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# Technology War Frontier: Analyzing the Impact of Defense Strategies and Economic Dependency on National Policies Towards Chinese 5G Technology

By

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**Abstract**

This thesis explores the complex interplay of geopolitical, economic, and institutional factors influencing national policies towards Chinese 5G technology. In an era defined by rapid technological advancement and escalating geopolitical tensions, the rollout of 5G technology has become a critical point of international relations and national security discussions. Particularly, Chinese firms like Huawei have been at the center of global debates, prompting varied governmental responses ranging from cautious acceptance to outright bans. Through comprehensive quantitative analysis, this thesis seeks to untangle the reasons behind this divergent policy preference, examining how the dynamics of the international political economy, domestic political influences, and security considerations shape policies. From a national security perspective, this thesis founds that great power influence through arm transfer is pivotal in countries' foreign trade and technology decision. From a political economic perspective, this study challenges the assumptions of commercial peace and reveales the prevailing protectionist strategies, suggesting that concerns about economic dependency are more pivotal than mere trade imbalances in shaping state actions towards Chinese 5G technology. By integrating theoretical insights with empirical data, this study contributes to the discourse on technology governance and international trade policy, offering new perspectives on the intersection of global economics and national security.

**Keywords:** International Political Economy, Protectionism, Technology Sovereignty, Trade War

**Introduction**

In the contemporary geopolitical landscape, the rivalry between the United States and China has emerged as a pivotal axis around which global strategic alignments and policy decisions pivot. This competition extends beyond military or territorial disputes into the realms of technology, trade, and diplomacy. Among the various arenas of this rivalry, the deployment and acceptance of 5G technology have become significant points of contention. Recognizing the nature of this competition, this thesis aims to dissect the factors influencing countries' decisions to ban or adopt Chinese 5G products, focusing on the interplay between geopolitical alignments, economic dependencies, and domestic institutional frameworks. The implementation of 5G involves deploying new communication infrastructure. This technology supports a variety of industries, including automotive, entertainment, manufacturing, and healthcare, enabling new applications such as autonomous vehicles, augmented reality (AR), and virtual reality (VR) experiences, smart factories, and remote surgery.

The global 5G network market, a cornerstone of today's technological landscape, is projected to expand from USD 107.0 billion in 2022 to USD 331.1 billion by 2027 (MarketsandMarkets, 2023). This remarkable growth trajectory positions the 5G industry as a lucrative sector and a catalyst for advancements across various technological domains. However, the development of the 5G industry is deeply entangled with complex international political dynamics, a situation highlighted by the US-imposed sanctions on Huawei in 2019. As the industry evolves, it becomes increasingly influenced by the intensifying geopolitical rivalry between China and the United States. This thesis seeks to understand how diplomatic and economic factors under international political dynamics, particularly the competition between nations, influence governmental policies toward Chinese 5G products.

The significance of this research lies in its examination of the influences shaping the 5G technology landscape, which is increasingly recognized as a critical frontier in global technological competition. Firstly, 5G technology is pivotal not only because of its potential to generate massive market profits but also due to its technological importance, a key technology shaping global communications and connectivity. Secondly, this research underscores how 5G technology has become a symbol of the technological battleground among leading global powers. It is situated at the core of great power competitions, where technology is not merely a matter of economic interest but a pivotal element of national security and global influence. Thirdly, by exploring how international political economy affects industrial foreign policy, particularly in high-stakes technology markets, this study provides valuable insights into how states navigate complex geopolitical landscapes to bolster their technological sovereignty and competitive standing.

Lastly, the thesis fills a crucial gap in existing literature that has predominantly focused on qualitative assessments, by employing quantitative methods to dissect and quantify the impacts of political decisions on the 5G market. This approach enables a more precise understanding of how specific policies influence market dynamics and industry trajectories. The insights obtained could assist both policymakers and industry stakeholders as they develop tech sectors that emerge within a global political arena of competition. Moreover, by applying economic theories of protectionism to the technologically advanced realm of 5G, the research extends traditional economic concepts into a modern, technologically driven context.

**Literature Review**

5G telecommunications, similar to other manufacturing industries, rely on an integrated global market and supply chains. According to Statista (2023), Chinese 5G products constitute over 50 percent of the market share. A restrictive policy would directly reduce supply and raise the world price of 5G products. Neokosmidis et al. (2017) examined the prospects of success in the 5G industry by showing that value is created through hybrid collaborations among operators, distributors, vendors, and service providers, and is further augmented by collaborations between vertical industries, where network sharing evolves beyond the traditional infrastructure-sharing model. Contrarily, empirical evidence afterward suggests that countries such as the United States have imposed bans on Chinese 5G products, citing concerns over privacy and security.

<u>National Security Perspective: Trade Policy as Defense Strategy</u>

The national security perspective conceptualizes trade policy of foreign technology, particularly Chinese 5G, as an extension of a nation's defense strategy. Governments' decisions to restrict foreign technology are primarily motivated by security concerns, wherein trade policy serves as a strategic tool to mitigate potential risks posed by technological vulnerabilities and espionage. This aligns with the classical security dilemma, which posits that the introduction of potentially threatening foreign technology might be perceived as an imbalance in the security status quo, prompting governments to take defensive measures (Jervis, 1978).

Similar dynamics are observed in the policy stance against the Chinese 5G products. This theory is supported by the observation of Radu et al. (2021), who noted that the incentives of countries to ban Chinese 5G products are politically oriented, stemming either from path dependency or investigations of political risks. Building on the work of Knut Blind and Crispin Niebel (2022), who suggest that EU policies are significantly shaped by the need to maintain technological sovereignty and address geopolitical concerns, which contributed to the failure of the 5G products rollout in Europe, this thesis will further explore the national security perspective.

Moreover, this theory better explains the motivations of smaller countries to ban Chinese 5G products. The national and global costs of protection in traditional markets create extra rents in the disequilibrium economy (Feenstra, 1992). This is particularly prominent for small countries (Gawande et al., 2024). Large countries are more influenced by exporters' interests because their trade policies can impact global prices. For small economies, however, such policies would not only fail to influence global prices but might also lead to economic disadvantages without yielding significant benefits. Therefore, the national interest for smaller countries in banning Chinese 5G products does not lie in economic gains but might be rooted in political, security, or diplomatic motivations. These decisions could be driven by pressures to align with larger geopolitical blocs or the need to assert sovereignty in the face of potential security threats posed by technological dependence on foreign powers. This analysis prompts a deeper investigation into what constitutes national interests and threats to national security.

## Political Economic Perspectives: Foreign Trade Policy as Commercial Peace or Protectionism

From a political economic viewpoint, the interplay between economic ties and foreign trade policy towards Chinese 5G technology can be analyzed through two contrasting but interrelated frameworks: commercial peace theory or protectionist strategies. The effects of trade relations on the technology foreign policy are more sophisticated than the defense influence.

### *Commercial Peace Theory*

The theory of commercial peace suggests that countries with substantial economic interdependence through trade are less likely to engage in conflict and are more likely to sustain peaceful relations. The Dell Theory, articulated by Thomas Friedman (2005), proposes that no two countries involved in a major global supply chain will engage in war against each other as long as their economic interdependence exists. Expanding on Dell's framework, Michael Mousseau's (2019) perspective on commercial peace suggests that developed and market-oriented economies inherently disincentivize war by fostering a robust global marketplace.

Built on the commercial peace theory, a more recent study by Chen (2021) introduced the concept of "Extended Dependence." Chen argues that not only do economic ties between two direct adversaries influence the likelihood of military conflict, but so do the economic relationships between a potential challenger and the allies of the target state. This extended network of economic interdependencies raises the opportunity costs of conflict for the challenger, as military aggression against one state could result in economic retaliation from multiple countries, thereby amplifying the economic consequences of war. This dependency extended the economic peace argument beyond bilateral relationships to include multilateral economic connections.

While these theories traditionally focus on the avoidance of armed conflict, they can be extended to interpret technological and trade conflicts, particularly in the context of Chinese 5G technology. It could be argued that nations with significant economic ties to China might be less inclined to ban Chinese 5G products due to the potential economic fallout from such actions. These countries might perceive the benefits of continued economic engagement and the mutual gains from trade as outweighing the security risks associated with adopting foreign technology. Thus, the commercial peace theory would predict a reduced likelihood of banning Chinese 5G technology in countries where economic interdependence with China is high, suggesting that the intersection of interests fosters a form of economic cooperation and peace rather than conflict.

*Protectionist Strategy*

Protectionism as a strategy is motivated by a desire to shield domestic industries from international competition. In the context of Chinese 5G technology, such policies could be enacted to protect nascent or established domestic technological sectors from being overtaken by more cost-effective and high-quality Chinese alternatives. This perspective aligns with the traditional understanding of protectionism where trade barriers are erected to preserve jobs, foster local industries, and respond to trade imbalances. An increase in trade deficits with China might be viewed by some countries as an economic threat, compelling them to implement restrictive measures to curb the dominance of Chinese 5G equipment and services as a means to rebalance trade disparities.

International political and economic backgrounds are crucial in understanding trade policy as they set powerful constraints and incentives for policymakers when they make decisions in trade policy (Arvid Lukauskas, 2014). This perspective is critical as it highlights that decisions to maintain or dismantle protectionist measures are not solely economic but deeply political as well. As global dynamics shift—driven by factors such as technological advancement and international leadership competition—the expected gains of maintaining protected markets increase, pushing policymakers toward protectionism, outweighing the cost of protectionism. This framework can be applied to understand why some nations might choose to restrict Chinese 5G technologies—not just for economic self-sufficiency but also as a response to global competitive pressures and the changing costs associated with technological protectionism.

