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What is the impact of geopolitical fragmentation on global value chains? - a structural gravity approach

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Niklas Martin Kirsamer B.Sc.

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Abstract

This thesis examines the impact of geopolitical fragmentation on global value chains using a structural gravity framework. While most of the literature focuses on gross trade flows, this study analyzes trade in value added, which better reflects the structure of global value chains. The empirical analysis combines OECD Trade in Value Added (TiVA) data with a bilateral index of geopolitical distance presented by Kirsamer and Riha (2025) and estimates a structural gravity model using Poisson pseudo-maximum likelihood. To account for indirect trade routes within global value chains, the model incorporates a measure of the cost of global value chain integration, following Njike (2021). The results show a robust negative relationship between geopolitical distance and bilateral value-added trade. In the cross-section, a 0.1 increase in political distance is associated with about 9.26% lower value-added exports, while panel estimates indicate smaller but significant effects. Controlling for tariffs reduces the magnitude of the coefficients, suggesting that trade policy partly mediates the relationship between geopolitics and trade. Overall, the findings provide evidence of friend-shoring in global value chains.

Abstract

Diese Arbeit untersucht die Auswirkungen geopolitischer Fragmentierung auf globale Wertschöpfungsketten unter Verwendung eines strukturellen Gravitationsmodells. Während sich die meisten Veröffentlichungen auf Bruttohandelsströme konzentrieren, analysiert diese Studie den Handel mit Wertschöpfung, der die Struktur globaler Wertschöpfungsketten besser widerspiegelt. Die empirische Analyse kombiniert Daten der OECD zum Handel mit Wertschöpfung (TiVA) mit einem bilateralen Index der geopolitischen Distanz, der von Kirsamer und Riha (2025) entwickelt wurde, und schätzt das strukturelles Gravitationsmodell unter Verwendung der Poisson-Pseudo-Maximum-Likelihood-Methode. Um indirekte Handelswege innerhalb globaler Wertschöpfungsketten zu berücksichtigen, beinhaltet das Modell ein Maß für die Kosten der Integration in globale Wertschöpfungsketten nach Njike (2021). Die Ergebnisse zeigen eine robuste negative Beziehung zwischen geopolitischer Distanz und bilateralem Wertschöpfungshandel. Im Querschnitt ist ein Anstieg der politischen Distanz um 0,1 mit einem Rückgang der Wertschöpfungsexporte um etwa $9,26\%$ verbunden, während die Panelschätzungen geringere, aber signifikante Effekte anzeigen. Nachdem für Zölle kontrolliert wurde, verringert sich die Größe der Koeffizienten, was darauf hindeutet, dass die Handelspolitik die Beziehung zwischen Geopolitik und Handel teilweise beeinflusst. Insgesamt liefern die Ergebnisse Hinweise auf Friend-Shoring in globalen Wertschöpfungsketten.

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1 Introduction

The recent years have highlighted that the time of liberalization of economic flows that were significant for the period of globalization have come to an end. Many papers and reports, including Aiyar, Chen, et al. (2023), World Trade Organization (2023), Aiyar and A. Ilyina (2023) and Gopinath et al. (2025), have highlighted the risk of an increasingly fragmented world. Especially for European countries, geoeconomic risks emerged especially from value chain dependencies in crucial sectors such as critical minerals and energy. The Russian invasion of the Ukraine and the COVID-19 pandemic have exposed these issues. Furthermore, the relationship with the most important ally, the United States, has become increasingly difficult since the beginning of the second presidential term of Donald Trump. Under his presidency, tariffs, as well as financial and migration flows have become weapons that are used to achieve the geopolitical goals of the United States. The recent US-China trade war that turned into a US war on trade made it clear that while coming at the loss of the gains from trade, the trajectory of this policy will not change soon. On top of this, the emergence of new global players such as China and India poses an economic and political challenge. In the light of these geopolitical events, this master thesis aims to explore the effects of geopolitical fragmentation on global value chains. Compared to the existing literature, which focuses mainly on the conventional import and export measures (e.g. Abeliansky and Mayrhuber (2025), Gopinath et al. (2025), Bosone and Stamato (2024)), this paper uses a trade in value-added approach with data provided by the OECD TiVA database and argues that this way of measuring trade better represents the global production and value chain network. The thesis modifies a simple general equilibrium model of trade based on Krugman (1980) with an extension for value-added trade that accounts for all possible routes value-added can travel from exporter to importer, a method proposed by Njike (2021). The resulting measure is a scaling factor that enters the regression specification and indicates the capability of the exporter in a country pair, to circumvent direct bilateral trade cost. This way, the thesis provides a descriptive and empirical overview over key features of value-added trade, value chains and fragmentation.

Main findings suggest that geopolitical fragmentation, measured by a bilateral, political theory based index of geopolitical distance proposed by Kirsamer and Riha (2025), is connected to lower levels of value-added trade flows in the cross section. In the panel analysis, the thesis further finds that an increase in political distance statistically and economically significant reductions in value-added trade. Further, the cost of global value chain integration, which corresponds to the model extension proposed by Njike (2021), is an important amplifier of trade costs especially in the panel analysis and after controlling for tariffs. Another key finding includes that tariffs likely pose an omitted variable bias for value-added exports, as the introduction of tariffs into the regression significantly reduces the trade elasticity with respect to geopolitical fragmentation. Lastly, the thesis reveals some heterogeneity between time periods and along the geopolitical distribution of country pairs. In line with the current perception of global world politics, in recent years and during the peak of globalization efforts, geopolitical distance has its largest impact, especially for country pairs, which are neither geopolitically extremely distant or extremely close.

The remainder of the paper is structured as follows: In Section 2: Literature review, the thesis defines important concepts and describes the current state of research on fragmentation, global value chains and their interaction. Section 3: Method explains the data creation process and derives the empirical specification from the model of Krugman (1980) with the extension proposed by Njike (2021). In section 4: Empirical results, the thesis provides the descriptive and estimation results together with a small simulation and robustness and heterogeneity regressions. In Section 5, the thesis addresses limitations, before Section 6 concludes the thesis.

2 Literature review

This section presents an overview of the relevant literature and and defines important concepts used in the thesis such as geopolitical and geoeconomic fragmentation and trade in value added.

2.1 Fragmentation

As mentioned in the introduction, a more recent concern for trade comes from fragmentation. Before addressing further literature, defining the term is key to understanding the impact it has on global flows. This discussion is linked to the slowdown in growth of international trade flows that has started after the Great Financial Crisis (GFC) in 2008 and the discussion about de-globalization. Antràs (2020) analyzes how the COVID-19-Pandemic affects global value chains. The paper argues that sunk costs, economies of scale, and complementarities prevent widespread reshoring, but predicts regionalization due to the increasing importance of resilient global value chains. The paper notes that on the political side, increased skepticism towards globalization has led to the election of "champions" of protectionism (e.g. Trump, Orban, Farage), making it harder for deep trade agreements to be formed, even leading to a decline in regional integration (e.g. Brexit) and trade wars (e.g. China-USA 2018). The paper by Aiyar, Chen, et al. (2023) is more recent on the political behalf and adds that next to the pandemic, the war in Ukraine triggered geopolitical tensions through dislocations in the global value chains imposed by sanctions. The resulting surge of the energy prices in many European countries led to discussion about the resilience of global value chains and geo-economic dependencies. Aiyar and A. Ilyina (2023) also note that there has been an increase in the mentions of "national security" in country reports, and an increase in the key words "reshoring", "onshoring", and "near-shoring" in corporate earnings reports from 2018 onward. Furthermore, they identify international trade, cross-border migration, capital flows, especially foreign direct investment, and technology diffusion as transmission channels of geo-economic fragmentation. Aiyar and A. Ilyina (2023) come up with a definition that takes into consideration the political aspects and economic aspects described, and define geoeconomic fragmentation as *"a policy driven reversal of global economic integration often guided by strategic considerations"*.

With this definition and the transmission channels in mind, what is the impact of geoeconomic fragmentation on the real world economy? The 2023 World Trade Report (WTR) of the WTO, titled "Re-globalization for a secure, inclusive and sustainable future", addresses the increasing concerns regarding the risks of geoeconomic fragmentation in the global trading system. Worsening US-China relations, the Russian invasion of Ukraine and the COVID-19 pandemic have sparked a trend towards geopolitical bloc-formation. The report states that trade between countries with divergent policy stances is growing 4-6% slower than trade within politically aligned blocs. By this way, countries expect to increase the resilience of their global value chains (GVC) to political shocks. However, Mayer, Mejean, and Thoenig (2025) present a compelling case that instead of enhancing security or resilience, this actually increases the risk of conflict, as the opportunity cost of war are reduced through less exposure. Further, the World Trade Organization (2023) argues that economic fragmentation could lead to diminished prosperity, increased volatility, and reduced capacity to address global challenges. This is especially problematic for developing economies. Their simulations show that GDP growth in developing economies could fall 3–4 percentage points behind advanced economies under a "full geopolitical rivalry" scenario, increasing global inequality. Further empirical studies on the matter report similar results. Fernández-Villaverde, Mineyama, and Song (2024) who introduce a fragmentation index based on 16 indicators across trade, finance, and politics, finds that fragmentation has been rising since 2008, with strong negative GDP effects, especially for emerging economies. Bekkers and Góes (2023) use a general equilibrium model to estimate the long-run costs of fragmentation. They find global GDP losses between 5–12%, concentrated in developing economies. Aiyar, Presbitero, and Ruta (2023) estimate long-term GDP losses of up to 7% under moderate fragmentation and 12% under technological decoupling. Similar to the papers above, they also highlight the asymmetric burden on emerging economies. Hakobyan, Zymek, and Meleshchuk (2023) use a multi-country, multi-sector models to investigate the effects of fragmentation on per-capita income and welfare. They find that emerging markets are more exposed to welfare losses due to dependence on global value chains, with median incomes decreasing 80-120% more than advanced economy median incomes. In summary, the common consensus in the literature reports that fragmentation reduces overall trade and global income significantly, while at the same time hurting developing and emerging economies more than advanced economies.

At the center of many of these analyses are geopolitical fragmentation and bloc-formation scenarios used to quantify the effects on GDP, trade, financial flows and welfare. The term is closely related to geoeconomic fragmentation, but describes the political dimension of fragmentation. In the literature, it is seen as a driver for geoeconomic fragmentation. A common measure for geopolitical fragmentation is the Ideal Point Distance (IPD), a distance based index calculated based on the similarities in voting behavior of a country in the UN General Assembly. The measure has been invented by Bailey, Strezhnev, and Voeten (2017) and aims at capturing foreign policy preferences. It is convenient due to its bilateral, and simple nature. Additionally, it can be used in gravity estimation, the workhorse of international economics. Several papers have used it to investigate the impact of geopolitics on geo-economic fragmentation and global flows:

Aiyar and Ohnsorge (2024) examine how rising geoeconomic fragmentation affects global trade and finance. They introduce two new indices of geoeconomic vulnerability and connectedness combining the IPD with trade and financial data. They find that emerging markets are more vulnerable to geoeconomic fragmentation as they are more connected than advanced economies. Abeliansky and Mayrhuber (2025) investigate how geopolitical alignment affects trade, by using the IPD as a measure of geopolitical distance in a gravity framework. They find that greater political distance between countries reduces bilateral trade, especially after 2015. The impact is strongest for emerging markets and developing economies. Bosone and Stamato (2024) find similar results in a framework that also includes the IPD and the three-way fixed effects of gravity estimation, but also includes an IV-estimation with exposure to terrorism as an instrument to deal with the potential reverse causality issue of geopolitical distance. They provide robust evidence that geopolitical distance is now a significant trade friction, increasing in importance since 2018, suggesting friend-shoring. The effect is most pronounced for advanced economies, with trade between aligned nations rising. A 10% increase in political distance is associated with a decrease in bilateral trade of 2%. Further, Gopinath et al. (2025) compare today's fragmentation to the early Cold War using granular trade, FDI, and portfolio data in combination with the IPD data and the gravity setup. They find that since the Russian invasion of the Ukraine, trade and FDI between rival blocs fell by 11–12%, while flows within blocs strengthened. They also investigate the role of non-aligned connector countries and identify them as crucial intermediaries. Other papers that investigate geo-economic fragmentation using the IPD but on other dimensions than trade include Abeliansky, Belabed, and Mayrhuber (2024) and Grover and Vézina (2025), who focus on FDI flows and Raggl and Ramskogler (2025) who investigate friend-shoring in migration.

