" is seeing economic centres in both Europe and Asia moving slightly northwards, further increasing the possible advantage of Arctic shipping (Verny & Grigentin, 2009).

On the other hand, the development of Arctic shipping routes also has political effects for one of the world's most important shipping lanes, the Suez Canal. The ongoing conflicts in the Middle East, further highlighted by the Israel-Palestine conflict, observes cargo ships being targeted on their way to/from the Suez Canal. This, in addition to issues concerning piracy off the coast of Somalia, are strong factors pushing governments to find alternative shipping routes that do not pass by conflict zones. In addition to war and piracy, the Suez Canal and its neighbouring countries are also affected by significant policies provided by the USA, Russia, China, and other countries (Zhang et al., 2024).

Furthermore, Arctic shipping routes offer a much quicker travel time as well as shorter travel distance, decreasing the demand for vital chokepoints such as the Panama Canal, the Strait of Malacca, and the Suez Canal. If less ships travel through these passages, the countries who control them are left with less control over global trade, as well as less customers who fund the revenue of these chokepoints (Humpert & Raspotnik, 2012).

Whilst most of the world is not a direct stakeholder in the Arctic, the development of Arctic shipping lanes will still significantly affect global trade. On the one hand, clear opportunities arise between China and Europe, further strengthening trade relationships and assuring the development of Arctic shipping routes, whilst being based in a vital relationship focused on importing and exporting goods.

2.4 Maritime Law and Governance in the Arctic

2.4.1 Sovereignty of the Arctic

Sovereignty is the ability for one country to exercise absolute authority (exclusive jurisdiction over territory in legal, administrative, and judicial matters) on an area which is considered theirs. The issue of Sovereignty in the Arctic has been a pressing issue ever since it was first explored, with the 5-Arctic nations, USA, Canada, Russia, Greenland (Denmark) and Norway all possessing a section of the Arctic region (Hossain, 2023). The leading convention concerning maritime boundaries is the United Nations Convention on the Law of the Sea (UNCLOS), which is the longest treaty in the history of the United Nations and contains parties of all Arctic nations except the USA. According to international law stated in article 57 of the UNCLOS, each coastal country has an EEZ (Exclusive Economic Zone), which extends 200 nautical miles from their coastlines, and gives them jurisdiction of any natural resources contained there (UNCLOS, 1982). In addition to this, according to article 76 of the UNCLOS convention, every Arctic country has a claimed or potential extended continental shelf which gives them limited control of the activities that occur 350 nautical miles from the country's baselines (UNCLOS, 1982). The current state of the Sovereignty of the Arctic is represented in Figure 5 below:

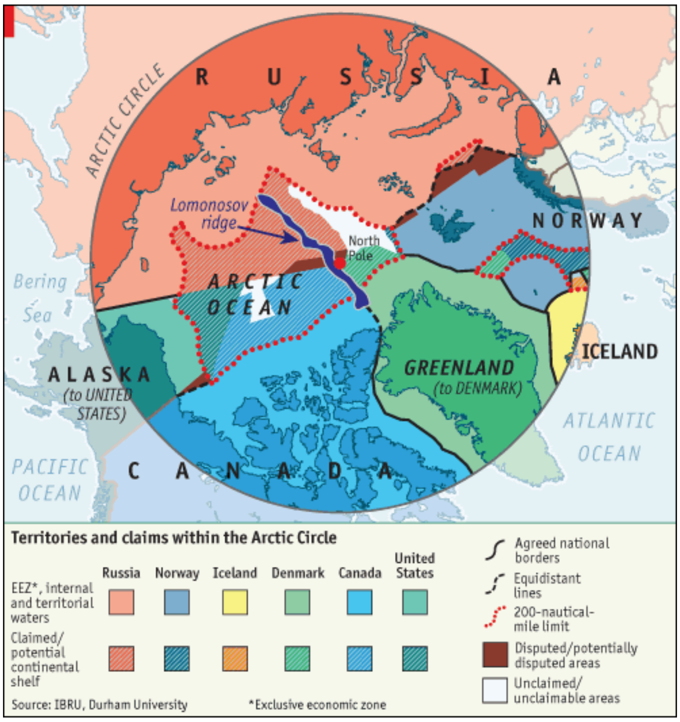

Figure 5. Map of the territories and claims within the Arctic Circle (McIntosh, 2016)

Currently, Russia holds most of the sovereignty over the NSR as article 57 of the UNCLOS council, puts the NSR inside of Russia’s EEZ (UNCLOS,1982). The sovereignty of parts of the NSR, specifically regarding the entry and exit points, are still being discussed with countries such as the USA, Norway and Iceland (Østerud & Hønneland, 2014).

On the other hand, the sovereignty of the NWP has been in discussion for years. In Canada’s perspective the NWP lies within its sovereign waters, meaning that they should have legal and political governance over their section of the NWP. Canada believes this to be important as they are concerned about the possibility of environmental disasters affecting their eco-systems, as well as illegal immigration into Canadian borders by terrorists. Other perspectives, such as that of the USA and the EU, maintain that the NWP should remain international waters to ensure that there is a non suspendable right of transit for all ships throughout the NWP. Due to both sides of the discussion having valid points, the sovereignty of the NWP has not yet been concluded, although Canada and Russia have both recognized each other’s claims on their portions of the Arctic shipping lanes (Gricius, 2021).

Whilst the NSR and NWP lie inside of the partial jurisdiction of certain Arctic countries, the TSR does not. This means that the legal framework governing the TSR is a lot vaguer than that of other shipping routes. Due to this, Shipping companies will focus on the possibilities of utilizing the TSR as a shipping route over other routes, which avoids problems stemming from national jurisdictions (Humpert & Raspotnik, 2012). Humpert and Raspotnik (2012) theorize in their paper on the future of Arctic shipping that the TSR will be regulated in accordance with the two main

International Maritime Organization (IMO) treaties, the International Convention for the Safety of life at Sea (SOLAS) 1974 and the International Convention for the Prevention of Pollution from Ships (MARPOL) 1973/1978. In addition to this the IMO has also developed a mandatory Polar code to guide ships that operate in Arctic waters. The Polar code, implemented in 2014, states valuable guidelines for ships operating in the water of the poles, specifying conditions of ship design, construction and equipment; operational and training concerns; search and rescue and the protection of the unique environment and ecosystems of the polar regions. Additionally, in accordance with the Polar code, any ship that intends to operate in polar regions must apply for a Polar Ship Certificate, categorizing the ship into 3 classes, and ensuring that safety and environmental measures are upheld (IMO, 2014).

2.4.2 Environmental Regulations

The increased accessibility of the Arctic, and therefore the increased presence of ships means that meaningful environmental regulations and policies need to be implemented, to ensure that the fragile ecosystem of the Arctic is preserved. Whilst the IMO has defined the Polar Code as the leading guidelines for protecting the environment of polar-climates, Arctic nations such as Canada and Norway have taken it upon themselves to construct their own environmental policies and regulations to ensure the preservation of the Arctic ecosystems.

The efforts of stakeholder nations focus on greenhouse gas emissions, climate pollutants (methane, black carbon, etc.), research, adaptation and mitigation, and international cooperation (Uryupova, 2024). However, due to varying political frameworks and viewpoints, different stakeholder nations have different priorities when it comes to environmental regulations. For example, Canada, has more than 100,000 indigenous people in their Arctic alone, with 300,000 more living in the surrounding Arctic regions, and wants to make sure that their communities are protected (Canada, 2024). Additionally, Norway is one of the global front-runners in Arctic environmental policy, setting its focus on the reduction of greenhouse gases, changes in biodiversity, and pollution. On the other hand, Russia's focus lies more on development and militarization, whilst de-prioritizing the local issues of the Arctic, and ignoring the environmental impact of their Arctic work. Whilst Russia's Arctic development policies can be useful for developing Arctic shipping, the methodology of how to do it is inherently unsustainable and leaves the Arctic ecosystem more vulnerable (Uryupova, 2024).

Due to the nature of their jurisdiction, environmental regulations can limit the development and usage of Arctic shipping routes such as the NSR and NWP, however for many nations this is less likely, as they are focused on different methods of preservation. The TSR on the other hand has a more open jurisdiction and is therefore not necessarily bound by environmental regulations, for now.

2.4.3 Rights of Passage on Arctic Shipping Routes

The right of passage for ships who want to traverse Arctic shipping lanes is determined by those who govern the shipping lanes. For the NSR, the Russian government has full governance over who and what passes through their shipping lanes. Citing Article 234 of the UNCLOS, the Russian government requires all vessels traversing the NSR to obtain advanced permission. Additionally, the Russian (originally USSR's) Ministry of Merchant Marine also rules the requirements for ship structure, experience of the crew in ice navigation, route controls, compulsory escort of ships by icebreakers and criminal penalties (Furuichi & Otsuka, 2012). If a ship is required to use an Icebreaker to traverse the Arctic, it is required to pay an ice breaker fee as shown in Figure 3 and Table 1. Due to the decrease of ice in the Arctic, it is possible to traverse the NSR without an ice breaker in certain months, in this scenario, no ice breaker fee is required.

Whilst the governance of the NSR is mainly in the hands of Russia, the NWP has more political issues that blur the governance of the shipping lane. On the one hand, Canada claims that the NWP shipping route is mainly situated in Canadian waters, over which the Canadian government has full jurisdiction. This perspective supports Canadian governance of the Arctic shipping route, most likely resulting in the requirement for ships to gain permission by the Canadian government, to traverse the NWP (Boylan, 2021). On the other hand, the NWP also passes through waters in the USA's and Greenland's (Denmark's) EEZ's, which promotes the argument that the shipping lane counts as international waters, removing the ability for Canada to govern who passes through the NWP. Currently, the USA's and Canadian Governments are closely working together to ensure that the NWP is researched and developed by both sides. However, the discourse of this topic has not yet been completed, as the NWP is currently not a viable shipping lane. Once climate change ensures that a safe passage is viable through the NWP, all countries involved must come to an arrangement to ensure that a sustainable economic benefit can be derived from this new shipping lane (Boylan, 2021).

Finally, the TSR has the simplest governance of the three shipping lanes, as it is international waters and does not run through any EEZ's. It is important to note that due to the TSR's theoretical nature, this topic has not fully been discussed yet, and new discourse might appear in the future (Furuichi & Otsuka, 2012).

2.5 Overview of the Literature Study

In chapter 2.5 the findings of the literature study will be presented in the form of a table for easy overview and readability.

Table 3. Overview of the Literature Study

Characteristics	**North-West Passage (NWP)**	**Transpolar Sea Route (TSR)**	**North Sea Route (NSR)**
Passes through EEZ of	Canada, USA, Greenland	International Waters	Russia, Norway, Iceland
Sovereignty	Disputed (Canada claims, others see as international waters)	No clear national jurisdiction	Predominantly Russian jurisdiction
Opportunities	Shortens maritime routes between Europe and Pacific countries	Potential shortest route between Atlantic and Pacific	Shortens transit times and costs between Atlantic and Pacific ports
Obstacles	Icebergs, severe weather, need for ice-class ships or icebreaker services	Highly dependent on future ice reduction, severe weather	Icebergs, severe weather, need for ice-class ships or icebreaker services
Governance Issues	Dispute between Canada, USA, and EU on its international status	Governed by international maritime law (IMO treaties)	Governed by Russian maritime regulations and fees
Environmental Challenges	Environmental regulations by Canada, potential ecological impact	Governed by IMO's Polar Code, less stringent due to international waters	Russia prioritizes development over environmental conservation
Development Status	Increasingly navigable in summer, infrastructure under development	Mostly theoretical, future reductions in sea ice needed	Increasingly navigable, infrastructure and SAR stations being developed
Economic Impact	Potential to alter global shipping patterns, reduce transit times	Significant changes in global logistics if operational	Realignment of major shipping routes, economic efficiency gains

3 Research Methodology

3.1 Data Description

The quantitative analysis of this thesis will include two primary data sources. Data acquired using Geographical Information Systems, as well as macro-economic data such as trade value data acquired through the UN Comtrade database.

3.1.1 Geographical Information System Data

To collect the necessary time and distance data between ports/countries on the global shipping network, the geographical information system QGIS was used. The route model built on this software mapped out global shipping routes, as determined by the American Central Intelligence Agency (Benden, 2022), categorized into major, middle and minor sea routes. Each category of sea routes includes the average speed that the UN Trade and Development organisation (UNCTAD) predicts larger cargo carrying vessels travel at, with major, middle and minor routes allowing an average speed of 38.5, 27.5 and 19.5 km/h respectively (UNCTAD, 2022). This means that when the transport times for the shipping lanes are calculated, the major shipping lanes will be less time consuming than the minor shipping lanes. This allows for accurate transport times to be calculated in the case of difficult to navigate shipping lanes in comparison to easy to navigate shipping lanes. In addition to this, the 522 largest coastal or river harbours, according to the World Port Index (National Geospatial-Intelligence Agency, 2016), have been mapped out on a global scale. The fastest connection from each harbour to the closest shipping route, used as the entry cost input, is determined by the QGIS software. In addition to this, the 3 Arctic shipping routes (NWP, TSR, and NSR) are mapped out separately to simulate a past version where none of the Arctic sea routes exists and a future version where all 3 Arctic sea routes are functional. Whilst the NWP was categorized as a middle shipping lane, due to its navigational challenges and smaller size, the TSR and NSR were categorized into Major shipping lanes. The resulting model is represented in Figure 6.

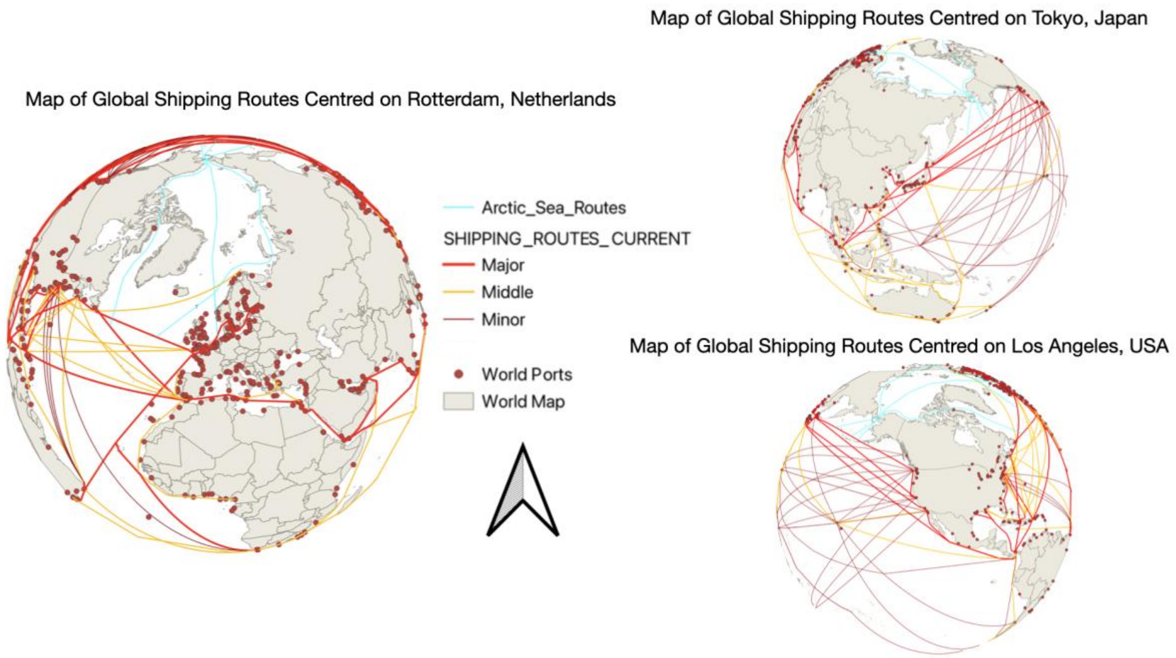

Figure 6. Global Shipping route model with Arctic Shipping Routes (own composition using QGIS)

To obtain the distance and time data between ports, the QNEAT Distance Matrix plugin is run on time optimization, with a topology tolerance of one degree (approx. 111 km) to ensure that each port reaches the nearest Shipping route. The three-Dimensional configuration of this model also ensures that the ellipsoidal effect of the earth's circumference is considered. The resulting network costs will represent the amount of time in seconds it would take a large cargo carrying ship to enter, travel and exit the shipping network from port A to port B. To simplify further analysis, the lowest costing connection between country i and county j is used for every country pairing.

3.1.2 Trade Data

The quality of the quantitative analysis of this thesis is reliant on the quality of the trade data that is obtained, to ensure a valid and accurate evaluation of the Arctic shipping lanes. Although there are multiple databases to choose from online, the most reliable data source that could be found was the "United Nations Comtrade Database". This database collects trade data directly from national statistics offices, covering over 170 reporting countries, according to standardized systems such as the Harmonized System (HS) (UN Comtrade, 2023).

The data collected from the UN Comtrade Database was filtered to account for only water transported exports between nations in the year 2023. By using this filter, the trade data can accurately depict the shipping trade relationship that this thesis aims to analyse. The trade value is measured in USD, as the US Dollar is an economically stable currency, whilst also being the most held reserve currency (Byström, 2014).

3.2 Methodology of the Analysis

The first part of the quantitative analysis involves running a Stata simulation using a structural gravity equation, which aims optimize and find the general equilibrium of trade on the affected countries in the dataset. The resulting model will provide a general idea of the change in the spatial economy resulting from the introduction of Arctic shipping lanes.

3.2.1 Structural Gravity Equation and Spatial Model

The required simulation that will determine the changes in the global spatial economy will be derived from the textbook "An Advanced Guide to trade Policy", by Yotov et al. (2017). This textbook clearly explains how the trade value between two countries is affected by the addition of trade shocks, in this scenario the reduction of trade costs through Arctic shipping. The aim of this model is to find the full endowment spatial equilibrium of all countries who participate in trade through shipping.

The first step in developing the structural gravity equation involves deriving the necessary consumer preferences, which in this scenario, sets the consumer utility. This will create a baseline for our analysis to follow, as rational consumers will always act to maximize their utility. Following the consumer preference, this chapter will develop the structural gravity equation, originating from Isaac Newton's equation for gravitational forces, to include the necessary factors such as transport friction, inward multilateral resistance and outward multilateral resistance (Anderson & van Wincoop, 2003). After defining these crucial factors, which represent the transport costs, pulling and pushing force of trade, the optimization of the model can start which will reveal how trade among countries changes once Arctic shipping is introduced into the global shipping network. As the default gravity equation is based on a fixed amount of flow between two locations, this analysis will "anchor" trade volumes on the cost of trade, where low trade cost is negatively proportional to volume of trade (Yotov et al., 2017).

To achieve this, several assumptions must be made. The first assumption is that goods are differentiated by origin, meaning that each good is not a perfect substitute. Secondly, the model assumes that all consumers have homothetic preferences and that consumers choose which good to buy based on price and quantity, aligning with a constant elasticity of substitution (CES) utility function (Yotov et al., 2017). The CES-utility function for country j is presented below:

$$\left\{\sum_i \alpha_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{1-\sigma}{\sigma}}\right\}^{\frac{1-\sigma}{\sigma}} \quad (1)$$

Here, $\sigma > 1$ represents the elasticity of substitution between different varieties, meaning goods from various countries. The term $\alpha_i > 0$ is the CES preference parameter, which is treated as an exogenous taste parameter. Additionally, c_{ij} denotes the consumption of varieties from country i in country j.

The next assumption, states that all trade between countries is conducted from the pair of ports with the lowest transport cost. Finally, the last assumption is that there is no cost to trade over borders, except for the time cost of transportation.

Following these assumptions, the spatial model can be further constructed using the structural gravity equation presented below:

$$lnX_{ij} = lnE_j + lnY_i - lnY_{World} + (1-\sigma)lnt_{ij} - (1-\sigma)lnP_j - (1-\sigma)ln\Pi_i + \varepsilon_{ij} \qquad (2)$$

In equation (2), the X_{ij} represents the trading volume between countries i and j, E_j represents the expenditure of the importer country, Y_i represents the output of the exporter country, Y_{world} represents the total worldwide output and t_{ij} represents the transport friction between countries i and j. P_j and Π_i represents the inward and outward multilateral resistance term, whilst the ε_{ij} constant represents the error value of trade.

The structural gravity model ensures that prices are anchored through the multilateral resistance terms P_j and Π_i. The idea of the multilateral resistance terms was first introduced by Anderson and van Wincoop (2003) as a form of price indices that incorporate the effects of all trade barriers that a country faces in trading globally, ensuring that prices are consistent with the overall trade environment. The multilateral resistance is divided into two parts, Outward Multilateral Resistance (OMR) and Inward Multilateral Resistance (IMR). OMR captures how difficult it is for exporters to sell their goods to a global market, whilst IMR captures how difficult it is for importers to buy goods from a global market. Empirically, these values are captured through a Pseudo Poisson Maximum Likelihood estimator (PPML), which captures the fixed effects of a regression of trade against the export and import fixed effects as well as the log of current trade costs. An example of this regression can be found in the Stata log in appendix 7.3.

To ensure accuracy in trade value, the spatial model uses the structural gravity model to ensure that the prices of goods are anchored to a specified country, in this scenario Bulgaria, which is least affected by the transport shock. Bulgaria has been chosen as the anchoring country as it has a mean change in transport friction of 0, which shows that Bulgarian exports do not utilize Arctic shipping lanes and is therefore a strong control to represent current trade. This ensures that that the amount of trade that occurs worldwide is not limited to existing trade, however changes with the change in price in different countries, controlling for the introduced transport shock.