Furthermore, the pandemic, trade war, and various outbreaks of conflicts have increased feelings of political and economic insecurity, which push countries toward "beggar-thy-neighbor" trade policies (Baccini and Kim, 2012). More recent research by Nolke (2022) examined such tendencies toward protectionism in the post-pandemic era since the US-China trade war and the pandemic had weakened the liberal trade agenda. Furthermore, survey experiments conducted by Alfaro et al. (2023) in the US reveal that even when information about the price benefits of trade is presented to respondents, respondents surprisingly still prefer protectionism. This counterintuitive outcome suggests that even positive economic outcome of trade can reinforce protectionist attitudes, potentially due to economic uncertainty, the rise of Conservativism, the Sinophobia sentiment, and the general perception of China as a strategic competitor. These findings underscore a critical challenge to the commercial peace theory in the contemporary international political economy—namely, that the mere presence of economic benefits from trade is insufficient to sway public opinion towards liberal economic policies.

**Theoretical Framework**

This thesis begins with the observation that international rivalries between the US and China significantly influence foreign policy decisions regarding Chinese 5G technology. This paper uses foreign policy on Huawei as the indicator of a country's stance on 5G, which serves as a barometer for restrictions on Chinese 5G products. The restrictions imposed by countries, notably by the United States during the Trump administration, reflect a complex interplay of geopolitical pressures and national security concerns. Conversely, close relationships with China may disincentivize countries from imposing bans. This research draws upon a robust theoretical framework that merges insights from both national security and political economic perspectives to dissect the motivations behind governmental policies on Chinese 5G technology. This thesis proposes that both defense alignments and trade dynamics significantly shape attitudes toward Chinese 5G products.

From the national security perspective, this paper contends that national security concerns are not autonomously generated but are deeply intertwined with a country's defense alliances and diplomatic ties with great powers. It posits that the great powers, particularly the United States and China, actively wield defense influence, prompting aligned countries to adopt specific stances toward Chinese 5G technology. Security influence reflects broader geopolitical strategies where defense and security policies are closely linked to international alignments and rivalries.

The mutual defense alliance does not adequately capture this influence since it may not distinguish defense cooperation by the level of influence and incur commitment issues (Chiba et al., 2015). Furthermore, the defense diplomacy of the United States is built on well-established alliance systems with mutual defense agreements and overseas US military bases. However, defense alliance is inappropriate to capture the defense and diplomatic ties of China with other countries since China does not have a clearly defined alliance system nor does it value such diplomatic relations. Therefore, this paper hypothesizes that stronger defense ties with the United States through arms transfers are expected to correlate positively with the adoption of restrictive measures against Chinese 5G, and vice versa. Christian Catrina (2023) examined the dependency dynamics that arms transfers can create, affecting the recipient nations' policy autonomy and aligning them with the supplier's strategic interests. T. V. Paul (1992) argued that arms transfers were used to establish and maintain a patron-client relationship in the case of US-Pakistan during the Cold War, reinforcing the idea that arms transfers are a potent form of influence in international relations. This is applicable in the 5G technology case, where the United States and China can persuade its arms transfer recipients to adopt trade policy that fit their national interest.

On the trade front, the thesis challenges the commercial peace theory, supporting instead that protectionist sentiments predominate. The extended dependence of trade and alliances is not effective in this scenario because the dynamics shift from traditional military confrontations to a more nuanced form of economic and technological rivalry, which is the new trend of conflicts between the US and China. This necessitates a reevaluation of how economic dependencies influence international policies and conflicts. First, in the traditional sense, the presence of military alliances deters potential aggressors by amplifying the economic costs of military conflict through trade disruptions with allied nations. In the context of technological conflicts, however, the measures aim to limit a rival's technological reach instead of engaging in direct military conflict. Therefore, the bidding effect of defensive alliance pacts is weakened, decreasing the level of deterrence of extended dependence.

Secondly, in the realm of technology and trade policies, the costs of conflicts are less visible in immediate economic or military loss and more revealed in long-term strategic disadvantages. The economic costs associated with banning 5G products might also be deemed tolerable or even beneficial in the potential gains of protecting domestic technology industries. Thus, the deterrent effect of economic costs, central to the commercial peace theory, is less potent in this setting.

Thirdly, commercial peace theory does not adequately address the motivations that lead to the initiation of conflicts, especially in the context of global power dynamics and technological supremacy. The perception of gaining a technological edge, coupled with national security considerations, provides strong incentives for countries to escalate conflicts. These technology conflicts are generally perceived as less costly compared to full-scale military operations, making them more appealing as strategic tools in international relations.

Thus, this paper argues that contrary to the expectations that extensive trade ties would mitigate conflict through economic interdependence, the rise in trade protectionism reflects a strategic maneuver to counterbalance perceived threats and economic vulnerabilities. This perspective emphasizes that significant trade flows with China, rather than merely creating peaceful economic interdependence, might instead heighten concerns over economic sovereignty and lead to protective measures against perceived economic and technological threats. Therefore, in the current international dynamics marked by polarization and skepticism towards globalization, protectionist policies may gain more traction than those advocating for open trade, regardless of the latter's potential economic benefits.

This theoretical framework provides a comprehensive approach to understanding foreign trade policy on Chinese 5G technology. Examining these two perspectives, this thesis maintains that decisions to ban Chinese 5G products are influenced by a complex interplay of factors that weigh economic benefits against potential security risks. This thesis proposes two hypotheses:

Hypothesis 1: Defense Strategy and Influence through Arms Transfers

This hypothesis posits that restrictive policies on Chinese 5G technology are often adopted as a defense strategy, influenced by arm transfers. Arm transfers from the United States and China significantly impact these policies, with U.S. arms fostering policies that limit Chinese technology due to security alignments, and Chinese arms potentially discouraging such restrictions due to economic or strategic ties.

Hypothesis 2: The Predominance of Protectionism in the Current International Environment

Despite the theoretical interplay of commercial peace and protectionism in shaping trade policy decisions, this hypothesis argues that protectionist impulses prevail, leading countries to adopt restrictive policies towards Chinese 5G technology.

Alternative theories may suggest that, instead of geopolitical factors, domestic political and economic factors, such as lobbying by domestic technology corporations, and state regimes, such as democratic and authoritarian regimes, are the primary factors that influence countries' policies on Chinese 5G technology. Considering the institutional factors in the international political economy, this paper will identify the interactions between geopolitical variables and regime types by incorporating institutional fixed effects.

## Empirical Design

### Variable Identification

In the era of great power competition between the United States and China, the bilateral relationships of other countries with these two nations are the main geopolitical variables to consider. Both countries exert their foreign influence through defense and trade, which can be quantified by defense cooperation data and trade data.

*Dependent Variable*

Within the scope of this analysis, the study employs multiple indicators to represent the nuances of policy adoption and geopolitical dynamics. The dependent variable is the policy stance toward restricting or banning Chinese 5G products. The trajectory of such policies is marked by two seminal events. Initially, the prohibition by the Trump administration in 2018 of Huawei and other Chinese 5G vendors marked a significant policy shift, based on concerns over national security within the United States. This move precipitated a domino effect, with approximately ten countries, including Australia and Japan, instituting similar restrictions (Donaldson, 2020). Subsequently, the Clean Network Initiative, led by U.S. Secretary of State Mike Pompeo in August 2020, marked a pivotal moment for an international wave of policy shifts. This bipartisan, and U.S. government-led endeavor was devised to mitigate what it describes as "the long-term threat to data privacy, security, human rights, and principled collaboration posed to the free world by authoritarian malign actors" (U.S. Department of State, n.d.). The Initiative advocates for a comprehensive commitment from countries and international telecom providers to avoid using Chinese equipment in their 5G infrastructures.

Given these considerations, this paper will use the policy of banning Huawei 5G products as an indicator of policies against Chinese 5G technologies. Huawei, as the largest Chinese 5G vendor, is in direct competition for market leadership with western vendors such as Ericsson and Nokia (see in Appendix A). Thus, nations joining the Clean Network Initiative or explicitly prohibiting Huawei are classified as adopting restrictive policies toward Chinese 5G products. This classification is based on the information provided by the Council on Foreign Relations (2021), combining with member country lists of the Clean Network Initiative. This classification transforms the countries' policy positions into a binary variable, providing a structured lens through which to examine the international landscape of 5G policy decisions. The countries that classified as adopting restrictive policy with the reasons are presented in Table B (Appendix B).

*Defense Influential Factor*

This paper chooses the arms transfer data from the United States and China to other countries between 2018 to 2023 as a proxy for understanding the depth and nature of defense diplomatic relationships. This period marks a critical phase in the 5G technology rollout and the escalating tensions between the US and China over the technological domain. Arms transfer data, in this context, offers a tangible measure of the military and strategic partnerships that countries maintain with the great powers. Firstly, arms transfers from China and the United States signify the one-sided exertion of defense influence across borders. Secondly, it measures and differentiates the level of defense relationships between countries. Lastly, it balances the measurement both the United States and China, countries with drastically different defense cooperation policies, on the same scale. It is essential to underscore that arms transfer is not merely a transactional relationship but a manifestation of deeper strategic ties, mutual trust, and long-term commitments to security cooperation. Therefore, this variable not only captures the defense diplomacy dynamics but also serves as a lens through which the geopolitical orientations of nations can be discerned.

