

# SNA4DS Project - Report Submission 2

Group 08

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# 1 Glossary

Table 1: Definitions of Key Terms

Term	Definition
Bilateral Trade	Trade between two specific countries, measured as exports from one to the other and vice versa.
Export value	The total monetary value of goods and services sold by one country to another, measured in U.S. dollars.
Macroeconomic Stability	The condition in which a country experiences low inflation, steady growth, and minimal fiscal or external imbalances.
Institutional Similarity	The degree to which countries share similar governance qualities, such as rule of law, corruption control, and regulatory quality.
Worldwide Governance Indicators (WGI)	Quantitative measures developed by the World Bank to assess broad patterns in perceptions of the quality of governance across countries and over time. The WGI reports governance indicators for over 200 countries and territories for six dimensions of governance: Voice and Accountability; Political Stability and Absence of Violence/Terrorism; Government Effectiveness; Regulatory Quality; Rule of Law; Control of Corruption.
Government Effectiveness: Estimate	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
Regulatory Quality: Estimate	Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.
Rule of Law: Estimate	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.

Term	Definition
Control of Corruption: Estimate	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.

## 2 Abstract

Chau What is the main topic you are addressing? What are your research questions and hypotheses? What are your results and the main conclusion?

## 3 Introduction

### 3.1 Common Ground: The Relationship Between Governance and Trade

The global trade network is a core foundation of the modern economy, enabling countries to exchange goods, services, and capital in ways that drive productivity and long-term growth. International trade is shaped not only by economic fundamentals but also by the governance environments in which countries operate. Understanding how governance similarity shapes bilateral trade is essential, as institutional alignment can enhance regulatory predictability and foster trust, thereby amplifying trade volumes and strengthening economic integration. This research specifically investigates how governance similarity between nations influences the strength of their bilateral trade relations.

Building on evidence that institutional quality, corruption control, and regulatory effectiveness significantly shape trade performance, this study applies the Multiple Regression Quadratic Assignment Procedure (MRQAP) and the Generalized Exponential Random Graph Model (GERGM) to capture structural interdependencies and trade intensity within the global trade network. By modeling trade as a weighted network, this research provides a more accurate understanding of how governance characteristics shape the magnitude of international trade flows, addressing gaps left by prior network analyses.

Empirical studies consistently demonstrate that governance conditions affect bilateral trade costs and export performance. Evidence from (De Groot, Linders, Rietveld, & Subramanian, 2004) shows that countries with similar institutional frameworks trade approximately 13% more with each other, while improvements in overall institutional quality can increase bilateral trade volumes by 30–44%. Research from (Sabry, 2022), examining Arab exports to Germany, similarly finds that regulatory quality and government effectiveness drive export performance, although the magnitude of these effects varies across regions and industries, such as textiles. Likewise, (Landry, 2024) reports that improvements in corruption control and democratic governance increase African exports to Western partners, but do not produce the same effect in trade with China.

Further evidence reinforces these governance effects. (Tamas & Miron, 2021) using an augmented gravity model for Romanian–EU trade, finds that regulatory quality has the strongest positive impact on exports, while weak institutional performance limits deeper trade integration. (Didier & Hoarau, 2021) documents asymmetric governance effects in Sub-Saharan African trade with China: stronger governance enhances Chinese exports to Africa, whereas weaker governance, particularly higher corruption, can facilitate African exports to China.

### 3.2 Complication: The Network Structure Problem

Despite this evidence, most studies rely on gravity models that assume independence across trade pairs and overlook interdependencies in the global trade network, such as reciprocity, clustering, and transitivity. To address this, recent research has adopted Exponential Random Graph Models (ERGMs), which explicitly account for relational dependencies and allow structural, political, and economic factors to be assessed simultaneously (Cranmer & Desmarais, 2011; Schweitzer et al., 2009). For example, (Gutierrez, Adenso-Díaz, & Lozano, 2020) applies ERGMs to the global wheat trade and shows that reciprocity, GDP, and geographic proximity shape tie formation, while (Setayesh, Sourati Hassan Zadeh, & Baharak, 2022) finds that GDP, distance, diplomatic exchanges, and landlocked status influence trade relations, with transitivity adding explanatory power beyond dyadic predictors.

However, existing ERGM applications often rely on backbone extraction methods such as the disparity filter (M. A. Serrano, Boguna, & Vespignani, 2009) to convert weighted networks to binary ones. While this simplifies estimation, it discards important information on trade intensity, limiting the detection of variation in export strength and obscuring key patterns of economic interdependence, especially among closely integrated or institutionally aligned countries. As (Setayesh et al., 2022) note, studies should “observe the global trade network as a weighted network without applying backbone methods” to capture both the presence and magnitude of trade ties accurately.

### 3.3 Concern

To address this gap, the present study employs GERGM, developed by (Desmarais & Cranmer, 2012), which extends ERGM methodology to networks with continuous-valued edges. GERGM models endogenous network dependencies, including reciprocity, transitivity, and clustering, while incorporating edge weights that represent trade intensity. This approach enables a comprehensive representation of the global trade system as both structurally interdependent and quantitatively differentiated, capturing not only whether trade ties exist but also their relative economic significance. Additionally, most prior research focuses on region- or sector-specific cases, limiting global generalizability, and governance is commonly proxied using World Bank indicators, introducing variation that may affect comparability and interpretation.