Once the starting values for multilateral resistance, as well as prices, are assigned, the optimization of the full endowment equilibrium can be conducted. This simulation is performed by determining trade through a function of the changes in transport cost, prices and multilateral resistance. This simulation iterates through different values until the standard deviation or maximum difference of the change in prices goes below 0.001. This would result in a scenario where prices no longer change significantly, and hence the optimal equilibrium is found. To ensure the analysis of every Arctic shipping lane, the simulation will be run four times, once for every Arctic shipping lane and once for all three shipping lanes combined. This will provide insightful data on the effect of every shipping lane on global trade.

Due to limited export data on the countries trade relationships, provided through the UN Comtrade database, in combination with the filter for the 522 largest ports in the world, the simulation was only able to analyse trade of 57 exporting countries and 97 importing countries.

3.2.2 Difference-In-Difference Analysis

The introduction of Arctic shipping lanes has significant implications for global trade flows. To quantify these effects, a Difference-in-Difference (DiD) analysis is employed, leveraging empirical data to provide robust causal inferences. This chapter outlines the methodology of the DiD analysis, which compares trade flows before and after the introduction of Arctic shipping routes between affected and unaffected routes.

The DiD analysis requires four distinct groups of data:

1. Pre-treatment Group: Trade values affected and not affected by the Arctic routes before their introduction.

2. Post-treatment Group: Trade values affected and not affected by the Arctic routes after their introduction.

These groups help control for existing selection biases and isolate the impact of Arctic trade routes on trade flows.

The pre-treatment trade values are obtained through a PPML (Poisson Pseudo Maximum Likelihood) regression of trade on multilateral resistances, and the log of current time costs. The predicted trade values from this regression serve as the pre-treatment data. For post-treatment values, the full spatial model is iterated until the maximum or standard deviation of the change in prices is less than 0.001, simulating the new full endowment spatial equilibrium with Arctic sea routes.

To split the data into treatment and control groups, a t-test determines if the change in the transport factor (Δt_{ij} = $t_{ij\ Pre-Shock}$ - $t_{ij\ Post-Shock}$) is significantly different from zero. If the hypothesis ($\Delta t_{ij} == 0$) is rejected at a 5% significance level, the route is included in the treatment group. This approach ensures that only routes significantly impacted by the Arctic lanes are considered treated.

Once the groups are allocated, the mean trade values from both groups (pre- and post-treatment) are used to calculate the Average effect of treatment on the treated (ATT). This calculation involves comparing the changes in trade values before and after treatment between the treatment and control groups, effectively removing selection bias. The ATT is computed as follows:

$$[Y_1(1)|T = 1, t = 1] - E[Y_1(0)|T = 1, t = 0] - (E[Y_1(0)|T = 0, t = 1] - E[Y_1(0)|T = 0, t = 0] \quad (3)$$

Note: This equation is further explained in Appendix 7.1.3.

This equation isolates the effect of Arctic routes by controlling for trends common to both treated and control groups, providing a clear evaluation of their impact.

The spatial model offers theoretical insights and simulations regarding the potential changes due to Arctic shipping lanes. However, the DiD analysis empirically validates these insights by using observed trade data, enhancing the robustness of the findings. This empirical approach helps understand the real-world complexities and variations that theoretical models might not fully capture. The primary advantage of using a DiD approach is its ability to control for unobserved heterogeneity variables that differ between groups but remain constant over time. This feature reduces bias from confounding variables, ensuring that observed effects are attributable to the treatment (Arctic shipping lanes) rather than other factors.

The DiD analysis presented in chapter 4.2 provides empirical evidence on the impact of Arctic shipping lanes on global trade. By controlling for selection biases and confounding variables, the analysis isolates the true effect of Arctic routes, offering valuable insights into their potential as alternatives to traditional shipping lanes. This robust methodological approach underscores the importance of empirical validation in understanding the economic implications of new trade routes.

4 Quantitative Analysis

To further understand the extent that Arctic shipping will develop as an alternative trade route, a quantitative analysis was performed using a spatial economy simulation as well as a difference-in-difference analysis. The obtained results are explained in the chapters below.

4.1 The Spatial Economy with Arctic Shipping Routes

Having run the spatial model simulation on 57 countries, as well as the 4 possible scenarios of Arctic shipping (TSR,NSR,NWP, and TOTAL), the following results were found for each of the Arctic shipping lanes.

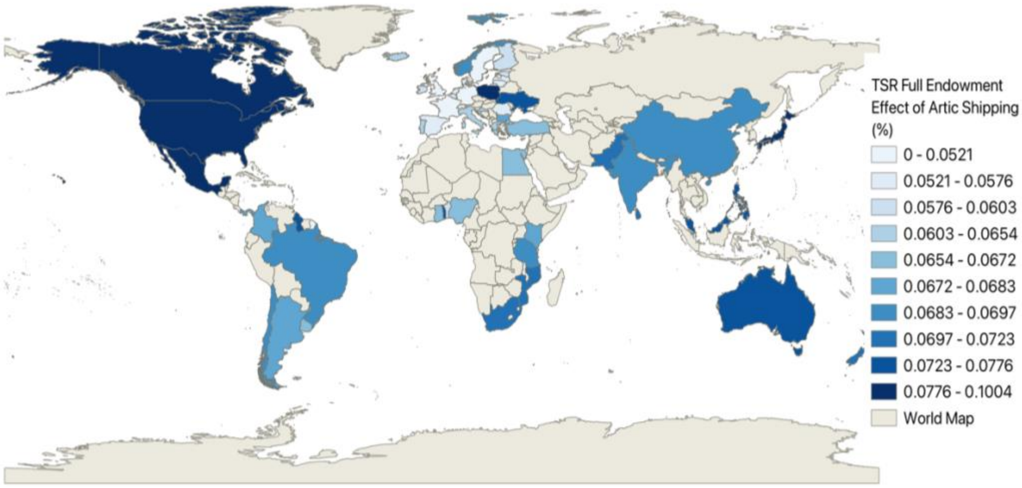

Figure 7. Full endowment Spatial Equilibrium map of global trade with the TSR (own composition using QGIS)

As depicted in figure 7, European countries have increased their trade volume by about 0.05%, when only the TSR is implemented. The larger increases for the more northern located European countries such as Norway as well as Eastern European countries such as Poland and Ukraine, can be attributed to their quick and easy access to the TSR, which reduces their time costs invested into trading on a global scale. Additionally, the north American continent has also increased their trading volume substantially, possibly resulting from the introduction of the TSR and the quick access that Canada and the USA have to it. Interestingly, it seems that the north American continent is also the stakeholder who benefits the most from the TSR shipping route, increasing their trade volume approximately 0.1% due to the introduction of a single major shipping lane. Furthermore, figure 7 shows that the Eastern Asian countries, such as Japan, China and the Philippines also show an increase in trading volume, which can also be attributed to their quick and easy access to the TSR shipping lane. Interestingly, many south American and oceanic countries see a strong increase in trade, even though they are not necessarily affected by the transport shock. One explanation for this could be that vital trading partners, such as the north American region and East Asian region experience large trade growth, which creates a spillover effect onto the oceanic and south American regions.

Whilst the increase in trade is less than expected in Central-West Europe, as the TSR is a major shipping lane that significantly reduces transport costs, the general increase in trade for countries in the northern hemisphere supports the idea that developing Arctic shipping will increase trade.

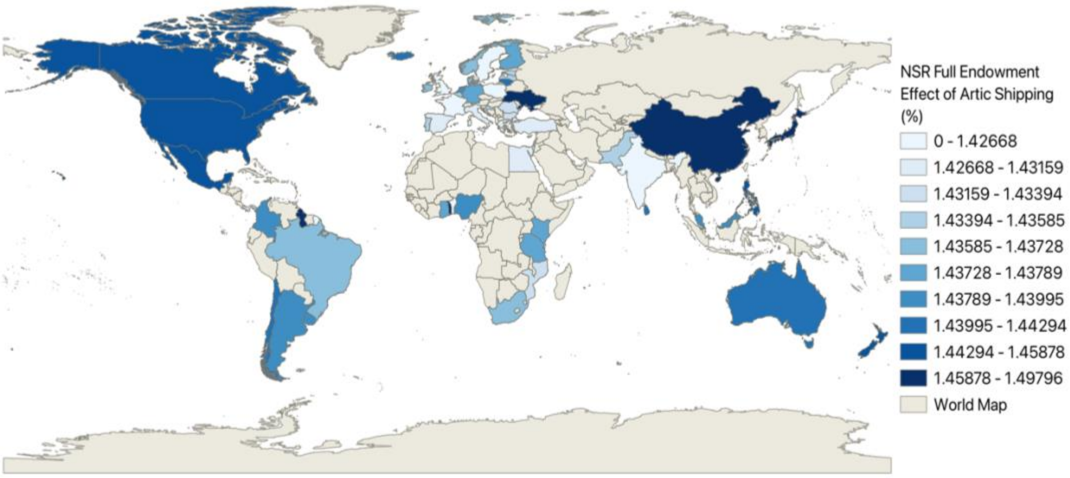

Figure 8. Full endowment Spatial Equilibrium map of global trade with the NSR (own composition using QGIS)

Similarly to the TSR shipping route, the NSR shipping route also creates a general global increase in trade as depicted in figure 8. The key difference between the NSR and TSR is that the stakeholder nations that are located close to the NSR, such as north and Eastern European countries and especially the East Asian countries, see the largest increases. This is because they are located closest to the NSR shipping route and have the most to gain through its introduction. Furthermore, the north American continent sees a relatively larger increase in trade as with the TSR, however, it is no longer the region that benefits most. As seen with the TSR shipping route, south American and oceanic countries also experience increases in trade, even though they are not necessarily directly affected by the Arctic shipping routes. The smallest increases are experienced by countries such as India and Egypt, the reason for which can be attributed to the decrease in shipping traffic along the Suez canal, in combination with the increase of prices from neighbouring trading partners.

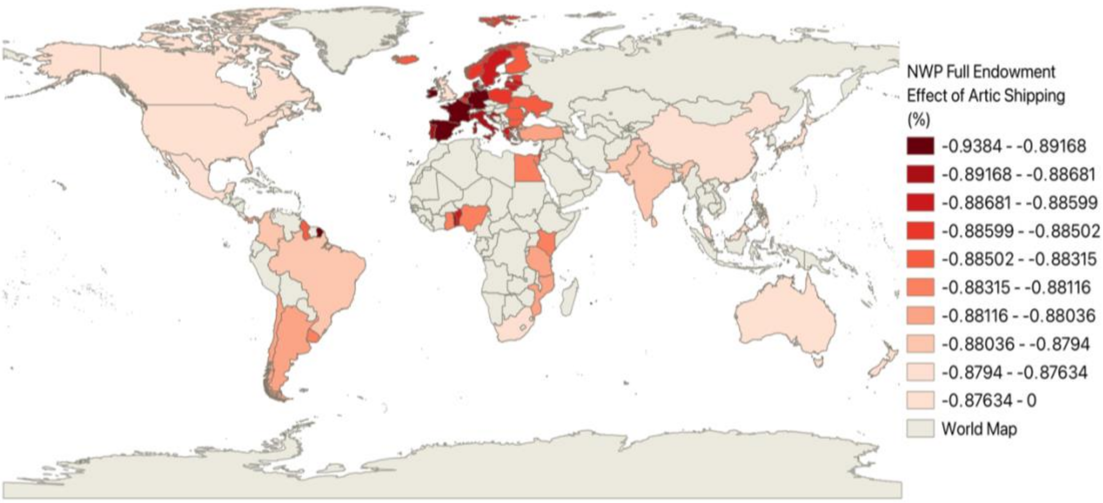

Figure 9. Full endowment Spatial Equilibrium map of global trade with the NWP (own composition using QGIS)

In comparison to the NSR and TSR, the NWP is categorized as a middle trading route. This means that the average speed of the NWP is the lowest in the Artic, which is attributed to the narrow passageways and the difficult navigation of the route. This could be one of the reasons that the full endowment spatial equilibrium with only the NWP, shown in figure 9, represents a general decrease in trade for all countries. The decrease in the highest in central and western Europe. Whilst these countries generally experience a decrease in domestic prices, making them attractive trading partners for other countries, their outward multilateral resistance increases significantly. This means that European countries have high costs to export goods out of their countries. The trend of increasing outward multilateral resistance continues outside of Europe as well, however in regions such as north America and East Asia the effect is not as prevalent. Due to the geographic location of the NWP, it was expected to see that the north American region would experience an increase in trade due to the new shipping lane, however this was not the observation that was made.

This issue can be attributed to a limitation of the model, as the shortest shipping connection between two countries is used for every trade partner, meaning that East and West coast ports are utilized depending on if the trade partner is on the Atlantic or Pacific side. This would result in the NWP being an insignificant trade route for the north American continent.

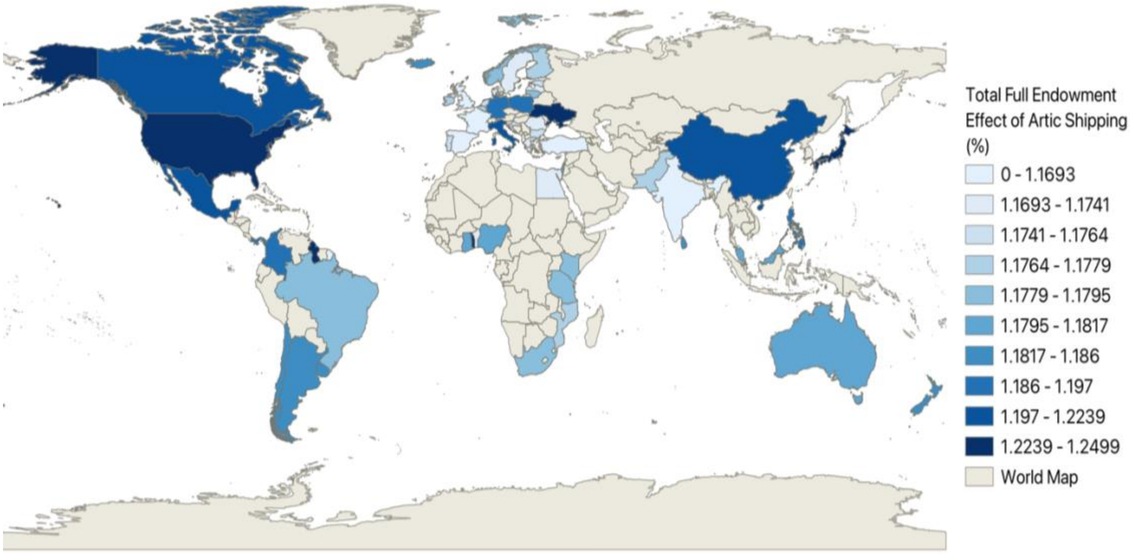

Figure 10. Full endowment Spatial Equilibrium map of global trade with Arctic Shipping lanes (own composition using QGIS)

When combining the results from all three Arctic shipping lanes, the full endowment spatial equilibrium shows a general increase in global trade by around 1.2% per country. Figure 10 depicts that the North American continent experiences some of the largest benefits that Arctic shipping has to offer. This is partly due to the low cost of accessing the Arctic shipping lanes, which in turn saves time and money transporting goods.

Additionally, European countries experience large increases in trading volume, with Central and East Europe increasing trade the most in Europe. This result can be attributed to the new and quicker connection to the Pacific through the Arctic, as countries such as Poland and Germany no longer need to circumnavigate the strait of Gibraltar, the Mediterranean Sea or the Suez Canal to reach East Asian trading partners.

Furthermore, the East Asia region, with countries such as China and Japan, experiences some large growth as well. The geographic location of this area, being located right next to the vertex where all three Arctic shipping lanes converge, allows for a large decrease in transport costs, as well as incentive to export to western countries.

Finally, the southern hemisphere also see's increases in trade, which seem to be a result from lower prices and relatively low values for OMR. Whilst this may not stem directly from a decrease in transport costs, it may be an indirect effect of trading partners who are affected by the transport shock.

In summary, there is a general increase in trading globally, which can be partially attributed to the decreasing trade costs resulting from the Arctic shipping lanes. It appears that the major economic superpowers, such as the USA, China, Japan and Germany, all experience some of the highest increases in trade. This can result from lower domestic prices and lower OMR that larger economies can offer, in addition to decreased transportation costs. The theorised increase in trade relationship between Europe and East Asia, from chapter 2.3.2, is also supported through this spatial equilibrium as we see clear increases in trade value from both stakeholder regions.

4.2 Difference-In-Difference Analysis of Arctic Shipping

Similarly to the spatial model, the DiD analysis will utilize 4 different results, one for each Arctic shipping lanes and one for the total of all Arctic shipping.

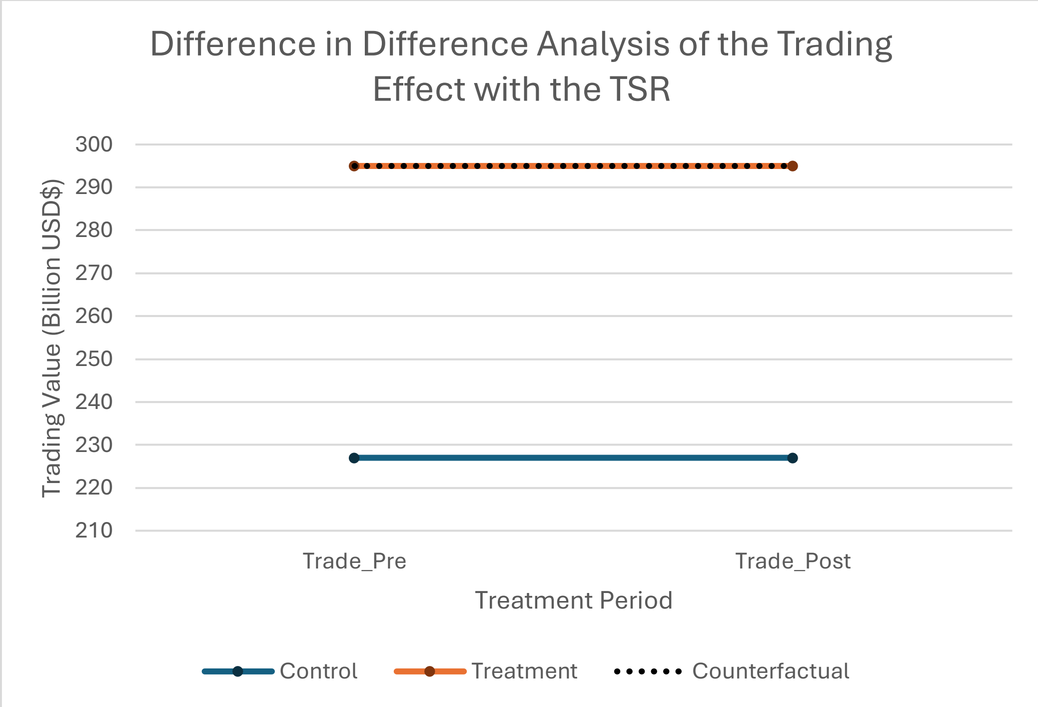

Figure 11. Difference-In-Difference Graph of the Trading effect of Arctic Shipping with the TSR on Global Mean Trade

As figure 11 shows, the introduction of the TSR alone has a very small ATT. Due to the large figures that are handled in this analysis, the change in trade due to TSR can be summarized to 0%.

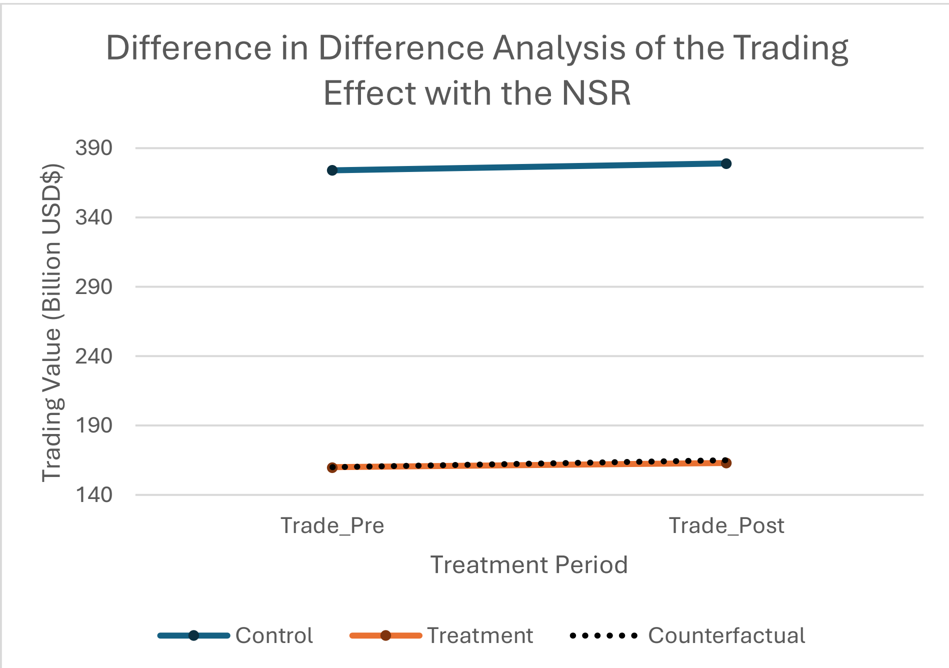

Figure 12. Difference-In-Difference Graph of the Trading effect of Arctic Shipping with the NSR on Global Mean Trade

When analysing the ATT of the NSR trade route on global trade, even though figure 8 shows a general increase in trade after the transport shock, the ATT is -1.21%. This means that on average countries decrease their trade volume by 1.21% when they utilize the NSR in comparison to countries who don't. In absolute terms, this results in an average decrease of 2 billion USD per country.