The arms transfer data comes from the Stockholm International Peace Research Institute (SIPRI) Arms Transfer Database, which contains data of all transfers of major conventional arms from 1950 to the most recent full calendar year calculated in volume (SIPRI, 2021). The weapon transfer volume is measured using a common unit, the trend-indicator value (TIV), which is based on the known unit production costs of a core set of weapons and is intended to represent the transfer of military resources rather than the financial value of the transfer deal. By using this measurement, the arms transfer data serves as a proxy for military resources transferred by the United States or China to other recipient countries, indicating the level of military cooperation and influence of the supplier countries to the recipient countries. Furthermore, using the aggregated sum of arms transfers from 2018 to 2023 covers the periods of the banning policy in effect and the nature of long-term contracts of weapons. The raw data from the SIPRI database is scaled at million units, where 1 denotes 1 million. To standardize the measure with the trade data, this paper aggregates the values of arms transfers by 1,000,000 to match with trade data units so that the scale of influence can be evaluated at the same level, then this paper takes the log of the transformed data (see Figure C1 and Figure C2 in Appendix C).

*Economic Influence Factor*

Building on the premise that arms transfers serve as a proxy for defense diplomatic relationships, a parallel consideration of trade factors offers a comprehensive understanding. The gravity of trade relationships, characterized by the volume and complexity of capital and commodity flows, reflects the depth of economic integration between countries. Trade volume data serve as critical indicators of economic engagement and dependency between countries and the United States or China (Word Bank, 2021a, 2021b). Nonetheless, using trade volume data directly can be biased and less representative since China and the United States naturally have higher trade volumes with more economically developed countries. To eliminate the effects of GDP volume and other factors, this paper will use gravity models to evaluate the trade ties of the United States and China with other countries. The gravity model, by accounting for the size of economies and the distance between them, provides a robust framework for assessing the intensity and potential of trade relationships. If commercial peace theory holds true, a higher trade volume with China may indicate a country's inclination towards maintaining favorable relations, potentially reducing the likelihood to ban Chinese 5G products.

More specifically, trade deficit data with China is included in the model as a representation of trade pressure from Chinese exports. Under the Trump administration in 2018, the same period when the 5G ban was imposed, the aggregated trade deficit stirred concerns among domestic producers about Chinese competitors in import competing industries, which the US government claimed as an initiative to start the Trade War and adopted protectionist policies due to high trade deficit with China (Stiglitz, 2018). Consequently, significant trade deficits might reflect economic vulnerabilities or protectionist inclinations that could predispose a country towards restricting Chinese technology, driven by broader concerns over economic sovereignty and national security.

The trade volume and trade deficit data for 2021 were sourced from the World Integrated Trade Solution (WITS) database, which is jointly developed by the World Bank, the United Nations Conference on Trade and Development (UNCTAD), and the United Nations Statistical Division (World Bank, 2021a). Given that this study assesses the impact of policies towards Chinese 5G products specifically in the year 2021, the use of contemporaneous trade data ensures that the economic context captured is immediately relevant to the policy decisions under review. This choice recognizes that while historical trade patterns offer valuable background information, the trade dynamics and economic pressures of 2021 are crucial for a precise understanding of the economic factors influencing countries' stances on Chinese 5G technology.

*Gravity Model Explanation*

The gravity model of trade states that bilateral trade flows between two countries are directly proportional to their economic size and inversely proportional to the geographical distance between them. To create the gravity model, GDP data for 2021 were sourced from the World Bank's World Development Indicators database (World Bank, 2023). This data reflects the economic size of each country, serving as a proxy for its trade capacity. Geographical distance was obtained from the CEPII GeoDist database, which provides distance measures between country pairs, accounting for factors such as shared borders and access to sea routes (Mayer, 2011). Additionally, to control regional trade dynamics and the impact of geographic proximity on trade, continental fixed effects were included. This allows for a more refined analysis by accounting for unobserved heterogeneity across different continents that could influence trade patterns, such as regional trade agreements or shared regulatory standards. By employing a log-log model, this paper generates the gravity model from the 2021 actual trade flow for China and the US (see Table D1 and Table D2 in Appendix D). After creating the gravity trade models, this paper uses these models to estimate log trade flows. The distribution of the estimated log trade flows is presented in Figure E1 and Figure E2 in Appendix E.

In addition to these external factors, this paper also incorporates the domestic political institutional framework into the models. The institutional setting can significantly affect policy continuity, decision-making processes, and the susceptibility of national policies to external influences. It also interacts with the arms transfers data since countries with closer political institutions tend to share more political ideology and cooperate more closely. Democratic nations are more inclined politically towards the United States and may perceive Chinese technological advances as a potential threat to democratic values. Conversely, countries with less democratic systems might not view China's technological rise as ideologically threatening. By adding the institutional fixed effect, this thesis acknowledges the complex interplay between international dynamics and domestic political structures in shaping technology policy decisions. The institutional dummy variables are sourced from the SYSTEM variable of the Database of Political Institutions 2020 (DPI2020) by the Inter-American Development Bank (Scartascini, Cruz, & Keefer, 2021). SYSTEM classifies political institutions into Parliamentary (2), Assembly-elected President (1), Presidential (0), with systems with unelected executives receiving a 0. In the context of this thesis, two dummy variables were created to represent the Parliamentary and Presidential systems, with the Assembly-elected Presidential system omitted to avoid multicollinearity.

*Table 1: Variable Definition*

| *Variable Name* | *Variable Coding* | *Variable Definition* |
|---|---|---|
| *Policy* | policy | The policy to restrict or not restrict Chinese 5G products (Huawei) in country i. |
| *Arm Transfers (US)* | us_log | The (log) arm transfers of the US to country i. |
| *Arm Transfers (China)* | cn_log | The (log) arm transfers of China to country i. |
| *Trade Flow (China)* | estimated_log_trade_flow_cn | The (log) trade volume of China with country i. |
| *Trade Flow (US)* | estimated_log_trade_flow_us | The (log) trade volume of the US with country i. |
| *Trade Deficit (China)* | trade_deficit_log | The (log) trade deficit of country i with China where positive value is trade deficits and negative value is trade surplus (sign is kept in log transformation). |
| *Presidential* | presidential | The dummy variable Presidential system where D1i=1 if the country has a Presidential system, and 0 otherwise. |
| *Parliamentary* | parliamentary | The dummy variable Parliamentary system where D2i=1 if the country has a Parliamentary system, and 0 otherwise. |

Table 1 shows the variable names, coding, and definition in the model. The variable name will be used for clarity in the data presentation and model specifications. All of the arm transfer and trade variables are taken logarithm to normalize the scale. The Policy and institution variables are dummy variables.

Model Construction

*Table 2: Descriptive Data of Dependent and Independent Variables*

| | *N* | *Mean* | *Median* | *σ* | *min* | *25%* | *75%* | *max* |
|---|---|---|---|---|---|---|---|---|
| *Arm Transfers (US)* | 185 | 9.184 | 13.816 | 9.122 | 0.000 | 0.000 | 17.687 | 23.160 |
| *Arm Transfers (China)* | 185 | 4.117 | 0.000 | 7.350 | 0.000 | 0.000 | 0.000 | 22.421 |
| *Trade Flow (China)* | 185 | 14.797 | 14.790 | 2.293 | 9.167 | 13.414 | 16.559 | 20.681 |
| *Trade Flow (US)* | 185 | 13.953 | 13.830 | 2.499 | 7.348 | 12.288 | 15.927 | 19.760 |
| *Trade Deficit (China)* | 185 | 6.548 | 12.906 | 12.565 | -18.394 | 7.897 | 14.738 | 18.298 |
| *Presidential* | 185 | 0.497 | 0.000 | 0.501 | 0.000 | 0.000 | 1.000 | 1.000 |
| *Parliamentary* | 185 | 0.319 | 0.000 | 0.467 | 0.000 | 0.000 | 1.000 | 1.000 |
| *Policy* | 185 | 0.195 | 0.000 | 0.397 | 0.000 | 0.000 | 0.000 | 1.000 |

This paper primarily utilizes the Ordinary Least Squares (OLS) model for data analysis. Despite the binary dependent variable, the OLS model is chosen for its simplicity and interpretability. This thesis acknowledges the limitations concerning the interpretation of these coefficients, as they may predict values outside the typical binary range of 0 to 1. The OLS model offers a standardized framework for evaluating all variables of interest, enabling their collective and isolated analysis without concerns of model non-convergence. It provides coefficients that are straightforward to interpret, offering insights into the linear relationship between independent variables and the binary outcome. This capability is particularly beneficial for examining the independent and interdependent effects of variables across various OLS model configurations. Specifically, the analysis will explore defense variables, trade variables, and trade deficit variables, both individually and in combination, aiming to pinpoint significant influences and interactions among these variables. A total of five comparative models will be presented, and the equations of the models are presented in the tables in Appendix F.

Moreover, while logistic regression is typically more appropriate for binary outcomes, it can encounter issues such as non-convergence or produce infinite or highly unstable estimates in cases of perfect or quasi-perfect separation in the data. In contrast, OLS does not suffer from these problems and can provide reliable coefficient estimates under circumstances where logistic regression might fail. Additionally, one significant advantage of OLS in this context is its ability to effectively handle sparse data. This feature is particularly relevant since arms transfers from China exhibit up to 75 percent zero values, as shown in Table 2, similar to the policy variable. Logistic regression could potentially overfit or fail to discern meaningful patterns in such data, whereas OLS's insensitivity to the distribution of the dependent variable allows it to still provide valuable insights, albeit with cautious interpretation.

Furthermore, to validate the findings from the OLS models, logistic regression will be employed as a supplementary analysis.  This dual approach ensures that the results are robust, providing comprehensive validation of the analytical outcomes. The logistic models, serving as sensitivity checks, will help confirm the reliability of interpretations from the OLS analysis.