However, as described by Kirsamer and Riha (2025), the IPD itself has several issues. First, it is one-dimensional, capturing only foreign policy preferences, but ignores the institutional background that shapes international policy preferences. Further, the measure only captures long-term political interests, and under-represents the current political environment of countries. Therefore, Kirsamer and Riha (2025) turn to the theory of international relations and identify national interests, cooperation, interdependence and the divide between autocratic and democratic countries as key drivers of bilateral relations. Based on these determinants, they build a component proximity index of geopolitical fragmentation that yields a more nuanced view on bilateral relations. In this setup, geopolitical fragmentation corresponds to a decline in geopolitical proximity between countries. Through several policy channels, economies define their position in the global political world order to other countries. For the index used in the thesis, three channels are identified: First, bilateral representation, cooperation and interdependence, captured by the Level of Representation Index by Moyer (2024). The index contains information about bilateral missions, embassies, and ambassador representation. Second, the aforementioned IPD by Bailey, Strezhnev, and Voeten (2017) which covers national interests as well as foreign policy interest. And third, the Voice and Accountability Index, a measure developed by Kaufmann and Kraay (2024) that measures the perceived capabilities of democratic participation in a country. This index aims to capture the divide between democratic and autocratic countries.

2.2 Global Value Chains, Value Added and Trade Costs

Global value chains have received increased attention over the past years as for example by the World Development Report 2020 (WDR). In response, Antràs and Chor (2021) present a detailed overview of empirical and theoretical research, emphasizing the need to account for trade in value added, accurately measure GVCs, and reconsider the nature of trade costs in a GVC world. They report that GVC participation has increased from the 1990s up to 2008, where it stagnated. Small open economies, like Luxembourg and Denmark are heavily integrated, followed by less integrated large open economies like the US and Brazil. The World Bank (2020) adds that developing economies are often integrated only at the bottom of the GVCs, where the value-added is low. From the sectoral perspective, the manufacturing and mining sectors are heavily integrated, while services are less involved.

However, the traditional import and export measures are not enough to capture the full nature of the network of relations. Sebastien Miroudot and Yamano (2013) present three key problems of the conventional trade measures with respect to global value chains. The first issue relates to intermediate inputs and services: Double-counting. If trade is measured in aggregate gross terms, every time a good crosses borders, e.g. by being redirected through other countries or by reimporting intermediate goods, the value of its intermediate inputs is implicitly counted. A second problem arises when looking at the contribution of an export to the economy. Today, exports increasingly include intermediate inputs sourced from abroad and in many advanced economies, services provide the largest value added to a manufactured good. Therefore, gross exports fail to correctly identify the origin of value added. However the value added is an important factor to identify the contribution of an export to the real economy in terms of employment and income. The third problem relates to intra-firm trade. Often, production is fragmented vertically inside a multinational firm, leading to some of the value added along the chain being redirected to the parent company, underestimating the true value added. Two of these three problems can be solved by the value added export measure, which will be used as the dependent variable in the thesis. Johnson and Noguera (2012) define value added export from country i to country j in sector s at time t as $va_{ijst} \equiv r_{its}y_{ijst}$. r_{its} describes the ratio of value added to gross output produced by sector s in country i and y_{ijst} corresponds to the total exports from country i to j in sector s. Further, they provide a new decomposition of trade flows. Standard exports between two countries i and j consist of three components:

1. exports of final goods from i that are absorbed in j (absorption),
2. intermediate goods from i that are reflected back by j through final goods (reflection),
3. and intermediates from i to j that are redirected to third countries (redirection).

This definition of exports emphasizes the issue described earlier bySebastien Miroudot and Yamano (2013). Johnson and Noguera (2012) circumvent this by defining value-added trade between countries i and j consisting of net absorption and indirect exports:

1. exports of i (final and intermediate goods) absorbed in j minus intermediate goods exported to j used to produce final goods exported back to i (net absorption).
2. value added from i to third destinations that is embodied in final goods absorbed in j, but not produced in i (indirect exports).

There are a few limitations however, as presented by Antràs and Chor (2021): Value-added data is derived from World Input-Output Tables (WIOT), where imports have to be sorted according to country and use (intermediate vs. final good), often leading to measurement errors. Data availability also presents a significant issue, as for optimal quantification, granular sectoral data is needed. Subsequently, many flows are estimated or derived with models which rely on assumptions, which could misrepresent production/value-added realities.

Nonetheless, research on TiVA and especially trade costs is important. Antràs and Chor (2021) highlight the infant stage of the literature with respect to trade costs and emphasize their potential effect, especially on GVCs. For conventional measures of international trade, Anderson and Wincoop (2004) summarize evidence on a variety of trade costs. Sources of trade cost reported in the paper include policy barriers, such as tariffs and non tariff-barriers (e.g. subsidies), transportation cost, currency barriers, language barriers, contracting cost, insecurity and general information barriers. Johnson and Noguera (2012) show in a gravity setting that for value added exports, the common gravity trade cost parameters remain significant, but also highlight that third country barriers can affect the value added trade. Further, Antràs and Chor (2021) note that high tariffs on inputs could lead to magnifying cascading effects, as components cross borders multiple times before final assembly. Consequently, tariffs on intermediate goods hurt competitiveness more than tariffs on final goods. This picks up an issue first described by Noguera (2012), explained with regional trade agreements. By entering in a regional trade agreement, country i also inherits value added from the partner country j's trading partners k, meaning trade costs between third countries and partner countries matter as well. Generally speaking, a change in trade costs (tariffs, non-tariff barriers, regional trade agreements, etc.) between the partner country j and third country k cascades into the trade cost function between i and j. Noguera (2012) deals with the issue by deriving a gravity equation specifically for bilateral value-added trade. The result shows that value-added trade is dependent on the input-output structure of the world production, the economic masses of all other countries k that use i's value added to produce final goods that are shipped to j and bilateral trade costs between country i and other countries k, country j and other countries k, and countries $k \neq i$ and $l \neq j$ through which i's value added flows to country j. Empirically, Noguera (2012) estimates a first-difference gravity equation of value-added to keep the estimation traceable and comparable to the standard gravity equation for the conventional import/export measures. Heiland and Šváb (2025) further explore this issue and highlight that without addressing third-country trade costs, the structural gravity equation is misspecified in the case of free-trade agreements, leading to omitted variable bias in the estimation. While they advocate for a structural model approach when using value-added data to evaluate free-trade agreements, they also present papers that have at least addressed the issue empirically:

Laget et al. (2020) investigate the role of deep trade agreements in global value chains. They use a principal component analysis to summarize a vector of variables on the depth of preferential trade agreements and investigate its effect on value added trade. Third country trade costs are addressed by weighting their variable of interest with the share of value added from country i to country j that is embodied in country k's final products exported to country j and the share of value added from i that is embodied in intermediate inputs produced in k that are absorbed as final demand in country j after moving through multiple countries l. Similarly, Kang and Gapay (2024) estimate the effect of preferential trade agreements on forward and backward value-added separately. Forward GVC participation measures how much domestic value added (DVA) a country contributes to other countries' exports, backward GVC participation measures how much foreign value added (FVA) a country uses in producing its exports. Compared to Laget et al. (2020), they then add only the relevant of the two indirect effects into the regression. Njike (2021) is the only paper in the list that does not estimate the effect of trade agreements, but evaluates African exports with a structural gravity approach and trade in value-added data. To handle third country cascade effects, he estimates an inverse cost of value chain fragmentation parameter using gross export data for each country pair. It captures the sum of third countries' trade costs through which the value-added travels to the final destination. The estimated equation is derived from a theoretical modification of the standard gravity model by Anderson and Wincoop (2003).

2.3 Geopolitical Fragmentation and Global Value Chains

For the remainder of the thesis, fragmentation is characterized by two dimensions: Geopolitical and geo-economic. Based on the literature review, the thesis tries to explain the geo-economic fragmentation in global value chains represented by trade in value-added exports through geopolitical fragmentation, measured by the geopolitical fragmentation index of Kirsamer and Riha (2025). In one sentence, the thesis investigates *the connection of global economic integration in global value chains and bilateral foreign policy (decisions).* This section examines the channel through which geopolitical fragmentation and other trade costs affect global value chains. As highlighted previously, the theoretical foundation in terms of structural models underlying TiVA is quite small, with Blanchard, Bown, and Johnson (2025) being a notable exception. They estimate and calibrate a general equilibrium model of GVCs to explain patterns in foreign trade policy. To circumvent this issue, the thesis applies a theoretical trick to identify trade costs in a structural framework: As noted by Lanz, Sébastien Miroudot, and Nordås (2011) GVCs and TiVA can be seen as trade in tasks, where the value added corresponds to the value of that specific task. When thinking about trade in this manner, trade in value-added is just trade in varieties of a product. To provide a theoretical foundation, the thesis therefore needs a structural baseline model that incorporates this kind of assumption into the derivation. This essentially means that each sector in each country faces monopolistic competition. Therefore, the thesis uses the general equilibrium model developed by Krugman (1980) as a baseline model for the analysis of trade in value added. As emphasized in Antràs and Chor (2021), this model has been used in the trade literature as a baseline framework for trade policy studies under imperfect competition and intermediate input trade. An example includes Antràs, Fort, et al. (2024), who study optimal tariffs by extending the Krugman (1980) model.

In the model, gains from trade are realized due to economies of scale, incorporated through the assumption of monopolistic competition and decreasing average cost. This leads to firms differentiating their tasks, with in the end, each firm supplying one task to the global value chain. Exports correspond to the value-added by the task supplied from sector s in country i, transported to another country. Consequently, each country supplies a number of tasks n to the world. n can be interpreted as the degree of specialization of GVCs in the model, driven by the size of the country and the fixed cost. Trade costs will lead to differences in real wages, as prices of tasks between countries differ. Krugman shows that this favors workers in large economies, as increasing trade cost lead to near-shoring of activity to large markets. Further, the degree of specialization n remains unaffected by trade costs. This feature is another argument for the model as a theoretical lens for fragmentation: A common trade cost, according to Anderson and Wincoop (2003) for gross trade flows, and Noguera (2012) for value-added trade flows, is distance. In the model, distance leads to near-shoring of trade flows to the largest markets. With the same logic, when applying the political distance index by Kirsamer and Riha (2025), an increase in political distance leads to friend-shoring of activities to the largest markets. This creates clusters of countries similar to geo-economic blocs of countries, revolving around large leading economies, like the US and China, based on bilateral geopolitical relations. In short - Krugman (1980) can explain near-shoring, which allows the reinterpretation in the case of friend-shoring, defined as the relocation of value chain activities to geopolitically close or friendly economies (da Rocha, da Fonseca, and Kogut, 2025). A consequence from this key feature is that increasing trade costs also disproportionately hurt smaller economies, which in the light of the thesis, could be interpreted as emerging or developing countries. This fits to the overall consensus of the literature, as highlighted previously. With this insight, the model provides a suitable interpretation and framework for the research interest of the thesis. Another convenient feature of the model by Krugman (1980), is that it can be estimated by the structural gravity model. More on this in Section 3.2 and the appendix.

The question that remains is why political distance acts as a trade cost at all. First and foremost and already highlighted in Section 2.1, because it diminishes the gains from trade, which includes gains from specializations such as comparative advantage and economies of scale, or global competition. If countries have common foreign policy interests, cultural and political ties, or share the same political system, they likely work towards the same geopolitical goals, making economic cooperation feasible as an instrument to achieve them. This interpretation also works the opposite way. If countries do not have common foreign interests, or even conflicting ones, economic cooperation is less viable, resulting in lower trade flows. In some cases this could even lead to the manipulation of flows to strategically weaken geopolitical opponents. Examples include the US-China trade wars of 2018 and 2025. From the firms' perspective, these risks can be mitigated by choosing intermediate products from politically aligned countries or countries with similar political systems, which stands in opposition to the gains from trade. In the model of Krugman (1980) political distance between countries therefore diminishes economies of scale, as the degree of specialization n remains unchanged, leading to increased price levels and lower real wages. For the consumers' side, a potential explanation lies in the Home Bias, where in this case, home refers to politically aligned or close.

3 Method

This section describes the data creation and collection and derives the final empirical estimation specification from the structural gravity equation.