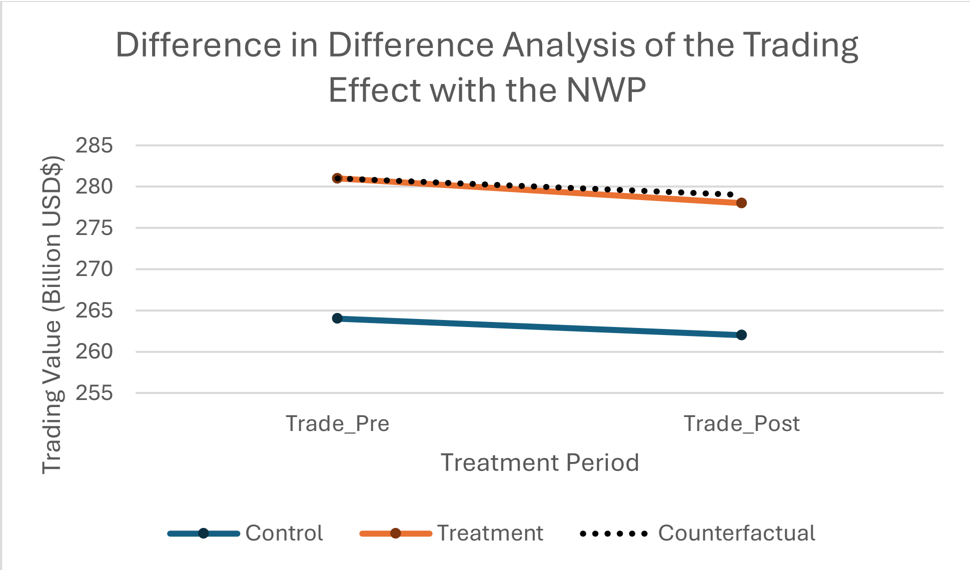

Figure 13. Difference-In-Difference Graph of the Trading effect of Arctic Shipping with the NWP on Global Mean Trade

When analysing the effect of the NWP trade route, the DiD result shows that countries that utilize the NWP on average decreases their trade volume by 0.35%. This agrees with the spatial model for the NWP trade route, which found that the full endowment equilibrium will result in less trade being conducted between countries. Whilst the NWP ATT is not as extensive as the NSR ATT, it is still approximately worth a decrease of 1 billion USD.

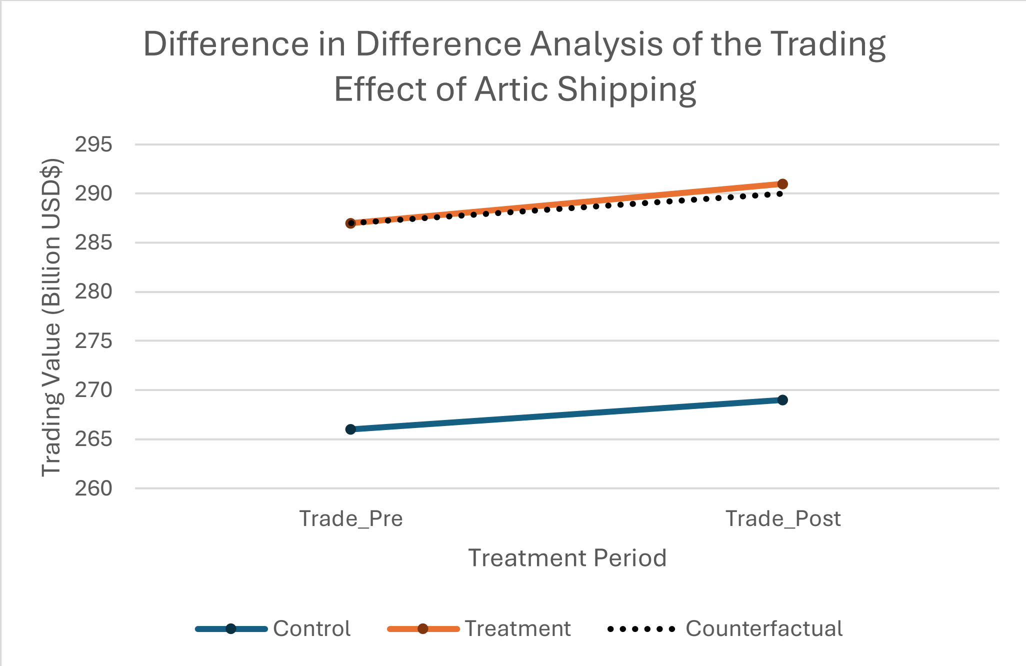

Figure 14. Difference-In-Difference Graph of the Trading effect of Arctic Shipping with all Shipping lanes on Global Mean Trade

Finally, Figure 14 represents the ATT of all three Arctic shipping lanes. When combining the three shipping lanes, the resulting ATT is approximately 0.35%. This result supports the idea that the development of Arctic shipping routes, such as the TSR, NWP and NSR will increase the amount of trade that occurs on a global scale, and thereby incentivises stakeholder countries to use the Arctic routes as alternatives to pre-existing trade routes.

5 Discussion and Review of the Study

5.1 Conclusion

The introduction of the three main Arctic Shipping lanes, the NWP, NSR and TSR, has the potential to reshape global shipping patterns. Throughout this study, the Arctic shipping lanes were analysed to answer one main question, "To what extent will Arctic shipping (NWP, NSR, and TSR) develop as an alternative to traditional global shipping trade in the next 100 years?". Whilst multiple different opportunities and challenges were identified, the full extent of the effect of Arctic shipping is summarized in this chapter.

To summarize the three trade routes, the NWP offers a shortened maritime route between the Atlantic and the Pacific, but it faces challenges related to severe weather conditions and disputed sovereignty claims. The TSR, while promising the shortest connection between the Atlantic and Pacific, remains largely theoretical and dependent on future ice reductions. The NSR, under Russian jurisdiction, is becoming increasingly navigable and presents substantial economic benefits, albeit with significant environmental and geopolitical considerations.

Whilst all three Arctic passages offer a clear reduction of maritime travel distance, the challenges which surround them, such as navigational issues, SAR challenges, and environmental obstacles, affect how well these trade routes will develop as an alternative to pre-existing ones. Due to climate change, over time the natural challenges that prevent ships from currently utilizing the Arctic shipping network will disperse and clear up passageways for which every trading ship with ocean crossing capabilities is suited. Furthermore, the investment of time and money into Arctic nations which lay closest to the Arctic shipping pathways, such as Canada and Russia, will provide the necessary port and SAR infrastructure that can support major and middle-sized shipping lanes.

In addition to this, the opening of the Arctic shipping routes also offers an opportunity to develop stakeholder relationships between all nations. As explained in chapter 2.3.2, the trading relationship between China and Europe is set to benefit from the decrease in travel time. This theory is also supported by the empirical research done through the spatial model and the DiD analysis in chapter 4. This suggests that the trading relationship between the EU and major East-Asian economies could potentially increase due to Arctic shipping. Additionally, the decrease of Arctic ice caps is set to incentivise nations to benefit from natural resources hidden below the ice. This economic incentive will help develop the necessary infrastructure and interest to ensure that the Arctic shipping routes are developed to their full potential due to increased demand (Kaiser et al., 2023). Another factor pushing for the development of alternative trade routes is the current political environment in the Middle East, where war, sanctions and criminal activity are constantly finding ways to interrupt global shipping lanes such as the Suez Canal (Zhang et al., 2024).

Finally, one of the largest hurdles that still needs to be overcome in the process of developing Arctic shipping is the sovereignty of the Artic, specifically that of the NWP. Whilst the sovereignty of TSR and NSR are generally undisputed, the USA and Canada are still in the process of figuring out the legal challenges behind developing a middle-sized trade route (NWP) through the Artic. The judicial framework of the Arctic has been set by the IMO and several conventions, which means that there is a general understanding on how to behave when traversing the far reaches of the Artic. It is also important to note that multiple nations have sovereignty over parts of the artic, which means that there are different laws and conventions that need to be followed depending on where in the Arctic a ship is located.

Empirically, the Arctic shipping lanes seem to generate the most trade once all the Arctic passages are opened, as presented by in the DiD analysis of chapter 4.2. Whilst the resulting ATT increase of 0.35% per country does not seem like a lot, when considering the massive scale at which countries trade, this increase can become a vital benefit. Additionally, the general increase of trade in the northern hemisphere, as depicted in figure 10, is a possible result of the effect that Arctic shipping has on countries who can utilize the decrease in maritime transport. The full endowment general equilibrium resulting from the full Arctic simulation, also incentivises stakeholders to develop Arctic shipping as consumers utilities are maximized, which lies in the interest of the nation.

5.2 Limitations of the Research

Whilst the model utilized throughout this study used recent trade and maritime data for the analysis, there are major external shocks that impact the outcome of the analysis, such as the Ukraine-Russia conflict, the Houthis attacks in the Suez canal and the increasing droughts in the Panama canal, that were not accounted for. All these current events are a great example of economic transport shocks that can affect how trade is conducted worldwide, which needs to be included in economic models to make them more applicable to the real world.

In addition to this, there are also parts of real world that the analysis in chapter 4 did not cover, for example, trade relationships between countries. Whilst the spatial model used clear assumptions, these do not necessarily always apply to the real world, setting a strong limitation to how countries interact with each other outside of transport time, prices of goods and multilateral resistance. For example, political relationships play a vital role in how countries trade with each other, something that is very difficult to quantify in numbers.

Additionally, the model did not include congestive pressure, which on the open seas does not necessarily play a significant role, however when coming across chokepoints such as the Panama Canal, the Suez Canal and the strait of Malacca, congestion can significantly affect the transport costs of shipping.

Furthermore, the combination of datasets and the limited trade data between countries resulted in the analysis of only 57 out of 107 possible exporters. This created a research limitation as the global economy was not researched as a whole, which could have yielded different results in global trading.

Another limitation that occurred was through the anchoring country Bulgaria. Whilst Bulgaria was the country with the most similar pre and post-shock transport time values when all Arctic shipping lanes were present, occasionally it would be classified as different from 0 in the separate analysis scenarios. However, to keep the anchored country constant throughout the experiment, it was decided to keep Bulgaria as control in all 4 analysis scenarios. Further testing indicated that this limitation had a negligible impact on the analysis results.

Finally, the geography of the Arctic shipping routes presents a limitation for this analysis. The start and end points of the Arctic shipping lanes are similar in location, resulting in only minor differences in the associated costs. Consequently, the primary variations between the lanes are solely in terms of speed and the specific side of the Arctic they traverse. This similarity limits the potential for significant differences in the results of the analysis

5.3 Proposals for Further Research

For further research purposes, it could be interesting to complete the whole dataset to ensure that all affected countries are included, which would result in a high number of fixed effects and a clearer analysis of the full endowment general equilibrium. Furthermore, narrowing the scope of the research to only look at one trade relationship, such as the relationship between China and Europe, could yield interesting results in how individual trading relationships are affected by the introduction of Arctic shipping. Finally, the use of weather and environmental data to simulate ice caps in the Arctic could prove to be an interesting research addition to investigate Arctic scenarios that humanity will face in the coming years. When conducting this kind of research, the Arctic should be monitored every 6 to 12 months to get the most accurate data on real life changes happening.

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7 Appendix

7.1 Equations

7.1.1 Constant Elasticity of Substitution utility function

$$\left\{\sum_i \alpha_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{1-\sigma}{\sigma}}\right\}^{\frac{1-\sigma}{\sigma}} \quad (1)$$

Here, $\sigma > 1$ represents the elasticity of substitution between different varieties, meaning goods from various countries. The term $\alpha_i > 0$ is the CES preference parameter, which is treated as an exogenous taste parameter. Additionally, c_{ij} denotes the consumption of varieties from country i in country j.

7.1.2 Structural Gravity Equation

$$lnX_{ij} = lnE_j + lnY_i - lnY_{World} + (1-\sigma)lnt_{ij} - (1-\sigma)lnP_j - (1-\sigma)ln\Pi_i + \varepsilon_{ij} \quad (2)$$

Where:

- X_{ij} represents the value of exports from country i to country j.
- E_j is the total expenditure of country j on goods from all countries.
- Y_i is the total output of country i.
- Y_{World} is the total output of the world.
- t_{ij} denotes the bilateral trade costs between country i and country j.
- P_j is the multilateral resistance term for the destination country j, reflecting the average trade costs that country j faces with all its trading partners.
-Π_i is the multilateral resistance term for the origin country i, reflecting the average trade costs that country i faces with all its trading partners.
- σ is the elasticity of substitution between varieties of goods.
- $\varepsilon_{ij}$is an error term capturing unobserved factors affecting trade between i and j.

Note: The structural gravity equation presented here is a fundamental model used in international trade to explain bilateral trade flows between countries, utilizing transport costs, price of goods and multilateral resistances

7.1.3 Average Treatment effect of the Treated Equation

$$E[Y_1(1)|T=1,t=1] - E[Y_1(0)|T=1,t=0] - (E[Y_1(0)|T=0,t=1] - E[Y_1(0)|T=0,t=0] \quad (3)$$

where:

- Y_1: Outcome variable of interest.
- T: Treatment group indicator ($T = 1$ for the treated group, $T = 0$ for the control group).
- t: Time indicator ($t = 1$ for post-treatment period, $t = 0$ for pre-treatment period).

Note: The ATT equation presented above utilizes the counterfactual of the treatment group to find the treatment effect of an experiment without selection bias

7.2 Country and Treatment/Control Groups

Table 4: List of Variables

Exporter	Treatment Group
Antigua and Barbuda	0
Argentina	0
Australia	0
Belgium	0
Benin	0
Brazil	0
Bulgaria	0
Canada	1
Chile	1
China	0
China, Hong Kong SAR	1
China, Macao SAR	0
Colombia	1
Croatia	0
Denmark	0
Egypt	0
Estonia	1
Finland	1
France	0
Germany	0
Ghana	0
Greece	0
Guyana	0
Iceland	1
India	1
Ireland	1
Israel	0
Italy	0
Japan	1
Kenya	0
Latvia	0
Lithuania	0
Malaysia	0
Malta	1
Mexico	1
Mozambique	1
Netherlands	0
New Zealand	1
Nigeria	0
Norway	1
Pakistan	1
Panama	1
Philippines	1
Poland	1
Portugal	0

Romania	0
South Africa	1
Spain	0
Sri Lanka	0
Sweden	0
Togo	0
T‚rkiye	1
USA	1
Ukraine	0
United Kingdom	0
United Rep. of Tanzania	0
Uruguay	0

Note: Treatment group dummy identifies a country in the treatment group, change in transport cost is significantly different from 0

7.3 Stata log

The following Stata log is an example of how one of the Stata simulations was run using the transport costs data which was edited to optimize analysis using python.

```
------------------------------------------------------------------------
----------------------------------------------
. use "/Users/sebastianhaidinger/iCloud Drive
(Archive)/Desktop/ERASMUS/YEAR_3/BACHELOR_THESIS/THESIS/DATA/ANALYSIS_I
> NDIVIUDAL_ROUTES/EDITED_MODEL_DATA.dta"

.
. rename origin exporter_2

. rename destination importer_2

. drop if trade_value_USD < 0
(1 observation deleted)

.
. gen trade_per_partner = trade_value_USD / unique_trade_partners

.
. replace trade_value_USD = trade_per_partner if exporter_2 ==
importer_2
(56 real changes made)

.
.
. gen trade_per_capita = trade_value_USD

.
. gen log_trade = log(trade_value_USD)

. gen log_future_time_cost = log(future_time_cost)

. gen log_current_time_cost = log(current_time_cost)

.
```

```
.
. *drop if missing(trade_value_USD)
.
. * STATA commands to estimate the baseline gravity model:
. * Create variables for output and expenditure
. bysort exporter_2: egen Y = sum(trade_value_USD)

. bysort importer_2: egen E = sum(trade_value_USD)

. * Define the country of reference
. generate E_deuBLN = E if importer_2 == "BG"
(5,065 missing values generated)

. replace exporter_2 = "ZZZ" if exporter_2 == "BG"
variable exporter_2 was str2 now str3
(96 real changes made)

. replace importer_2 = "ZZZ" if importer_2 == "BG"
variable importer_2 was str2 now str3
(54 real changes made)

. egen E_deu = mean(E_deuBLN)

.
. tabulate exporter_2, generate(EXPORTER_FE)

 exporter_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AG |         33        0.64        0.64
         AR |         92        1.80        2.44
         AU |         97        1.89        4.34
         BE |         96        1.88        6.21
         BJ |         65        1.27        7.48
         BR |         97        1.89        9.38
         CA |         97        1.89       11.27
         CL |         94        1.84       13.11
         CN |         96        1.88       14.98
         CO |         95        1.86       16.84
         DE |         95        1.86       18.70
         DK |         96        1.88       20.57
         EE |         96        1.88       22.45
         EG |         94        1.84       24.28
         ES |         97        1.89       26.18
         FI |         96        1.88       28.05
         FR |         96        1.88       29.93
         GB |         97        1.89       31.82
         GH |         91        1.78       33.60
         GR |         97        1.89       35.50
         GY |         74        1.45       36.94
         HK |         93        1.82       38.76
         HR |         96        1.88       40.63
         IE |         97        1.89       42.53
         IL |         72        1.41       43.93
         IN |         97        1.89       45.83
         IS |         84        1.64       47.47
         IT |         94        1.84       49.31
         JP |         97        1.89       51.20
         KE |         93        1.82       53.02
```

```
         LK |         97        1.89       54.91
         LT |         97        1.89       56.81
         LV |         97        1.89       58.70
         MO |         30        0.59       59.29
         MT |         91        1.78       61.07
         MX |         87        1.70       62.77
         MY |         96        1.88       64.64
         MZ |         80        1.56       66.20
         NG |         81        1.58       67.79
         NL |         96        1.88       69.66
         NO |         97        1.89       71.56
         NZ |         96        1.88       73.43
         PA |         64        1.25       74.68
         PH |         96        1.88       76.56
         PK |         96        1.88       78.43
         PL |         97        1.89       80.33
         PT |         97        1.89       82.22
         RO |         96        1.88       84.10
         SE |         96        1.88       85.97
         TG |         65        1.27       87.24
         TR |         95        1.86       89.10
         TZ |         86        1.68       90.78
         UA |         93        1.82       92.60
         US |         96        1.88       94.47
         UY |         90        1.76       96.23
         ZA |         97        1.89       98.12
        ZZZ |         96        1.88      100.00
------------+-----------------------------------
      Total |      5,119      100.00

. tabulate importer_2, generate(IMPORTER_FE)

 importer_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AE |         57        1.11        1.11
         AG |         49        0.96        2.07
         AR |         51        1.00        3.07
         AU |         56        1.09        4.16
         BD |         54        1.05        5.22
         BE |         56        1.09        6.31
         BH |         52        1.02        7.33
         BJ |         52        1.02        8.34
         BM |         43        0.84        9.18
         BR |         55        1.07       10.26
         BS |         52        1.02       11.27
         CA |         57        1.11       12.39
         CI |         54        1.05       13.44
         CL |         53        1.04       14.48
         CM |         51        1.00       15.47
         CN |         57        1.11       16.59
         CO |         55        1.07       17.66
         CU |         52        1.02       18.68
         CW |         46        0.90       19.57
         DE |         56        1.09       20.67
         DK |         56        1.09       21.76
         DO |         53        1.04       22.80
         DZ |         52        1.02       23.81
         EE |         51        1.00       24.81
```