<u>Multicollinearity Check</u>

The estimated trade flow of China has a Variance Inflation Factor (VIF) of 6.739 and that of estimated trade flow of the US is 5.487, exceeding the common threshold of 5 but below the concerning level of 10 (see Appendix G1). Specifically, the correlation matrix plot shows that the trade flows of China and the United States have a correlation of 0.88 (see Appendix G2). The interdependence of these trade variables could distort their individual estimated effects. This is likely linked with the intertwined nature of trade and the facts that China and the US are the largest global exporters and importers respectively.

To address this issue, the estimated trade flow with the US will be removed in the models since the trade relationship and dynamics with China has more direct effects on the trade policy toward Chinese goods. The trade flow with the US is also insignificant in conjunction with the trade flow of China from the preliminary results, so it would also be removed in the baseline model. By removing the trade flow with the US from the models, the VIF of trade flow of China decreases to 2.014 (see Appendix G3), and the correlations matrix indicates low level of multicollinearity over all (see Appendix G4). Ensuring the OLS model produces unbiased estimators.

**Result and Output**

*Table 3: Baseline OLS Model of Arms Transfers and Trade Variables (Model 5)*

*Baseline OLS Model of Arms Transfers and Trade Deficit (Model 5)*

| | Coefficient | σ | t | P>\|t\| |
|---|---|---|---|---|
| *Arm Transfer (US)* | 0.011 | 0.003 | 3.715 | 0.000 |
| *Arm Transfer (China)* | -0.012 | 0.003 | -4.100 | 0.000 |
| *Trade Flow (China)* | 0.055 | 0.013 | 4.328 | 0.000 |
| *Trade Deficit (China)* | 0.005 | 0.002 | 2.669 | 0.008 |
| *Presidential* | -0.187 | 0.061 | -3.043 | 0.003 |
| *Parliamentary* | 0.181 | 0.065 | 2.762 | 0.006 |
| *N* | | | | 185 |
| *R-squared* | | | | 0.472 |
| *Adjusted R-squared* | | | | 0.457 |
| *F-Statistics* | | | | 32.420 |

*Notes: The Baseline Model above is the same as Model 5, and the baseline model with Trade Flow (US) are presented in Appendix H for reference.*

Table 3 offers a comprehensive overview of the Baseline Ordinary Least Squares (OLS) regression model delineating the relationships between arms transfers, trade variables, and the policies pertaining to Chinese 5G products. Due to the issue of multicollinearity of trade flow with China and the US, Trade Flow of the US is removed in the baseline model. The OLS model including the Trade Flow (US) variable is presented in Appendix H. It shows that the Trade Flow (US) is not statistically significant, while the Trade Flow (China) remain significant when both variables are included. Therefore, it is clear that the trade flow with China has a more discerning impact on the policy adoption compared to that of the US.

In table 3, the coefficient for Arm Transfer (US) stands at 0.0110, implying a positive association with the policy variable; for every unit increase in the logarithm of arms transfers from the United States, there is a 0.011 increase in the likelihood of a policy being adopted, holding all other variables constant. This effect is statistically significant ($p < 0.001$), suggesting a strong link between U.S. arms transfers and the adoption of restrictive policies against Chinese 5G technology. Conversely, the coefficient of Arm Transfer (China) is -0.012, indicating a negative relationship with the policy outcome. A unit increase in the logarithm of arms transfers from China correlates with a 0.012 decrease in the likelihood of adopting such policies, and this predictor is also statistically significant ($p < 0.001$).

The variables Trade Flow (China) represent the log-transformed trade flow with China, with a significant positive coefficient of 0.055 ($p < 0.\ 001$), suggesting that increased trade with China is associated with a greater likelihood of policy implementation against Chinese 5G products. The Trade Deficit (China) exhibits a positive coefficient of 0.005 ($p < 0.01$), indicating that a higher trade deficit with China correlates with an increased propensity to adopt policies against Chinese 5G technologies.

Regarding the political system variables, the presidential country has a negative coefficient of -0.187, which is statistically significant ($p < 0.01$), indicating that presidential systems are less likely to adopt restrictive policies towards Chinese 5G products. On the other hand, parliamentary systems are more likely to implement such policies, as evidenced by a positive coefficient of 0.181 ($p < 0.01$).

*Comparative OLS Models of Defense and Trade Factors*

*Table 4: Comparative Analysis of OLS Model Coefficients Across Different Specifications*

*Table 4: Comparative Analysis of OLS Model Coefficients Across Different Specifications*

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| *Arm Transfers (US)* | 0.02*** | | 0.013*** | 0.019*** | 0.011*** |
| | (0.002) | | (0.003) | (0.002) | (0.003) |
| *Arm Transfers (China)* | -0.010** | | -0.012*** | -0.010*** | -0.012*** |
| | (0.003) | | (0.003) | (0.003) | (0.003) |
| *Trade Flow (China)* | | 0.076*** | 0.046*** | | 0.055*** |
| | | (0.011) | (0.013) | | (0.013) |
| *Trade Deficit (China)* | | 0.006*** | | 0.003 | 0.005** |
| | | (0.002) | | (0.002) | (0.002) |
| *Presidential* | -0.122 | -0.242*** | -0.186** | -0.115 | -0.187** |
| | (0.062) | (0.065) | (0.062) | (0.062) | (0.061) |
| *Parliamentary* | 0.255*** | 0.192** | 0.178** | 0.265*** | 0.181** |
| | (0.065) | (0.070) | (0.067) | (0.065) | (0.065) |
| *Observations* | 185 | 185 | 185 | 185 | 185 |
| *R-Squared* | 0.465 | 0.439 | 0.503 | 0.472 | 0.522 |
| *Adjusted R-Squared* | 0.453 | 0.426 | 0.489 | 0.457 | 0.506 |
| *F-Statistics* | 39.150 | 35.200 | 36.240 | 31.990 | 32.420 |

*Notes: (1) * represents P<0.05, ** represents P<0.01, *** represents P<0.001. (2) Standard error in parentheses.*

Table 4 presents the results from a series of five Ordinary Least Squares (OLS) regression models designed to investigate the influence of various predictors on the propensity of countries to adopt policies against Chinese 5G technology. Building on the baseline OLS model, these models vary in the range of variables included, from defense-related factors to trade volumes and deficits, enabling an assessment of their individual and combined effects. See Appendix I for the detailed model specifications of model 1to model 5.

Model 1 focuses exclusively on defense variables. Arm transfers from the US are positively associated with policy adoption (coefficient = 0.019, $p < 0.001$), indicating that greater US arms transfers are linked with a higher likelihood of adopting restrictive policies. Conversely, Chinese arm transfers show a negative association (coefficient = -0.010, $p < 0.01$), suggesting that increased arms transfers from China may reduce the likelihood of such policy actions. The scale of influence of arm transfers remains consistent in Model 1 and other models.

Model 2 shifts attention to trade variables alone. The trade flow with China emerges as a significant predictor (coefficient = 0.046, $p < 0.001$), while the trade volume with the US does not significantly relate to policy adoption. The trade deficit with China also shows a positive relationship (coefficient = 0.006, $p < 0.001$). Without taking defense factors into consideration, the trade volume and trade deficit still yield a significant influence, implying that the effect of international political economic factors is independent of the defense factors.

Model 3 and Model 4 introduce the trade volume and trade deficit variables alongside defense variables to examine their relative effects. In Model 3, US arms transfers remain positively significant, while Chinese arms transfers maintain a negative association with policy adoption. However, the trade volume of China ($p < 0.001$) continues to be statistically significant.  In Model 4, US arms transfers and Chinese arms transfers maintain their respective positive and negative significances, but the trade variables are not significantly linked to policy adoption ($p = 0.137$). The findings from Model 3 and Model 4 indicate that trade flows are consistently significant, but the trade balance is ineffective; merely having a trade deficit with

China does not correlate significantly with the decision to adopt restrictive policies. Having high trade flows with China, however, clearly influence countries policy preferences.

Model 5 takes all variables into the regression model, except for the trade flow of the US, which is different from the baseline models. While the arm transfers and trade deficits are significant as anticipated, the trade flow of China has similar effects and higher statistical significance (coefficient = 0.055, p-value < 0.001) without the trade flow of the US. This indicates that by removing the inflated effects caused by multicellularity, the trade flow of China still exhibits a strong positive correlation with the adoption of policy.

Across all models, the variable representing presidential systems (presidential) consistently shows a significant negative relationship with the adoption of restrictive policies, suggesting that countries with presidential systems are less likely to impose restrictions. Conversely, the variable for parliamentary systems (parliamentary) is positively associated with policy adoption, indicating a higher propensity for parliamentary systems to enact such measures. Moreover, even after controlling for institutional effects, the data on arms transfers and trade continue to show significant correlations with policy adoption decisions. This underscores the influence of international political and economic factors on these policy outcomes.