3.1 Data

Data is collected from several sources and combined into a panel, as fixed effects need to be estimated to successfully identify the structural parameters. The main trade and value-added data is acquired from the OECD (2025) TiVA database. It is derived from the OECD Inter-Country Input-Output (ICIO) tables and includes 81 economies from 1995 to 2022. Sectors are included as well, with a total of 7 economic activities based on the International Standard Industry Classification (ISIC) Rev. 4. The subdivison into sectors allows for the construction of a large panel, which enables precise estimation of parameters. Data on tariffs is acquired from the database constructed by Teti (2024) and matched with the TiVA data based on ISO 3 country codes, years and a conversion table between ISIC 3.3 and ISIC 4. Further, the bilateral, time-variant index of political fragmentation, based on Kirsamer and Riha (2025) is used, which includes the Level of Representation Index from the Diplometrics Diplomatic Representation Database, the Voice and Accountability Index by the World Bank, and the Ideal Point Distances calculated by Bailey, Strezhnev, and Voeten (2017). Data is matched based on country pairs and years. Standard gravity controls and further macroeconomic variables that may be of interest, such as GDP, distance, common border, common language are downloaded from the CEPII Gravity database.

The final dataset contains approximately 900 000 observations across 20 years and 79 countries plus a rest of the world (RoW) aggregate. To match the TiVA data with the geopolitical distance data, it is necessary to construct a political distance measure for the RoW aggregate. For each country-RoW pair, the average political distance to all countries not included in the TiVA dataset is computed, therefore creating a hypothetical country in the data. The same logic applies to tariffs. For each exporter-RoW pair, the average tariff faced in each sector over all non-TiVA countries is calculated and for the RoW-importer pairs, the average tariff applied to all non-Tiva countries. Further, as geopolitical distance measures for Taiwan and Hong Kong are missing, Taiwan is added to the RoW aggregate while Hong Kong is added to China. Table 1 presents summary statistics.

Table 1: Summary statistics

Statistic	N	Mean	Std. Dev.	Min	Max
Value-Added Exports	884,800	308.66	2,622.56	0.00	267,613.90
Pol. distance (t–1)	873,572	0.30	0.21	0.00	0.87
Tariff (%)	884,800	3.31	5.24	0.00	52.52

The analysis and simulations are conducted in R, by using the *dplyr* and *data.table* libraries for data cleaning and *ggplot2* for visualization of results. The gravity equation is estimated and visualized with $fixest$. The package allows simple implementation of PPML estimation with fixed effects and output visualization.

3.2 Empirical Specification

To identify the effect of geopolitical fragmentation on trade in value-added exports, the structural gravity equation as presented by Mayer and Head (2013) is used as a baseline regression model. It offers a simple estimation approach, while also taking into account general equilibrium effects and being applicable to wide range of theoretical models, including Krugman (1980), which serves as theoretical lens to the thesis. More formally, the model fulfills all requirements that enable a structural model to be determined by the structural gravity equation. According to Allen, Arkolakis, and Takahashi (2020), these include:

1. Constant elasticity of substitution (CES) type demand function.
2. Constant elasticity of substitution (CES) type supply function.

3. Market clearing.

4. Choice of a numeraire.

5. "Iceberg"-type bilateral trade frictions.

6. Exogenous trade deficit.

Mayer and Head (2013) further specify two conditions on the equations of interest:

7. The spatial allocation of trade flows originating from one economy must be representable as a share of total expenditure of said economy.

$$X_{ij} = \pi_{ij} X_j \tag{1}$$

where X_{ij} describes expenditure of importer j on goods of economy i, π_{ij} is the share, and X_j describes total expenditure of importer j. Further, $\pi_{i,j}$ is defined by

$$\pi_{ij} = \frac{S_i \phi_{ij}}{\Phi_j}, \qquad \text{where} \qquad \Phi_j = \sum_l S_l \phi_{lj} \tag{2}$$

where S_i summarizes the capabilities of exporter i as a supplier to all destinations. ϕ_{ij} captures the accessibility of market j to exporter i. This term essentially includes all kinds of trade costs, e.g. tariffs or distance. Φ_j measures the set of opportunities of consumers in the importer country j, or the degree of competition. This also comprises goods from exporters, which is why Φ_j is the weighted sum of exporters' capabilities (S_i) and trade costs (ϕ_{ij}), including "exports" from importer j to j.

8. The sum of of all exports by i, including what is consumed by i, needs to be equal to the total production Y_i. This is essentially a specification to the market clearing condition by Allen et al. (2019).

$$Y_i = \sum_j X_{ij} \tag{3}$$

Inserting the identities given by equations (1),(2) and solving for S_i, yields a definition for the capabilities of exporter i, determining them by the production capacity Y_i and a multilateral resistance term Ω_i, which is an index of market potential or access.

$$S_i = \frac{Y_i}{\Omega_i}, \qquad where \qquad \Omega_i = \sum_l \frac{\phi_{li} X_l}{\Phi_l} \tag{4}$$

Plugging equation (4) into (3), the share π_{ij}, and the resulting equation for π_{ij} into the initial equation (1) yields the structural gravity with the common multilateral resistance terms Ω_i,Φ_j, that can be used to estimate the parameters of trade:

$$X_{i,j} = \frac{Y_i}{\Omega_i}\frac{X_j}{\Phi_j}\phi_{ij} \tag{5}$$

In summary, trade flows are determined by the production capability of the exporter i, his relative market access Ω_i, the expenditure capacity of the importer j, its degree of consumer capabilities Φ_l and trade costs ϕ_{ij}.

You can find the formal proof that Krugman (1980) is compatible with the structural gravity equation in the appendix. To deal with heteroskedasticity and information contained in zero observations, the thesis estimates the structural gravity equation with the Pseudo Poisson Maximum Likelihood estimation (PPML). In the presence of heteroskedasticity, an OLS estimation approach would estimate the coefficient inconsistently. This has been highlighted by Silva and Tenreyro (2006). However, Mayer and Head (2013) also highlight that the PPML estimator is subject to small sample bias. Hence, the thesis uses sector level data to increase the sample size.

From the literature review, it is evident that to properly estimate the effect of geopolitical distance and other trade costs on value-added exports, one needs to account for indirect trade costs as value added traveling from country i to j through countries k. The thesis applies the approach presented by Njike (2021) who derives a scaling factor for the structural gravity equation, when applied on value-added trade. The following derivations are based on this paper. Consider the multi-country case of the gravity equation and the structural gravity definition by Mayer and Head (2013) as a starting point. This differs from Njike (2021), as he is using the gravity definition by Anderson and Wincoop (2003), however the logic stays equivalent. Let value-added exports be defined as

$$v_{ij} = \sum_k \pi_{ik} X_{kj} \tag{6}$$

where $v_{i,j}$ are the value-added exports from i to j. π_{ik} from now on represents the share of value added from i embodied in final output produced by k and X_{kj} are the gross exports from k to j. Inserting the gravity equation (5) for X_{kj} yields

$$v_{ij} = \sum_k \pi_{ik} \left(\frac{Y_k}{\Omega_k}\frac{X_j}{\Phi_j}\phi_{kj}\right) \tag{7}$$

In the next step, we pull the importer multilateral resistance term and expenditure out of the sum

$$v_{i,j} = \frac{X_j}{\Phi_j}\sum_k \pi_{ik}\frac{Y_k}{\Omega_k}\phi_{kj} \tag{8}$$

By dividing and multiplying the term with $\frac{Y_i}{\Omega_i}\phi_{ij}$, we can factor out the bilateral trade flows X_{ij} from the sum and receive

$$v_{ij} = \underbrace{\frac{Y_i}{\Omega_i}\frac{X_j}{\Phi_j}\phi_{ij}}_{X_{ij}} \times \underbrace{\frac{\sum_k \pi_{ik}\frac{Y_k}{\Omega_k}\phi_{kj}}{\frac{Y_i}{\Omega_i}\phi_{ij}}}_{T_{iKj}} \tag{9}$$

T_{iKj} is called the cost of fragmentation. To avoid confusion with geopolitical fragmentation, the thesis refers to the measure as cost of GVC integration. The measure relates the total cost of all the potential routes value added from i reaches j to the cost of the direct route and enters the regression specification multiplicatively as a scaling factor.

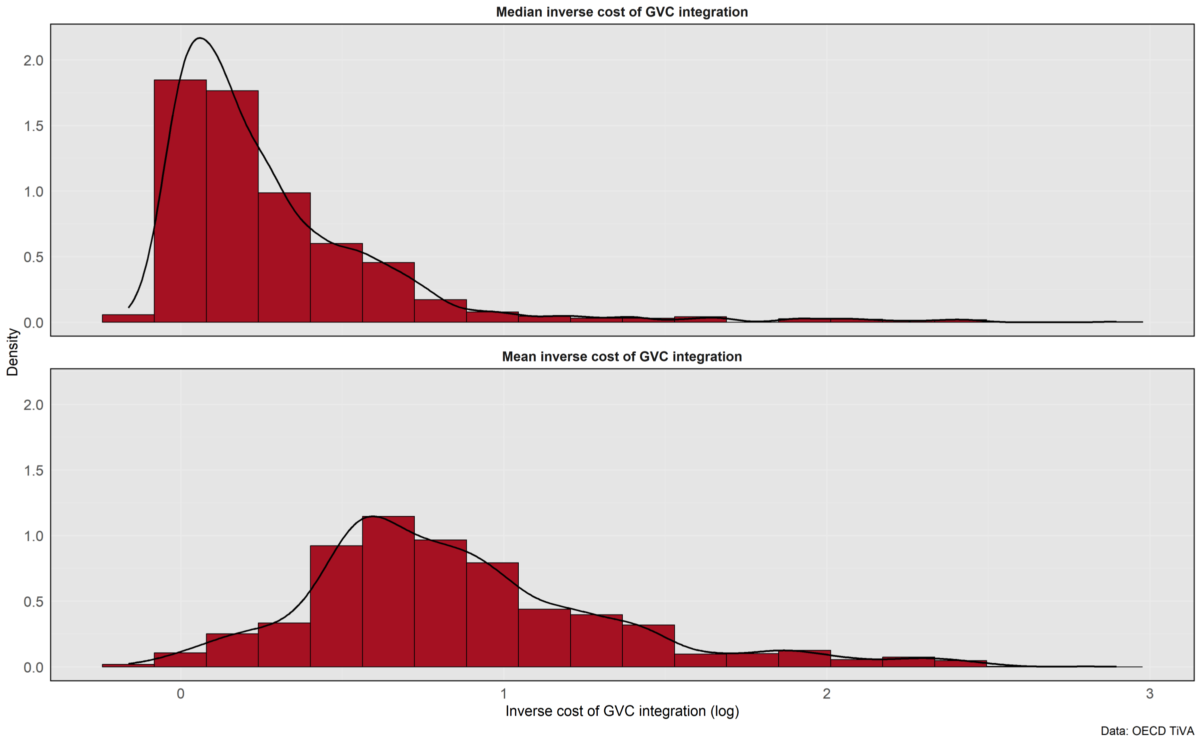
$$T_{iKn} = \frac{\sum_k \pi_{ik}\frac{Y_k}{\Omega_k}\phi_{k,j}}{\frac{Y_i}{\Omega_i}\phi_{ij}} \tag{10}$$

Essentially, it measures the cost of being integrated into the global value chain. The value of the measure is large, when an exporter of a country-pair faces high overall trade cost, relatively to exporting directly to the destination country or if the exporting country is economically speaking relatively small (indicated by $\frac{Y_i}{\Omega_i}$). If the value is high, the effect of the trade costs are amplified by this scaling factor. Conversely, if the value is small, the exporter is either well connected into the value chain, meaning it faces relatively low total trade cost relatively to directly exporting into the destination or the exporter is economically large. Hence, smaller values reduce the trade cost effect and reflect the capability of an exporter to bypass direct trade costs via indirect routes. In that sense, as also noted by Njike (2021), the measure is similar to a multilateral resistance term, but assigned to a country pair. In short, it measures the capability of an exporter in a bilateral relationship to circumvent the direct bilateral trade cost.

Empirically, the measure is constructed by estimating the structural gravity estimation with the same trade cost vector used in the final value-added regression, but with conventional exports as the dependent variable. The results of these intermediate regressions can be found in the appendix in Table 6, 7 and 8. By this way, one can obtain the MRTs Ω_{ik}. To identify Ω_{ik}, the thesis follows the guides on gravity estimation in the book by Yotov et al. (2016). The share of value-added from i embodied in final output of k and output/production Y_{ik} can be found in the OECD TiVA database (including conventional exports). In the regression specification, the thesis uses the log of T_{iKj} to improve the interpretation, as the measure can be large in absolute values. Figure 1 provides histograms showing the distribution of the median and mean log cost of GVC integration faced by each exporter and year and should give context for the interpretation. The distribution is left-leaning for both median and mean, although the mode of the median distribution is lower than the mode of the mean distribution. Note however, that the distribution of the cost of GVC integration changes with the trade cost vector estimated in the first step of the variable construction. Figure 1 displays the case of importer-time, exporter-time, importer-exporter-time fixed effects and geopolitical distance as independent variables.