EG |	55	1.07	25.88
ES |	56	1.09	26.98
FI |	53	1.04	28.01
FR |	56	1.09	29.11
GA |	53	1.04	30.14
GB |	57	1.11	31.26
GH |	55	1.07	32.33
GN |	52	1.02	33.35
GR |	56	1.09	34.44
GU |	38	0.74	35.18
GY |	49	0.96	36.14
HK |	55	1.07	37.21
HR |	52	1.02	38.23
HT |	48	0.94	39.17
ID |	55	1.07	40.24
IE |	57	1.11	41.36
IL |	53	1.04	42.39
IN |	57	1.11	43.50
IQ |	51	1.00	44.50
IR |	43	0.84	45.34
IS |	50	0.98	46.32
IT |	56	1.09	47.41
JM |	53	1.04	48.45
JP |	56	1.09	49.54
KE |	52	1.02	50.56
KH |	52	1.02	51.57
KR |	57	1.11	52.69
KW |	53	1.04	53.72
LB |	52	1.02	54.74
LK |	52	1.02	55.75
LT |	51	1.00	56.75
LV |	52	1.02	57.77
LY |	49	0.96	58.72
MA |	53	1.04	59.76
MO |	46	0.90	60.66
MR |	50	0.98	61.63
MT |	51	1.00	62.63
MX |	54	1.05	63.68
MY |	57	1.11	64.80
MZ |	50	0.98	65.77
NG |	55	1.07	66.85
NL |	56	1.09	67.94
NO |	54	1.05	69.00
NZ |	53	1.04	70.03
PA |	53	1.04	71.07
PE |	53	1.04	72.10
PH |	55	1.07	73.18
PK |	54	1.05	74.23
PL |	55	1.07	75.31
PT |	57	1.11	76.42
QA |	55	1.07	77.50
RO |	53	1.04	78.53
RU |	53	1.04	79.57
SA |	55	1.07	80.64
SD |	46	0.90	81.54
SE |	54	1.05	82.59
SG |	56	1.09	83.69
SN |	55	1.07	84.76

```
         SO |         44        0.86       85.62
         SY |         44        0.86       86.48
         TG |         49        0.96       87.44
         TH |         57        1.11       88.55
         TN |         51        1.00       89.55
         TR |         55        1.07       90.62
         TT |         51        1.00       91.62
         TZ |         52        1.02       92.64
         UA |         51        1.00       93.63
         US |         57        1.11       94.75
         UY |         51        1.00       95.74
         VE |         52        1.02       96.76
         VN |         56        1.09       97.85
         ZA |         56        1.09       98.95
        ZZZ |         54        1.05      100.00
------------+-----------------------------------
      Total |      5,119      100.00

.
. describe IMPORTER_FE*

Variable      Storage   Display    Value
    name         type    format    label      Variable label
------------------------------------------------------------------------
---------------------------------------------
IMPORTER_FE1    byte    %8.0g                 importer_2==AE
IMPORTER_FE2    byte    %8.0g                 importer_2==AG
IMPORTER_FE3    byte    %8.0g                 importer_2==AR
IMPORTER_FE4    byte    %8.0g                 importer_2==AU
IMPORTER_FE5    byte    %8.0g                 importer_2==BD
IMPORTER_FE6    byte    %8.0g                 importer_2==BE
IMPORTER_FE7    byte    %8.0g                 importer_2==BH
IMPORTER_FE8    byte    %8.0g                 importer_2==BJ
IMPORTER_FE9    byte    %8.0g                 importer_2==BM
IMPORTER_FE10   byte    %8.0g                 importer_2==BR
IMPORTER_FE11   byte    %8.0g                 importer_2==BS
IMPORTER_FE12   byte    %8.0g                 importer_2==CA
IMPORTER_FE13   byte    %8.0g                 importer_2==CI
IMPORTER_FE14   byte    %8.0g                 importer_2==CL
IMPORTER_FE15   byte    %8.0g                 importer_2==CM
IMPORTER_FE16   byte    %8.0g                 importer_2==CN
IMPORTER_FE17   byte    %8.0g                 importer_2==CO
IMPORTER_FE18   byte    %8.0g                 importer_2==CU
IMPORTER_FE19   byte    %8.0g                 importer_2==CW
IMPORTER_FE20   byte    %8.0g                 importer_2==DE
IMPORTER_FE21   byte    %8.0g                 importer_2==DK
IMPORTER_FE22   byte    %8.0g                 importer_2==DO
IMPORTER_FE23   byte    %8.0g                 importer_2==DZ
IMPORTER_FE24   byte    %8.0g                 importer_2==EE
IMPORTER_FE25   byte    %8.0g                 importer_2==EG
IMPORTER_FE26   byte    %8.0g                 importer_2==ES
IMPORTER_FE27   byte    %8.0g                 importer_2==FI
IMPORTER_FE28   byte    %8.0g                 importer_2==FR
IMPORTER_FE29   byte    %8.0g                 importer_2==GA
IMPORTER_FE30   byte    %8.0g                 importer_2==GB
IMPORTER_FE31   byte    %8.0g                 importer_2==GH
IMPORTER_FE32   byte    %8.0g                 importer_2==GN
IMPORTER_FE33   byte    %8.0g                 importer_2==GR
```

```
IMPORTER_FE34   byte    %8.0g                       importer_2==GU
IMPORTER_FE35   byte    %8.0g                       importer_2==GY
IMPORTER_FE36   byte    %8.0g                       importer_2==HK
IMPORTER_FE37   byte    %8.0g                       importer_2==HR
IMPORTER_FE38   byte    %8.0g                       importer_2==HT
IMPORTER_FE39   byte    %8.0g                       importer_2==ID
IMPORTER_FE40   byte    %8.0g                       importer_2==IE
IMPORTER_FE41   byte    %8.0g                       importer_2==IL
IMPORTER_FE42   byte    %8.0g                       importer_2==IN
IMPORTER_FE43   byte    %8.0g                       importer_2==IQ
IMPORTER_FE44   byte    %8.0g                       importer_2==IR
IMPORTER_FE45   byte    %8.0g                       importer_2==IS
IMPORTER_FE46   byte    %8.0g                       importer_2==IT
IMPORTER_FE47   byte    %8.0g                       importer_2==JM
IMPORTER_FE48   byte    %8.0g                       importer_2==JP
IMPORTER_FE49   byte    %8.0g                       importer_2==KE
IMPORTER_FE50   byte    %8.0g                       importer_2==KH
IMPORTER_FE51   byte    %8.0g                       importer_2==KR
IMPORTER_FE52   byte    %8.0g                       importer_2==KW
IMPORTER_FE53   byte    %8.0g                       importer_2==LB
IMPORTER_FE54   byte    %8.0g                       importer_2==LK
IMPORTER_FE55   byte    %8.0g                       importer_2==LT
IMPORTER_FE56   byte    %8.0g                       importer_2==LV
IMPORTER_FE57   byte    %8.0g                       importer_2==LY
IMPORTER_FE58   byte    %8.0g                       importer_2==MA
IMPORTER_FE59   byte    %8.0g                       importer_2==MO
IMPORTER_FE60   byte    %8.0g                       importer_2==MR
IMPORTER_FE61   byte    %8.0g                       importer_2==MT
IMPORTER_FE62   byte    %8.0g                       importer_2==MX
IMPORTER_FE63   byte    %8.0g                       importer_2==MY
IMPORTER_FE64   byte    %8.0g                       importer_2==MZ
IMPORTER_FE65   byte    %8.0g                       importer_2==NG
IMPORTER_FE66   byte    %8.0g                       importer_2==NL
IMPORTER_FE67   byte    %8.0g                       importer_2==NO
IMPORTER_FE68   byte    %8.0g                       importer_2==NZ
IMPORTER_FE69   byte    %8.0g                       importer_2==PA
IMPORTER_FE70   byte    %8.0g                       importer_2==PE
IMPORTER_FE71   byte    %8.0g                       importer_2==PH
IMPORTER_FE72   byte    %8.0g                       importer_2==PK
IMPORTER_FE73   byte    %8.0g                       importer_2==PL
IMPORTER_FE74   byte    %8.0g                       importer_2==PT
IMPORTER_FE75   byte    %8.0g                       importer_2==QA
IMPORTER_FE76   byte    %8.0g                       importer_2==RO
IMPORTER_FE77   byte    %8.0g                       importer_2==RU
IMPORTER_FE78   byte    %8.0g                       importer_2==SA
IMPORTER_FE79   byte    %8.0g                       importer_2==SD
IMPORTER_FE80   byte    %8.0g                       importer_2==SE
IMPORTER_FE81   byte    %8.0g                       importer_2==SG
IMPORTER_FE82   byte    %8.0g                       importer_2==SN
IMPORTER_FE83   byte    %8.0g                       importer_2==SO
IMPORTER_FE84   byte    %8.0g                       importer_2==SY
IMPORTER_FE85   byte    %8.0g                       importer_2==TG
IMPORTER_FE86   byte    %8.0g                       importer_2==TH
IMPORTER_FE87   byte    %8.0g                       importer_2==TN
IMPORTER_FE88   byte    %8.0g                       importer_2==TR
IMPORTER_FE89   byte    %8.0g                       importer_2==TT
IMPORTER_FE90   byte    %8.0g                       importer_2==TZ
IMPORTER_FE91   byte    %8.0g                       importer_2==UA
```

```
IMPORTER_FE92   byte    %8.0g                   importer_2==US
IMPORTER_FE93   byte    %8.0g                   importer_2==UY
IMPORTER_FE94   byte    %8.0g                   importer_2==VE
IMPORTER_FE95   byte    %8.0g                   importer_2==VN
IMPORTER_FE96   byte    %8.0g                   importer_2==ZA
IMPORTER_FE97   byte    %8.0g                   importer_2==ZZZ

. global N = 97

. global N_1 = $N - 1

.
. describe EXPORTER_FE*

Variable      Storage   Display    Value
    name         type    format    label      Variable label
------------------------------------------------------------------------
----------------------------------------------
EXPORTER_FE1    byte    %8.0g                   exporter_2==AG
EXPORTER_FE2    byte    %8.0g                   exporter_2==AR
EXPORTER_FE3    byte    %8.0g                   exporter_2==AU
EXPORTER_FE4    byte    %8.0g                   exporter_2==BE
EXPORTER_FE5    byte    %8.0g                   exporter_2==BJ
EXPORTER_FE6    byte    %8.0g                   exporter_2==BR
EXPORTER_FE7    byte    %8.0g                   exporter_2==CA
EXPORTER_FE8    byte    %8.0g                   exporter_2==CL
EXPORTER_FE9    byte    %8.0g                   exporter_2==CN
EXPORTER_FE10   byte    %8.0g                   exporter_2==CO
EXPORTER_FE11   byte    %8.0g                   exporter_2==DE
EXPORTER_FE12   byte    %8.0g                   exporter_2==DK
EXPORTER_FE13   byte    %8.0g                   exporter_2==EE
EXPORTER_FE14   byte    %8.0g                   exporter_2==EG
EXPORTER_FE15   byte    %8.0g                   exporter_2==ES
EXPORTER_FE16   byte    %8.0g                   exporter_2==FI
EXPORTER_FE17   byte    %8.0g                   exporter_2==FR
EXPORTER_FE18   byte    %8.0g                   exporter_2==GB
EXPORTER_FE19   byte    %8.0g                   exporter_2==GH
EXPORTER_FE20   byte    %8.0g                   exporter_2==GR
EXPORTER_FE21   byte    %8.0g                   exporter_2==GY
EXPORTER_FE22   byte    %8.0g                   exporter_2==HK
EXPORTER_FE23   byte    %8.0g                   exporter_2==HR
EXPORTER_FE24   byte    %8.0g                   exporter_2==IE
EXPORTER_FE25   byte    %8.0g                   exporter_2==IL
EXPORTER_FE26   byte    %8.0g                   exporter_2==IN
EXPORTER_FE27   byte    %8.0g                   exporter_2==IS
EXPORTER_FE28   byte    %8.0g                   exporter_2==IT
EXPORTER_FE29   byte    %8.0g                   exporter_2==JP
EXPORTER_FE30   byte    %8.0g                   exporter_2==KE
EXPORTER_FE31   byte    %8.0g                   exporter_2==LK
EXPORTER_FE32   byte    %8.0g                   exporter_2==LT
EXPORTER_FE33   byte    %8.0g                   exporter_2==LV
EXPORTER_FE34   byte    %8.0g                   exporter_2==MO
EXPORTER_FE35   byte    %8.0g                   exporter_2==MT
EXPORTER_FE36   byte    %8.0g                   exporter_2==MX
EXPORTER_FE37   byte    %8.0g                   exporter_2==MY
EXPORTER_FE38   byte    %8.0g                   exporter_2==MZ
EXPORTER_FE39   byte    %8.0g                   exporter_2==NG
EXPORTER_FE40   byte    %8.0g                   exporter_2==NL
```

```
EXPORTER_FE41   byte    %8.0g                  exporter_2==NO
EXPORTER_FE42   byte    %8.0g                  exporter_2==NZ
EXPORTER_FE43   byte    %8.0g                  exporter_2==PA
EXPORTER_FE44   byte    %8.0g                  exporter_2==PH
EXPORTER_FE45   byte    %8.0g                  exporter_2==PK
EXPORTER_FE46   byte    %8.0g                  exporter_2==PL
EXPORTER_FE47   byte    %8.0g                  exporter_2==PT
EXPORTER_FE48   byte    %8.0g                  exporter_2==RO
EXPORTER_FE49   byte    %8.0g                  exporter_2==SE
EXPORTER_FE50   byte    %8.0g                  exporter_2==TG
EXPORTER_FE51   byte    %8.0g                  exporter_2==TR
EXPORTER_FE52   byte    %8.0g                  exporter_2==TZ
EXPORTER_FE53   byte    %8.0g                  exporter_2==UA
EXPORTER_FE54   byte    %8.0g                  exporter_2==US
EXPORTER_FE55   byte    %8.0g                  exporter_2==UY
EXPORTER_FE56   byte    %8.0g                  exporter_2==ZA
EXPORTER_FE57   byte    %8.0g                  exporter_2==ZZZ

. global J = 57

. global J_1 = $J - 1

.
.
. ppml trade_value_USD EXPORTER_FE* IMPORTER_FE1-IMPORTER_FE$N_1
log_current_time_cost, ///
> cluster(pair_id) noconstant

note: checking the existence of the estimates
WARNING: trade_value_USD has very large values, consider rescaling
WARNING: log_current_time_cost has very large values, consider
rescaling  or recentering

Number of regressors excluded to ensure that the estimates exist: 0
Number of observations excluded: 0

note: starting ppml estimation
note: trade_value_USD has noninteger values

Iteration 1:   deviance =  2.56e+13
Iteration 2:   deviance =  1.59e+13
Iteration 3:   deviance =  1.40e+13
Iteration 4:   deviance =  1.38e+13
Iteration 5:   deviance =  1.38e+13
Iteration 6:   deviance =  1.38e+13
Iteration 7:   deviance =  1.38e+13
Iteration 8:   deviance =  1.38e+13
Iteration 9:   deviance =  1.38e+13
Iteration 10:  deviance =  1.38e+13
Iteration 11:  deviance =  1.38e+13
Iteration 12:  deviance =  1.38e+13
Iteration 13:  deviance =  1.38e+13
Iteration 14:  deviance =  1.38e+13
Iteration 15:  deviance =  1.38e+13
Iteration 16:  deviance =  1.38e+13
Iteration 17:  deviance =  1.38e+13
Iteration 18:  deviance =  1.38e+13
Iteration 19:  deviance =  1.38e+13
```

```
Iteration 20:  deviance =  1.38e+13
Iteration 21:  deviance =  1.38e+13

Number of parameters: 154
Number of observations: 5119
Pseudo log-likelihood: -6.882e+12
R-squared: .48119669
Option strict is: off
                                     (Std. err. adjusted for 5,119
clusters in pair_id)
-----------------------------------------------------------------------
----------------
                      |               Robust
      trade_value_USD | Coefficient  std. err.      z    P>|z|     [95%
conf. interval]
----------------------+------------------------------------------------
----------------
         EXPORTER_FE1 |   12.38436   .5923468    20.91   0.000
11.22338    13.54534
         EXPORTER_FE2 |   19.69431   .4479058    43.97   0.000
18.81643    20.57219
         EXPORTER_FE3 |   21.21817   .5019354    42.27   0.000
20.2344    22.20195
         EXPORTER_FE4 |    21.1909   .4112383    51.53   0.000
20.38489    21.99691
         EXPORTER_FE5 |   15.72008   .5973309    26.32   0.000
14.54933    16.89082
         EXPORTER_FE6 |   21.31425   .4342233    49.09   0.000
20.46318    22.16531
         EXPORTER_FE7 |   21.77958   .6715455    32.43   0.000
20.46337    23.09578
         EXPORTER_FE8 |   20.04875   .5071277    39.53   0.000
19.05479     21.0427
         EXPORTER_FE9 |   23.49676   .3984039    58.98   0.000
22.7159    24.27762
        EXPORTER_FE10 |     19.373   .4162018    46.55   0.000
18.55726    20.18874
        EXPORTER_FE11 |   22.61791   .3841125    58.88   0.000
21.86507    23.37076
        EXPORTER_FE12 |   19.92367   .4095225    48.65   0.000
19.12102    20.72632
        EXPORTER_FE13 |   18.39935   .4674681    39.36   0.000
17.48313    19.31557
        EXPORTER_FE14 |   19.19696   .4310933    44.53   0.000
18.35204    20.04189
        EXPORTER_FE15 |    21.3574   .4129664    51.72   0.000
20.548     22.1668
        EXPORTER_FE16 |   19.70555   .3843499    51.27   0.000
18.95224    20.45886
        EXPORTER_FE17 |   21.70016    .382631    56.71   0.000
20.95022    22.45011
        EXPORTER_FE18 |   21.54655   .3592652    59.97   0.000
20.8424     22.2507
        EXPORTER_FE19 |   18.09632   .4487064    40.33   0.000
17.21687    18.97577
        EXPORTER_FE20 |   19.25743   .4401338    43.75   0.000
18.39478    20.12007
```

EXPORTER_FE21	17.90941	.4646343	38.55	0.000	16.99875	18.82008
EXPORTER_FE22	21.74821	.6143017	35.40	0.000	20.5442	22.95222
EXPORTER_FE23	18.04586	.4696016	38.43	0.000	17.12546	18.96626
EXPORTER_FE24	20.78127	.4017595	51.73	0.000	19.99384	21.56871
EXPORTER_FE25	19.55991	.4114668	47.54	0.000	18.75345	20.36637
EXPORTER_FE26	21.51746	.380193	56.60	0.000	20.77229	22.26262
EXPORTER_FE27	17.37983	.5113618	33.99	0.000	16.37758	18.38208
EXPORTER_FE28	21.70534	.3733757	58.13	0.000	20.97354	22.43714
EXPORTER_FE29	22.00464	.3825386	57.52	0.000	21.25488	22.75441
EXPORTER_FE30	17.19307	.4636255	37.08	0.000	16.28438	18.10176
EXPORTER_FE31	17.96412	.3993817	44.98	0.000	17.18135	18.7469
EXPORTER_FE32	19.06057	.4306624	44.26	0.000	18.21649	19.90466
EXPORTER_FE33	18.40115	.4674584	39.36	0.000	17.48495	19.31735
EXPORTER_FE34	15.49675	.8728496	17.75	0.000	13.786	17.20751
EXPORTER_FE35	16.59499	.4649256	35.69	0.000	15.68375	17.50623
EXPORTER_FE36	21.79005	.7389967	29.49	0.000	20.34165	23.23846
EXPORTER_FE37	21.17959	.4124212	51.35	0.000	20.37126	21.98792
EXPORTER_FE38	17.58179	.47099	37.33	0.000	16.65866	18.50491
EXPORTER_FE39	19.76317	.4292481	46.04	0.000	18.92186	20.60448
EXPORTER_FE40	21.78974	.4343114	50.17	0.000	20.93851	22.64098
EXPORTER_FE41	20.64058	.4452014	46.36	0.000	19.768	21.51316
EXPORTER_FE42	19.27392	.4570328	42.17	0.000	18.37815	20.16969
EXPORTER_FE43	16.83611	.5282835	31.87	0.000	15.8007	17.87153
EXPORTER_FE44	19.76669	.410089	48.20	0.000	18.96293	20.57045
EXPORTER_FE45	18.90448	.4012145	47.12	0.000	18.11812	19.69085
EXPORTER_FE46	21.11696	.4678268	45.14	0.000	20.20004	22.03389
EXPORTER_FE47	19.80446	.4734653	41.83	0.000	18.87648	20.73243
EXPORTER_FE48	19.83472	.4625983	42.88	0.000	18.92805	20.7414
EXPORTER_FE49	20.59974	.3936482	52.33	0.000	19.8282	21.37127

EXPORTER_FE50	15.59412	.5372925	29.02	0.000	14.54105	16.6472
EXPORTER_FE51	20.8424	.3981158	52.35	0.000	20.0621	21.62269
EXPORTER_FE52	17.31467	.5317946	32.56	0.000	16.27237	18.35697
EXPORTER_FE53	18.92442	.4512999	41.93	0.000	18.03989	19.80895
EXPORTER_FE54	22.96604	.4424678	51.90	0.000	22.09882	23.83326
EXPORTER_FE55	17.56727	.4831025	36.36	0.000	16.62041	18.51414
EXPORTER_FE56	19.94316	.4051529	49.22	0.000	19.14907	20.73724
EXPORTER_FE57	19.00279	.4362448	43.56	0.000	18.14776	19.85781
IMPORTER_FE1	1.860901	.3081168	6.04	0.000	1.257004	2.464799
IMPORTER_FE2	-3.110082	.6127709	-5.08	0.000	-4.311091	-1.909073
IMPORTER_FE3	.6198638	.390104	1.59	0.112	-.144726	1.384454
IMPORTER_FE4	1.865427	.3076068	6.06	0.000	1.262529	2.468325
IMPORTER_FE5	.4469946	.4135079	1.08	0.280	-.363466	1.257455
IMPORTER_FE6	2.306437	.3294116	7.00	0.000	1.660802	2.952072
IMPORTER_FE7	-1.161716	.3199583	-3.63	0.000	-1.788823	-.5346092
IMPORTER_FE8	-2.002355	.3847179	-5.20	0.000	-2.756389	-1.248322
IMPORTER_FE9	-3.541196	.5488083	-6.45	0.000	-4.61684	-2.465551
IMPORTER_FE10	1.829137	.3058826	5.98	0.000	1.229618	2.428656
IMPORTER_FE11	-1.339764	.5777158	-2.32	0.020	-2.472066	-.2074618
IMPORTER_FE12	2.676246	.6060878	4.42	0.000	1.488336	3.864156
IMPORTER_FE13	-.8631239	.3672629	-2.35	0.019	-1.582946	-.1433018
IMPORTER_FE14	.8106903	.3309233	2.45	0.014	.1620926	1.459288
IMPORTER_FE15	-1.440706	.4168033	-3.46	0.001	-2.257626	-.6237869
IMPORTER_FE16	3.546417	.396858	8.94	0.000	2.76859	4.324244
IMPORTER_FE17	.4752189	.3458584	1.37	0.169	-.2026511	1.153089
IMPORTER_FE18	-2.13098	.3660803	-5.82	0.000	-2.848484	-1.413475
IMPORTER_FE19	-3.340245	.4919587	-6.79	0.000	-4.304467	-2.376024
IMPORTER_FE20	3.293525	.3514353	9.37	0.000	2.604724	3.982325
IMPORTER_FE21	.9550775	.3653962	2.61	0.009	.2389142	1.671241