Therefore, the challenge is to develop a modeling approach that simultaneously:

- Captures structural network dependencies, including reciprocity, transitivity, and clustering;
- Preserves trade intensity information through weighted edges;
- Incorporates country-level governance attributes;

- Tests the role of institutional similarity in shaping trade patterns.

Based on these considerations, the present study addresses two main research questions. First, it examines how countries' governance characteristics influence the intensity of their bilateral trade relationships. Second, it investigates how governance similarity, along with network structural interdependencies, such as reciprocal exchange and clustered trading patterns, shapes the overall configuration of global export ties, thereby capturing the interdependent nature of the international trade network. For the purposes of this study, the analysis focuses on four dimensions that are most directly relevant to economic and institutional indicators of trade: Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption, while excluding Voice and Accountability and Political Stability and Absence of Violence/Terrorism, which fall outside the scope of the research.

**Research Question 1:** How do similarities in governance characteristics between country pairs influence the intensity of their bilateral trade relationships?

1. **Hypotheses H1a:** Countries with more similar levels of regulatory quality engage in higher-value bilateral trade.
2. **Hypothesis H2a:** Countries with more similar levels of corruption control engage in higher-value bilateral trade.

When countries share comparable institutional frameworks, firms face lower coordination and enforcement costs through contract negotiation and dispute resolution, according to (Dixit, 2011; Francois & Manchin, 2013), reducing transaction frictions and enabling greater private-sector participation in cross-border markets. Because regulatory quality reflects a government's capacity to design and implement policies that support private-sector development, institutional similarity is expected not only to increase the likelihood of trade relationships emerging but also to enhance the intensity of existing trade flows. By lowering firms' adaptation costs when entering foreign markets, similar regulatory environments facilitate deeper export integration, forming the basis for *Hypothesis H1a* and *Hypothesis H1b*.

As noted in the (Shleifer & Vishny, 1993), firms also face lower enforcement costs when corruption levels and rule-of-law standards are comparable, reducing uncertainty about contract enforcement and thereby improving trade potential, motivating *Hypothesis H2a*. Likewise, similarity in the rule of law reduces legal uncertainty in cross-border transactions and mitigates the negative effects of weak contract enforcement on trade flows (De Groot et al., 2004; Long, Gam, Vu Hong, & Bui Hoang, 2023). When both trading partners have comparable legal systems, including strong contract enforcement and effective property rights protection, firms can confidently enter into long-term trade relationships and make relationship-specific investments, supporting *Hypothesis H2a* and *Hypothesis H2b*.

**Research Question 2:** How do similarities in governance quality and the broader patterns of interdependence among trading partners influence the formation and intensity of bilateral export relationships across countries in the global economy?

1. **Hypotheses H1b:** Countries with more similar levels of regulatory quality are expected to engage in higher-value bilateral trade
2. **Hypothesis H2b:** Countries with more similar rule-of-law conditions are expected to engage in higher-value bilateral trade
3. **Hypothesis H3b:** Bilateral export relationships are expected to display reciprocity, such that higher export volumes from one country to its trading partner are associated with higher export volumes received in return from that partner.
4. **Hypothesis H4b:** Trade relationships exhibit transitivity, where countries are more likely to trade intensively with partners of their existing trading partners, resulting in clustered patterns of export ties
5. **Hypothesis H5b:** Countries that already receive high levels of imports from many partners are likely to become attractive trade destinations, making others more likely to export to them

Trade networks are not random but exhibit systematic structural patterns driven by economic, political, and strategic considerations. One key structural feature of trade networks is reciprocity, which reflects the tendency for countries to return export flows received from their partners (Setayesh et al., 2022). Reciprocal trade emerges through several channels, including diplomatic norms, bilateral or regional trade agreements, and mutual economic interdependence, all of which encourage balanced exchange rather than one-sided trade flows. Research from (Philippe, Thierry, & Mathias, 2008) shows that mutual economic dependence creates incentives for countries to maintain stable, reciprocal trade relationships, as disruptions would harm both partners. Together, these studies provide the theoretical foundation for *Hypothesis H3b*.

Clustering patterns are another important determinant of trade network structure, motivating *Hypothesis H4b*. Countries within regional trade blocs (e.g., EU, ASEAN, NAFTA) develop dense, interconnected trade relationships through harmonized regulations and reduced non-tariff barriers (De Groot et al., 2004; Frankel, Wei, & Stein, 1995), which transitive closure is significant in service trade networks (Feng, Xu, Wu, & Zhang, 2021). Additionally, large import markets create economies of scale for exporters, justifying the fixed costs of market entry. As a result, exporters prioritize these markets, leading to a concentration of trade ties on high-import countries, which explains the logic behind the core-periphery structure (M. Serrano, Boguñá, & Vespignani, 2007; Setayesh et al., 2022). This research highlights the highly heterogeneous nature of trade connections and demonstrates that network degree and centrality patterns matter, as a small number of countries act as major hubs, holding a disproportionately large share of global trade flows. Consequently, the concentration of trade ties on large import markets supports *Hypothesis H5b*.

Understanding these structural patterns is essential because they reflect systemic forces that operate beyond bilateral or single-country characteristics, shaping the overall architecture of the global trade.