*Logistic Regression Sensitivity Check*

*Table 5: Logistic Model of Defense and Trade Variables*

| | ***Coefficient*** | ***σ*** | ***z*** | ***P>\|z\|*** | ***[0.025*** | ***0.975]*** |
|---|---|---|---|---|---|---|
| *Arm Transfer (US)* | 0.156 | 0.049 | 3.182 | 0.001 | 0.06 | 0.253 |
| *Arm Transfers (China)* | -0.332 | 0.093 | -3.587 | 0.000 | -0.513 | -0.151 |
| *Trade Flow (China)* | 0.894 | 0.271 | 3.305 | 0.001 | 0.364 | 1.425 |
| *Trade Deficit (China)* | 0.082 | 0.034 | 2.366 | 0.018 | 0.014 | 0.149 |
| *Presidential* | -3.113 | 1.187 | -2.623 | 0.009 | -5.44 | -0.787 |
| *Parliamentary* | 2.194 | 1.073 | 2.045 | 0.041 | 0.092 | 4.296 |
| *N* | | | | | | 185 |
| *Pseudo R-squared* | | | | | | 0.700 |

*Notes: Possibly complete quasi-separation: A fraction 0.12 of observations can be perfectly predicted. This might indicate that there is complete quasi-separation. In this case some parameters will not be identified.*

The logistic regression results presented in Table 5 provide a sensitivity analysis complementary to the previously discussed OLS models. The consistency in the direction and significance of the coefficients for arms transfers (both from the US and China) and the institutional variables across both the OLS and logistic models suggests robustness in the effects of these predictors, irrespective of the modeling approach. The continued significance of the trade deficit variable in both models underscores its robust importance in shaping policy decisions toward Chinese 5G technology. The logistic model including the trade flows of the US is presented in Appendix J. In logistic regression, multicollinearity not only inflates variances but can also lead to larger confidence intervals and less precise estimates, which can distort the odds ratios and lead to unreliable significance tests. Because logistic model is particularly sensitive to multicollinearity, the trade flows of China would be insignificant when including the trade flow of the US. It also causes problems with the convergence of the logistic regression model, resulting in higher quasi-separation (15 percent of perfectly predicted observations) in Logistic Regression Model 2.

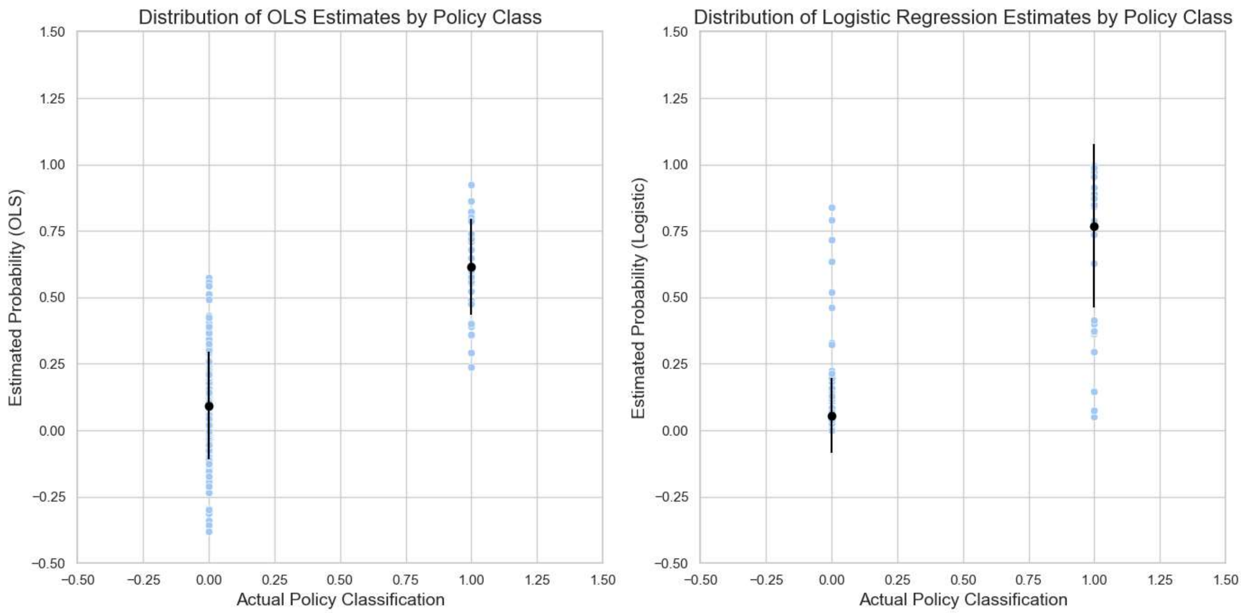


*Figure 1: Distribution of Predicted Probabilities by Policy Classification from OLS and Logistic Regression Models*

Figure 1 presents a comparative visualization of the predicted probabilities from the Ordinary Least Squares (OLS) and logistic regression models. Each blue point represents an individual estimate against the actual policy classification. The left panel illustrates the estimates from the OLS model, while the right panel displays those from the logistic regression model. Each panel contrasts the estimated probabilities against the actual policy decisions of countries, where '0' represents no adoption of restrictive policies against Chinese 5G technology, and '1' indicates adoption. The visualizations reveal that both models can distinguish between the two policy classes, suggesting that they are capable of capturing the underlying dynamics that govern policy decisions on Chinese 5G technology. Despite the intrinsic differences between OLS and logistic regression, both models exhibit robustness in reflecting the distribution of the policy outcome variable across the sampled nations.

## Discussion

Defense Influence on Policy Decisions

The models consistently reveal that arms transfers from the United States are positively correlated with the adoption of restrictive policies against Chinese 5G technology, as evidenced by the significant coefficients across all models. Specifically, in Model 5, each unit increase in the logarithm of US arms transfers is associated with a higher probability of policy adoption (coefficient = 0.011, $p < 0.001$). This suggests that stronger defense ties with the US encourage policies that limit Chinese technological presence in a given country.

The consistency and strength of the correlation between US arm transfers and restrictive 5G policies underscore the extent to which defense alliances shape national security strategies. It indicates that these policies may be less about the intrinsic security risks posed by Chinese 5G technology and more about the geopolitical dynamics dictated by major powers, particularly the United States. The findings suggest that the narrative of national security concerns regarding Chinese 5G might be partially constructed or amplified by the interests of dominant geopolitical actors. This international political economic framework of defense posits that major powers can leverage their military relationships to influence the technology policies of allied nations, effectively aligning global technological landscapes with their strategic interests.

Moreover, the inverse relationship observed with Chinese arm transfers further supports the idea that countries embedded in China's defense network may experience different kinds of pressures that dissuade them from adopting policies adverse to Chinese interests. In Model 5, for instance, each unit increase in the logarithm of Chinese arms transfers is correlated with a decrease in the likelihood of policy adoption (coefficient = -0.012, $p < 0.001$). This indicates that countries receiving more military support from China are less inclined to impose restrictions on

Chinese 5G technologies. This dynamic highlights how defense ties can serve as conduits for economic and technological influence, affecting national policy decisions in ways that extend beyond traditional military alliances.

These arms transfers are indicative of the defense relationships between the donor and recipient countries and serve as a proxy for defense influence exerted by the US and China. The high and sustained significance of these variables across various model specifications underscores the robust correlation between defense factors and a country's decision to ban Chinese 5G products. While some nations may cite concerns over privacy intrusions, the findings suggest that considerations of national security and defense cooperation with the US and China play a more significant role in policy enactment.

Complex Impact of Trade Factors

The trade volume with the United States does not present a consistent level of significance across the different models in this analysis. This inconsistency could be attributed to the correlation between the trade flows of the U.S. and China. As the world's largest importer and exporter, respectively, the U.S. and China have high trade volumes with many nations, which could obscure the individual effects of their trade relationships on policy outcomes. This variability suggests that the impact of trade with the U.S. on policy decisions regarding Chinese 5G technology is less distinct and could be contingent upon the interplay with other influencing factors. This implies that trade relationships with the United States, who considers China as strategic competitor and actively advocate for pre-emptive ban against Chinese 5G products, does not impose its influence through trade relationship.

By contrast, the significance of trade relationship with China across all models suggests that economic interactions with China could have a more direct impact on the decision-making processes related to Chinese 5G technology. Model 2 indicates a positive association (coefficient = 0.076, $p < 0.001$), which is reaffirmed in Model 3 (coefficient = 0.046, $p < 0.001$) and Model 5 (coefficient = 0.055, $p < 0.001$). The trade deficit with China demonstrates a positive and significant relationship with policy adoption in Model 2 and Model 5, including the logistic regression model (coefficient = 0.080, $p < 0.05$), suggesting that countries with larger trade deficits with China are more likely to adopt restrictive policies against Chinese 5G products. However, this effect is not consistent across all models. In Model 4, when the trade deficit variable is tested with only the defense variable, it becomes insignificant (coefficient = 0.003, $p = 0.137$), indicating that the relationship between trade deficit with China and policy decisions is complex.

*Trade Flow and Trade Dynamics with China in Conjunction*

Because the trade deficit factors are noted as positive, whereas trade surplus with China is noted as negative, the positive coefficient indicates that trade surplus with China would reduce the likelihood of restrictive policy against Chinese 5G products, while trade deficits increase such likelihood. The observed positive correlation between trade ties with China—assessed via a gravity model controlled for confounding factors such as GDP, geographical distance, and continental fixed effects—and the adoption of restrictive policies against Chinese 5G technology clearly defies the commercial peace assumption and directs to the narrative of protectionism.

Crucially, the significance of the trade deficit with China arises predominantly when it is analyzed in conjunction of the trade flows. When modeled separately, its influence is markedly reduced, overshadowed by the defense-related variables. This finding is particularly insightful, as it contradicts the expectation that trade deficits would be the primary motivator behind restrictive policies. Instead, the overall volume of trade with China emerges as a more reliable estimator.

Thus, this finding challenges the conventional wisdom that trade policies, particularly those involving restrictions, are primarily motivated by concerns over trade imbalances. Instead, the results indicate while trade imbalance is an important factor in technological trade policy, the sheer volume of trade is a more decisive factor.