IMPORTER_FE22	-.3153843	.4827605	-0.65	0.514	-1.261578	.6308089
IMPORTER_FE23	-.0491265	.3372556	-0.15	0.884	-.7101354	.6118824
IMPORTER_FE24	-.5045018	.4049696	-1.25	0.213	-1.298228	.289224
IMPORTER_FE25	.5738458	.2984862	1.92	0.055	-.0111764	1.158868
IMPORTER_FE26	2.321843	.3232323	7.18	0.000	1.688319	2.955367
IMPORTER_FE27	.5147742	.3649851	1.41	0.158	-.2005834	1.230132
IMPORTER_FE28	2.764298	.349892	7.90	0.000	2.078522	3.450073
IMPORTER_FE29	-2.552823	.3617497	-7.06	0.000	-3.261839	-1.843806
IMPORTER_FE30	2.822562	.2902005	9.73	0.000	2.25378	3.391345
IMPORTER_FE31	-.6268342	.4364848	-1.44	0.151	-1.482329	.2286602
IMPORTER_FE32	-1.773125	.4110731	-4.31	0.000	-2.578813	-.9674367
IMPORTER_FE33	.6248524	.3147932	1.98	0.047	.007869	1.241836
IMPORTER_FE34	-4.047101	.4570201	-8.86	0.000	-4.942844	-3.151359
IMPORTER_FE35	-2.175513	.3819654	-5.70	0.000	-2.924151	-1.426874
IMPORTER_FE36	2.490236	.4965024	5.02	0.000	1.51711	3.463363
IMPORTER_FE37	-.3312416	.3906606	-0.85	0.396	-1.096922	.4344391
IMPORTER_FE38	-2.5589	.4563427	-5.61	0.000	-3.453315	-1.664485
IMPORTER_FE39	1.452266	.3759969	3.86	0.000	.715326	2.189207
IMPORTER_FE40	1.114983	.3931558	2.84	0.005	.3444116	1.885554
IMPORTER_FE41	.8458227	.3001502	2.82	0.005	.2575391	1.434106
IMPORTER_FE42	2.31421	.3071273	7.54	0.000	1.712252	2.916168
IMPORTER_FE43	.2376401	.4291013	0.55	0.580	-.603383	1.078663
IMPORTER_FE44	-.386962	.4207978	-0.92	0.358	-1.211711	.4377865
IMPORTER_FE45	-1.530827	.3913274	-3.91	0.000	-2.297815	-.7638396
IMPORTER_FE46	2.428055	.3313221	7.33	0.000	1.778676	3.077435
IMPORTER_FE47	-1.691468	.3986629	-4.24	0.000	-2.472833	-.9101031
IMPORTER_FE48	2.568886	.3078183	8.35	0.000	1.965573	3.172198
IMPORTER_FE49	-.5649605	.4017027	-1.41	0.160	-1.352283	.2223623
IMPORTER_FE50	-.6991042	.6304629	-1.11	0.267	-1.934789	.5365804

IMPORTER_FE51	2.463101	.313083	7.87	0.000	1.849469	3.076732
IMPORTER_FE52	-.4437215	.2957553	-1.50	0.134	-1.023391	.1359482
IMPORTER_FE53	-1.172499	.3348303	-3.50	0.000	-1.828754	-.5162437
IMPORTER_FE54	-1.029175	.4144601	-2.48	0.013	-1.841502	-.216848
IMPORTER_FE55	.0612704	.3655276	0.17	0.867	-.6551504	.7776913
IMPORTER_FE56	-.4518825	.4062521	-1.11	0.266	-1.248122	.3443569
IMPORTER_FE57	-.6500048	.3791909	-1.71	0.086	-1.393205	.0931958
IMPORTER_FE58	.4150848	.374584	1.11	0.268	-.3190863	1.149256
IMPORTER_FE59	-1.561375	.4223922	-3.70	0.000	-2.389249	-.7335016
IMPORTER_FE60	-2.346299	.336131	-6.98	0.000	-3.005104	-1.687494
IMPORTER_FE61	-1.019694	.3418932	-2.98	0.003	-1.689793	-.349596
IMPORTER_FE62	2.696661	.5581016	4.83	0.000	1.602802	3.79052
IMPORTER_FE63	1.603123	.3999639	4.01	0.000	.8192086	2.387038
IMPORTER_FE64	-.771536	.5357976	-1.44	0.150	-1.82168	.278608
IMPORTER_FE65	.4495597	.3741773	1.20	0.230	-.2838143	1.182934
IMPORTER_FE66	2.818693	.2993814	9.42	0.000	2.231916	3.40547
IMPORTER_FE67	.8944467	.3891153	2.30	0.022	.1317948	1.657099
IMPORTER_FE68	.1225801	.3527251	0.35	0.728	-.5687483	.8139085
IMPORTER_FE69	.2299671	.3461931	0.66	0.507	-.4485589	.908493
IMPORTER_FE70	.2590632	.3429863	0.76	0.450	-.4131775	.9313039
IMPORTER_FE71	1.070018	.4055119	2.64	0.008	.2752298	1.864807
IMPORTER_FE72	.0065797	.428201	0.02	0.988	-.8326787	.8458381
IMPORTER_FE73	2.129452	.3707181	5.74	0.000	1.402858	2.856046
IMPORTER_FE74	1.01317	.4568384	2.22	0.027	.1177828	1.908556
IMPORTER_FE75	-.2211516	.3303832	-0.67	0.503	-.8686908	.4263876
IMPORTER_FE76	.9764075	.3794067	2.57	0.010	.232784	1.720031
IMPORTER_FE77	1.519371	.5190569	2.93	0.003	.5020377	2.536703
IMPORTER_FE78	1.347993	.3040401	4.43	0.000	.7520852	1.9439
IMPORTER_FE79	-1.965427	.4550288	-4.32	0.000	-2.857267	-1.073587

```
        IMPORTER_FE80 |   1.453535    .352815     4.12   0.000     
.7620299    2.145039
        IMPORTER_FE81 |   2.081496   .3274965     6.36   0.000     
1.439614    2.723377
        IMPORTER_FE82 |  -.9383148   .3722574    -2.52   0.012    -
1.667926   -.2087038
        IMPORTER_FE83 |  -2.347805   .4295837    -5.47   0.000    -
3.189773   -1.505836
        IMPORTER_FE84 |  -3.318203    .416084    -7.97   0.000    -
4.133713   -2.502694
        IMPORTER_FE85 |   -1.01885   .4412778    -2.31   0.021    -
1.883739   -.1539615
        IMPORTER_FE86 |   1.670613    .365285     4.57   0.000     
.9546677    2.386559
        IMPORTER_FE87 |  -.8698555    .371904    -2.34   0.019    -
1.598774    -.140937
        IMPORTER_FE88 |   1.792274   .2914942     6.15   0.000     
1.220956    2.363592
        IMPORTER_FE89 |  -1.592844   .4568417    -3.49   0.000    -
2.488237   -.6974503
        IMPORTER_FE90 |  -.6749238   .4628053    -1.46   0.145    -
1.582005    .2321579
        IMPORTER_FE91 |   .2492461   .4240463     0.59   0.557    -
.5818695    1.080362
        IMPORTER_FE92 |   4.224588   .3435785    12.30   0.000     
3.551187     4.89799
        IMPORTER_FE93 |  -.9504328   .3665432    -2.59   0.010    -
1.668844   -.2320213
        IMPORTER_FE94 |  -1.240122   .3709889    -3.34   0.001    -
1.967247   -.5129967
        IMPORTER_FE95 |   1.894389   .4840246     3.91   0.000     
.9457184     2.84306
        IMPORTER_FE96 |   .9449762   .2997229     3.15   0.002     
.3575302    1.532422
log_current_time_cost |  -.0600218    .018673    -3.21   0.001    -
.0966202   -.0234233
------------------------------------------------------------------------
----------------

. predict tradehat_BLN, mu

. 
. * STATA commands to obtain baseline trade costs:
. * Construct the variables for export- and import-fixed effects
. forvalues i = 1 (1) $N_1 {
  2. capture replace IMPORTER_FE`i' = IMPORTER_FE`i' * 
(exp(_b[IMPORTER_FE`i']))
  3. }

. 
. forvalues i = 1 (1) $J_1 {
  2. capture replace EXPORTER_FE`i' = EXPORTER_FE`i' * 
(exp(_b[EXPORTER_FE`i']))
  3. }

. 
. 
. replace EXPORTER_FE$J = EXPORTER_FE$J * exp(_b[EXPORTER_FE$J])
```

```
variable EXPORTER_FE57 was byte now float
(96 real changes made)

. replace IMPORTER_FE$N = IMPORTER_FE$N * exp(0)
(0 real changes made)

.
. egen exp_pi_BLN = rowtotal(EXPORTER_FE1-EXPORTER_FE$J)

. egen exp_chi_BLN = rowtotal(IMPORTER_FE1-IMPORTER_FE$N)

. * Compute the variables of bilateral trade costs and multilateral
resistances
. generate tij_BLN = exp(_b[log_current_time_cost] *
log_current_time_cost )

. generate OMR_BLN = Y * E_deu / exp_pi_BLN

. generate IMR_BLN = E / (exp_chi_BLN * E_deu)

. * Compute the estimated international trade for given output and
expenditures
. generate tempXi_BLN = tradehat_BLN

. bysort exporter_2: egen Xi_BLN = sum(tempXi_BLN)

.
.
.
. * STATA commands to define counterfactual scenario of removing
international borders
. * Option 1: eliminate the border variable
. generate tij_CFL = exp(_b[log_current_time_cost]*
log_future_time_cost)


.
. * Generate the logged trade costs us
. generate ln_tij_CFL = log(tij_CFL)


.
. gen sigma = (1-_b[log_current_time_cost])


.
. ///gen sigma = 1.5
>
. ////////////////////////////Conditional general equilibrium
effects//////////////////////////////////
>
. * STATA commands to estimate the conditional gravity model:
. * Re-create a new set of exporter and importer fixed effects
. drop EXPORTER_FE* IMPORTER_FE*

. tabulate exporter_2, generate(EXPORTER_FE)

 exporter_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AG |         33        0.64        0.64
         AR |         92        1.80        2.44
```

```
         AU |         97        1.89        4.34
         BE |         96        1.88        6.21
         BJ |         65        1.27        7.48
         BR |         97        1.89        9.38
         CA |         97        1.89       11.27
         CL |         94        1.84       13.11
         CN |         96        1.88       14.98
         CO |         95        1.86       16.84
         DE |         95        1.86       18.70
         DK |         96        1.88       20.57
         EE |         96        1.88       22.45
         EG |         94        1.84       24.28
         ES |         97        1.89       26.18
         FI |         96        1.88       28.05
         FR |         96        1.88       29.93
         GB |         97        1.89       31.82
         GH |         91        1.78       33.60
         GR |         97        1.89       35.50
         GY |         74        1.45       36.94
         HK |         93        1.82       38.76
         HR |         96        1.88       40.63
         IE |         97        1.89       42.53
         IL |         72        1.41       43.93
         IN |         97        1.89       45.83
         IS |         84        1.64       47.47
         IT |         94        1.84       49.31
         JP |         97        1.89       51.20
         KE |         93        1.82       53.02
         LK |         97        1.89       54.91
         LT |         97        1.89       56.81
         LV |         97        1.89       58.70
         MO |         30        0.59       59.29
         MT |         91        1.78       61.07
         MX |         87        1.70       62.77
         MY |         96        1.88       64.64
         MZ |         80        1.56       66.20
         NG |         81        1.58       67.79
         NL |         96        1.88       69.66
         NO |         97        1.89       71.56
         NZ |         96        1.88       73.43
         PA |         64        1.25       74.68
         PH |         96        1.88       76.56
         PK |         96        1.88       78.43
         PL |         97        1.89       80.33
         PT |         97        1.89       82.22
         RO |         96        1.88       84.10
         SE |         96        1.88       85.97
         TG |         65        1.27       87.24
         TR |         95        1.86       89.10
         TZ |         86        1.68       90.78
         UA |         93        1.82       92.60
         US |         96        1.88       94.47
         UY |         90        1.76       96.23
         ZA |         97        1.89       98.12
        ZZZ |         96        1.88      100.00
------------+-----------------------------------
      Total |      5,119      100.00
```

```
. tabulate importer_2, generate(IMPORTER_FE)

 importer_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AE |         57        1.11        1.11
         AG |         49        0.96        2.07
         AR |         51        1.00        3.07
         AU |         56        1.09        4.16
         BD |         54        1.05        5.22
         BE |         56        1.09        6.31
         BH |         52        1.02        7.33
         BJ |         52        1.02        8.34
         BM |         43        0.84        9.18
         BR |         55        1.07       10.26
         BS |         52        1.02       11.27
         CA |         57        1.11       12.39
         CI |         54        1.05       13.44
         CL |         53        1.04       14.48
         CM |         51        1.00       15.47
         CN |         57        1.11       16.59
         CO |         55        1.07       17.66
         CU |         52        1.02       18.68
         CW |         46        0.90       19.57
         DE |         56        1.09       20.67
         DK |         56        1.09       21.76
         DO |         53        1.04       22.80
         DZ |         52        1.02       23.81
         EE |         51        1.00       24.81
         EG |         55        1.07       25.88
         ES |         56        1.09       26.98
         FI |         53        1.04       28.01
         FR |         56        1.09       29.11
         GA |         53        1.04       30.14
         GB |         57        1.11       31.26
         GH |         55        1.07       32.33
         GN |         52        1.02       33.35
         GR |         56        1.09       34.44
         GU |         38        0.74       35.18
         GY |         49        0.96       36.14
         HK |         55        1.07       37.21
         HR |         52        1.02       38.23
         HT |         48        0.94       39.17
         ID |         55        1.07       40.24
         IE |         57        1.11       41.36
         IL |         53        1.04       42.39
         IN |         57        1.11       43.50
         IQ |         51        1.00       44.50
         IR |         43        0.84       45.34
         IS |         50        0.98       46.32
         IT |         56        1.09       47.41
         JM |         53        1.04       48.45
         JP |         56        1.09       49.54
         KE |         52        1.02       50.56
         KH |         52        1.02       51.57
         KR |         57        1.11       52.69
         KW |         53        1.04       53.72
         LB |         52        1.02       54.74
         LK |         52        1.02       55.75
```

```
         LT |         51        1.00       56.75
         LV |         52        1.02       57.77
         LY |         49        0.96       58.72
         MA |         53        1.04       59.76
         MO |         46        0.90       60.66
         MR |         50        0.98       61.63
         MT |         51        1.00       62.63
         MX |         54        1.05       63.68
         MY |         57        1.11       64.80
         MZ |         50        0.98       65.77
         NG |         55        1.07       66.85
         NL |         56        1.09       67.94
         NO |         54        1.05       69.00
         NZ |         53        1.04       70.03
         PA |         53        1.04       71.07
         PE |         53        1.04       72.10
         PH |         55        1.07       73.18
         PK |         54        1.05       74.23
         PL |         55        1.07       75.31
         PT |         57        1.11       76.42
         QA |         55        1.07       77.50
         RO |         53        1.04       78.53
         RU |         53        1.04       79.57
         SA |         55        1.07       80.64
         SD |         46        0.90       81.54
         SE |         54        1.05       82.59
         SG |         56        1.09       83.69
         SN |         55        1.07       84.76
         SO |         44        0.86       85.62
         SY |         44        0.86       86.48
         TG |         49        0.96       87.44
         TH |         57        1.11       88.55
         TN |         51        1.00       89.55
         TR |         55        1.07       90.62
         TT |         51        1.00       91.62
         TZ |         52        1.02       92.64
         UA |         51        1.00       93.63
         US |         57        1.11       94.75
         UY |         51        1.00       95.74
         VE |         52        1.02       96.76
         VN |         56        1.09       97.85
         ZA |         56        1.09       98.95
        ZZZ |         54        1.05      100.00
------------+-----------------------------------
      Total |      5,119      100.00

. * Estimate the constrained gravity model with the PPML estimator
. ppml trade_value_USD EXPORTER_FE* IMPORTER_FE1-IMPORTER_FE$N_1,
cluster(pair_id) ///
> noconstant offset(ln_tij_CFL)

note: checking the existence of the estimates
WARNING: trade_value_USD has very large values, consider rescaling

Number of regressors excluded to ensure that the estimates exist: 0
Number of observations excluded: 0

note: starting ppml estimation
```

```
note: trade_value_USD has noninteger values

Iteration 1:   deviance =  2.25e+13
Iteration 2:   deviance =  1.54e+13
Iteration 3:   deviance =  1.41e+13
Iteration 4:   deviance =  1.39e+13
Iteration 5:   deviance =  1.39e+13
Iteration 6:   deviance =  1.39e+13
Iteration 7:   deviance =  1.39e+13
Iteration 8:   deviance =  1.39e+13
Iteration 9:   deviance =  1.39e+13
Iteration 10:  deviance =  1.39e+13
Iteration 11:  deviance =  1.39e+13
Iteration 12:  deviance =  1.39e+13
Iteration 13:  deviance =  1.39e+13
Iteration 14:  deviance =  1.39e+13
Iteration 15:  deviance =  1.39e+13
Iteration 16:  deviance =  1.39e+13
Iteration 17:  deviance =  1.39e+13
Iteration 18:  deviance =  1.39e+13
Iteration 19:  deviance =  1.39e+13

Number of parameters: 153
Number of observations: 5119
Pseudo log-likelihood: -1.276e+13
R-squared: .56420998
Option strict is: off
                             (Std. err. adjusted for 5,119 clusters in
pair_id)
------------------------------------------------------------------------
--------
              |               Robust
trade_value~D | Coefficient  std. err.      z    P>|z|     [95% conf.
interval]
--------------+---------------------------------------------------------
--------
 EXPORTER_FE1 |   12.38611   .5403807    22.92   0.000     11.32698
13.44524
 EXPORTER_FE2 |   19.69524   .3618842    54.42   0.000     18.98596
20.40452
 EXPORTER_FE3 |   21.22099   .4456168    47.62   0.000      20.3476
22.09438
 EXPORTER_FE4 |   21.19336   .3441947    61.57   0.000     20.51875
21.86797
 EXPORTER_FE5 |   15.72103   .5388261    29.18   0.000     14.66495
16.77711
 EXPORTER_FE6 |   21.31502   .3686278    57.82   0.000     20.59252
22.03752
 EXPORTER_FE7 |    21.7763   .6273215    34.71   0.000     20.54678
23.00583
 EXPORTER_FE8 |    20.0491   .4398368    45.58   0.000     19.18703
20.91116
 EXPORTER_FE9 |   23.49297   .2897836    81.07   0.000     22.92501
24.06094
EXPORTER_FE10 |   19.37108   .3308972    58.54   0.000     18.72253
20.01962
EXPORTER_FE11 |   22.61688    .301205    75.09   0.000     22.02653
23.20723
```