Figure 1: Distribution of the cost of global value chain integration

Median and mean across destinations by exporter and year



The final regression specification estimated with the PPML estimator corresponds to

$$v_{ijst} = \exp\left[\underbrace{\pi_{ist}}_{\frac{Y_i}{\Omega_i}} + \underbrace{\chi_{jst}}_{\frac{X_j}{\Phi_j}} + \underbrace{\mu_{ijs} + \beta_1\theta_{ijst} + \beta_2 pol\_dis_{ijt-1}}_{\phi_{ij}} + \beta_3 lnT_{iKj}\right] \times \varepsilon_{ijst} \qquad (11)$$

where π_{ist} and χ_{jst} capture the multilateral resistance terms, μ_{ijs} collects unobserved bilateral trade costs and θ_{ijst} is a vector of control variables such as bilateral tariffs. pol_dis_{ijt-1} is the political distance between exporter i and importer j presented by Kirsamer and Riha (2025). This measure is scaled between zero and one, where higher values indicate higher distance. Additionally, to mitigate reverse causality concerns, following Abeliansky and Mayrhuber (2025), the variable is lagged by one year. Lastly, lnT_{iKj} represents the log cost of GVC integration. The log transformation is used to better interpret the coefficient.

4 Empirical Results

This section documents the empirical results. First, descriptive results are presented, followed by the estimation and simulation results.

4.1 Descriptive Analysis

Focusing on the cross-section first, Figure 2 shows the value added trade flows within and between geopolitical blocs of countries in 2022. Note that the geopolitical blocs have been determined by Kirsamer and Riha (2025) based on the same political distance index used as a regressor in this thesis. Further, the within bloc trade for the emerging and growth leading economies (EAGLES) bloc and the Eastern/China bloc are likely to be underestimated because the OECD data is biased towards the western bloc and includes many economies not part of the western bloc into the RoW aggregate. However, there are two key takeaways from this graph. First, the US/Western bloc likely holds the majority of value-added trade flows, which mirrors the stylized facts GVC integration. Many countries of the US/Western bloc are advanced economies who are specifically integrated at the top of the value chain, where value-added is high. Second, when summing up the between and within bloc flows, the within bloc value added flows dominate the between bloc flows. This highlights a key cross-sectional pattern in the data: Value-added trade flows correlate with geopolitical blocs of countries.

Figure 2: Value-added trade flows across geopolitical blocs, 2022
Billion US$

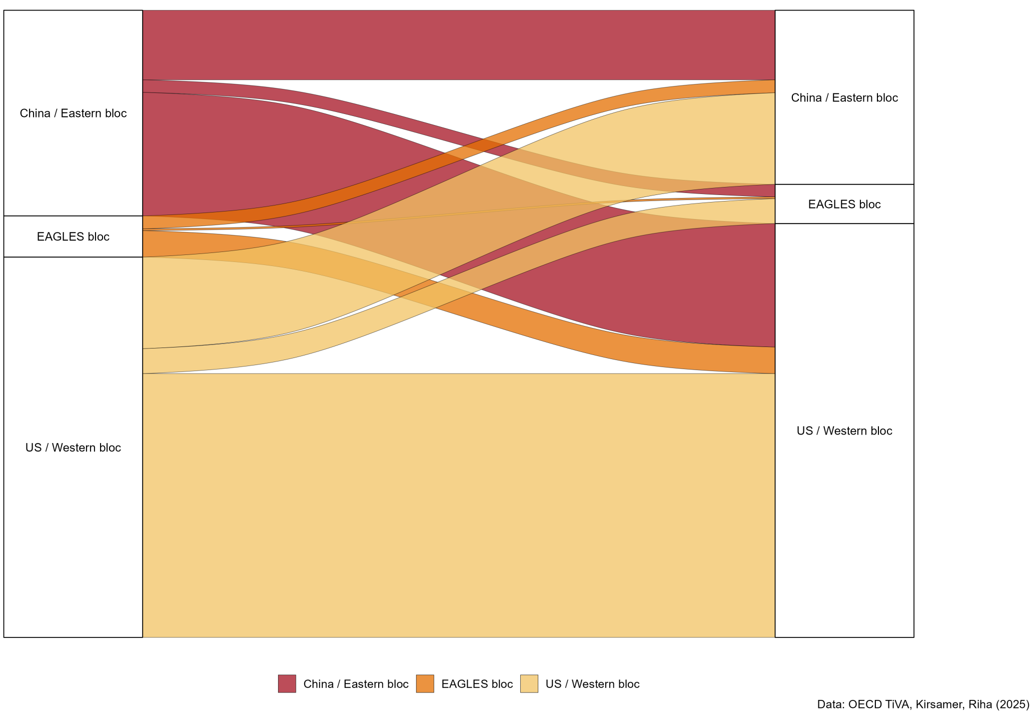


Figure 3 further highlights this, but emphasizes the time dimension of the relation. It depicts the development of the difference between within and between bloc value-added trade over time. For reference, the overall trend of value-added trade is shown in the background. Note that over the whole sample period, the between bloc trade never exceeds the within bloc trade, confirming what has already been shown in Figure 2 for 2022. However, from 2003 until 2012, this difference significantly decreases, which coincides with the era of globalization. The steep increase in value-added trade and economic integration during that time may be driven by geopolitical and geoeconomic integration between blocs. From 2012 onward, the difference stagnates and even increases again, emphasizing the increasing relative importance of within bloc trade in recent years. This development coincides with geopolitical events like the Arab Spring, the civil war in Syria, the Russia-Ukraine Crimea conflict, but also with geoeconomic events like the first US-China trade war and the Covid 19 pandemic. Concluding on this graph, the within and between bloc trade difference co-moves with perceived eras of political integration, but also political dis-integration. Taken together, Figure 2 and Figure 3 highlight a key hypothesis of the paper: There exists a relationship between political fragmentation and value-added trade.

Figure 3: Difference within and between-bloc value-added trade

Primary axis: difference (Billion US$), Secondary axis: total VA-exports index (2002=100)

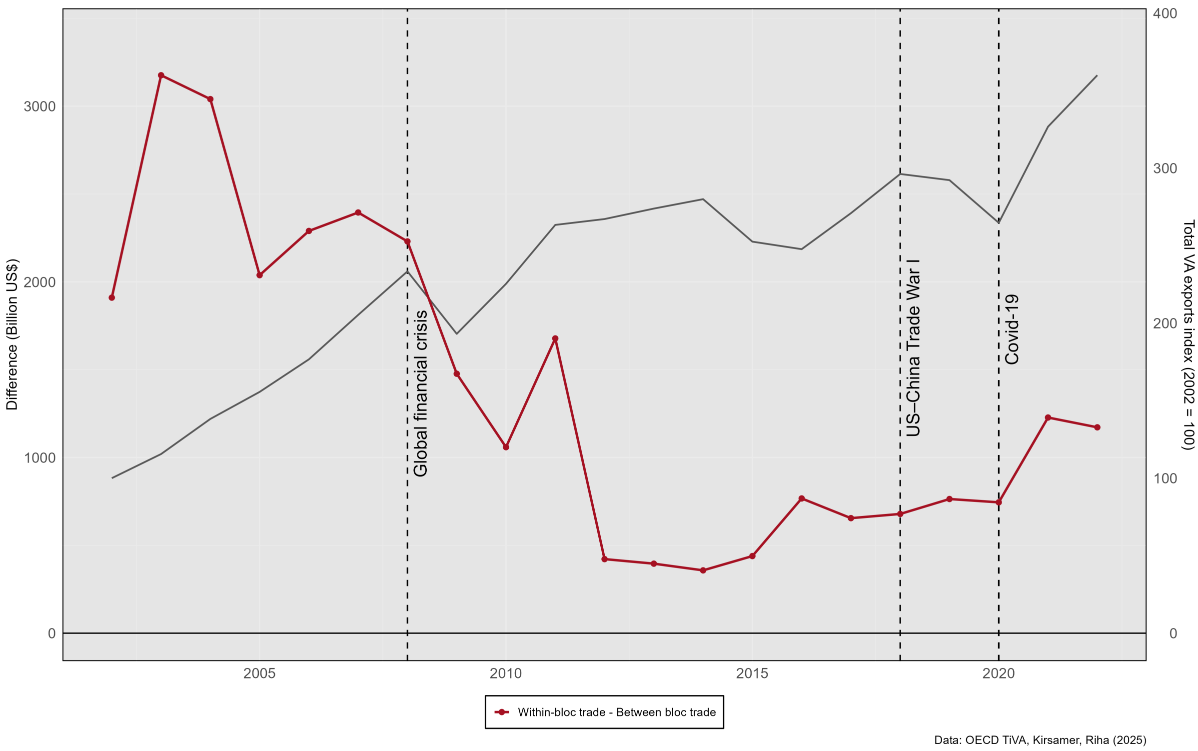
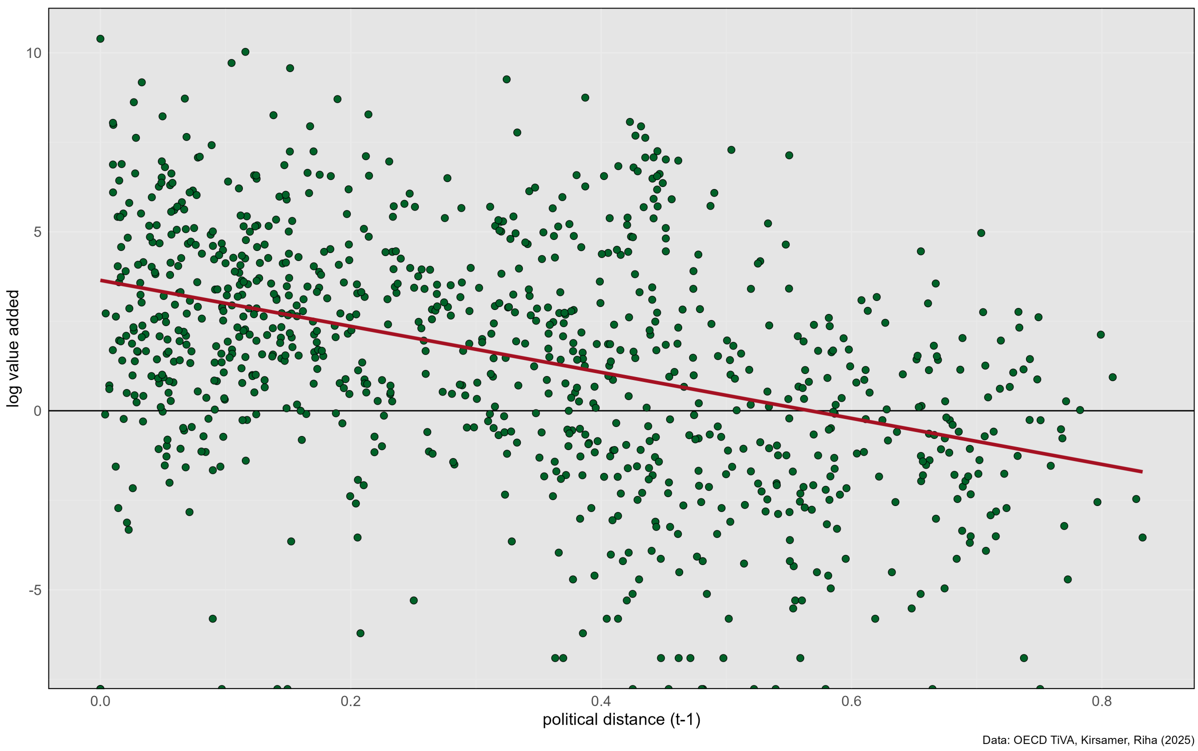


Figure 4, which shows a scatterplot of 1000 randomly drawn observations, with value-added exports on the y-axis, and political distance on then x-axis, further emphasizes that this relationship is negative. As suggested by the trend line, countries who are politically closer to each other trade less in value-added. Figure 5 focuses on some heterogeneities between country pairs. The graph shows the cumulative shares of value-added exports on the y-axis held by the cumulative share of country pairs, ranked by their political proximity to each other on the x-axis. In that sense, the graph is similar to a Lorenz-curve and therefore measures the concentration of value-added trade. The colored lines present different years, the dashed line represents the line of equality. If a distribution tracked this line, then all country pairs would hold equal shares of the total value-added trade. Overall, the concentration of value-added trade flows approximately decreased over time, as the distribution moved closer to the equality line, with the largest change over the time period 2003-2012. This mirrors the result of Figure 3. Especially integration between the middle percentiles of the political proximity distributions seems to have driven the decline in concentration. Interestingly, the bottom 20% of country pairs almost hold no share of bilateral value-added trade, throughout the whole sample, meaning even during the time of globalization, there has been no integration in value chains between politically distant countries. On the other hand, the top 40% in terms of political proximity almost hold equal shares of value-added trade in 2022. For those country pairs, political proximity may not be a factor at all.