Table 2: Hypotheses, Model Terms, and Theoretical Motivation

Hypothesis	GERGM Term	Motivation
<b>H1b: Regulatory Quality Similarity</b> Countries with more similar levels of regulatory quality are expected to engage in higher-value bilateral trade	<code>absdiff(regulatory_quality)</code>	The <code>absdiff(regulatory_quality)</code> term captures the tendency for countries with similar regulatory frameworks to form higher-value trade relationships. Similar regulatory standards reduce compliance costs, streamline approval processes, and increase operational compatibility, facilitating valuable bilateral trade
<b>H2b: Rule of Law Similarity</b> Countries with more similar rule-of-law conditions are expected to engage in higher-value bilateral trade	<code>absdiff(rule_of_law)</code>	The <code>absdiff(rule_of_law)</code> term captures how similar institutions reduce transaction costs through aligned contract enforcement, shared regulatory standards, and comparable property rights protections, facilitating high-value trade flows
<b>H3b: Reciprocity</b> Bilateral export relationships are expected to display reciprocity, such that higher export volumes from one country to its trading partner are associated with higher export volumes received in return from that partner	<code>mutual(alpha = 0.8)</code>	The <code>mutual(alpha = 0.8)</code> term captures the tendency for bilateral trade relationships to exhibit reciprocity, whereby higher export flows from one country are associated with higher return flows from its trading partner. Reciprocal trade reflects balanced exchange and mutual commitment, reducing asymmetric dependence and fostering more stable and sustainable trading relationships than those based on one-sided export flows
<b>H4b: Transitivity</b> Trade relationships exhibit transitivity, where countries are more likely to trade intensively with partners of their existing trading partners, resulting in clustered patterns of export ties	<code>ctriads(alpha = 0.8)</code>	The <code>ctriads(alpha = 0.8)</code> term captures the tendency for triadic closure in trade networks, in which countries sharing a common trading partner are more likely to trade intensively with each other. Shared partners reduce information asymmetries and search costs, facilitating clustered export patterns

Hypothesis	GERGM Term	Motivation
<b>H5b: Popularity</b> Countries that already receive high levels of imports from many partners are likely to become attractive trade destinations, making others more likely to export to them	<code>receiver("total_imports")</code>	The <code>receiver("total_imports")</code> term captures the tendency for countries with high import volumes to attract additional export ties. Large import markets signal strong demand and institutional reliability, lowering perceived risks for new exporters and generating self-reinforcing patterns in which highly connected import destinations continue to receive a disproportionate share of global exports

#### *Control Variables:*

- *GDP (current USD)*: Economic size is a central determinant of a country's trade capacity, as consistently demonstrated in gravity-model research (Leitão, 2024). Larger economies tend to produce a greater volume and diversity of exportable goods while also generating higher import demand. Including GDP as a control variable accounts for these scale effects, allowing the analysis to isolate the contribution of governance similarity to trade intensity.
- *Inflation Rate*: Elevated inflation can reduce export competitiveness and increase uncertainty in cross-border transactions. Controlling for inflation ensures that the estimated governance effects are not confounded by broader macroeconomic volatility.

### 3.4 Connection to Previous Work and Contribution

Understanding how governance similarity shapes both the formation and intensity of trade relationships has significant theoretical and policy implications. Institutional similarity not only increases the likelihood of trade but also amplifies trade volumes, indicating that policies promoting convergence, such as regulatory harmonization, anti-corruption cooperation, or system alignment, may yield greater economic benefits than previously recognized. Trade agreements with enforceable governance provisions can facilitate deeper economic integration beyond tariff reduction (Horn, Mavroidis, & Sapir, 2010).

Second, if governance similarity strengthens reciprocity or clustering, the global trade system may display path-dependent dynamics, where countries outside these communities face higher barriers to integration due to network position and institutional distance rather than formal trade restrictions (Long et al., 2023). This suggests to policymakers that institutional convergence offers benefits beyond simply lowering transaction costs. It enables countries to establish stronger and more resilient trade relationships within the global economy. By aligning their institutional frameworks, countries can position themselves more advantageously within the broader architecture of international trade.

Third, theoretically, incorporating institutional similarity into network models provides a fuller understand-

ing of global economic structures. Rather than viewing institutions solely as bilateral friction reducers, this approach recognizes that institutions operate within a complex, interdependent system where governance similarity affects not just dyadic trade but the entire configuration of the trade network.

The remaining structure of the report is organized into four main sections. The Dataset section outlines the sources, construction, and characteristics of the trade and governance data, including relevant network configurations. The Research Rationale section explains why the selected modelling approaches: MRQAP and GERGM, are well suited to the research questions and discusses potential alternative methods. The Results section presents and interprets the empirical findings from these models, comparing and evaluating the outcome in relation to the proposed hypotheses. Finally, the Conclusion provides the insights from the findings, highlights remaining challenges, and suggests paths for future research.

## 4 Dataset

### 4.1 Dataset collection

This research combines multiple datasets that capture international trade flows, trade facilitation indicators, economic development, and governance quality across countries.

#### 4.1.1 Primary Dataset

The primary dataset used is the International Trade Database obtained from Kaggle, which is compiled from UN Comtrade through the World Integrated Trade Solution (WITS) platform. UN Comtrade is the official repository of international trade statistics, maintained by the United Nations Statistics Division (UNSD), and serves governments, academia, and research institutions worldwide (UN Comtrade, 2025). It covers more than 99% of the world's merchandise trade and provides country-reported data on international trade flows.