One potential explanation for this observation may be drawn upon the theory that globalization fosters populism (Rodrik, 2021). The populist narrative leverages globalization shocks to foster a broader skepticism towards free trade and open markets, advocating for more protectionist measures as means to safeguard domestic interests against global economic pressures. According to this perspective, the growing public skepticism towards high levels of economic interdependency, especially with a geopolitical challenger like China, may fuel nationalist sentiments and protectionist policies. The substantial trade flow could symbolize a perceived over-reliance on China, which, in the realm of advanced technology such as 5G, stirs apprehensions about economic sovereignty and security.

Furthermore, this explanation aligns with the broader discourse on the backlash against globalization. In the context of the US-China trade war, the dynamic of retaliation and generalized reciprocity elucidates why the public may grow increasingly skeptical of free trade. This skepticism is not only a reaction to direct economic conflicts but also a broader distrust towards global economic practices, influenced by a perceived lack of cooperation and fairness on the international stage (Steinberg and Tan, 2023). As economies become more intertwined, any disruption or perceived threat could amplify calls for reasserting control over critical sectors, including telecommunications. Thus, the decision to impose restrictions on Chinese 5G technology may be less about correcting trade deficits and more about mitigating the risks associated with economic integration.

Similarly, economic vulnerability and dependence theory posits that vulnerabilities arising from economic dependencies compel states to adopt protective measures to safeguard their national interests. The positive relationship between trade deficits with China and the adoption of restrictive policies against Chinese 5G products can be interpreted through this lens. Large trade deficits may be perceived as vulnerabilities that threaten national economic security, prompting states to adopt protectionist measures as a counterbalance. The situation with Rare Earth Elements (REEs) in Europe exemplifies a similar scenario of economic dependency and its implications. Georgios Charalampides et al. (2015) discuss how Europe's industrial dependency on China for REEs—critical in numerous high-tech and industrial applications—mirrors broader concerns of economic vulnerability. Just as China's dominance in REEs has led Europe to consider diverse strategies to secure resources and reduce dependency, the significant trade flows and deficit experienced by countries in their trade with China triggers concerns of economic dependency and the desire to technological sovereignty, resulting in similar strategic protective actions against Chinese 5G technologies.

The combining effects of trade volume and deficit with China also supports the narrative of economic realism. Similar to its political counterpart, economic realism believes that trade policies are strategic tools used to enhance a country's relative power (Baughn & Yaprak, 1996). In this context, strong correlation of trade flow and trade deficit with China can be seen as reflective of deeper strategic calculations. Countries leverage trade relationships not only for economic gains but also to maintain balance and assertiveness in a geopolitical landscape characterized by power competitions and nationalism (Helleiner, 2002). The positive effects of trade volume and trade deficit with China in adopting banning policy shows that economic actions serve broader national security and power-balancing objectives.

In summation, while trade deficit with China has less discernible standalone impacts on policy alongside defense variables, the joint trade factors reveal a more pronounced effect. This indicates that policy decisions are more about the broader implications of trade dependency rather than just the imbalances that accompany it. The significant role of trade volume highlights a growing unease with the extent of economic interdependence, reflecting broader concerns over national economic autonomy in the face of deepening globalization. The growing trends of protectionism and anti-globalization, evidenced by the rejection of free trade norms and the weakening of multilateral agreements, suggest a shifting global economic order. This shift is not solely driven by the influence of great power competition since the trade ties with United States remain insignificant in countries policy but is also a reaction to weakening trade liberalism and countries own favor of national over global interests. Harris (1989) suggested that the typical prisoners' dilemma model may not be appropriate for these scenarios, anticipating retaliation from the other side also caused free trade to be unsustainable even in the long run, so managed trade is a more plausible outcome than strategic trade policies in oligopolistic industries. This tendency could lead to a dangerous signal of security spiral in the trade and technological fronts.

Control and Validation Through Institutional Fixed Effects

By controlling for institutional types, the research has validated the significance of arms transfers and trade variables in influencing policy decisions regarding Chinese 5G technology, independent of the potential confounding effect of institutional affinity. For example, it is plausible that the United States predominantly supplies military resources to nations with democratic institutions akin to its own. By holding institutional types of constant, the enduring significance of the defense and trade variables adds a robust layer of validation to their predictive power. This approach mitigates the concern that the observed effects of arms transfers on policy decisions are merely artifacts of institutional affinity.

In addition, it has illuminated the divergence in which presidential and parliamentary systems perceive and address potential threats posed by foreign technological advancements. Consistent with theories of democratic peace, which postulate that democratic states are more likely to view one another as non-threatening and often align on issues of international security, this study finds that parliamentary democracies are more inclined to consider China's technological expansion a potential threat to democratic values. This is evident from the positive association between the parliamentary system variable and the adoption of restrictive policies against Chinese 5G technology across all models. Democracies may perceive policies restricting Chinese technology as a stance against what they may view as the spread of a successful autocratic model of governance.

On the other hand, states with non-electoral presidential systems—often associated with more centralized and autocratic governance structures—appear less likely to adopt restrictive policies. This may reflect an emphasis on state sovereignty and regime stability, aligning with theories that suggest autocratic states prioritize internal control and may be less concerned with the ideological implications of technology adoption. They may not perceive the expansion of Chinese technology as an ideological encroachment but rather assess it through the pragmatic lens of state sovereignty and national interests by providing access to affordable 5G technology.

**Future Research and Limitation**

This paper has several limitations which lead to potential further studies. Firstly, the study utilizes GDP and trade data in the year 2021, a period that corresponds with many countries' decisions to join the Clean Network Initiative. Given the rapidly changing landscape of global trade and the current trends of economic decoupling, the trade balance data could evolve significantly over time. Future research could explore these dynamics further, examining how shifting economic ties influence policy decisions in subsequent years.

Secondly, the current model focuses on broader national trends and does not delve into the intricacies of government decision-making processes. Future studies could investigate the internal political mechanisms at play, including the influence of lobbying efforts, the stance of interest groups, and the role of political bargaining, which may offer a deeper understanding of policy formulation and adoption.

Thirdly, this research considers the adoption of policies at the national level but does not address their practical implementation, which can vary widely. The actual enforcement of these policies might involve complex negotiations at both the corporate and sub-national levels. Furthermore, the reciprocal responses from China and subsequent policy adjustments by other nations present a dynamic interplay that warrants further exploration.

Lastly, countries with the technological expertise and infrastructure to develop their own 5G networks may exhibit different policy behaviors compared to those that rely on foreign technology. While this thesis hints at the potential influence of a country's technological capacity, potentially reflected in its GDP, the direct impact of technological self-sufficiency on policy decisions remains an open question for future inquiry.

This analysis calls for a more in-depth interpretation of trade data in policy research, considering the multi-dimensional nature of trade relationships and their implications for international policy decisions. The observed patterns of significance suggest that the underlying reasons for policy adoption against Chinese 5G technology are complex and cannot be fully explained by trade deficits alone. Further research might explore the implications of these findings in the context of globalization and the recent trends towards protectionism and economic nationalism.

**Conclusion**

The comprehensive analysis in this thesis offers substantial insights into the determinants of national policy decisions regarding Chinese 5G technology. Through empirical evaluation across multiple models, this study has identified defense ties with global powers and international trade dynamics with China as significant factors shaping such policies.

Defense relationships, particularly arms transfers from the United States, have emerged as a positive predictor of the likelihood of adopting policies restricting Chinese 5G technology. This suggests that countries with closer defense ties to the U.S. may align with its geopolitical stance on limiting Chinese technological influence. On the contrary, the receipt of arms from China is negatively associated with policy adoption, indicating that countries with stronger military links to China may prefer not to hinder its 5G technologies, likely due to the nuances of their strategic partnerships.

Contrary to the view of Commercial Peace that high trade volumes with China might disincentivize restrictive policies due to economic dependence, the analysis reveals a more nuanced narrative. It is not the trade deficit alone but the combination of substantial trade engagement and a pronounced trade flows with China that correlates with the adoption of restrictive policies. This combination likely represents a form of trade pressure, where countries perceive a significant trade flow and deficit with China as a threat to economic sovereignty or as leverage exerted by China. Consequently, these nations might respond with policy measures to counterbalance this influence, including the restriction of Chinese 5G technology, which they may perceive as another potential domain of undue influence.

Furthermore, this thesis has highlighted the importance of domestic political institutions in influencing policy decisions. The negative influence of the presidential institution suggests that countries with non-electoral presidential systems are less likely to adopt restrictive policies against Chinese 5G technology. In contrast, the positive influence of the parliamentary variable across models indicates that parliamentary democracies are more attuned to the ideological dimensions of technology policy, perceiving China's technological rise as a potential threat to democratic norms.

In conclusion, the findings of this study contribute to a more in-depth understanding of the geopolitical and institutional determinants of technology policy. They provide evidence that national policies on Chinese 5G technology are not merely reactions to economic incentives or privacy concerns but are deeply embedded in the strategic, security, and ideological frameworks that govern international relations and domestic political structures. As nations navigate the complexities of 21st-century technology governance, this research underscores the multifaceted nature of policymaking in an era where technology, security, and ideology intersect.