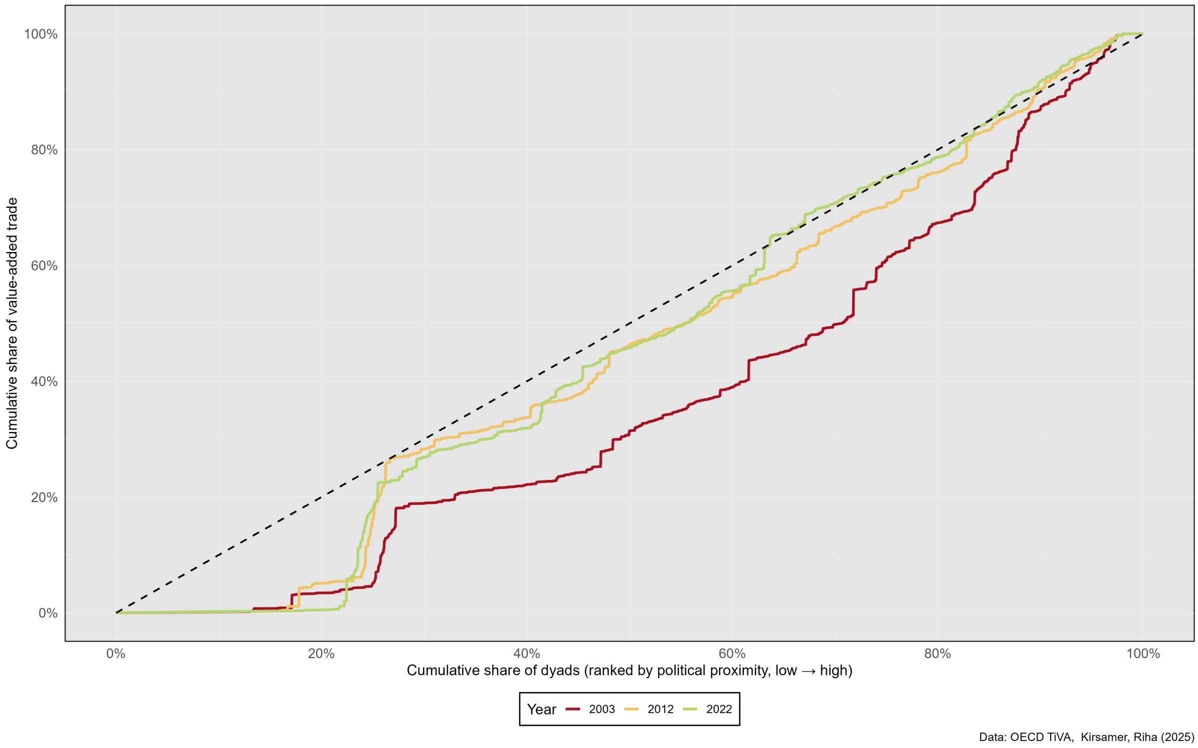
Figure 4: Political distance and value-added exports
Subsample (≈ 1000 observations, randomly drawn)



In sum, the descriptive analysis pictures global value chains measured by value-added exports as politically aligned over the whole sample period, but with a difference in importance over time. It presents preliminary descriptive evidence for friendshoring and fragmentation in global value chains especially in recent years, although over the whole sample period, alignment has decreased, especially during the time of globalization. This decline was mainly driven by integration between country pairs in the middle percentiles of the political distance distribution and by integration between geopolitical blocs of countries. For the estimation, political distance is expected to have a negative and significant effect on value-added exports.

Figure 5: Lorenz curve of value-added trade concentration

Selected years



4.2 Estimation Results

Table 2 shows the baseline regression results for the regression model given in equation (11), where column (1) and (2) display the cross-sectional results and column (3) and (4) the panel results. In (1) and (2), the thesis exploits the between variation by dropping the time subscript t in the regression specification, while (3) and (4) includes it to exploit the within variation in political distance. In column (2) and (4), the cost of GVC integration are included.

Turning to specification (1) and (2) first, the cross-sectional analysis reveals that country pairs with higher political distance have lower levels of bilateral value-added trade, indicated by a negative coefficient. The coefficient is statistically and economically significant, where a difference in political distance by 0.1 is associated with 9.26% lower levels of value-added exports in specification (1). This result is robust to the addition of the inverse cost of GVC integration, where the difference is associated with 9.26% lower levels of value-added trade as well. Overall, the coefficients from (1) and (2) empirically confirm what had already been shown descriptively in Figure 2 and Figure 4: Global value chains are politically aligned. Speaking in terms of Krugman (1980), geopolitical distance introduces differences in prices between domestic and foreign tasks, which diminishes the gains from increasing returns to scale, as consuming the domestic task is relatively cheaper for the domestic market. Potential reasons or channels for this are incorporated in the geopolitical distance measure: Unfitting foreign policy interest pose a threat to cooperation on the geoeconomic level, missing political interdependence makes it harder to employ common trade policies and especially for many democratic countries, trade with opposite political system is often seen by consumers and firms as a risk, which acts similar to a home bias. As a result, value added exports concentrate at geopolitically closer economies, leading to the pattern observable in the data, which corresponds to the definition of friendshoring in Section 2.3 of the thesis. Turning to the cost of GVC integration next, the coefficient is not statistically different from zero, but positive in magnitude. A difference in the log cost of GVC integration by one is connected to 9.84% higher levels of value-added trade. Interpreting this result is not straight-forward. The measure approximates the trade costs along all possible trading routes of value added between exporter i and importer j (See: numerator of equation (10)), relative to their direct bilateral trade cost (the denominator of equation (10)) and enters the regression specification as a scaling factor. The positive coefficient can be explained by the fact that the measure is large for country pairs, whose exporter faces relatively low direct bilateral trade cost compared to the trade costs along all other possible value-added trade routes. Therefore a positive coefficient indicates that exporters of country pairs which are not able to easily circumvent direct bilateral trade costs, have higher amplified trade costs. However, the coefficient is not significant in the cross-section, which leads to the interpretation that there are no significant differences between country pairs, and the main determinant for value-added exports are the direct trade cost elasticities. From the cross-sectional analysis the thesis therefore concludes that the coefficient confirms the geopolitical alignment patterns highlighted in the descriptive part of the analysis, while additionally showing patterns that are specific to global value chains. The results confirm the existence of friendshoring in the data, as lower levels of value-added exports are connected to higher geopolitical distance.

Table 2: Baseline regression

Dependent Variable:	Value-Added Exports			
Model:	(1)	(2)	(3)	(4)
Variables				
Pol. distance (t-1)	-2.610***	-2.609***	-0.1569***	-0.1666***
	(0.4645)	(0.4585)	(0.0466)	(0.0463)
Cost of GVC Integration		0.0939		0.1793***
		(0.0846)		(0.0163)
Fixed-effects				
Origin-Sector	Yes	Yes		
Destination-Sector	Yes	Yes		
Origin-Destination-Sector	Yes	Yes	Yes	Yes
Origin-Sector-Year			Yes	Yes
Destination-Sector-Year			Yes	Yes
Fit statistics				
Observations	860,152	729,816	860,152	729,193
Squared Correlation	0.90505	0.90523	0.99453	0.99456
Pseudo R^2	0.97431	0.97380	0.99502	0.99509
BIC	42,185,732.7	40,833,502.6	8,954,726.0	8,296,910.5

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1, Transformation:* $\left(e^{\beta_i} - 1\right) \times 100$

For the panel analysis in Column (3) and (4) of Table 2, the coefficient of political distance implies that an increase in political distance by 0.1 is connected to a decrease in value-added trade by 1.45% or 1.53% after controlling for the cost of GVC integration. Increases in political distance therefore significantly worsen the terms of trade, which increases the price differential in the importer country, making the exporter's tasks relatively more expensive compared to domestic and other competitors' products, leading to a decrease in the demand for tasks from the exporter and consequently lower value-added exports. Potential explanations include changes in foreign policy interests, which lead to potential conflicting trade policies, or diplomatic disputes that erupt into trade conflicts or changes the regime of a country, leading to the destination country being perceived as riskier from the consumers' and firms' perspective. Interestingly, after controlling for time trends, the coefficient of the cost of GVC integration becomes statistically significant at the 1%-level. An increase in the log cost of GVC integration by one is now connected to a 19% increase in value-added exports. Two explanations arise from this: First, the variation in the numerator of equation (10) over time is likely to be small, as the trade costs of all possible value-added trade routes is close to constant from the perspective of a single economy. On the other hand, the variation in the direct trade costs in the denominator, is likely to be larger. Therefore, after controlling for time trends, the direct cost channel dominates the indirect one. If increases in the cost of GVC integration are mainly driven by decreases in direct trade costs, then the coefficient is positive, as lower direct trade cost improve the terms of trade, leading to an increased demand for tasks from the exporter, explaining the increase in value added trade. The second explanation relates to the numerator. If the trade cost along all possible routes of value-added exports increase, the trade cost of the exporter are amplified further by the cost of GVC integration term. From the results in column (3) and (4), the thesis concludes that this part of the analysis quantifies the partial equilibrium elasticity of value added exports to shocks in geopolitical distance and/or friendshoring efforts.

Table 3: Pairwise correlations of key variables

Variable	(1)	(2)	(3)	(4)
(1) Value-Added Exports	1.0000			
(2) Pol. distance (t–1)	-0.0340	1.0000		
(3) Tariff (%)	-0.0002	0.1411	1.0000	
(4) Cost of GVC Integration	-0.0769	0.1177	-0.0303	1.0000

The US-China trade wars of 2018 and 2025, as well as the foreign policy of the Trump administration that often uses tariffs as a tool to achieve geopolitical goals have sparked a debate about the role of tariffs in connection with geopolitics. Economic papers that explore the issue include Becko, Grossman, and Helpman (2025) and Clayton, Maggiori, and Schreger (2023). Both papers develop general equilibrium models that incorporate game theoretical aspects by assuming the existence of hegemonies with some sort of geopolitical power exerted by tariffs or trade costs in general. Taken together with the correlation between tariffs and geopolitical distance in Table 3, the thesis suspects an omitted variable bias when omitting tariffs. Economies which are geopolitically closer to each other may set lower bilateral tariffs, which increases trade in value added. Therefore, tariffs are included as an additional control variable in Table 4.

Table 4: Regression with tariffs

Dependent Variable:	Value-Added Exports			
Model:	(1)	(2)	(3)	(4)
Variables				
Pol. distance (t-1)	-1.952***	-1.909***	-0.1422***	-0.1505***
	(0.3952)	(0.3763)	(0.0457)	(0.0453)
Tariff (%)	-0.0613***	-0.0618***	-0.0112***	-0.0116***
	(0.0026)	(0.0025)	(0.0015)	(0.0015)
Cost of GVC Integration		0.1350*		0.1732***
		(0.0817)		(0.0163)
Fixed-effects				
Origin-Sector	Yes	Yes		
Destination-Sector	Yes	Yes		
Origin-Destination-Sector	Yes	Yes	Yes	Yes
Origin-Sector-Year			Yes	Yes
Destination-Sector-Year			Yes	Yes
Fit statistics				
Observations	860,152	729,816	860,152	729,193
Squared Correlation	0.91207	0.91246	0.99449	0.99452
Pseudo R^2	0.97694	0.97658	0.99503	0.99511
BIC	37,923,687.5	36,561,514.5	8,933,391.4	8,276,952.4

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1, Transformation:* $\left(e^{\beta_i} - 1\right) \times 100$

Indeed the inclusion of tariffs into the regression significantly changes the coefficient of geopolitical distance. In the cross-sectional analysis shown in column (1) and (2), the addition of tariffs lead to a drop in the coefficient compared to Table 2. A difference in geopolitical distance by 0.1 is now connected to a 8.58% lower levels of value-added exports, compared to the 9.26% without the inclusion of tariffs. When controlling for the cost of GVC integration, the coefficient implies 8.52% lower levels. In the panel analysis shown in column (3) and (4), the coefficient drops as well, where a decrease in political distance by 0.1 leads to a 1.32% or 1.39% decrease in value-added exports when controlling for the cost of GVC integration, compared to the 1.45% or 1.52% in the baseline regression. Regarding the cost of GVC integration, the inclusion of tariffs into the regression specification leads to an increase in the coefficient and a change in the significance. A difference in the log cost by one is now connected to 13.94% higher value-added exports, significant at the 10%-level. This means that after controlling for tariffs, exporters of country pairs who face higher relative trade cost along all possible value added routes have higher amplified trade costs. In the panel regression, the coefficient of the inverse cost of GVC integration on the other hand is robust to the inclusion of tariffs with only a minor change. Regarding the tariffs itself, a difference in tariffs by one percentage point is connected to 5.95%/5.96% lower levels of value-added exports in the cross-section in column (1) and (2). In the panel regression in column (3) and (4), an increase in tariffs by one percentage point is connected to a 1.11% or 1.15% decrease in value-added exports. The economic interpretation compared to the coefficient of geopolitical distance is similar, as increases in tariffs lead to an increase in the price differential between countries, which leads to the products of the exporter becoming relatively more expensive compared to the domestic and other economies, leading to lower value added exports. However, the structural model of Krugman (1980) has one caveat in connection with tariffs. As it assumes iceberg trade costs and does not model a government sector that has a budget constraint, the revenues of tariffs are assumed to "melt" away. In reality, these revenues can have real economic impact depending on the destination of government spending. This needs to be taken into account when using the models in simulations.