The dataset contains annual export values (measured in thousands of U.S. dollars) from 1988 to 2021, recording exports from a reporting country  $i$  to a partner country  $j$  in year  $t$ . Each observation represents the total export value of all goods shipped from country  $i$  to country  $j$  in a given year. For this study, the analysis focuses on data from 2018, the year immediately preceding the COVID-19 pandemic, as it ensures the widest data availability and comparability across countries in terms of governance, economic performance, and trade facilitation indicators prior to the global disruptions of the pandemic.

#### 4.1.2 Supplementary Data

Sources To complement the trade network with country-level attributes, three supplementary datasets from the World Bank's open data repositories were integrated, all extracted for the year 2018.

1. The Doing Business Indicators (DBI) provide detailed measures of trade facilitation (World Bank, 2020). This dataset includes information on border and documentary compliance times and costs for both imports and exports, as well as the overall *Trading Across Borders* score. These indicators reflect the efficiency and costliness of customs procedures and border management in each country.

2. The World Development Indicators (WDI) contain key macroeconomic measures such as GDP (current USD), GDP growth rate, and inflation rate (World Bank, 2025). These indicators offer insights into each country's level of economic development, performance, and stability.
3. The Worldwide Governance Indicators (WGI) capture institutional quality across several governance dimensions, including government effectiveness, regulatory quality, rule of law, and control of corruption (World Bank, 2024). These measures describe the strength of governance systems that may influence trade relationships, institutional reliability, and policy effectiveness.

## 4.2 Data Integration and cleaning

All datasets were joined using the country code (ISO3) as the unique key identifier. The trade data were filtered to include only valid reporting and partner countries, excluding aggregate or non-sovereign entities such as World, European Union, and Other Asia, etc.

The World Bank datasets were combined into a single table using inner joins, ensuring that only countries present across all three sources were retained. Duplicate columns were removed and variable names were standardized for clarity.

Finally, the cleaned World Bank data were merged with the trade dataset to construct two key network components:

- A weighted directed edge list: representing exports from country i to country j. The edge attribute captures the trade value (measured in thousands of U.S. dollars), indicating the intensity or magnitude of the trade relationship between two countries. Each edge corresponds to a direct trade flow from an exporting country (reporter) to an importing country (partner).
- A vertex attribute table: in which each vertex represents a country. This table includes country-specific attributes such as economic indicators (GDP, inflation rate, etc), governance quality (government effectiveness, regulatory quality, etc), and trade facilitation measures (border time and cost for export and import).

The resulting dataset covers 181 countries with 18940 trade links in 2018.

## 4.3 Descriptive Statistics

This chapter examines the structure of international trade relationships in 2018. The data reveals an interconnected global economy with strong reciprocal trading partnerships. The network shows a high density (0.581) and reciprocity (0.755), indicating that most countries engage in bilateral trade relationships rather than one-way flows. With 18,940 trade connections and very high transitivity (0.809), the data demonstrates that trading partners form tight-knit regional and global trading clusters. The dominance of mutual dyads (7,149) over asymmetric ones (4,641) further confirms that relationships in 2018 were predominantly two-way, reflecting the interdependent nature of the global economy.

Table 3: Network Statistics. Presents key structural metrics of the international trade network, showing a dense and highly reciprocal structure (density = 0.581; reciprocity = 0.755) with strong clustering (transitivity = 0.809) and no isolated nodes among 181 countries.

Metric	Value
Number of Vertices	181
Number of Edges	18,940
Density	0,581
Reciprocity	0,755
Transitivity	0,809
Mean Distance	Inf
Number of Isolates	0

Table 4: Dyad Census. Summarizes the distribution of dyadic relationships in the network, indicating that most country pairs engage in mutual trade (7,149 mutual dyads) compared to fewer asymmetric or null trade relationships.

Mutual	Asymmetric	Null
7,149	4,641	4,500

Table 5: Triad Census Reports the frequencies of triadic configurations, revealing a predominance of fully connected triads (type 300) and reciprocated trade structures (e.g., 111U, 120U), reflecting strong transitivity and clustering within the global trade system.

003	012	102	021D	021U	021C	111D	111U
70972	89605	53883	63714	7989	12420	11889	142706

030T	030C	201	120D	120U	120C	210	300
15583	405	66890	5027	120839	8840	100917	200000

Table 6: Dataset attributes. Summary statistics for all numerical attributes in the dataset, including trade performance indicators, documentation and border processing times, costs, and macroeconomic measures. The results show substantial variation across countries, particularly in trade costs and GDP, indicating heterogeneity in trade efficiency, economic quality, and governance quality among countries.