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Appendix A: Market Sales of Huawei, Ericsson and Nokia

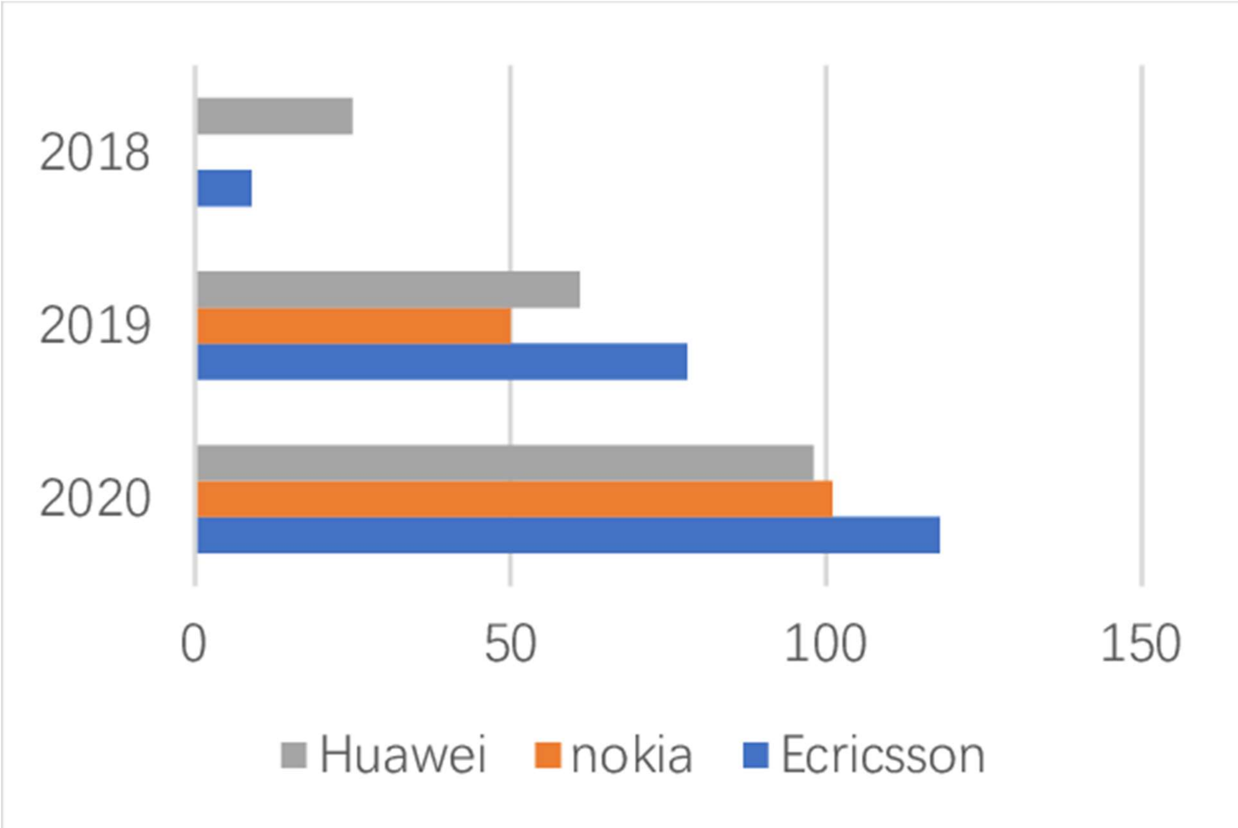


*Figure A: Global Markt Share of Huawei, Nokia, and Ericsson*

*Source: The figure is from Liying Wang (2022). China's Huawei in the US-China Trade War in the Communications Sector Game.*

## Appendix B: Country with Restrictive Policy and Description of Classification

*Table B: Country with Restrictive Policy against Huawei / Chinese 5G Vendors*

| country | Description |
|---|---|
| Albania | Although Albania has not issued an outright ban on Huawei, in August 2020, the country joined the U.S. State Department's "Clean Network" initiative, which would seem to preclude the country from using the company's 5G equipment. |
| Australia | In 2018, Australia banned Huawei from building its 5G network due to national security concerns. |
| Belgium | While Belgium has not banned Huawei, in June 2020, it moved to bar "high-risk vendors" from the core of its 5G network and announced it would cap the share of components such vendors could provide. In October 2020, Belgium contracted out development of its 5G network to Nokia. |
| Bulgaria | In October 2020, Bulgaria joined the U.S. State Department's "Clean Network" initiative. |
| Canada | While Canada has not formally banned Huawei, it has put off a decision long enough to force its telecom providers to pick alternatives to Huawei. |
| Czechia | Czech Republic joined the Clean Network Initiative on June 25, 2020. |
| Germany | In September 2020, Germany announced stricter regulations on 5G vendors and intensified scrutiny of Huawei's operations in the country, though it did not issue an outright ban on the company. Previously, German telecom company Telefonica Deutschland announced it had selected Ericsson to build its 5G core. |
| Denmark | In June 2020, Denmark announced it would like to use 5G suppliers from countries considered security allies. |
| Spain | Two of Spain's largest carriers, Telefonica and Orange, have begun to roll out 5G to most of the country's population, using Ericsson and Nokia equipment. |
| Estonia | In May 2020, Estonia's parliament passed a law, dubbed the "Huawei law," that mandated new security reviews for telecommunications gear. Previously, in November 2019, the United States and Estonia released a joint declaration on 5G security in which they pledged to coordinate on 5G. |
| Finland | In October 2020, Finland signed a contract with Nokia to replace existing 2G, 3G, and 4G networks that Huawei deployed in 2015. Finland has also contracted development of its 5G network to Nokia. In December 2020, Finland passed a law allowing authorities to ban the use of telecommunications equipment endangering "national security or national defense," clearly taking aim at Huawei. |
| France | In July, France announced telecommunications operators wouldn't be able to renew licenses for Huawei equipment when they expired, effectively phasing out the company's presence in the country. |
| United Kingdom | In July 2020, the United Kingdom banned Huawei from its 5G networks, giving telecommunications companies until 2027 to remove all existing Huawei equipment from their 5G services. |
| Greece | Greece has joined the U.S. State Department's "Clean Network" initiative, and later announced it was considering banning Huawei. The country has decided to use Ericsson to develop its 5G infrastructure. |
| Croatia | In June 2020, Croatia's Hrvatski Telekom (HT) selected Ericsson as its sole supplier of 5G products and services, consistent with the EU's 5G Action Plan. |
| Hungary | In 2019, Hungary announced Huawei would develop its 5G network. |
| India | Although India has not issued a formal, written ban on Huawei, the country has begun to phase out the use of Huawei equipment in future projects, including 5G networks. |
| Israel | Although a U.S. official reported that Israel was strongly considering banning Huawei from supplying equipment for the country's future 5G network, Israel has yet to issue official restrictions. |
| Italy | While Italy has not banned Huawei, it has recently taken a tougher stance, vetoing a deal between Huawei and telecommunications provider Fastweb that would have used Huawei as the sole supplier for its 5G core network. |

| | |
|---|---|
| Japan | Japan banned Huawei from entering government contracts in 2018, citing fears of intelligence leaks and cyber-attacks. In 2019, Japanese telecom company SoftBank announced it would use Nokia and Ericsson to build its 5G network. |
| Lithuania | In September 2020, Lithuania and the United States signed an MOU on 5G security, in which Lithuania pledged to evaluate the security risks of 5G suppliers. |
| Luxembourg | All of the country's telecommunications companies are now considered "Clean Telcos" by the U.S. Department of State, meaning that they do not use Huawei components in their networks. |
| Latvia | In March 2020, Latvia, one of the first countries to have a working 5G network, signed a joint declaration with the United States calling for a "rigorous evaluation" of 5G suppliers to prevent security threats. |
| Mexico | In 2017, Huawei secured a contract to build Mexico's next-generation telecommunications network, but the contract stipulated that Nokia would provide the equipment for the network's core and sites near the U.S. border. Separately, AT&T removed Huawei equipment from sensitive parts of its network in Mexico. |
| North Macedonia | In October 2020, North Macedonia joined the U.S. State Department's "Clean Network" initiative. |
| Netherlands | While the Netherlands announced it would force its telecom companies to vet their 5G equipment more thoroughly, two out of three Dutch telecommunications providers are conducting 5G testing with Huawei. |
| Norway | Ericsson won the bid to build the core of Norway's 5G network, working with state-controlled Telenor. While Norway has not formally banned Huawei, allowing its telecommunications providers to freely choose their suppliers for the non-core parts of its 5G network, it did effectively exclude Huawei from its 5G core. Telenor will continue to use Huawei to maintain its 4G network and upgrade some 5G coverage in the country. |
| New Zealand | In 2018, New Zealand banned telecommunications provider Spark from using Huawei equipment in its 5G network. |
| Poland | Poland issued a joint declaration on 5G with the United States, joined the U.S. State Department's "Clean Network" initiative, and released criteria for assessing the risk of telecoms equipment providers that effectively banned Huawei from its 5G network. In response, Huawei has accused Poland of violating EU law and threatened to sue. |
| Portugal | While Portugal has not officially banned Huawei, it has committed to implementing the EU 5G Clean Toolbox. In July 2020, the country's three top telecommunications providers announced they would not use Huawei in their core 5G networks. |
| Romania | In November 2020, Romanian Prime Minister Ludovic Orban stated Huawei "does not meet [security] conditions" and "with respect to 5G, [China] cannot be our partner." Previously, Romania had joined the U.S. State Department's "Clean Network" initiative and signed an MOU with the United States on 5G cooperation. |
| Singapore | While Singapore hasn't formally banned Huawei, in June 2020, the country's telecommunications companies awarded Ericsson and Nokia the contracts to develop its 5G networks. |
| Slovak Republic | Slovak republic joined the Clean Network Initiative on October 23, 2020. |
| Slovenia | In August 2020, Slovenia signed a joint declaration with the United States on 5G security, where the country pledged to avoid suppliers that "are subject, without independent judicial review, to control by a foreign government." |
| Sweden | In October 2020, Sweden banned Huawei from its 5G networks. |
| Viet Nam | In Vietnam, though, major mobile carriers have explored 5G collaborations with Ericsson and Nokia, but not with Huawei. |