EXPORTER_FE12 |	19.92521	.3354109	59.41	0.000	19.26782	20.58261
EXPORTER_FE13 |	18.39074	.3983527	46.17	0.000	17.60998	19.1715
EXPORTER_FE14 |	19.1984	.3528937	54.40	0.000	18.50674	19.89005
EXPORTER_FE15 |	21.35915	.344137	62.07	0.000	20.68465	22.03365
EXPORTER_FE16 |	19.69948	.2972975	66.26	0.000	19.11679	20.28217
EXPORTER_FE17 |	21.70622	.3154061	68.82	0.000	21.08804	22.32441
EXPORTER_FE18 |	21.55289	.284369	75.79	0.000	20.99553	22.11024
EXPORTER_FE19 |	18.09738	.3680561	49.17	0.000	17.376	18.81875
EXPORTER_FE20 |	19.25887	.3683538	52.28	0.000	18.53691	19.98083
EXPORTER_FE21 |	17.91084	.3882447	46.13	0.000	17.1499	18.67179
EXPORTER_FE22 |	21.74312	.5872043	37.03	0.000	20.59222	22.89401
EXPORTER_FE23 |	18.04591	.402902	44.79	0.000	17.25623	18.83558
EXPORTER_FE24 |	20.77928	.3259869	63.74	0.000	20.14036	21.4182
EXPORTER_FE25 |	19.56082	.3282547	59.59	0.000	18.91746	20.20419
EXPORTER_FE26 |	21.51987	.2933519	73.36	0.000	20.94492	22.09483
EXPORTER_FE27 |	17.37183	.4457678	38.97	0.000	16.49814	18.24552
EXPORTER_FE28 |	21.70545	.2970938	73.06	0.000	21.12316	22.28774
EXPORTER_FE29 |	21.98981	.3032372	72.52	0.000	21.39548	22.58415
EXPORTER_FE30 |	17.1952	.3846133	44.71	0.000	16.44138	17.94903
EXPORTER_FE31 |	17.96731	.3086889	58.21	0.000	17.36229	18.57233
EXPORTER_FE32 |	19.05827	.3572565	53.35	0.000	18.35806	19.75848
EXPORTER_FE33 |	18.39929	.4005099	45.94	0.000	17.6143	19.18427
EXPORTER_FE34 |	15.4913	.8362754	18.52	0.000	13.85223	17.13037
EXPORTER_FE35 |	16.5914	.3954821	41.95	0.000	15.81627	17.36654
EXPORTER_FE36 |	21.79032	.7003566	31.11	0.000	20.41764	23.16299
EXPORTER_FE37 |	21.18352	.3273375	64.71	0.000	20.54195	21.82509
EXPORTER_FE38 |	17.58363	.3922693	44.83	0.000	16.8148	18.35246
EXPORTER_FE39 |	19.76426	.3422434	57.75	0.000	19.09348	20.43505
EXPORTER_FE40 |	21.79217	.3744397	58.20	0.000	21.05828	22.52605

EXPORTER_FE41 |	20.6343	.3752595	54.99	0.000	19.89881	21.3698
EXPORTER_FE42 |	19.27175	.3691143	52.21	0.000	18.5483	19.9952
EXPORTER_FE43 |	16.83475	.4641312	36.27	0.000	15.92507	17.74443
EXPORTER_FE44 |	19.76472	.3264869	60.54	0.000	19.12482	20.40463
EXPORTER_FE45 |	18.90687	.3109035	60.81	0.000	18.29751	19.51623
EXPORTER_FE46 |	21.11131	.406626	51.92	0.000	20.31434	21.90829
EXPORTER_FE47 |	19.80559	.406378	48.74	0.000	19.0091	20.60208
EXPORTER_FE48 |	19.83574	.3931995	50.45	0.000	19.06508	20.6064
EXPORTER_FE49 |	20.59773	.3155575	65.27	0.000	19.97924	21.21621
EXPORTER_FE50 |	15.59581	.4716168	33.07	0.000	14.67146	16.52016
EXPORTER_FE51 |	20.84315	.3189159	65.36	0.000	20.21809	21.46821
EXPORTER_FE52 |	17.31681	.464591	37.27	0.000	16.40622	18.22739
EXPORTER_FE53 |	18.92606	.3767674	50.23	0.000	18.18761	19.66451
EXPORTER_FE54 |	22.96422	.3490521	65.79	0.000	22.28009	23.64835
EXPORTER_FE55 |	17.56821	.4052802	43.35	0.000	16.77388	18.36255
EXPORTER_FE56 |	19.94524	.3115133	64.03	0.000	19.33469	20.5558
EXPORTER_FE57 |	19.00381	.3598053	52.82	0.000	18.29861	19.70902
IMPORTER_FE1 |	1.862506	.3081912	6.04	0.000	1.258462	2.466549
IMPORTER_FE2 |	-3.111257	.613295	-5.07	0.000	-4.313293	-1.909221
IMPORTER_FE3 |	.6189322	.3898779	1.59	0.112	-.1452145	1.383079
IMPORTER_FE4 |	1.866539	.3079372	6.06	0.000	1.262993	2.470085
IMPORTER_FE5 |	.448806	.4139006	1.08	0.278	-.3624242	1.260036
IMPORTER_FE6 |	2.30509	.3311008	6.96	0.000	1.656144	2.954035
IMPORTER_FE7 |	-1.160118	.3197486	-3.63	0.000	-1.786814	-.5334221
IMPORTER_FE8 |	-2.003433	.3840468	-5.22	0.000	-2.756151	-1.250715
IMPORTER_FE9 |	-3.546557	.5500326	-6.45	0.000	-4.624601	-2.468513
IMPORTER_FE10 |	1.827886	.3058186	5.98	0.000	1.228493	2.42728
IMPORTER_FE11 |	-1.337888	.5825795	-2.30	0.022	-2.479722	-.1960528
IMPORTER_FE12 |	2.669997	.60652	4.40	0.000	1.481239	3.858754

```
IMPORTER_FE13 |  -.8642786    .366695    -2.36   0.018    -1.582988   -
.1455695
IMPORTER_FE14 |   .8093053   .3305673     2.45   0.014     .1614053
1.457205
IMPORTER_FE15 |  -1.441706   .4158765    -3.47   0.001    -2.256808   -
.6266027
IMPORTER_FE16 |    3.54079   .4099155     8.64   0.000     2.737371
4.34421
IMPORTER_FE17 |   .4717904   .3451122     1.37   0.172    -.2046172
1.148198
IMPORTER_FE18 |  -2.133977    .366303    -5.83   0.000    -2.851917   -
1.416036
IMPORTER_FE19 |  -3.341464    .492483    -6.78   0.000    -4.306713   -
2.376215
IMPORTER_FE20 |   3.288953   .3526452     9.33   0.000     2.597782
3.980125
IMPORTER_FE21 |   .9521189   .3671464     2.59   0.010     .2325252
1.671713
IMPORTER_FE22 |  -.3166695   .4831369    -0.66   0.512      -1.2636
.6302614
IMPORTER_FE23 |  -.0518429   .3369058    -0.15   0.878     -.712166
.6084803
IMPORTER_FE24 |  -.5162826   .4061448    -1.27   0.204    -1.312312
.2797465
IMPORTER_FE25 |   .5747465    .298608     1.92   0.054    -.0105145
1.160007
IMPORTER_FE26 |   2.321041   .3236569     7.17   0.000     1.686686
2.955397
IMPORTER_FE27 |   .5051185   .3667914     1.38   0.168    -.2137795
1.224016
IMPORTER_FE28 |   2.767245   .3507542     7.89   0.000      2.07978
3.454711
IMPORTER_FE29 |  -2.553735   .3611095    -7.07   0.000    -3.261496   -
1.845973
IMPORTER_FE30 |   2.826509   .2910645     9.71   0.000     2.256033
3.396985
IMPORTER_FE31 |  -.6279887   .4355769    -1.44   0.149    -1.481704
.2257264
IMPORTER_FE32 |  -1.774329   .4101647    -4.33   0.000    -2.578237   -
.9704211
IMPORTER_FE33 |   .6257516   .3149911     1.99   0.047     .0083805
1.243123
IMPORTER_FE34 |  -4.061189   .4586551    -8.85   0.000    -4.960137   -
3.162242
IMPORTER_FE35 |  -2.176745   .3820707    -5.70   0.000     -2.92559
-1.4279
IMPORTER_FE36 |   2.483312   .4991367     4.98   0.000     1.505022
3.461602
IMPORTER_FE37 |  -.3332047   .3911938    -0.85   0.394    -1.099931
.4335211
IMPORTER_FE38 |  -2.560182   .4566955    -5.61   0.000    -3.455289   -
1.665075
IMPORTER_FE39 |   1.454312    .376338     3.86   0.000     .7167028
2.191921
IMPORTER_FE40 |   1.109543   .3946906     2.81   0.005     .3359642
1.883123
IMPORTER_FE41 |   .8462483   .3000359     2.82   0.005     .2581887
1.434308
```

```
IMPORTER_FE42 |    2.31599   .3074054     7.53   0.000     1.713486
2.918493
IMPORTER_FE43 |    .239245   .4292435     0.56   0.577    -.6020569
1.080547
IMPORTER_FE44 |  -.3852785   .4212404    -0.91   0.360    -1.210894
.4403375
IMPORTER_FE45 |   -1.54217   .3912123    -3.94   0.000    -2.308932    -
.7754076
IMPORTER_FE46 |    2.42693   .3311013     7.33   0.000     1.777983
3.075876
IMPORTER_FE47 |  -1.693903   .3990869    -4.24   0.000    -2.476099    -
.9117067
IMPORTER_FE48 |   2.554231   .3087478     8.27   0.000     1.949096
3.159365
IMPORTER_FE49 |  -.5635285   .4019871    -1.40   0.161    -1.351409
.2243517
IMPORTER_FE50 |  -.6971261   .6308904    -1.10   0.269    -1.933649
.5393965
IMPORTER_FE51 |   2.448371   .3154425     7.76   0.000     1.830115
3.066627
IMPORTER_FE52 |  -.4421168   .2958663    -1.49   0.135    -1.022004
.1377705
IMPORTER_FE53 |  -1.173356   .3349656    -3.50   0.000    -1.829876    -
.5168353
IMPORTER_FE54 |  -1.027156   .4146306    -2.48   0.013    -1.839817    -
.2144951
IMPORTER_FE55 |    .056157   .3679002     0.15   0.879    -.6649141
.7772281
IMPORTER_FE56 |  -.4569208    .408139    -1.12   0.263    -1.256859
.3430168
IMPORTER_FE57 |  -.6531881   .3794542    -1.72   0.085    -1.396905
.0905284
IMPORTER_FE58 |   .4142332    .375111     1.10   0.269    -.3209708
1.149437
IMPORTER_FE59 |  -1.569308   .4248092    -3.69   0.000    -2.401919
-.736697
IMPORTER_FE60 |  -2.347599   .3354149    -7.00   0.000       -3.005    -
1.690198
IMPORTER_FE61 |  -1.024181   .3419191    -3.00   0.003     -1.69433    -
.3540316
IMPORTER_FE62 |   2.694731    .558136     4.83   0.000     1.600805
3.788658
IMPORTER_FE63 |   1.604737   .4003894     4.01   0.000     .8199887
2.389486
IMPORTER_FE64 |  -.7704953   .5356309    -1.44   0.150    -1.820313
.279322
IMPORTER_FE65 |   .4485374   .3734785     1.20   0.230     -.283467
1.180542
IMPORTER_FE66 |   2.817309   .2995225     9.41   0.000     2.230255
3.404362
IMPORTER_FE67 |   .8847747   .3896283     2.27   0.023     .1211173
1.648432
IMPORTER_FE68 |   .1196577   .3522636     0.34   0.734    -.5707663
.8100817
IMPORTER_FE69 |   .2270714   .3456313     0.66   0.511    -.4503535
.9044964
IMPORTER_FE70 |   .2573571   .3425061     0.75   0.452    -.4139426
.9286568
```

```
IMPORTER_FE71 |   1.066043   .4071655     2.62   0.009     .2680128    
1.864072
IMPORTER_FE72 |   .0083051     .42877     0.02   0.985    -.8320687    
.8486788
IMPORTER_FE73 |   2.119479   .3704354     5.72   0.000     1.393439    
2.845519
IMPORTER_FE74 |   1.011546   .4572409     2.21   0.027     .1153701    
1.907722
IMPORTER_FE75 |  -.2195466   .3300614    -0.67   0.506     -.866455    
.4273617
IMPORTER_FE76 |   .9764007   .3795592     2.57   0.010     .2324783    
1.720323
IMPORTER_FE77 |    1.57314   .5478294     2.87   0.004      .499414    
2.646866
IMPORTER_FE78 |   1.349598   .3043057     4.44   0.000     .7531696    
1.946026
IMPORTER_FE79 |  -1.963951   .4551506    -4.31   0.000    -2.856029   -
1.071872
IMPORTER_FE80 |    1.44753   .3543285     4.09   0.000     .7530592    
2.142001
IMPORTER_FE81 |   2.083547   .3274462     6.36   0.000     1.441764    
2.72533
IMPORTER_FE82 |  -.9395475   .3713813    -2.53   0.011    -1.667441   -
.2116534
IMPORTER_FE83 |  -2.346259   .4296999    -5.46   0.000    -3.188455   -
1.504063
IMPORTER_FE84 |  -3.319074   .4165999    -7.97   0.000    -4.135594   -
2.502553
IMPORTER_FE85 |   -1.01993   .4407429    -2.31   0.021     -1.88377   -
.1560896
IMPORTER_FE86 |   1.674719   .3669363     4.56   0.000     .9555373    
2.393901
IMPORTER_FE87 |  -.8722658   .3719381    -2.35   0.019    -1.601251   -
.1432805
IMPORTER_FE88 |   1.792511   .2915079     6.15   0.000     1.221166    
2.363856
IMPORTER_FE89 |  -1.594124   .4571867    -3.49   0.000    -2.490193   -
.6980542
IMPORTER_FE90 |  -.6734927   .4631195    -1.45   0.146     -1.58119    
.2342049
IMPORTER_FE91 |   .2492208   .4241405     0.59   0.557    -.5820794    
1.080521
IMPORTER_FE92 |   4.219702   .3521879    11.98   0.000     3.529426    
4.909977
IMPORTER_FE93 |  -.9513644   .3662122    -2.60   0.009    -1.669127   -
.2336017
IMPORTER_FE94 |  -1.241427   .3707315    -3.35   0.001    -1.968047   -
.5148068
IMPORTER_FE95 |   1.895967   .4845045     3.91   0.000     .9463555    
2.845578
IMPORTER_FE96 |    .946126   .2996153     3.16   0.002     .3588909    
1.533361
   ln_tij_CFL |          1  (offset)
-----------------------------------------------------------------------
--------

. predict tradehat_CD, mu
```

```
.
.
. * STATA commands to obtain conditional general equilibrium effects:
. * Construct the variables for export- and import-fixed effects
. forvalues i = 1 (1) $N_1 {
  2. capture eplace IMPORTER_FE`i' = IMPORTER_FE`i' *
(exp(_b[IMPORTER_FE`i']))
  3. }

.
. forvalues i = 1 (1) $J_1 {
  2. capture replace EXPORTER_FE`i' = EXPORTER_FE`i' *
(exp(_b[EXPORTER_FE`i']))
  3. }

.
. replace EXPORTER_FE$J = EXPORTER_FE$J * exp(_b[EXPORTER_FE$J])
variable EXPORTER_FE57 was byte now float
(96 real changes made)

. replace IMPORTER_FE$N = IMPORTER_FE$N * exp(0)
(0 real changes made)

. egen exp_pi_CD = rowtotal(EXPORTER_FE1-EXPORTER_FE$J)

. egen exp_chi_CD = rowtotal(IMPORTER_FE1-IMPORTER_FE$N)

. * Compute the conditional general equilibrium effects of multilateral
resistances
. generate OMR_CD = Y * E_deu / exp_pi_CD

. generate IMR_CD = E / (exp_chi_CD * E_deu)

. * Compute the conditional general equilibrium effects of trade
. generate tempXi_CD = tradehat_CD if exporter_2 != importer_2
(56 missing values generated)

. bysort exporter: egen Xi_CD = sum(tempXi_CD)

.
. ////////////////////////////Full endowment general equilibrium
effects/////////////////////////////////
>
.
. gen change_tij =  tij_BLN - tij_CFL

.
. gen phi = E / Y // As per page 13 of the Guide

. gen tradehat_1 = tradehat_BLN

.
. gen change_OMR_FULL_1 = 0.05

. gen change_IMR_FULL_1 = 0.05

.
. gen change_pricei_1 = 3
```

```
. gen change_pricej_1 = 3

.
.
. gen OMR_FULL_1 = OMR_BLN

. gen IMR_FULL_1 = IMR_BLN

. gen exp_pi_1 = exp_pi_BLN

. gen exp_chi_1 = exp_chi_BLN

. gen Y_1 = Y

. gen E_1 = E

.
.
.
. ** starting value for exp_py_j_1 **
. generate tempvar2 = exp_pi_1 if exporter_2 == importer_2
(5,063 missing values generated)

. bysort importer_2: egen exp_pi_j_1 = mean(tempvar2)
(2,102 missing values generated)

. ** starting value for tempE_deu_2
. egen double E_deu_1 = mean(E_deu)

. gen change_pricei_0 = 2

.
.
.
. * STATA commands to construct the iterative procedure to converge to
full endowment
. * general equilibrium effects:
. * Set the criteria of convergence
. local s = 3

. local sd_dif_change_p = 1

. local max_dif_change_p = 1

. local iter = 1

.
. while (`sd_dif_change_p' > 0.001) | (`max_dif_change_p' > 0.001) {
  2. local s_1 = `s' - 1
  3. local s_2 = `s' - 2
  4. local s_3 = `s' - 3
  5. * i. Create the new dependent variable and estimate the gravity
model with PPML
. generate trade_`s_1' = change_tij * tradehat_`s_2' *
change_pricei_`s_2' * ///
> change_pricej_`s_2' / (change_OMR_FULL_`s_2' * change_IMR_FULL_`s_2')
  6.
```

```
. //replace trade_`s_1' = tradehat_`s_2' if missing(trade_`s_1')
.
.
. di "At iteration _________________________`iter'
___________________________________________________"
  7.
. drop EXPORTER_FE* IMPORTER_FE*
  8. tabulate exporter_2, generate(EXPORTER_FE)
  9. tabulate importer_2, generate(IMPORTER_FE)
 10. recast double EXPORTER_FE*
 11. recast double IMPORTER_FE*
 12.
.
. capture ppml log(trade_`s_1') EXPORTER_FE* IMPORTER_FE1-
IMPORTER_FE$N_1, ///
> cluster(pair_id) offset(ln_tij_CFL) noconstant iter(30)
 13.
. **************************** FIX: ****************************
. *capture ppml log(trade_`s_1') EXPORTER_FE* IMPORTER_FE1-
IMPORTER_FE$N_1, ///
> *cluster(pair_id) offset(ln_tij_CFL) noconstant iter(30)
. *************************************************************
.
. predict tradehat_`s_1', mu
 14.
. * ii. Update output and expenditures
. bysort exporter_2: egen Y_`s_1' = total(tradehat_`s_1')
 15. //replace Y_`s_1' = Y_`s_2' if missing(Y_`s_1')
.
. generate tempE_`s_1' = phi * Y_`s_1'
 16. bysort importer_2: egen E_`s_1' = mean(tempE_`s_1')
 17. //replace E_`s_1' = E_`s_2' if missing(E_`s_1')
.
.
. generate tempE_deu_`s_1' = E_`s_1' if importer_2 == "ZZZ"
 18. egen double E_deu_`s_1' = mean(tempE_deu_`s_1')
 19. * iii. Update factory-gate prices and multilateral resistances
. forvalues i = 1 (1) $N {
 20.  capture replace IMPORTER_FE`i' = IMPORTER_FE`i' *
(exp(_b[IMPORTER_FE`i']))
 21. }
 22.
. forvalues i = 1 (1) $J {
 23. capture replace EXPORTER_FE`i' = EXPORTER_FE`i' *
(exp(_b[EXPORTER_FE`i']))
 24. }
 25.
. egen exp_pi_`s_1' = rowtotal(EXPORTER_FE1-EXPORTER_FE$J)
 26. egen exp_chi_`s_1' = rowtotal(IMPORTER_FE1-IMPORTER_FE$N)
 27. //replace exp_pi_`s_1' = exp_pi_`s_2' if missing(exp_pi_`s_1' )
. //replace exp_chi_`s_1' = exp_chi_`s_2' if missing(exp_chi_`s_1')
.
.
. generate tempvar1 = exp_pi_`s_1'
 28. bysort importer_2: egen exp_pi_j_`s_1' = mean(tempvar1)
 29.
. //replace exp_pi_j_`s_1' = exp_pi_j_`s_2' if missing(exp_pi_j_`s_1')
.
```

```
. generate change_pricei_`s_1' = ((exp_pi_`s_1' / exp_pi_`s_2') ///
> / (E_deu_`s_1' / E_deu_`s_2'))^(1/(1-sigma))
 30.
. generate change_pricej_`s_1' = ((exp_pi_j_`s_1' / exp_pi_j_`s_2') ///
> / (E_deu_`s_1' / E_deu_`s_2'))^(1/(1-sigma))
 31.
. gen double OMR_FULL_`s_1' = (Y_`s_1' * E_deu_`s_1') / exp_pi_`s_1'
 32. generate change_OMR_FULL_`s_1' = OMR_FULL_`s_1' / OMR_FULL_`s_2'
 33. gen double IMR_FULL_`s_1' = E_`s_1' / (exp_chi_`s_1' *
E_deu_`s_1')
 34. generate change_IMR_FULL_`s_1' = IMR_FULL_`s_1' / IMR_FULL_`s_2'
 35. * iv. Iterate until the change in factory-gate prices has
converged to zero
. generate dif_change_p_`s_1' = change_pricei_`s_2' -
change_pricei_`s_3'
 36. summarize dif_change_p_`s_1'
 37. local sd_dif_change_p = r(sd)
 38. local max_dif_change_p = abs(r(max))
 39. local s = `s' + 1
 40. drop temp*
 41. local iter = `iter' + 1
 42. display `sd_dif_change_p'
 43. display `max_dif_change_p'
 44. }
At iteration __________________________1
_____________________________________________________

 exporter_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AG |         33        0.64        0.64
         AR |         92        1.80        2.44
         AU |         97        1.89        4.34
         BE |         96        1.88        6.21
         BJ |         65        1.27        7.48
         BR |         97        1.89        9.38
         CA |         97        1.89       11.27
         CL |         94        1.84       13.11
         CN |         96        1.88       14.98
         CO |         95        1.86       16.84
         DE |         95        1.86       18.70
         DK |         96        1.88       20.57
         EE |         96        1.88       22.45
         EG |         94        1.84       24.28
         ES |         97        1.89       26.18
         FI |         96        1.88       28.05
         FR |         96        1.88       29.93
         GB |         97        1.89       31.82
         GH |         91        1.78       33.60
         GR |         97        1.89       35.50
         GY |         74        1.45       36.94
         HK |         93        1.82       38.76
         HR |         96        1.88       40.63
         IE |         97        1.89       42.53
         IL |         72        1.41       43.93
         IN |         97        1.89       45.83
         IS |         84        1.64       47.47
         IT |         94        1.84       49.31
         JP |         97        1.89       51.20
```