Attribute	Mean	Std	Min	Median	Max
export_border_time_hrs	55.4698	54.40175	0	48	296
import_border_time_hrs	69.83424	74.52605	0	54	402
trading_score	71.09771	22.35462	0	72.68096	100
export_doc_time_hrs	48.1589	68.24675	0.5	25.61538	528
import_doc_time_hrs	60.56441	99.47628	0.5	35	1090
export_border_cost_usd	393.3322	355.6893	0	319	2222.692
export_border_cost_score	64.04019	28.25334	0	68.65352	100
export_doc_cost_usd	122.3535	164.3328	0	84	1800
import_border_cost_usd	450.4859	407.7731	0	380	3039
import_border_cost_score	63.46928	28.72403	0	68.11778	100
import_doc_cost_usd	157.7586	189.2184	0	92.8	1025
import_doc_cost_score	77.4976	25.01695	0	86.07143	100
import_border_time_score	75.05148	25.65405	0	81.00358	100
import_doc_time_score	76.62794	26.96001	0	85.35565	100
inflation_rate	4.506356	8.657342	-2.8147	2.449891	83.50153
gdp_growth	3.374654	6.853632	-19.4973	2.989838	91.13704
gdp_current_usd	4.11E+11	1.81E+12	48015260	2.63E+10	2.07E+13
gov_effectiveness	6.55E-10	1	-2.32056	-0.06429	2.231766
regulatory_quality	3.21E-09	1	-2.38674	-0.0441	2.221292
control_corruption	3.28E-09	1	-1.78583	-0.17626	2.171759
rule_of_law	4.02E-09	1	-2.29866	-0.15911	2.034399

### 4.3.1 Distribution Analysis Vertices

The distribution peaks around  $\log_{10} 5 - 6$  has a long tail extending to the right (Figure 1). This tells us most trade relationships are moderate-sized, and there are fewer extremely large trade relationships. The highest frequency is around 5,5 to 6 which translates to between \$316 million and \$1 billion in trade. The right tail shows some relationships that are 100-1000x larger than typical ones. These are likely major trade corridors.

Figure 1: Distribution of Trade Values

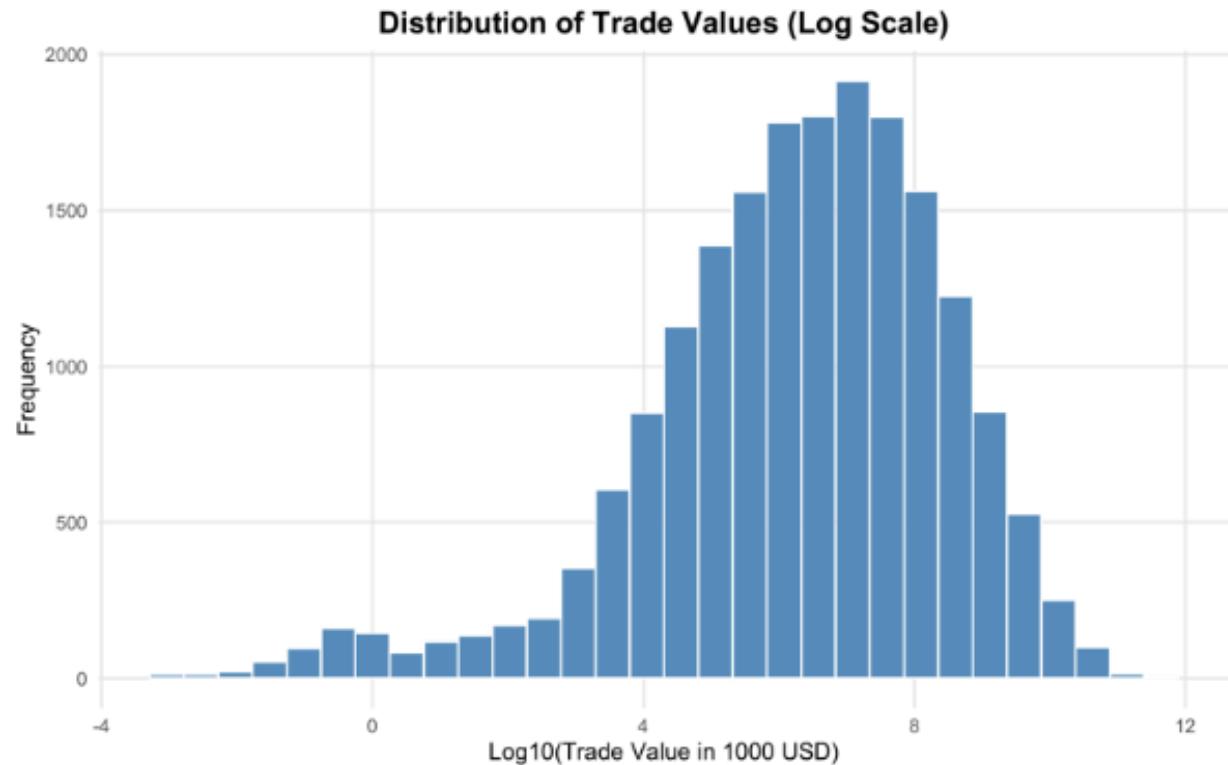
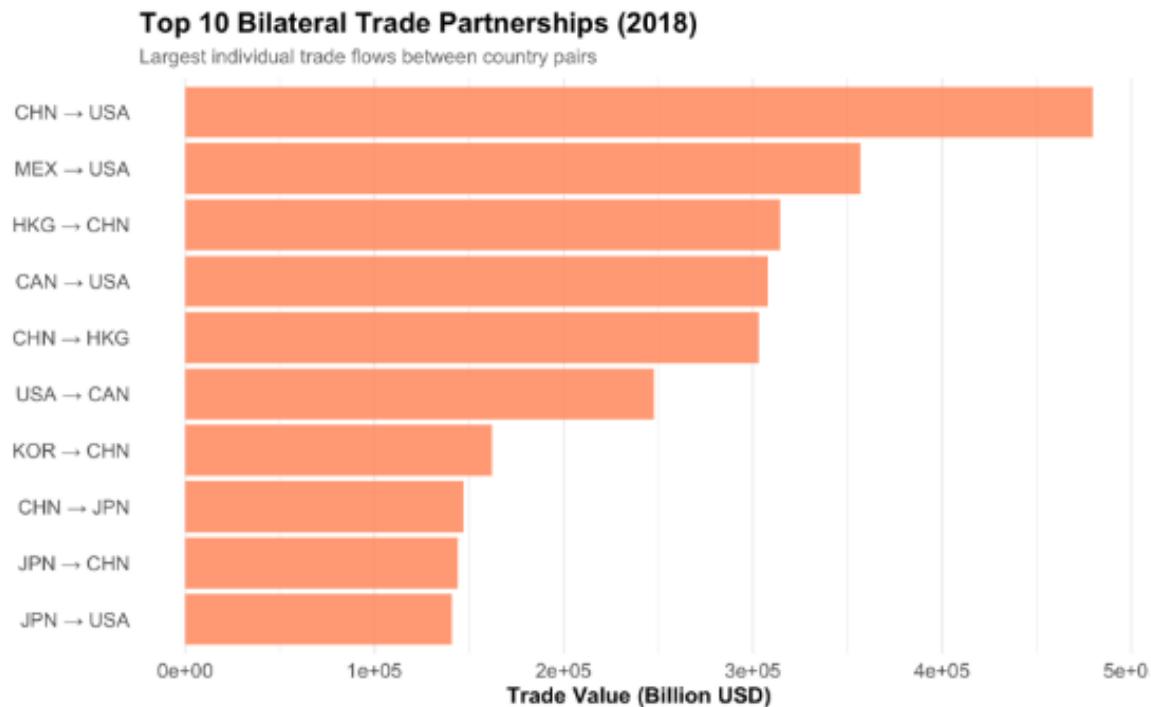