In summary, the empirical estimation shows that cross-sectionally and in panel setups, geopolitical distance has a negative impact on trade in value added exports, by worsening the terms of trade and therefore diminishing the gains. Even after controlling for tariffs, which are assumed to pose an omitted variable bias, the coefficients remain statistically and economically significant. Furthermore, the cost of global value chain integration significantly amplify trade cost of a bilateral relationship only after the inclusion of tariffs, and after controlling for time trends.

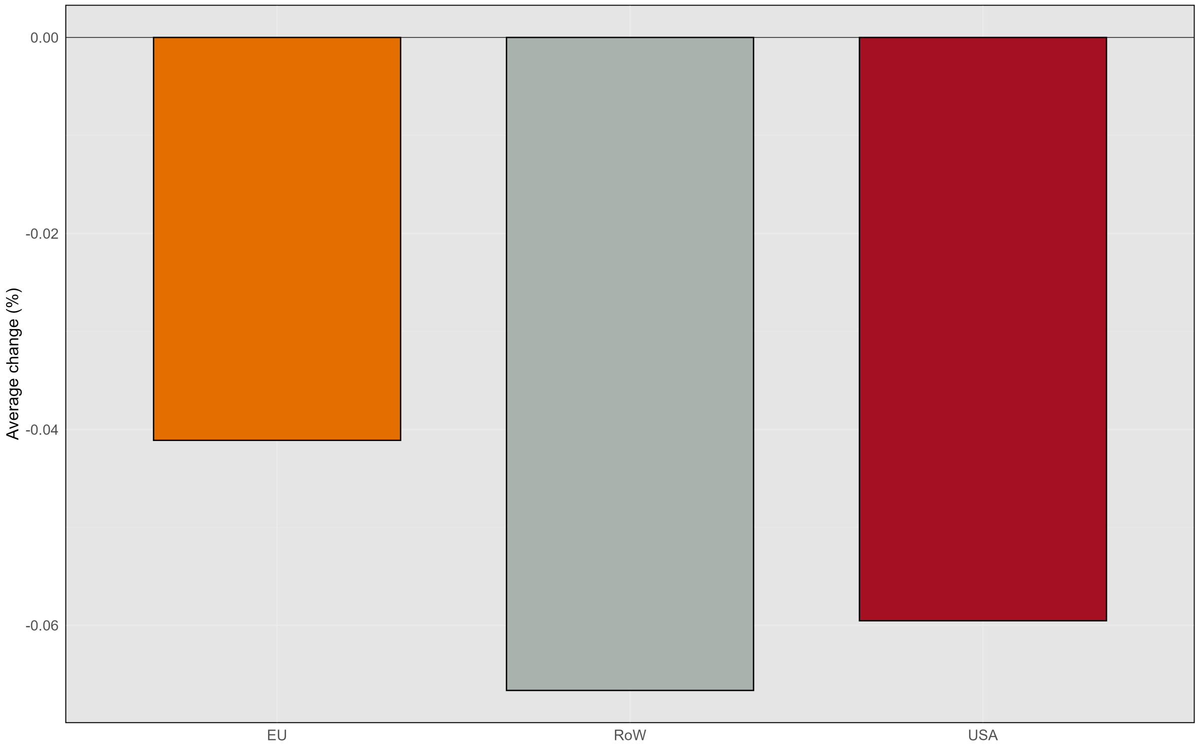
4.3 Simulation

To make the results from Section 4.2 more specific, this section presents the results of a conditional general equilibrium analysis. In the recent months, political tensions have emerged between the European Union and the US due to the aggressive foreign policy of the Trump administration. To highlight what could happen in the short run, the thesis simulates an increase in political distance between the US and countries of the European Union by 0.2, conditional on output and expenditure remaining unchanged. The baseline data represents the fitted values for the year 2022, as this is the latest available data. The empirical model underlying Table 4 is chosen as the baseline model. Figure 6 represents the results.

Overall, when looking at the magnitude of the changes, the aggregate impact of the increase in political distance is small. The average weighted decrease in value added exports averaged over the countries in the respective group is 0.04% for the EU, 0.061% for the

Figure 6: Simulation results

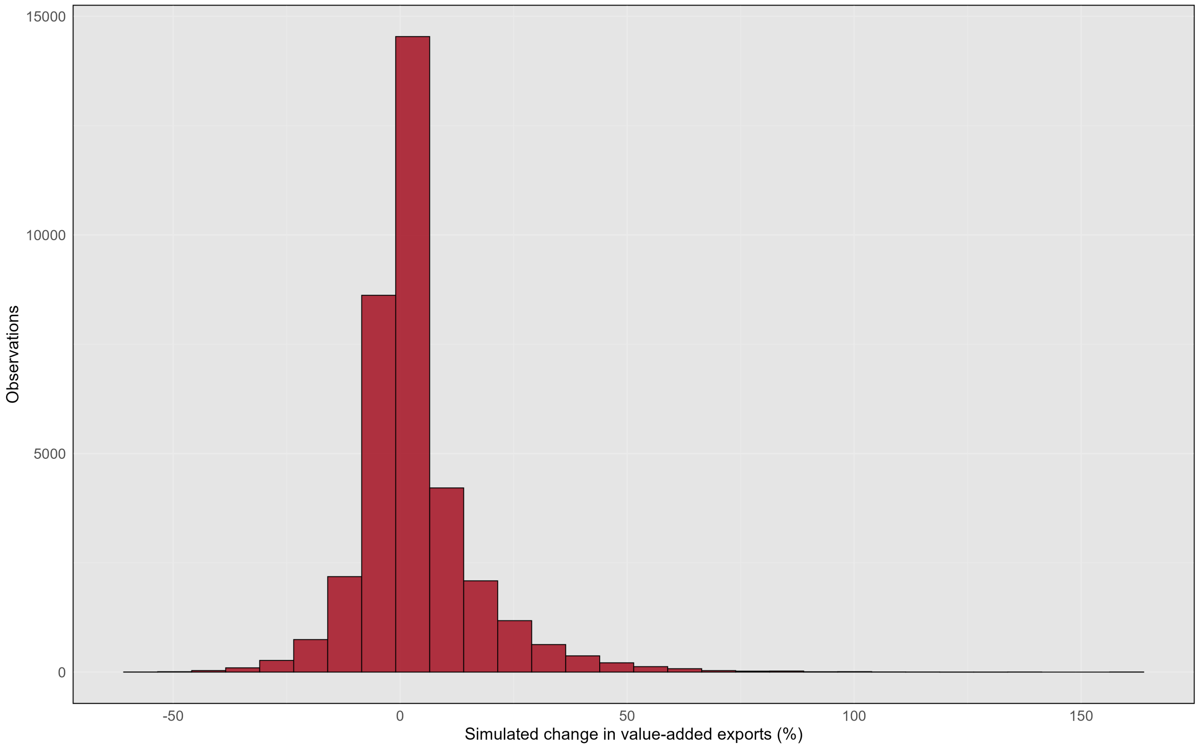
Conditional GE - Y and E fix; weighted change in average VA-exports



rest of the world and 0.064% for the USA. However, there are large heterogeneities between the different sectors and countries as implied by the histogram in Figure 7. When looking at the individual countries, especially small and highly open economies like Luxembourg, Ireland, Netherlands, and Belgium lose comparably more than other European countries. Although the overall impact of the simulated change on the European Union countries ranges from -0.35% to 0.16%. Larger economies, such as France and Italy, lose less in comparison, while countries with proximity to the European Union and the largest European economy, Germany, gain in the short run. Therefore, I conclude that the increase in geopolitical distance has a small negative effect on average, meaning the effect in the short term leads more to a reallocation of value-added trade flows between sectors and countries instead of a major decrease in flows. Another explanation for the small overall impact of the shock lies in the GVC integration. Both European countries and the USA are well connected and likely face low barriers to trade along their value chains. Specifically the European Union with the common market is likely facing low cost of GVC integration in general. This may also explain the 0.024 percentage point difference to the US. In conclusion, I argue that reallocation of value-added trade flows is the main driver behind the low aggregate impact of the geopolitical shock. Note however that this simulation does not apply to long-term changes, as expenditure and output are held constant in this analysis. Furthermore, the revenues of tariffs are assumed to “melt” away, due to the structural setup of the model. Hence, the simulation may not capture the whole short run effects of the geopolitical shock.

Figure 7: Histogram of the simulation results

Conditional GE - Y and E fix



4.4 Robustness & Heterogeneity

Section 4.1 has highlighted some heterogeneity over time and along the distribution of geopolitical distance. In this section, the thesis addresses them together with some robustness regressions. The results are summarized in Table 5. In column (1) and (2), the thesis replicates the regression equation (11), but excludes the energy sector from the sample. The underlying reasoning follows Bosone and Stamato (2024). They argue that the energy sector often is used as a tool to achieve geopolitical goals and is therefore at the center of many geopolitical debates. In that sense, energy value-added exports resemble tariffs, which could alter the coefficient significantly. However, the exclusion does not lead to significant changes in the coefficients. I conclude that the inclusion of the sector level fixed effect in the regression likely absorbed most of the potential variation introduced by the characteristics of the sector.

In column (3) of Table 5, the thesis excludes the political distance term and replaces it with several interaction terms that indicate time periods. As shown with Figure 3, it is likely that the coefficient and importance of political distance varies over time. The regression specification is given by

$$v_{ijst} = \exp\left[\pi_{ist} + \chi_{jst} + \mu_{ijs} + \beta_1\theta_{ijst} + \beta_2 pol\_dis_{ijt-1} \times d_t + \beta_3 lnT_{iKj}\right] \times \varepsilon_{ijst} \tag{12}$$

where d_t is a dummy that is equal to 1 if an observation belongs to a certain time period. The goal is to make heterogeneity in the coefficients with respect to time visible. The resulting coefficients in Table 5 confirm what has been brought to the front by Figure 3. Especially in the time period of globalization before the great financial crisis in 2008, the coefficient is significant and larger than in the baseline scenario with tariffs in Table 4. During the time period of 2003 to 2007, an increase in political distance by 0.1 is connected to a statistically significant decrease in value-added exports by 2.27%, which is 0.75 percentage points larger than in the baseline. Together with the marked decrease in the gap between within and between bloc trade, this lends support to the hypothesis that globalization efforts in the 2000s were driven by geopolitical integration between countries. The following time periods 2008 to 2012 and 2013 to 2017 show the opposite pattern. Here, the coefficients are lower in absolute value compared to Table 4. From 2008 to 2012, an increase in political distance by 0.1 is connected to a 1.02% decrease in value-added exports, and from 2013 to 2017, an increase in political distance by 0.1 decreases value-added exports by 1.15%. The coefficients emphasize a lower importance of geopolitical bilateral distance in magnitude during these time periods, although the impact is still significantly different from zero. For the time period of 2018-2022, which includes important geopolitical and geoeconomic events like the US-China trade war, the global pandemic and the Russian war of aggression against Ukraine, the magnitude of the impact increases again, where an increase in political distance by 0.1 is connected to a 2.08% decrease in value-added exports. This provides evidence for the perceived increase in importance of geopolitics in recent years. Note that in this regression model tariffs are included, meaning even after the inclusion of tariffs, the main tool of trade policy, the coefficients are still significantly different from zero. Therefore, the results for regression specification (12) in column (3) further reinforce the evidence found in the descriptive analysis of the paper: The interplay between geoeconomic and geopolitical integration is an important determinant for globalization, while especially in recent years, geopolitical conflicts and fragmentation have led to increased importance of geopolitical relations in trade flows. Note that the wording interplay is chosen, as reverse causality issues pose a concern for the findings of the thesis. In Section 5, Limitations, the thesis addresses the issue.