KE	93	1.82	53.02
LK	97	1.89	54.91
LT	97	1.89	56.81
LV	97	1.89	58.70
MO	30	0.59	59.29
MT	91	1.78	61.07
MX	87	1.70	62.77
MY	96	1.88	64.64
MZ	80	1.56	66.20
NG	81	1.58	67.79
NL	96	1.88	69.66
NO	97	1.89	71.56
NZ	96	1.88	73.43
PA	64	1.25	74.68
PH	96	1.88	76.56
PK	96	1.88	78.43
PL	97	1.89	80.33
PT	97	1.89	82.22
RO	96	1.88	84.10
SE	96	1.88	85.97
TG	65	1.27	87.24
TR	95	1.86	89.10
TZ	86	1.68	90.78
UA	93	1.82	92.60
US	96	1.88	94.47
UY	90	1.76	96.23
ZA	97	1.89	98.12
ZZZ	96	1.88	100.00
Total	5,119	100.00	

importer_2	Freq.	Percent	Cum.
AE	57	1.11	1.11
AG	49	0.96	2.07
AR	51	1.00	3.07
AU	56	1.09	4.16
BD	54	1.05	5.22
BE	56	1.09	6.31
BH	52	1.02	7.33
BJ	52	1.02	8.34
BM	43	0.84	9.18
BR	55	1.07	10.26
BS	52	1.02	11.27
CA	57	1.11	12.39
CI	54	1.05	13.44
CL	53	1.04	14.48
CM	51	1.00	15.47
CN	57	1.11	16.59
CO	55	1.07	17.66
CU	52	1.02	18.68
CW	46	0.90	19.57
DE	56	1.09	20.67
DK	56	1.09	21.76
DO	53	1.04	22.80
DZ	52	1.02	23.81
EE	51	1.00	24.81
EG	55	1.07	25.88

ES	|	56	1.09	26.98
FI	|	53	1.04	28.01
FR	|	56	1.09	29.11
GA	|	53	1.04	30.14
GB	|	57	1.11	31.26
GH	|	55	1.07	32.33
GN	|	52	1.02	33.35
GR	|	56	1.09	34.44
GU	|	38	0.74	35.18
GY	|	49	0.96	36.14
HK	|	55	1.07	37.21
HR	|	52	1.02	38.23
HT	|	48	0.94	39.17
ID	|	55	1.07	40.24
IE	|	57	1.11	41.36
IL	|	53	1.04	42.39
IN	|	57	1.11	43.50
IQ	|	51	1.00	44.50
IR	|	43	0.84	45.34
IS	|	50	0.98	46.32
IT	|	56	1.09	47.41
JM	|	53	1.04	48.45
JP	|	56	1.09	49.54
KE	|	52	1.02	50.56
KH	|	52	1.02	51.57
KR	|	57	1.11	52.69
KW	|	53	1.04	53.72
LB	|	52	1.02	54.74
LK	|	52	1.02	55.75
LT	|	51	1.00	56.75
LV	|	52	1.02	57.77
LY	|	49	0.96	58.72
MA	|	53	1.04	59.76
MO	|	46	0.90	60.66
MR	|	50	0.98	61.63
MT	|	51	1.00	62.63
MX	|	54	1.05	63.68
MY	|	57	1.11	64.80
MZ	|	50	0.98	65.77
NG	|	55	1.07	66.85
NL	|	56	1.09	67.94
NO	|	54	1.05	69.00
NZ	|	53	1.04	70.03
PA	|	53	1.04	71.07
PE	|	53	1.04	72.10
PH	|	55	1.07	73.18
PK	|	54	1.05	74.23
PL	|	55	1.07	75.31
PT	|	57	1.11	76.42
QA	|	55	1.07	77.50
RO	|	53	1.04	78.53
RU	|	53	1.04	79.57
SA	|	55	1.07	80.64
SD	|	46	0.90	81.54
SE	|	54	1.05	82.59
SG	|	56	1.09	83.69
SN	|	55	1.07	84.76
SO	|	44	0.86	85.62

SY	44	0.86	86.48
TG	49	0.96	87.44
TH	57	1.11	88.55
TN	51	1.00	89.55
TR	55	1.07	90.62
TT	51	1.00	91.62
TZ	52	1.02	92.64
UA	51	1.00	93.63
US	57	1.11	94.75
UY	51	1.00	95.74
VE	52	1.02	96.76
VN	56	1.09	97.85
ZA	56	1.09	98.95
ZZZ	54	1.05	100.00
Total	5,119	100.00	

(5,065 missing values generated)
(2,102 missing values generated)

Variable	Obs	Mean	Std. dev.	Min	Max
dif_change~2	5,119	1	0	1	1

0
1
(2,102 missing values generated)
At iteration __________________________2
____

exporter_2	Freq.	Percent	Cum.
AG	33	0.64	0.64
AR	92	1.80	2.44
AU	97	1.89	4.34
BE	96	1.88	6.21
BJ	65	1.27	7.48
BR	97	1.89	9.38
CA	97	1.89	11.27
CL	94	1.84	13.11
CN	96	1.88	14.98
CO	95	1.86	16.84
DE	95	1.86	18.70
DK	96	1.88	20.57
EE	96	1.88	22.45
EG	94	1.84	24.28
ES	97	1.89	26.18
FI	96	1.88	28.05
FR	96	1.88	29.93
GB	97	1.89	31.82
GH	91	1.78	33.60
GR	97	1.89	35.50
GY	74	1.45	36.94
HK	93	1.82	38.76
HR	96	1.88	40.63
IE	97	1.89	42.53
IL	72	1.41	43.93
IN	97	1.89	45.83
IS	84	1.64	47.47
IT	94	1.84	49.31

JP	97	1.89	51.20
KE	93	1.82	53.02
LK	97	1.89	54.91
LT	97	1.89	56.81
LV	97	1.89	58.70
MO	30	0.59	59.29
MT	91	1.78	61.07
MX	87	1.70	62.77
MY	96	1.88	64.64
MZ	80	1.56	66.20
NG	81	1.58	67.79
NL	96	1.88	69.66
NO	97	1.89	71.56
NZ	96	1.88	73.43
PA	64	1.25	74.68
PH	96	1.88	76.56
PK	96	1.88	78.43
PL	97	1.89	80.33
PT	97	1.89	82.22
RO	96	1.88	84.10
SE	96	1.88	85.97
TG	65	1.27	87.24
TR	95	1.86	89.10
TZ	86	1.68	90.78
UA	93	1.82	92.60
US	96	1.88	94.47
UY	90	1.76	96.23
ZA	97	1.89	98.12
ZZZ	96	1.88	100.00
Total	5,119	100.00	

importer_2	Freq.	Percent	Cum.
AE	57	1.11	1.11
AG	49	0.96	2.07
AR	51	1.00	3.07
AU	56	1.09	4.16
BD	54	1.05	5.22
BE	56	1.09	6.31
BH	52	1.02	7.33
BJ	52	1.02	8.34
BM	43	0.84	9.18
BR	55	1.07	10.26
BS	52	1.02	11.27
CA	57	1.11	12.39
CI	54	1.05	13.44
CL	53	1.04	14.48
CM	51	1.00	15.47
CN	57	1.11	16.59
CO	55	1.07	17.66
CU	52	1.02	18.68
CW	46	0.90	19.57
DE	56	1.09	20.67
DK	56	1.09	21.76
DO	53	1.04	22.80
DZ	52	1.02	23.81
EE	51	1.00	24.81

EG	55	1.07	25.88
ES	56	1.09	26.98
FI	53	1.04	28.01
FR	56	1.09	29.11
GA	53	1.04	30.14
GB	57	1.11	31.26
GH	55	1.07	32.33
GN	52	1.02	33.35
GR	56	1.09	34.44
GU	38	0.74	35.18
GY	49	0.96	36.14
HK	55	1.07	37.21
HR	52	1.02	38.23
HT	48	0.94	39.17
ID	55	1.07	40.24
IE	57	1.11	41.36
IL	53	1.04	42.39
IN	57	1.11	43.50
IQ	51	1.00	44.50
IR	43	0.84	45.34
IS	50	0.98	46.32
IT	56	1.09	47.41
JM	53	1.04	48.45
JP	56	1.09	49.54
KE	52	1.02	50.56
KH	52	1.02	51.57
KR	57	1.11	52.69
KW	53	1.04	53.72
LB	52	1.02	54.74
LK	52	1.02	55.75
LT	51	1.00	56.75
LV	52	1.02	57.77
LY	49	0.96	58.72
MA	53	1.04	59.76
MO	46	0.90	60.66
MR	50	0.98	61.63
MT	51	1.00	62.63
MX	54	1.05	63.68
MY	57	1.11	64.80
MZ	50	0.98	65.77
NG	55	1.07	66.85
NL	56	1.09	67.94
NO	54	1.05	69.00
NZ	53	1.04	70.03
PA	53	1.04	71.07
PE	53	1.04	72.10
PH	55	1.07	73.18
PK	54	1.05	74.23
PL	55	1.07	75.31
PT	57	1.11	76.42
QA	55	1.07	77.50
RO	53	1.04	78.53
RU	53	1.04	79.57
SA	55	1.07	80.64
SD	46	0.90	81.54
SE	54	1.05	82.59
SG	56	1.09	83.69
SN	55	1.07	84.76

```
         SO |         44        0.86       85.62
         SY |         44        0.86       86.48
         TG |         49        0.96       87.44
         TH |         57        1.11       88.55
         TN |         51        1.00       89.55
         TR |         55        1.07       90.62
         TT |         51        1.00       91.62
         TZ |         52        1.02       92.64
         UA |         51        1.00       93.63
         US |         57        1.11       94.75
         UY |         51        1.00       95.74
         VE |         52        1.02       96.76
         VN |         56        1.09       97.85
         ZA |         56        1.09       98.95
        ZZZ |         54        1.05      100.00
------------+-----------------------------------
      Total |      5,119      100.00
(5,065 missing values generated)

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
dif_change~3 |      5,119   -1.990801    .0652815  -2.100198  -1.719695
.06528145
1.7196947
At iteration __________________________3
_____________________________________________________

 exporter_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AG |         33        0.64        0.64
         AR |         92        1.80        2.44
         AU |         97        1.89        4.34
         BE |         96        1.88        6.21
         BJ |         65        1.27        7.48
         BR |         97        1.89        9.38
         CA |         97        1.89       11.27
         CL |         94        1.84       13.11
         CN |         96        1.88       14.98
         CO |         95        1.86       16.84
         DE |         95        1.86       18.70
         DK |         96        1.88       20.57
         EE |         96        1.88       22.45
         EG |         94        1.84       24.28
         ES |         97        1.89       26.18
         FI |         96        1.88       28.05
         FR |         96        1.88       29.93
         GB |         97        1.89       31.82
         GH |         91        1.78       33.60
         GR |         97        1.89       35.50
         GY |         74        1.45       36.94
         HK |         93        1.82       38.76
         HR |         96        1.88       40.63
         IE |         97        1.89       42.53
         IL |         72        1.41       43.93
         IN |         97        1.89       45.83
         IS |         84        1.64       47.47
         IT |         94        1.84       49.31
         JP |         97        1.89       51.20
```

KE	93	1.82	53.02
LK	97	1.89	54.91
LT	97	1.89	56.81
LV	97	1.89	58.70
MO	30	0.59	59.29
MT	91	1.78	61.07
MX	87	1.70	62.77
MY	96	1.88	64.64
MZ	80	1.56	66.20
NG	81	1.58	67.79
NL	96	1.88	69.66
NO	97	1.89	71.56
NZ	96	1.88	73.43
PA	64	1.25	74.68
PH	96	1.88	76.56
PK	96	1.88	78.43
PL	97	1.89	80.33
PT	97	1.89	82.22
RO	96	1.88	84.10
SE	96	1.88	85.97
TG	65	1.27	87.24
TR	95	1.86	89.10
TZ	86	1.68	90.78
UA	93	1.82	92.60
US	96	1.88	94.47
UY	90	1.76	96.23
ZA	97	1.89	98.12
ZZZ	96	1.88	100.00
Total	5,119	100.00	

importer_2	Freq.	Percent	Cum.
AE	57	1.11	1.11
AG	49	0.96	2.07
AR	51	1.00	3.07
AU	56	1.09	4.16
BD	54	1.05	5.22
BE	56	1.09	6.31
BH	52	1.02	7.33
BJ	52	1.02	8.34
BM	43	0.84	9.18
BR	55	1.07	10.26
BS	52	1.02	11.27
CA	57	1.11	12.39
CI	54	1.05	13.44
CL	53	1.04	14.48
CM	51	1.00	15.47
CN	57	1.11	16.59
CO	55	1.07	17.66
CU	52	1.02	18.68
CW	46	0.90	19.57
DE	56	1.09	20.67
DK	56	1.09	21.76
DO	53	1.04	22.80
DZ	52	1.02	23.81
EE	51	1.00	24.81
EG	55	1.07	25.88

ES	56	1.09	26.98
FI	53	1.04	28.01
FR	56	1.09	29.11
GA	53	1.04	30.14
GB	57	1.11	31.26
GH	55	1.07	32.33
GN	52	1.02	33.35
GR	56	1.09	34.44
GU	38	0.74	35.18
GY	49	0.96	36.14
HK	55	1.07	37.21
HR	52	1.02	38.23
HT	48	0.94	39.17
ID	55	1.07	40.24
IE	57	1.11	41.36
IL	53	1.04	42.39
IN	57	1.11	43.50
IQ	51	1.00	44.50
IR	43	0.84	45.34
IS	50	0.98	46.32
IT	56	1.09	47.41
JM	53	1.04	48.45
JP	56	1.09	49.54
KE	52	1.02	50.56
KH	52	1.02	51.57
KR	57	1.11	52.69
KW	53	1.04	53.72
LB	52	1.02	54.74
LK	52	1.02	55.75
LT	51	1.00	56.75
LV	52	1.02	57.77
LY	49	0.96	58.72
MA	53	1.04	59.76
MO	46	0.90	60.66
MR	50	0.98	61.63
MT	51	1.00	62.63
MX	54	1.05	63.68
MY	57	1.11	64.80
MZ	50	0.98	65.77
NG	55	1.07	66.85
NL	56	1.09	67.94
NO	54	1.05	69.00
NZ	53	1.04	70.03
PA	53	1.04	71.07
PE	53	1.04	72.10
PH	55	1.07	73.18
PK	54	1.05	74.23
PL	55	1.07	75.31
PT	57	1.11	76.42
QA	55	1.07	77.50
RO	53	1.04	78.53
RU	53	1.04	79.57
SA	55	1.07	80.64
SD	46	0.90	81.54
SE	54	1.05	82.59
SG	56	1.09	83.69
SN	55	1.07	84.76
SO	44	0.86	85.62

```
         SY |         44        0.86       86.48
         TG |         49        0.96       87.44
         TH |         57        1.11       88.55
         TN |         51        1.00       89.55
         TR |         55        1.07       90.62
         TT |         51        1.00       91.62
         TZ |         52        1.02       92.64
         UA |         51        1.00       93.63
         US |         57        1.11       94.75
         UY |         51        1.00       95.74
         VE |         52        1.02       96.76
         VN |         56        1.09       97.85
         ZA |         56        1.09       98.95
        ZZZ |         54        1.05      100.00
------------+-----------------------------------
      Total |      5,119      100.00
(5,065 missing values generated)

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
dif_change~4 |      5,119   -.0091994    .0652815  -.2803053   .1001984
.06528146
.10019839
At iteration __________________________4
_____________________________________________________

 exporter_2 |      Freq.     Percent        Cum.
------------+-----------------------------------
         AG |         33        0.64        0.64
         AR |         92        1.80        2.44
         AU |         97        1.89        4.34
         BE |         96        1.88        6.21
         BJ |         65        1.27        7.48
         BR |         97        1.89        9.38
         CA |         97        1.89       11.27
         CL |         94        1.84       13.11
         CN |         96        1.88       14.98
         CO |         95        1.86       16.84
         DE |         95        1.86       18.70
         DK |         96        1.88       20.57
         EE |         96        1.88       22.45
         EG |         94        1.84       24.28
         ES |         97        1.89       26.18
         FI |         96        1.88       28.05
         FR |         96        1.88       29.93
         GB |         97        1.89       31.82
         GH |         91        1.78       33.60
         GR |         97        1.89       35.50
         GY |         74        1.45       36.94
         HK |         93        1.82       38.76
         HR |         96        1.88       40.63
         IE |         97        1.89       42.53
         IL |         72        1.41       43.93
         IN |         97        1.89       45.83
         IS |         84        1.64       47.47
         IT |         94        1.84       49.31
         JP |         97        1.89       51.20
         KE |         93        1.82       53.02
```

LK	97	1.89	54.91
LT	97	1.89	56.81
LV	97	1.89	58.70
MO	30	0.59	59.29
MT	91	1.78	61.07
MX	87	1.70	62.77
MY	96	1.88	64.64
MZ	80	1.56	66.20
NG	81	1.58	67.79
NL	96	1.88	69.66
NO	97	1.89	71.56
NZ	96	1.88	73.43
PA	64	1.25	74.68
PH	96	1.88	76.56
PK	96	1.88	78.43
PL	97	1.89	80.33
PT	97	1.89	82.22
RO	96	1.88	84.10
SE	96	1.88	85.97
TG	65	1.27	87.24
TR	95	1.86	89.10
TZ	86	1.68	90.78
UA	93	1.82	92.60
US	96	1.88	94.47
UY	90	1.76	96.23
ZA	97	1.89	98.12
ZZZ	96	1.88	100.00
Total	5,119	100.00	

importer_2	Freq.	Percent	Cum.
AE	57	1.11	1.11
AG	49	0.96	2.07
AR	51	1.00	3.07
AU	56	1.09	4.16
BD	54	1.05	5.22
BE	56	1.09	6.31
BH	52	1.02	7.33
BJ	52	1.02	8.34
BM	43	0.84	9.18
BR	55	1.07	10.26
BS	52	1.02	11.27
CA	57	1.11	12.39
CI	54	1.05	13.44
CL	53	1.04	14.48
CM	51	1.00	15.47
CN	57	1.11	16.59
CO	55	1.07	17.66
CU	52	1.02	18.68
CW	46	0.90	19.57
DE	56	1.09	20.67
DK	56	1.09	21.76
DO	53	1.04	22.80
DZ	52	1.02	23.81
EE	51	1.00	24.81
EG	55	1.07	25.88
ES	56	1.09	26.98