Figure 2: Bilateral Trade Network



This chart highlights the dominance of China -> USA trade (480 billion), the largest bilateral flow in 2018. The USA features prominently as a destination for Mexican and Canadian exports, while Hong Kong serves as a crucial intermediary for Chinese trade. Asian manufacturing networks (Korea, Japan, China) and significant trade imbalances characterize global commerce.

## 5 Research Rationale

In line with recent research on trade networks, we draw on studies that employ the Multiple Regression Quadratic Assignment Procedure (MRQAP) to analyze bilateral trade flows. For example, (Yang, Shen, Szakálné Kanó, Kosztopoulosz, & Hu, 2025) use MRQAP to identify the economic, geographic, and logistical drivers of EU lithium-ion battery trade, while (Hu et al., 2023) apply the method to the global rare-earths trade network, demonstrating that factors such as economic scale, geographical contiguity, and institutional distance shape dyadic trading patterns. Following this literature, we adopt MRQAP to model our trade network. MRQAP is particularly suitable because our data are network-based, representing trade between pairs of countries. Observations are interdependent, as trade relations are interconnected. Traditional regression methods cannot accommodate such dependencies, but MRQAP corrects for them using permutation tests, providing statistically valid results while including dyadic predictors such as GDP, inflation, and governance quality.

The international trade network examined in this study consists of directed, weighted ties, with each edge representing the value of exports from one country to another. This structure captures both the presence and intensity of trade. Traditional Exponential Random Graph Models (ERGMs) are well-suited for modeling network dependencies, but they treat ties as binary, obscuring the magnitude of trade relationships. Because trade intensity is central to understanding economic interdependence, backbone reduction or binarization would result in substantial information loss. Consequently, the dataset requires a modeling framework that retains continuous edge weights while simultaneously capturing the endogenous structure of the global trade network.

### 5.1 Suitability of MRQAP and GERGM

MRQAP is appropriate for our research questions because it evaluates how similarities or differences in country attributes, such as economic performance or governance quality, affect the strength of bilateral trade ties. It models the export network as a function of dyadic similarities, showing whether countries with comparable characteristics trade more. By accounting for network dependencies, MRQAP provides accurate insights into how governance and economic factors shape global trade connections. Since RQ1 focuses on attribute-based relationships rather than structural dependencies, MRQAP is particularly suitable.

The Generalized Exponential Random Graph Model (GERGM) extends ERGM methodology to continuous-valued networks, allowing weighted export flows to be analyzed while simultaneously estimating structural network effects and country-level attributes such as governance quality and macroeconomic conditions. GERGM is therefore well-suited to examine how governance similarity, reciprocity, clustering, and popularity jointly shape both the formation and intensity of export relationships. By preserving the full distribution

of trade values, GERGM provides a more realistic representation of the global trade system than binary ERGMs, offering deeper insight into the interaction between institutional and structural factors.