Column (4) of Table 5 further investigates the results of Figure 5. The specification is the same as equation (12), with the difference that the dummy d_t now is equal to one, if the country pair belongs to a certain quintile of the yearly geopolitical distance distribution.

Column (4) therefore sheds light to heterogeneity along the geopolitical distribution of country pairs. Q1 collects country pairs with the lowest political distance, Q5 contains countries with the highest political distance. Interestingly, for country pairs in the lower quintile, meaning for countries with close geopolitical relationships, changes in geopolitical distance do not lead to significant changes in value-added trade different from zero. While in magnitude, the coefficient is similar to the baseline in Table 4, the standard errors are too large to establish statistical significance. Two potential interpretations arise from this. First, trade partners who are geopolitically close are less affected by geopolitical changes. An explanation for this pattern would be that changes in geopolitically close relationships are less prone to be connected to increased geopolitical risk. Often, these relationships are also embedded in secure trade agreements or common markets as for example the EU. The second interpretation relates to the variation of geopolitical distance at the lower end of the distribution. Geopolitically close countries have a smaller number of shocks as these relationships are likely to be more stable over time compared to other quintiles. In both cases, an insignificant coefficient signals stability of the relations, either politically, or economically speaking. For Q5, collecting country pairs with the highest political distance, the pattern is the same. The coefficient is also not significantly different from zero, and is similar in magnitude to the baseline. Combined with the findings of Figure 5, where geopolitically distant country pairs always hold no share of value-added trade, the coefficient indicates that for country pairs in the highest quintile, shocks in geopolitical distance do not lead to significant changes in value-added exports. A potential interpretation for this pattern is that there is a threshold in geopolitical distance, above which there is no trade possible due to political disputes or general incompatibility between the geopolitical interest between countries. This explanation is likely, when considering the fact that the chosen indicator for political distance, includes democracy, foreign policy interest and bilateral representation as key determinants. The other explanation is simply that there is not enough variation in the explanatory variable.

The major impact of geopolitical distance is found in the quintiles between Q1 and Q5. Here, all coefficients are significantly different from zero, although at different levels: For Q2 and Q3, the coefficient is statistically significant at the 5%-level, for Q4 it is significant at the 1%-level. In terms of magnitude, the coefficient for Q4, meaning countries with considerably high geopolitical distance, is the largest. An increase in political distance by 0.1 is connected to a 2.04% decrease in value-added trade. Improvements in political relations in this quintile have the largest impact on value added exports. For Q3, an increase in geopolitical distance by 0.1 is connected to a 1.68% decrease in value-added exports, which is still above the baseline, but less than the magnitude of the coefficient of Q2 and Q4. For Q2, an increase in geopolitical distance by 0.1 is connected to a 1.93% increase in value-added exports. To sum up, geopolitical integration has the largest im-

Table 5: Robustness & heterogeneity results

Dependent Variable:	Value-Added Exports			
Model:	(1)	(2)	(3)	(4)
Variables				
Pol. distance (t-1)	-1.910***	-0.1504***		
	(0.3764)	(0.0453)		
Tariff (%)	-0.0618***	-0.0116***	-0.0119***	-0.0117***
	(0.0025)	(0.0015)	(0.0016)	(0.0027)
Cost of GVC Integration	0.1350*	0.1732***	0.1749***	0.1746***
	(0.0817)	(0.0163)	(0.0163)	(0.0310)
Dist. 2003-2007			-0.2570***	
			(0.0573)	
Dist. 2008-2012			-0.1074**	
			(0.0460)	
Dist. 2013-2017			-0.1224***	
			(0.0455)	
Dist. 2018-2022			-0.2336***	
			(0.0470)	
Dist. Q1				-0.1502
				(0.1203)
Dist. Q2				-0.2140**
				(0.0904)
Dist. Q3				-0.1836**
				(0.0917)
Dist. Q4				-0.2284***
				(0.0865)
Dist. Q5				-0.1305
				(0.0948)
Fixed-effects				
Origin-Sector	Yes			
Destination-Sector	Yes			
Origin-Destination-Sector	Yes	Yes	Yes	Yes
Origin-Sector-Year		Yes	Yes	Yes
Destination-Sector-Year		Yes	Yes	Yes
Fit statistics				
Observations	729,816	729,193	729,193	729,193
Squared Correlation	0.91246	0.99452	0.99461	0.99463
Pseudo R^2	0.97658	0.99511	0.99511	0.99511
BIC	36,561,463.5	8,276,952.1	8,266,968.5	8,271,198.8

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1, Transformation:* $\left(e^{\beta_i} - 1\right) \times 100$

pact on value-added trade for country pairs with considerably high geopolitical distance and countries with considerably high geopolitical proximity.

All things considered, the heterogeneity and robustness analysis reveals further patterns to the finding that political distance has an overall negative effect. It finds that especially in recent years and during the period of globalization, its impact is the largest, and that especially geopolitical integration between "neutral" country pairs has the largest effect on value-added trade. Next to tariffs, the analysis is also robust to the exclusion of the geopolitically important energy sector.

5 Limitations

This section addresses important limitations of the paper. The major limitation is the reverse causality issue. Geopolitical distance and trade in value-added flows may be connected in the opposite way, mainly speaking that economic integration leads to geopolitical integration. While the thesis lags the explanatory variable by one year, employs a variety of fixed effects consistent with the gravity model, and excludes the energy sector for robustness, these measures can only mitigate the issue and not solve it. As mentioned in section 2.1, Bosone and Stamato (2024) address the issue by employing an IV-estimation. At this point, the thesis emphasizes that the only robust way to address this issue is to explore the causal channel through which geopolitical fragmentation affects geoeconomic flows. While it is possible with the index used in the empirical analysis of this thesis to connect the political motivations of states to the economic flows, the causal mechanisms underlying the system remain unclear. In this area, I want to highlight the possibility of political economy, game theory, and general equilibrium models. Interesting contributions come from already mentioned Becko, Grossman, and Helpman (2025) and Clayton, Maggiori, and Schreger (2023). Both papers view trade policy as a central transmitter in the relationship. In that sense, the thesis addresses this by including tariffs in the regression specification. Other interesting contributions that focus on concepts such as the opportunity cost of war include Mayer, Mejean, and Thoenig (2025) and Thoenig (2024). Therefore, the limitations of this thesis should be seen as a summary of potential further research on the causal channel of geopolitical fragmentation.

The second limitation concerns value-added trade. As highlighted by Sebastien Miroudot and Yamano (2013), the true value-added might be higher due to the underestimation of intra-firm trade, described in section 2.2. Further, measurement errors are also a source of concern, noted by Antràs and Chor (2021). Heiland and Šváb (2025) argue that conceptually, after controlling for the cost of GVC integration, the trade elasticities for value added trade and import/export measures are the same. In equation (6), it is clear that value added flows are derived from the conventional import/export measures, which means the gravity equation factored out from the sum in equation (9) theoretically estimates the same trade elasticities. The only difference lies in the cost of GVC integration. And indeed, the coefficients of the intermediate regressions presented in Table 6, 7, and 8 are very similar in magnitude to the ones estimated in the empirical analysis. However, I argue that the cost of GVC integration itself is an interesting measure, because it adds the relative position of a relationship in the global value chain. By this way, a trade relation is put into context and adds an additional layer of interpretation otherwise missing. In fact, this can also be an advantage, as it allows for a comparison of the coefficients of other papers in the literature. Further, the trade elasticities for geopolitical distance in the intermediate regressions presented in the appendix are often insignificant, specifically when controlled for time trends. This can lead to the false conclusion that geopolitical distance is not a factor in global trade, when in reality, it matters specifically for global value chains approximated by value added exports.

6 Conclusion

With the master thesis "What is the impact of geopolitical fragmentation on global value chains - a structural gravity approach", I investigate the important relationship between geopolitical distance and global value chains approximated by trade in value-added exports. The most important finding is the robust negative relationship between the two variables, even after controlling for tariffs, the cost of global value chain integration, other robustness checks and the embedding into a structural model. It highlights that foreign policy interests, political interdependence, cooperation and democracy concerns are important factors in the complex interplay between politics and economics. With those determinants, the thesis finds evidence for friendshoring in global value chains and reveals that especially in recent years, geopolitics has regained importance after being a less important factor since the slow-down of globalization. From the structural models perspective, these changes in geopolitical distance lead to geopolitical blocs of countries, clustered around large economies. However, I also want to emphasize the need for further research specifically on the causal channel between geopolitics and geoeconomics to address the prevalent reverse causality issue. While this paper delivers a few potential explanations embedded in the choice of the geopolitical distance determinants, the exact mechanism is unclear. Preliminary literature and the fact that in this analysis, tariffs likely pose an omitted variable bias, a potential channel could be trade policy and tariffs.

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Statement on the Usage of Artificial Intelligence

During the preparation of this work the author used the latest available version of ChatGPT to improve the language, formatting of tables and figures and to verify the correctness of the mathematical calculations. Further, it assisted in the debugging of R and Latex code. After using this tool, the author reviewed and edited the content as needed and take full responsibility for the content of the thesis.

7 Appendix

7.1 Krugman and Gravity

In this section, the thesis derives the structural gravity equation from the model of Krugman (1980) and explains the underlying mechanisms of it.

7.1.1 Assumptions and Setup

All calculations are based on the model proposed by Krugman (1980). Consider a large number of tasks that all enter symmetrically into demand. The demand for a certain task is determined by the utility function, which is the same for all agents that consume the task. The agents can be seen as a firm that uses the output of the task to produce an intermediate or final good in the next step. In case of the final task, one can interpret the agent as a consumer. All share the same utility function, given by

$$U = \sum_{s}^{n} c_s^{\theta} \quad with \quad 0 < \theta < 1, \frac{\partial U}{\partial c_s} > 0, \frac{\partial^2 U}{\partial^2 c_s} < 0 \tag{13}$$

where c_s is the consumption of the good produced by task s. The variable n describes the total number of tasks in the VCs and is interpreted as a measure of the degree of specialization of VCs, where a high n indicates that the VCs are divided into many tasks. θ is a parameter chosen such that the utility function is concave and increasing in c_i. θ is the constant elasticity of substitution parameter between different tasks i. Hence, the resulting demand equation, which will be derived in section B fulfills the first condition needed for gravity.

In the economy, there is only one factor of production, labor l_s, which is used to produce output of task s with the production function

$$l_s = \alpha + \beta y_s, \tag{14}$$

where α represents fixed costs and β the variable costs. Since labor is the only factor of production in this economy, the elasticity of substitution is constant, which is in line with the second requirement above. This equation implicitly assumes increasing returns to scale as the average cost AC decline with the output y_s of a task. Variable cost VC are constant and fixed cost FC are the same for all tasks. Each firm only produces one unique task.

Market clearing requires that consumption of task s must equal its production of output, given by

$$y_s = Lc_s \quad with \quad L = \sum_{s}^{n} l_s \tag{15}$$

where L is the total labor force of the economy.
Further assumptions include full employment, profit maximizing firms and free entry and exit, implying that profits are 0 in the equilibrium. This assumption models monopolistic competition. Taken together, market clearing is determined by the equation

$$L = \sum_{s}^{n} l_s = \sum_{s}^{n} (\alpha + \beta y_s) \tag{16}$$

Market clearing will carry over in section C and D, where I open the model to trade, fulfilling requirement three for gravity equations.