FI	53	1.04	28.01
FR	56	1.09	29.11
GA	53	1.04	30.14
GB	57	1.11	31.26
GH	55	1.07	32.33
GN	52	1.02	33.35
GR	56	1.09	34.44
GU	38	0.74	35.18
GY	49	0.96	36.14
HK	55	1.07	37.21
HR	52	1.02	38.23
HT	48	0.94	39.17
ID	55	1.07	40.24
IE	57	1.11	41.36
IL	53	1.04	42.39
IN	57	1.11	43.50
IQ	51	1.00	44.50
IR	43	0.84	45.34
IS	50	0.98	46.32
IT	56	1.09	47.41
JM	53	1.04	48.45
JP	56	1.09	49.54
KE	52	1.02	50.56
KH	52	1.02	51.57
KR	57	1.11	52.69
KW	53	1.04	53.72
LB	52	1.02	54.74
LK	52	1.02	55.75
LT	51	1.00	56.75
LV	52	1.02	57.77
LY	49	0.96	58.72
MA	53	1.04	59.76
MO	46	0.90	60.66
MR	50	0.98	61.63
MT	51	1.00	62.63
MX	54	1.05	63.68
MY	57	1.11	64.80
MZ	50	0.98	65.77
NG	55	1.07	66.85
NL	56	1.09	67.94
NO	54	1.05	69.00
NZ	53	1.04	70.03
PA	53	1.04	71.07
PE	53	1.04	72.10
PH	55	1.07	73.18
PK	54	1.05	74.23
PL	55	1.07	75.31
PT	57	1.11	76.42
QA	55	1.07	77.50
RO	53	1.04	78.53
RU	53	1.04	79.57
SA	55	1.07	80.64
SD	46	0.90	81.54
SE	54	1.05	82.59
SG	56	1.09	83.69
SN	55	1.07	84.76
SO	44	0.86	85.62
SY	44	0.86	86.48

```
         TG |         49        0.96       87.44
         TH |         57        1.11       88.55
         TN |         51        1.00       89.55
         TR |         55        1.07       90.62
         TT |         51        1.00       91.62
         TZ |         52        1.02       92.64
         UA |         51        1.00       93.63
         US |         57        1.11       94.75
         UY |         51        1.00       95.74
         VE |         52        1.02       96.76
         VN |         56        1.09       97.85
         ZA |         56        1.09       98.95
        ZZZ |         54        1.05      100.00
------------+-----------------------------------
      Total |      5,119      100.00
(5,065 missing values generated)

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
dif_change~5 |      5,119           0           0          0          0
0
0

.
.
.
. * STATA commands to obtain full endowment general equilibrium
effects:
. * Define the last number of iterations
. local S = `s' - 2

. * Compute the full endowment general equilibrium of factory-gate
price
. generate change_pricei_FULL = ((exp_pi_`S'/exp_pi_BLN) ///
> / (E_deu_`S' / E_deu))^(1/(1-sigma))

. * Compute the full endowment general equilibrium of output
. generate Y_FULL = change_pricei_FULL * Y_2

. * Compute the full endowment general equilibrium of aggregate
expenditures
. generate tempE_FULL = phi * Y_FULL

. bysort importer_2: egen E_FULL = mean(tempE_FULL)

. * Compute the full endowment general equilibrium of the multilateral
resistances
. generate OMR_FULL = Y_FULL * E_deu_`S' / exp_pi_`S'

. generate IMR_FULL = E_`S' / (exp_chi_BLN * E_deu)

. * Compute the full endowment general equilibrium of trade
. generate X_FULL = (Y_FULL * E_FULL * tij_CFL) /(IMR_FULL * OMR_FULL)

. generate tempXi_FULL = X_FULL

. bysort exporter_2: egen Xi_FULL = sum(tempXi_FULL)
```

```
.
.
. * Ensure the data is sorted by exporter
. sort origin_id3

.
. * Create a new variable to store the significance indicator
. gen sig_change_tj = .
(5,119 missing values generated)

.
. * Get the list of unique exporters
. levelsof origin_id3, local(origin_id3)
`"ARG"' `"ATG"' `"AUS"' `"BEL"' `"BEN"' `"BGR"' `"BRA"' `"CAN"' `"CHL"'
`"CHN"' `"COL"' `"DEU"' `"DNK"' `"EGY"' `"ESP
> "' `"EST"' `"FIN"' `"FRA"' `"GBR"' `"GHA"' `"GRC"' `"GUY"' `"HKG"'
`"HRV"' `"IND"' `"IRL"' `"ISL"' `"ISR"' `"ITA"'
> `"JPN"' `"KEN"' `"LKA"' `"LTU"' `"LVA"' `"MAC"' `"MEX"' `"MLT"'
`"MOZ"' `"MYS"' `"NGA"' `"NLD"' `"NOR"' `"NZL"' `"P
> AK"' `"PAN"' `"PHL"' `"POL"' `"PRT"' `"ROU"' `"SWE"' `"TGO"' `"TUR"'
`"TZA"' `"UKR"' `"URY"' `"USA"' `"ZAF"'

.
. * Loop through each exporter
. foreach exp of local origin_id3 {
  2.     * Restrict the data to the current exporter
.     preserve
  3.     keep if origin_id3 == "`exp'"
  4.
.     * Perform a t-test for the null hypothesis that change_tj = 0
.     ttest change_tij == 0
  5.
.     * Capture the p-value from the t-test
.     local p_value = r(p)
  6.     display "`exp' - p-value: `p_value'"
  7.     restore
  8.     * Determine significance at the 5% level (or your chosen
significance level)
.     if `p_value' < 0.05 {
  9.         replace sig_change_tj = 1 if origin_id3 == "`exp'"
 10.     }
 11.     else {
 12.         replace sig_change_tj = 0 if origin_id3 == "`exp'"
 13.     }
 14.
. }
(5,027 observations deleted)

One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------------
change~j |      92   -.0001437    .0001174    .0011257   -.0003768
.0000894
```

```
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.2244
H0: mean = 0                                     Degrees of freedom =
91

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1120         Pr(|T| > |t|) = 0.2240          Pr(T > t) =
0.8880
ARG - p-value: .2239650922159405
(92 real changes made)
(5,086 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      33   -.0001856    .0002992    .0017187    -.000795
.0004238
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.6204
H0: mean = 0                                     Degrees of freedom =
32

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.2697         Pr(|T| > |t|) = 0.5394          Pr(T > t) =
0.7303
ATG - p-value: .5393940573193303
(33 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97    .0003277    .0002791    .0027484   -.0002262
.0008817
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
1.1744
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
```

```
 Pr(T < t) = 0.8784         Pr(|T| > |t|) = 0.2432          Pr(T > t) =
0.1216
AUS - p-value: .2431520384622442
(97 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0001775    .0005575    .0054619   -.0012842
.0009291
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.3185
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.3754         Pr(|T| > |t|) = 0.7508          Pr(T > t) =
0.6246
BEL - p-value: .7508267564024982
(96 real changes made)
(5,054 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      65   -.0002295    .0002044    .0016475   -.0006377
.0001788
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.1229
H0: mean = 0                                     Degrees of freedom =
64

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1328         Pr(|T| > |t|) = 0.2657          Pr(T > t) =
0.8672
BEN - p-value: .2656578714981294
(65 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
```

```
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+----------------------------------------------------------------
-------
change~j |      96   -.0001175    .0001555    .0015239   -.0004263
.0001912
--------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.7557
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.2259         Pr(|T| > |t|) = 0.4517          Pr(T > t) =
0.7741
BGR - p-value: .4517091064174927
(96 real changes made)
(5,022 observations deleted)

One-sample t test
--------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+----------------------------------------------------------------
-------
change~j |      97   -.0002379      .00015    .0014778   -.0005357
.0000599
--------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.5855
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0581         Pr(|T| > |t|) = 0.1161          Pr(T > t) =
0.9419
BRA - p-value: .1161436699399562
(97 real changes made)
(5,022 observations deleted)

One-sample t test
--------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+----------------------------------------------------------------
-------
change~j |      97   -.0012458    .0003267    .0032178   -.0018943   -
.0005973
--------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-3.8131
```

```
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0001         Pr(|T| > |t|) = 0.0002          Pr(T > t) =
0.9999
CAN - p-value: .0002425139771567
(97 real changes made)
(5,025 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      94   -.0003161    .0001217    .0011798   -.0005577   -
.0000744
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.5974
H0: mean = 0                                     Degrees of freedom =
93

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0055         Pr(|T| > |t|) = 0.0109          Pr(T > t) =
0.9945
CHL - p-value: .0109195166964422
(94 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0022256    .0011266    .0110383   -.0044621
.000011
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.9755
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0256         Pr(|T| > |t|) = 0.0511          Pr(T > t) =
0.9744
CHN - p-value: .0511150818540478
(96 real changes made)
(5,024 observations deleted)
```

```
One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      95   -.0006511     .000229    .0022319   -.0011057   -
.0001964
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.8433
H0: mean = 0                                     Degrees of freedom =
94

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0027         Pr(|T| > |t|) = 0.0055          Pr(T > t) =
0.9973
COL - p-value: .0054782738335077
(95 real changes made)
(5,024 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      95   -.0006085    .0004226    .0041187   -.0014476
.0002305
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.4401
H0: mean = 0                                     Degrees of freedom =
94

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0766         Pr(|T| > |t|) = 0.1532          Pr(T > t) =
0.9234
DEU - p-value: .1531716946883377
(95 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96    .0010217    .0008503    .0083317   -.0006665
.0027098
```

```
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
1.2015
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.8837         Pr(|T| > |t|) = 0.2325          Pr(T > t) =
0.1163
DNK - p-value: .2325459073061728
(96 real changes made)
(5,025 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      94    6.24e-07     .000228    .0022105   -.0004521
.0004534
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
0.0027
H0: mean = 0                                     Degrees of freedom =
93

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.5011         Pr(|T| > |t|) = 0.9978          Pr(T > t) =
0.4989
EGY - p-value: .9978222940291848
(94 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97    .0000675    .0003319    .0032687   -.0005913
.0007263
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
0.2034
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
```

```
 Pr(T < t) = 0.5804         Pr(|T| > |t|) = 0.8393          Pr(T > t) =
0.4196
ESP - p-value: .8392548984878334
(97 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0028119    .0006696    .0065604   -.0041412   -
.0014826
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-4.1996
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0001          Pr(T > t) =
1.0000
EST - p-value: .0000602845805122
(96 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0018842    .0004719    .0046236    -.002821   -
.0009473
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-3.9928
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0001         Pr(|T| > |t|) = 0.0001          Pr(T > t) =
0.9999
FIN - p-value: .0001286597922068
(96 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
```

```
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96    .0005714    .0006245    .0061192   -.0006685
.0018112
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
0.9149
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.8187         Pr(|T| > |t|) = 0.3626          Pr(T > t) =
0.1813
FRA - p-value: .3625818069289105
(96 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97    .0007817    .0006909    .0068042   -.0005896
.0021531
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
1.1315
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.8697         Pr(|T| > |t|) = 0.2607          Pr(T > t) =
0.1303
GBR - p-value: .2606557911096349
(97 real changes made)
(5,028 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      91    -.000191    .0001582    .0015091   -.0005053
.0001233
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.2075
```

```
H0: mean = 0                                     Degrees of freedom =
90

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1152         Pr(|T| > |t|) = 0.2304          Pr(T > t) =
0.8848
GHA - p-value: .2304038137690873
(91 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97   -.0001353    .0002095    .0020629   -.0005511
.0002805
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.6459
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.2600         Pr(|T| > |t|) = 0.5199          Pr(T > t) =
0.7400
GRC - p-value: .519916588959076
(97 real changes made)
(5,045 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      74   -.0001696    .0001684    .0014484   -.0005051
.000166
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.0072
H0: mean = 0                                     Degrees of freedom =
73

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1586         Pr(|T| > |t|) = 0.3172          Pr(T > t) =
0.8414
GUY - p-value: .3171775042652661
(74 real changes made)
(5,026 observations deleted)
```

```
One-sample t test
------------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------------
-------
change~j |      93   -.0025016    .0007044    .0067925   -.0039005   -
.0011027
------------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-3.5516
H0: mean = 0                                     Degrees of freedom =
92

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0003         Pr(|T| > |t|) = 0.0006          Pr(T > t) =
0.9997
HKG - p-value: .0006060611902721
(93 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------------
-------
change~j |      96   -.0000476    .0003031    .0029701   -.0006494
.0005542
------------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.1569
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.4378         Pr(|T| > |t|) = 0.8757          Pr(T > t) =
0.5622
HRV - p-value: .8756812599744372
(96 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------------
-------
change~j |      97    .0001588    .0000705    .0006946    .0000188
.0002988
```

```
--------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
2.2517
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.9867         Pr(|T| > |t|) = 0.0266          Pr(T > t) =
0.0133
IND - p-value: .0266190623553056
(97 real changes made)
(5,022 observations deleted)

One-sample t test
--------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+----------------------------------------------------------------
-------
change~j |      97   -.0013505    .0003889      .00383   -.0021224   -
.0005786
--------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-3.4728
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0004         Pr(|T| > |t|) = 0.0008          Pr(T > t) =
0.9996
IRL - p-value: .0007739782575191
(97 real changes made)
(5,035 observations deleted)

One-sample t test
--------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+----------------------------------------------------------------
-------
change~j |      84   -.0038392    .0004149    .0038023   -.0046644   -
.0030141
--------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-9.2541
H0: mean = 0                                     Degrees of freedom =
83

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
```

```
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) =
1.0000
ISL - p-value: 2.02559101948e-14
(84 real changes made)
(5,047 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      72   -.0004684    .0002489    .0021122   -.0009647
.000028
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.8816
H0: mean = 0                                     Degrees of freedom =
71

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0320         Pr(|T| > |t|) = 0.0640          Pr(T > t) =
0.9680
ISR - p-value: .06398932595299
(72 real changes made)
(5,025 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      94    -.000458    .0002475    .0023995   -.0009494
.0000335
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.8505
H0: mean = 0                                     Degrees of freedom =
93

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0337         Pr(|T| > |t|) = 0.0674          Pr(T > t) =
0.9663
ITA - p-value: .067420487444203
(94 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
```

```
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+------------------------------------------------------------
-------
change~j |      97   -.0068641    .0006405    .0063081   -.0081355   -
.0055928
----------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t = -
10.7170
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) =
1.0000
JPN - p-value: 4.32390557882e-18
(97 real changes made)
(5,026 observations deleted)

One-sample t test
----------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+------------------------------------------------------------
-------
change~j |      93   -.0000461    .0000516    .0004975   -.0001486
.0000563
----------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.8944
H0: mean = 0                                     Degrees of freedom =
92

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1867         Pr(|T| > |t|) = 0.3734          Pr(T > t) =
0.8133
KEN - p-value: .3734307347366859
(93 real changes made)
(5,022 observations deleted)

One-sample t test
----------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+------------------------------------------------------------
-------
change~j |      97    .0004008     .000225    .0022156   -.0000457
.0008474
----------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
1.7817
```

```
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.9610         Pr(|T| > |t|) = 0.0780          Pr(T > t) =
0.0390
LKA - p-value: .07796572219065
(97 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97    -.001537    .0008731    .0085991   -.0032701
.0001961
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.7604
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0408         Pr(|T| > |t|) = 0.0815          Pr(T > t) =
0.9592
LTU - p-value: .0815188902856916
(97 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97   -.0011819    .0007758    .0076407   -.0027218
.0003581
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.5234
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0655         Pr(|T| > |t|) = 0.1309          Pr(T > t) =
0.9345
LVA - p-value: .1309408973582531
(97 real changes made)
(5,089 observations deleted)
```

```
One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      30   -.0008819    .0019392    .0106216   -.0048481
.0030843
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.4548
H0: mean = 0                                     Degrees of freedom =
29

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.3263         Pr(|T| > |t|) = 0.6527          Pr(T > t) =
0.6737
MAC - p-value: .6526574260205333
(30 real changes made)
(5,032 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      87   -.0004508    .0001624    .0015151   -.0007737   -
.0001279
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.7756
H0: mean = 0                                     Degrees of freedom =
86

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0034         Pr(|T| > |t|) = 0.0068          Pr(T > t) =
0.9966
MEX - p-value: .0067594696257605
(87 real changes made)
(5,028 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      91   -.0019367    .0004509    .0043016   -.0028326   -
.0010408
```

```
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-4.2949
H0: mean = 0                                     Degrees of freedom =
90

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) =
1.0000
MLT - p-value: .000044050125608
(91 real changes made)
(5,039 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      80   -.0002105    .0000507    .0004538   -.0003115   -
.0001096
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-4.1499
H0: mean = 0                                     Degrees of freedom =
79

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0001          Pr(T > t) =
1.0000
MOZ - p-value: .0000832769307212
(80 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96    .0007474     .000412    .0040365   -.0000704
.0015653
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
1.8143
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
```

```
 Pr(T < t) = 0.9636         Pr(|T| > |t|) = 0.0728          Pr(T > t) =
0.0364
MYS - p-value: .0727934983390237
(96 real changes made)
(5,038 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      81   -.0001871    .0001603    .0014429   -.0005062
.0001319
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.1673
H0: mean = 0                                     Degrees of freedom =
80

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1233         Pr(|T| > |t|) = 0.2466          Pr(T > t) =
0.8767
NGA - p-value: .2465528070565056
(81 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0001775    .0005575    .0054619   -.0012842
.0009291
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.3185
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.3754         Pr(|T| > |t|) = 0.7508          Pr(T > t) =
0.6246
NLD - p-value: .7508246288805029
(96 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
```

```
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97   -.0022975    .0004792    .0047197   -.0032487   -
.0013462
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-4.7943
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) =
1.0000
NOR - p-value: 5.95963985584e-06
(97 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0013462    .0001786    .0017497   -.0017007   -
.0009917
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-7.5385
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) =
1.0000
NZL - p-value: 2.78985366524e-11
(96 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96    .0001317    .0000574    .0005625    .0000177
.0002457
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
2.2944
```

```
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.9880         Pr(|T| > |t|) = 0.0240          Pr(T > t) =
0.0120
PAK - p-value: .0239715155388018
(96 real changes made)
(5,055 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      64   -.0006786    .0002571    .0020567   -.0011923   -
.0001648
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.6395
H0: mean = 0                                     Degrees of freedom =
63

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0052         Pr(|T| > |t|) = 0.0105          Pr(T > t) =
0.9948
PAN - p-value: .0104530331643554
(64 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0011958    .0005644    .0055297   -.0023162   -
.0000754
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.1188
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0184         Pr(|T| > |t|) = 0.0367          Pr(T > t) =
0.9816
PHL - p-value: .0367139589321946
(96 real changes made)
(5,022 observations deleted)
```

```
One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97   -.0014884    .0007283    .0071729   -.0029341   -
.0000428
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.0437
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0219         Pr(|T| > |t|) = 0.0437          Pr(T > t) =
0.9781
POL - p-value: .0437199000483324
(97 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97   -.0003055    .0002485    .0024477   -.0007988
.0001878
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.2292
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1110         Pr(|T| > |t|) = 0.2220          Pr(T > t) =
0.8890
PRT - p-value: .2220048888430016
(97 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0001175    .0001555    .0015239   -.0004263
.0001912
```

```
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.7557
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.2259         Pr(|T| > |t|) = 0.4517          Pr(T > t) =
0.7741
ROU - p-value: .4517145570553848
(96 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0002659     .000675    .0066141    -.001606
.0010743
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.3938
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.3473         Pr(|T| > |t|) = 0.6946          Pr(T > t) =
0.6527
SWE - p-value: .6945797742731601
(96 real changes made)
(5,054 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      65   -.0003669    .0002055    .0016572   -.0007776
.0000437
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.7851
H0: mean = 0                                     Degrees of freedom =
64

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
```

```
 Pr(T < t) = 0.0395         Pr(|T| > |t|) = 0.0790          Pr(T > t) =
0.9605
TGO - p-value: .0789796243922941
(65 real changes made)
(5,024 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      95   -.0005571    .0002089    .0020357   -.0009718   -
.0001424
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-2.6672
H0: mean = 0                                     Degrees of freedom =
94

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0045         Pr(|T| > |t|) = 0.0090          Pr(T > t) =
0.9955
TUR - p-value: .0090059888367355
(95 real changes made)
(5,033 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      86    -.000024    .0000501    .0004646   -.0001236
.0000756
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-0.4790
H0: mean = 0                                     Degrees of freedom =
85

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.3166         Pr(|T| > |t|) = 0.6332          Pr(T > t) =
0.6834
TZA - p-value: .6331899170133291
(86 real changes made)
(5,026 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
```

```
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      93   -.0002307    .0002001    .0019293    -.000628
.0001666
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.1531
H0: mean = 0                                     Degrees of freedom =
92

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.1259         Pr(|T| > |t|) = 0.2519          Pr(T > t) =
0.8741
UKR - p-value: .2518568021363622
(93 real changes made)
(5,029 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      90   -.0001885    .0001241    .0011777   -.0004352
.0000582
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-1.5186
H0: mean = 0                                     Degrees of freedom =
89

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0662         Pr(|T| > |t|) = 0.1324          Pr(T > t) =
0.9338
URY - p-value: .1324146283810609
(90 real changes made)
(5,023 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      96   -.0013005    .0003192    .0031274   -.0019342   -
.0006668
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-4.0743
```

```
H0: mean = 0                                     Degrees of freedom =
95

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0001          Pr(T > t) =
1.0000
USA - p-value: .000095683251469
(96 real changes made)
(5,022 observations deleted)

One-sample t test
------------------------------------------------------------------------
-------
Variable |     Obs        Mean    Std. err.   Std. dev.   [95% conf.
interval]
---------+--------------------------------------------------------------
-------
change~j |      97   -.0002557    .0000517    .0005091   -.0003584   -
.0001531
------------------------------------------------------------------------
-------
    mean = mean(change_tij)                                       t =
-4.9471
H0: mean = 0                                     Degrees of freedom =
96

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean
> 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) =
1.0000
ZAF - p-value: 3.20649071155e-06
(97 real changes made)

.
.
. * STATA commands to construct the percentage change of the general
equilibrium indexes:
. * Construct the percentage changes on export/production side
. collapse(mean) OMR_BLN OMR_CD OMR_FULL change_pricei_FULL Xi_BLN
Xi_CD ///
> Xi_FULL Y_2 Y_FULL sigma sig_change_tj, by(origin_id3)

. * Change in full endowment general equilibrium factory-gate price
. generate change_price_FULL = (change_pricei_FULL - 1) / 1 * 100

. * Change in conditional and full general equilibrium outward
multilateral resistances
. generate change_OMR_CDL = (OMR_CD^(1/(1-sigma)) - OMR_BLN^(1/(1-
sigma))) / OMR_BLN^(1/(1-sigma)) * 100

. generate change_OMR_FULL = (OMR_FULL^(1/(1-sigma)) - OMR_BLN^(1/(1-
sigma))) / OMR_BLN^(1/(1-sigma)) * 100

. * Change in conditional and full general equilibrium international
trade
. generate change_Xi_CDL = (Xi_CD - Xi_BLN) / Xi_BLN * 100
```

```
. generate change_Xi_FULL = (Xi_FULL - Xi_BLN) / Xi_BLN * 100

.
.
.
.
.
. collapse(mean) Xi_BLN Xi_FULL, by( sig_change_tj)

. line  Xi_BLN Xi_FULL sig_change_tj

.
.
.
.
.
.
.
end of do-file

. log close
-----------------------------------------------------------------------
----------------------------------------------
```