## 5.2 Comparison to Alternative Methods

Traditional gravity models estimated via ordinary least squares (OLS) or Poisson pseudo-maximum likelihood (PPML) are commonly used to study governance similarity and trade. However, they assume that dyads are independent, an assumption that fails in networked systems where reciprocity, shared partners, and clustering influence trade patterns (Cranmer & Desmarais, 2011). While governance similarity can be included in gravity models, these models cannot account for endogenous dependencies or the interplay between governance and network structure, and network autocorrelation can bias standard errors (Fagiolo, 2009). Standard ERGMs combined with binary backbone extraction similarly discard trade intensity, depend on arbitrary filtering thresholds, and cannot address our research questions, which concerns variation in trade magnitude (M. A. Serrano et al., 2009; Setayesh et al., 2022).

In contrast, MRQAP is well-suited for testing attribute-based hypotheses, maintaining dyadic trade values while accounting for network dependence via permutation-based inference (Dekker, Krackhardt, & Snijders, 2007). GERGM extends this by modeling continuous trade weights alongside structural characteristics such as popularity, reciprocity, and clustering. Together, these methods provide a theoretically coherent framework that integrates network dynamics and governance effects, offering a more complete and precise analysis of international trade patterns than alternative approaches.

# 6 Results (1300 words)

- View the SNA4DS template for reference how to add Code Block to write this part properly

## 6.1 MRQAP – Results for Model 1

We estimate a number of MRQAP models with bilateral trade intensity between country pairs as the dependent network in order to address Research Question 1. According to our hypotheses, regulatory quality similarity (H1a) and corruption control similarity (H2a) are the primary predictors that capture similarities in governance characteristics. We use inflation dissimilarity and the dyad's mean GDP as controls in every specification. We employ MRQAP with 5,000 QAP permutations to obtain network-robust p-values because trade relations between dyads are not independent.

We start with two baseline models that solely take economic covariates into account. The GDP dyadic average is included in Model 0. This model already explains about half of the variance in bilateral trade intensity ( $R^2 = 0.50$ ), as Table 9 demonstrates. This suggests that economic size is a very strong predictor of how intensely countries trade. According to the permu, the GDP\_mean coefficient is large, positive, and highly significant in all models (about 0.31).

Model 1 incorporates differences in inflation between pairs of countries. Dyads with more similar inflation rates typically engage in more intense trading, as indicated by the negative coefficient on Inflation\_diff. Its

two-tailed permutation p-value, however, is only marginally significant (between 0.07 and 0.09), indicating that this relationship is not as strong as the GDP effect. The overall fit is barely affected by the inclusion of inflation dissimilarity: When compared to the GDP-only baseline, R<sup>2</sup> rises slightly and mean squared error (MSE) falls slightly, but AIC and BIC values only slightly improve (Table 9).

To test H1a, we next present our first governance similarity metric, regulatory quality similarity. Higher values indicate more similar regulatory environments because this variable (RegQual\_similarity) is calculated as the negative absolute difference between the standardised regulatory quality scores of various nations. The strong positive effect of GDP\_mean and the weak negative effect of Inflation\_diff are essentially unchanged in Model H1a (not shown separately), while the coefficient on RegQual\_similarity is positive but very small in magnitude and statistically non-significant. In comparison to the purely economic baseline, adding regulatory quality similarity hardly affects R<sup>2</sup>, MSE, AIC, or BIC, according to the model fit statistics in Table 9.

Lastly, the governance similarity metrics RegQual\_similarity and CorrControl\_similarity are included in Model 1 MRQAP (Model H1a+H2a in Table 9). The complete set of coefficients is reported in Table 8. Once more, the RegQual\_similarity estimate is small and positive (~ 0.013), whereas the CorrControl\_similarity estimate is small and negative (~ -0.012). Crucially, after controlling for GDP and inflation, both coefficients have comparatively large two-tailed permutation p-values (approximately 0.11 and 0.10, respectively), suggesting that neither effect is statistically significant at conventional levels. On the other hand, Inflation\_diff continues to show a slight negative, marginally significant effect, and GDP\_mean maintains a strong, highly significant positive association with trade intensity.

Table 8 summarizes the MRQAP estimates for Model 1, focusing on the two governance similarity terms and the controls.

Table 8: MRQAP Model 1: Bilateral trade intensity regressed on governance similarity and controls.

Term	Estimate	Pr(<=b)	Pr(>=b)	Pr(>= b )
1	0.343	1.000	0.000	0.000
2	0.013	0.942	0.058	0.109
3	-0.012	0.049	0.951	0.103
4	0.306	1.000	0.000	0.000
5	-0.018	0.055	0.945	0.086

The estimated coefficients from Model 1 (not including the intercept) are shown in Figure Figure 3. With a significantly larger positive bar than any other term, the plot emphasises GDP\_mean's dominant role. A weaker effect is indicated by the Inflation\_diff bar, which is negative and noticeably smaller. The absolute value of the bars for RegQual\_similarity and CorrControl\_similarity is nearly zero, which graphically supports their lack of a significant and statistical influence on trade intensity.

To assess overall model performance more systematically, we compare mean squared error (MSE), R<sup>2</sup>, AIC

and BIC across the four specifications (baseline with GDP only, baseline plus inflation, H1a, and H1a+H2a). Table 9 shows these metrics.