7.1.2 Closed Economy

From the behavior of the agents and their utility functions, the thesis derives the demand function. Agents maximize their utility subject to their budget constraint, which includes their wage w and prices to obtain output of task s, p_s, yielding the following Lagrange equation:

$$\mathcal{L} = \sum_{s}^{n} c_s^{\theta} + \lambda \left(w - \sum_{s}^{n} p_s c_s \right) \tag{17}$$

Taking the derivative of the Lagrangian, solving for the price p_i and using the market clearing condition in 16 identifies the demand equation:

$$p_s = \frac{\theta}{\lambda} \left(\frac{y_s}{L} \right)^{\theta - 1} \tag{18}$$

λ represents the shadow price of income, describing the change in prices connected to changes in income. The corresponding elasticity of demand is constant, given by:

$$|\varepsilon| = \frac{1}{1 - \theta} \tag{19}$$

The firms face monopolistic competition, where the pricing decision is given by

$$p = \frac{1}{\varepsilon - 1} \times \varepsilon \times MC, \qquad where \qquad MC = \beta w, \varepsilon = \frac{1}{1 - \theta} \tag{20}$$

yielding a price function that is fully determined by the elasticity of demand:

$$p = \theta^{-1} \beta w \tag{21}$$

Prices from all goods are therefore the same and the subscript i can be dropped. However, the assumption of free entry implies that as soon as profits from further specialization (higher n) arise, $\pi_i > 0$, new firms will enter, driving profits down, thereby imposing the zero profit condition:

$$0 = px_s - (\alpha + \beta y_s)\, w \tag{22}$$

Rearranging the equation for y_s, and using the price equation (21), determines the output, given by:

$$y_s = \frac{\theta}{1-\theta}\frac{\alpha}{\beta} \tag{23}$$

Output is independent of the subscript s, implying that the zero profit identifies the output. Finally, we determine the number of tasks/degree of specialization by combining the market clearing condition (16) with output (23). The degree of specialization is given by:

$$L = \sum_{s}^{n} (\alpha + \beta y) = n\,(\alpha + \beta y) \rightleftharpoons n = \frac{L}{\alpha + \beta y} \rightleftharpoons n = \frac{L\,(1-\theta)}{\alpha} \tag{24}$$

7.1.3 Frictionless Trade

For the next section, the thesis assumes that trade cost are zero and countries have the same preferences and technologies. Since there are increasing returns to scale, each task will be produced in only one country and gains from trade arise through a higher degree of specialization n. Consider the case of two economies, i and j. Through symmetry, the wage rate w is the same for all countries and the number of varieties provided by are

$$n^i = \frac{L^i\,(1-\theta)}{\alpha}, n^j = \frac{L^j\,(1-\theta)}{\alpha} \tag{25}$$

However, expenditure is now allocated among all tasks, giving rise to trade flows. The share of expenditure that is allocated to i-tasks is given by

$$\frac{n^i}{n^i + n^j} \tag{26}$$

when setting a numeraire for the wage rate $w = 1$, task imports of i and j are

$$x^i = \frac{n^j}{n^i + n^j} L^i, x^j = \frac{n^i}{n^i + n^j} L^j \tag{27}$$

By setting the numeraire to solve for trade flows, the model fulfills requirement four needed for gravity estimation.

7.1.4 Trade Frictions

Assume now that trade frictions are of "iceberg"-type, meaning only a fraction τ arrives at the destination and $1 - \tau$ "melts" on the way to its destination. Hence, the model introduces trade costs, the way it is needed for gravity estimation, fulfilling requirement five highlighted in the literature review.

Due to the introduction of trade costs, prices of the same tasks are different between countries. Assume now that the price of domestic goods in the country j is given by p and the price of foreign goods is given by $p^* = p/\tau$. The mirror image is true for country i. We can use the Lagrange given by equation (17) to obtain the prices and the demand functions for domestic and foreign tasks. To take into account the goods lost in transaction, one can define the ratio between the total demand in j for foreign tasks to total demand in j for domestic tasks, σ:

$$\sigma = \frac{p^j}{p^i}^{\frac{1}{1-\theta}} \tau_{i,j}^{\frac{\theta}{1-\theta}} \tag{28}$$

With this in mind, consumers in country j spend their wage according to

$$(np + \sigma n^* p^*)d = w^j \tag{29}$$

d represents the consumption of a representative task. From the way trade costs are modeled, firm's decision is not affected by the trade costs, meaning the equilibrium outcomes of p and n in each country remains the same. Only the real wage ω differs due to different price levels in the countries.

However, it can be shown that a country's balance of payment is given by

$$B^j = \frac{\sigma^i n^j \omega}{\sigma^i n^i + n^j} L^i - \frac{\sigma^j n^i \omega}{\sigma^j n^i + n^j} L^j \tag{30}$$

Krugman then sets $B = 0$, which assumes balanced trade and therefore exogenously sets the trade deficits, fulfilling requirement six presented above. Taking the balance of payment (30) as a starting point, the second part of the equation represents the imports of j. I will use this, to derive the gravity equation as presented in equation (5), with the help of requirement seven and eight. I set a numeraire of $w^i = 1$ to determine imports of j:

$$X_{j,i} = \frac{\sigma^j n^i}{\sigma^j n^i + n^j} w^j L^j = \frac{\frac{p^j}{p^i}^{\frac{1}{1-\theta}} \overbrace{\tau_{j,i}^{\frac{\theta}{1-\theta}}}^{\phi_{j,i}} \overbrace{n^i}^{S_i}}{\frac{p^j}{p^i}^{\frac{1}{1-\theta}} \underbrace{\tau_{j,i}^{\frac{\theta}{1-\theta}}}_{\phi_{j,i}} \underbrace{n^i}_{S_i} + \underbrace{n^j}_{S_j}} \underbrace{w^j L^j}_{X_j} \tag{31}$$

The number of tasks n is the respective capability to export of each country, while $w^j L^j$ corresponds to the expenditure of the importer. Imports then can be further simplified to

$$X_{j,i} = S_i\phi_{j,i}\underbrace{\frac{\frac{p^j}{p^i}^{\frac{1}{1-\theta}}}{\frac{p^j}{p^i}^{\frac{1}{1-\theta}}\phi_{j,i}S_i + S_j}}_{\frac{1}{\Phi_j}} = \frac{S_i\phi_{j,i}}{\Phi_j} \tag{32}$$

However, we also need to fulfill requirement eight, which is why the sum of all of i imports need to be equal to its production Y^i, including imports from i to i.

$$Y^i = \underbrace{\frac{\frac{p^j}{p^i}^{\frac{1}{1-\theta}}\tau_{j,i}^{\frac{\theta}{1-\theta}}n^i}{\frac{p^j}{p^i}^{\frac{1}{1-\theta}}\tau_{j,i}^{\frac{\theta}{1-\theta}}n^i + n^j}w^jL^j}_{X_{j,i}} + \underbrace{\frac{\frac{p^i}{p^i}^{\frac{1}{1-\theta}}\tau_{i,i}^{\frac{\theta}{1-\theta}}n^i}{\frac{p^i}{p^i}^{\frac{1}{1-\theta}}\tau_{i,i}^{\frac{\theta}{1-\theta}}n^i + n^j}w^jL^i}_{X_{i,i}} \tag{33}$$

We can simplify this equation, as several terms cancel each other out. Further, we can factor n^i out.

$$Y^i = \underbrace{n^i}_{S_i}\left(\phi_{j,i}X_j\underbrace{\frac{\frac{p^j}{p^i}^{\frac{1}{1-\theta}}}{\frac{p^j}{p^i}^{\frac{1}{1-\theta}}\tau_{j,i}n_i + n_j}}_{\frac{1}{\Phi_j}} + \phi_{i,i}X_i\underbrace{\frac{1}{n_i + n_j}}_{\frac{1}{\Phi_i}}\right) \tag{34}$$

This can be written as:

$$Y^i = S_i\underbrace{\left(\frac{\phi_{j,i}X_j}{\Phi_j} + \frac{X_i}{\Phi_i}\right)}_{\Omega_i} = S_i\Omega_i \tag{35}$$

Solving this identity for S_i and plugging it into equation (2), yields the share of expenditure allocated to each country.

$$\pi_{j,i} = \frac{S_i\phi_{j,i}}{\Phi_j} = \frac{Y_i}{\Omega_i}\frac{1}{\Phi_j}\phi_{j,i} \tag{36}$$

Finally, we know that the imports by j from i are defined as

$$X_{j,i} = \pi_{j,i}X_j = \frac{Y_i}{\Omega_i}\frac{X_j}{\Phi_j}\phi_{j,i}, \tag{37}$$

which corresponds to the definition of the gravity equation given in (5). The corresponding exports from i to j are therefore defined as

$$X_{i,j} = \pi_{i,j}X_j = \frac{Y_i}{\Omega_i}\frac{X_j}{\Phi_j}\phi_{i,j}, \tag{38}$$

Hence, the model of Krugman (1980) can be estimated with the help of the structural gravity equation. Note that for simplicity and traceability, we derived the gravity equation from the two country case, although the model can be extended to a multi-country model. The structural gravity equation by Head, Mayer (2013) is defined in the multi-country case.

7.2 Intermediate Regressions

This section presents the intermediate regressions from which the multilateral resistance terms and trade cost vectors needed for the construction of the cost of GVC integration are extracted. A brief interpretation is included.

7.2.1 Intermediate Regression: Baseline

Table 6 presents the intermediate regression for the baseline regression results in Table 2. In column (1), a difference in political distance by 0.1 is connected to 8.97% lower export levels. The coefficient is significant at the 1%-level. In column (2), an increase in political distance by 0.1 leads to a 1.4% decrease in exports, however, the coefficient is not significantly different from zero.

Table 6: Intermediate regression: baseline

Dependent Variable:	Exports	
Model:	(1)	(2)
Variables		
Pol. distance (t-1)	-2.274***	-0.1509
	(0.3920)	(0.1203)
Fixed-effects		
Origin-Sector	Yes	
Destination-Sector	Yes	
Origin-Destination-Sector	Yes	Yes
Origin-Sector-Year		Yes
Destination-Sector-Year		Yes
Fit statistics		
Observations	848,352	847,729
Squared Correlation	0.90305	0.99100
Pseudo R^2	0.97269	0.99335
BIC	62,667,377.6	16,000,153.9

*Standard-errors in parentheses, Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

7.2.2 Intermediate Regression: Tariffs

Table 7 presents the intermediate regression for the baseline regression results in Table 4. In column (1), a difference in political distance by 0.1 is connected to 7.9% lower export levels. The coefficient is significant at the 1%-level. One percentage point higher tariffs are connected to 5.86% lower levels of exports. In column (2), an increase in political distance by 0.1 leads to a 1.4% decrease in exports, however, the coefficient is not significantly different from zero. An increase in tariffs by one percentage point leads to a 1.16% decrease in exports, which is statistically significant at the 1%-level.

Table 7: Intermediate regression: tariffs

Dependent Variable:	Exports	
Model:	(1)	(2)
Variables		
Pol. distance (t-1)	-1.559***	-0.1328
	(0.3089)	(0.1167)
Tariff (%)	-0.0604***	-0.0117***
	(0.0029)	(0.0026)
Fixed-effects		
Origin-Sector	Yes	
Destination-Sector	Yes	
Origin-Destination-Sector	Yes	Yes
Origin-Sector-Year		Yes
Destination-Sector-Year		Yes
Fit statistics		
Observations	848,352	847,729
Squared Correlation	0.90959	0.99085
Pseudo R^2	0.97546	0.99336
BIC	56,365,050.8	15,962,389.2

*Standard-errors in parentheses, Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

7.2.3 Intermediate Regression: Robustness and Heterogeneity

Table 8 belongs to Table 5 in the main analysis. The exclusion of the energy sector in column (1) and (2) does not lead to significantly different coefficients. In column (3), only the interaction term for the time period of 2018 to 2022 is significant. An increase in political distance by 0.1 leads to a decrease in exports by 2.16%, significant at the 5%-level. For column (3), political distance is significant for the quintiles two to four, with negative effects ranging from 1.67% to 2.04%, significant at the 5% and 10%-level.

Table 8: Intermediate regression: robustness

Dependent Variable:	Exports			
Model:	(1)	(2)	(3)	(4)
Variables				
Pol. distance (t-1)	-1.567***	-0.1317		
	(0.3089)	(0.1169)		
Tariff (%)	-0.0603***	-0.0117***	-0.0118***	-0.0119***
	(0.0029)	(0.0026)	(0.0029)	(0.0026)
Dist. 2003-2007			-0.2123	
			(0.1397)	
Dist. 2008-2012			-0.1007	
			(0.1160)	
Dist. 2013-2017			-0.1083	
			(0.1038)	
Dist. 2018-2022			-0.2432**	
			(0.1030)	
Dist. Q1				-0.1782
				(0.1353)
Dist. Q2				-0.1994*
				(0.1074)
Dist. Q3				-0.1833*
				(0.1077)
Dist. Q4				-0.2285**
				(0.1034)
Dist. Q5				-0.1004
				(0.1181)
Fixed-effects				
Origin-Sector	Yes			
Destination-Sector	Yes			
Origin-Destination-Sector	Yes	Yes	Yes	Yes
Origin-Sector-Year		Yes	Yes	Yes
Destination-Sector-Year		Yes	Yes	Yes
Fit statistics				
Observations	729,916	729,293	847,729	847,729
Squared Correlation	0.90944	0.99083	0.99101	0.99108
Pseudo R^2	0.97464	0.99319	0.99337	0.99337
BIC	55,537,858.9	15,527,398.4	15,947,536.5	15,951,310.2

*Standard-errors in parentheses, Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*