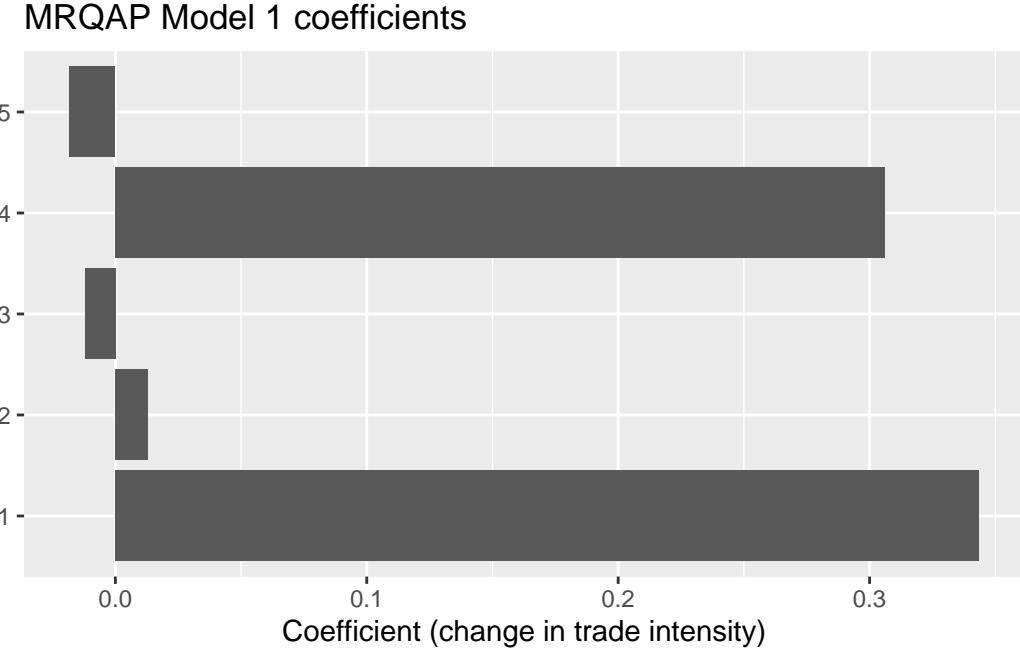
Table 9: Model fit statistics (MSE, R<sup>2</sup>, AIC, BIC) for alternative MRQAP specifications.

Model	MSE	R2	AIC	BIC
Baseline (GDP)	0.045	0.499	-91161.22	-91144.64
Baseline + Inflation	0.045	0.501	-91270.80	-91245.93
H1a: +Reg. quality similarity	0.045	0.501	-91273.84	-91240.69
H1a+H2a: +Corr. control similarity	0.045	0.502	-91304.44	-91263.00

The model comparison in Table 9 demonstrates that, in addition to the economic controls, governance similarity adds minimal explanatory power. When switching from the baseline models to the governance-augmented models, improvements in MSE, AIC, and BIC are minimal, and R<sup>2</sup> stays near 0.50 for all four specifications. This implies that rather than similarity in the two governance dimensions taken into consideration, economic size (and to a lesser extent, inflation differences) accounts for the majority of the explainable variation in bilateral trade intensity in our data.

To visualize the contributions of the different predictors in Model 1, Figure Figure 3 plots the estimated coefficients (excluding the intercept). This highlights the relative magnitude and direction of the effects.

Figure 3: Estimated coefficients from MRQAP Model 1 (excluding intercept).



The estimated coefficients from Model 1 (not including the intercept) are shown in Figure Figure 3. With a significantly larger positive bar than any other term, the plot emphasises GDP\_mean's dominant role.

A weaker effect is indicated by the Inflation\_diff bar, which is negative and noticeably smaller. The absolute value of the bars for RegQual\_similarity and CorrControl\_similarity is nearly zero, which graphically supports their lack of a significant and statistical influence on trade intensity.

When combined, these MRQAP findings only partially support Research Question 1. Economic fundamentals clearly influence the intensity of bilateral trade: country pairs with higher combined GDP trade significantly more, and there is some evidence that stronger trade ties are linked to macroeconomic similarity (lower inflation differences). However, once these economic factors are considered, we find no evidence that similarities in regulatory quality or corruption control, as measured here, result in systematically higher trade intensity. As a result, the MRQAP analysis does not support either H1a or H2a. The primary drivers of variation in bilateral trade intensity in this network seem to be basic economic capacity and modest macroeconomic stability rather than governance similarity.

## 6.2 ERGM – 2.5 POINTS - Chau + Leon

Present your results appropriately (plots, tables...) and discuss your findings in plain English. Discuss the meaning of your findings in relation to your hypothesis.

## 7 Conclusion (1000 words)

- What were your topic and research questions again? 1 sentence only

What did you learn from the two analyses you run? Most important point to address 0.5 POINTS - Noud

- Who benefits from your findings? Noud
- What remains an open problem? Noud
- Can you give suggestions for future work in this area? Leon

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## 8 Technology statement

During the preparation of this work, we used **ChatGPT** to check spelling, grammar, coherence, syntax and support our brainstorming process. The sections affected by the use of this tool include the **Introduction** and the **Research Rationale**. All outputs generated by ChatGPT were critically reviewed, validated, and edited by **Group 08 (Leon Boeren - Noud van Summeren - Chau Nguyen - Paritosh Singh - Silvia Petrova)** to ensure accuracy and academic integrity. **Group 08** assumes full responsibility for the final content of this work.