*Note: (1) Some of the definition is sourced from Council on Foreign Relations (2021). (2) The policy is recorded until 2021, some countries swinged in positions later in 2023, which is not considered in this regression model. (3) The actual implementation of policy is not discussed in the model.*

1. *Current president of Vietnam Vo Van Thuong invited Huawei to build its 5G networks in 2023.*
2. *After the outbreaks of the Russo-Ukrainian war, Ukraine intended to join the CNI.*

Appendix C: Visualization of Arm Transfers by China and the US

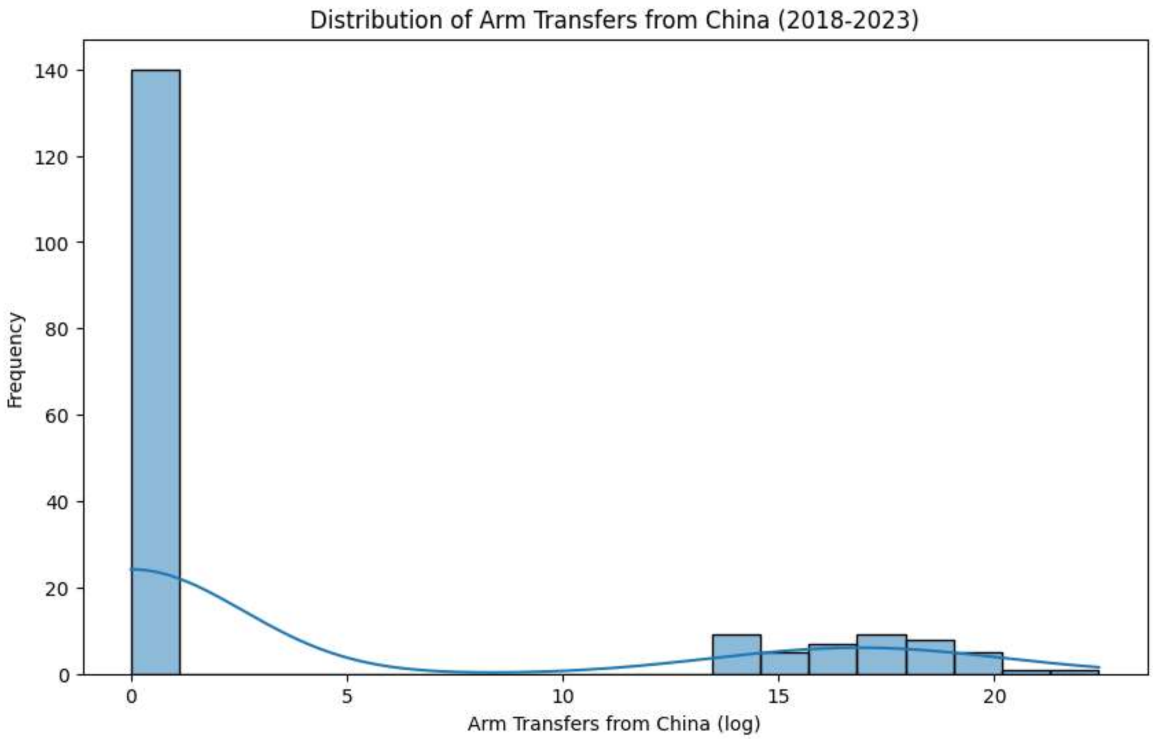


*Figure C1 Distribution of Arm Transfers of China*

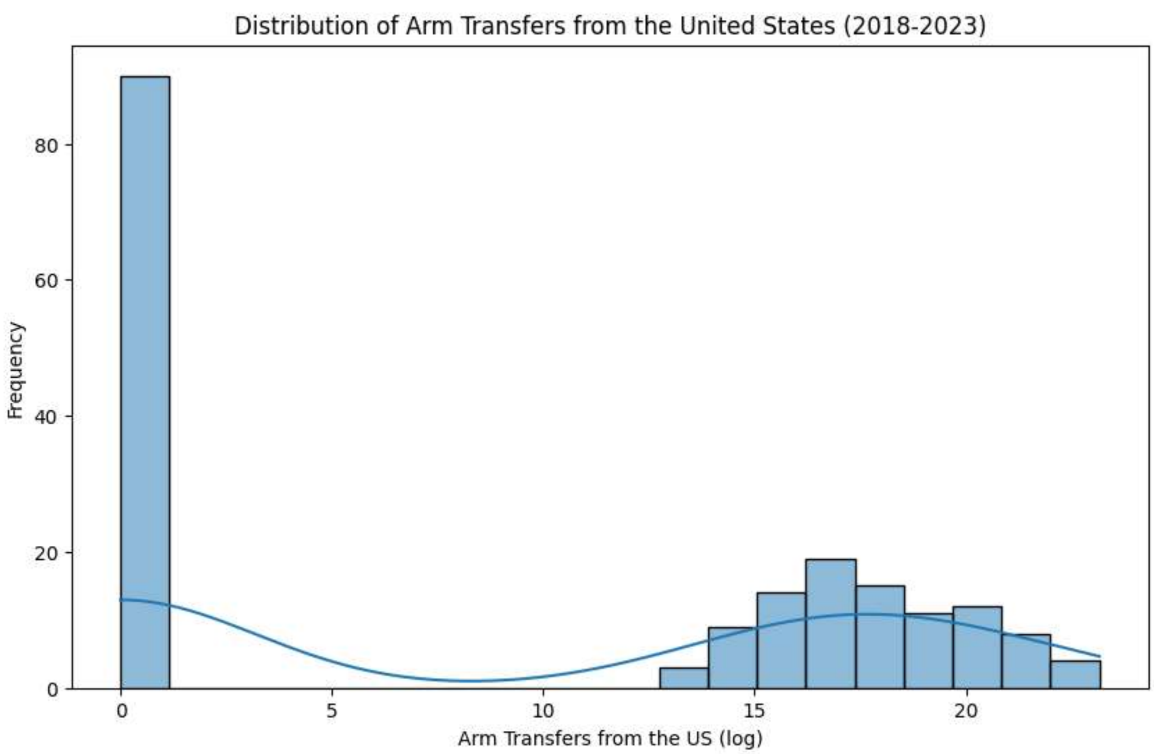


*Figure C2 Distribution of Arm Transfers of the United States*

Appendix D: Gravity Model Prediction of Trade Flows

*Table D1: Gravity Model to Estimate Trade Flow with China*

*Gravity Model of Trade flows with China (2021)*

| | **Coefficient** | **σ** | **t** | **P>\|t\|** | **[0.025** | **0.975]** |
|---|---|---|---|---|---|---|
| *Intercept* | -2.692 | 2.594 | -1.038 | 0.301 | -7.811 | 2.427 |
| *log_Distance* | -0.680 | 0.273 | -2.495 | 0.014 | -1.218 | -0.142 |
| *log_GDP* | 1.010 | 0.035 | 28.876 | 0.000 | 0.936 | 1.074 |
| *Africa* | -0.498 | 0.291 | -1.712 | 0.089 | -1.071 | 0.076 |
| *Asia* | -0.814 | 0.344 | -2.364 | 0.019 | -1.493 | -0.135 |
| *Europe* | -1.520 | 0.314 | -4.836 | 0.000 | -2.14 | -0.900 |
| *North America* | -1.228 | 0.336 | -3.651 | 0.000 | -1.892 | -0.564 |
| *South America* | -0.197 | 0.445 | -0.442 | 0.659 | -1.076 | 0.682 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.868 |
| *Adjusted R-squared* | | | | | | 0.863 |
| *AIC* | | | | | | 505.400 |
| *BIC* | | | | | | 531.200 |
| *F-Statistic* | | | | | | 165.9 |

*Notes: (1) log_Distance and log_GDP are the logarithm of distance between country i and China, and GDP of country i. (2) the continental dummy variables exclude Oceania to avoid perfect multicollinearity*

*Table D2: Gravity Model to Estimate Trade Flow with the US*

*Gravity Model of Trade flows with the US (2021)*

| | **Coefficient** | **σ** | **t** | **P>\|t\|** | **[0.025** | **0.975]** |
|---|---|---|---|---|---|---|
| *Intercept* | -13.109 | 3.576 | -3.666 | 0.000 | -20.166 | -6.051 |
| *log_Distance* | 1.073 | 0.044 | 24.220 | 0.000 | 0.985 | 1.160 |
| *log_GDP* | 0.132 | 0.357 | 0.370 | 0.712 | -0.573 | 0.837 |
| *Africa* | -0.950 | 0.361 | -2.626 | 0.009 | -1.662 | -0.236 |
| *Asia* | -0.720 | 0.386 | -1.864 | 0.064 | -1.482 | 0.042 |
| *Europe* | -0.398 | 0.458 | -0.868 | 0.387 | -1.301 | 0.506 |
| *North America* | 1.653 | 0.673 | 2.456 | 0.015 | 0.325 | 2.981 |
| *South America* | 0.614 | 0.550 | 1.115 | 0.267 | -0.473 | 1.700 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.832 |
| *Adjusted R-squared* | | | | | | 0.826 |
| *AIC* | | | | | | 587.650 |
| *BIC* | | | | | | 613.100 |
| *F-Statistic* | | | | | | 125.6 |

*Note: Venezuela and Yemen are not included in the model because of the absence of GDP data in World Bank database in 2021.*

Appendix E: Visualization of Trade Flows of China and the US

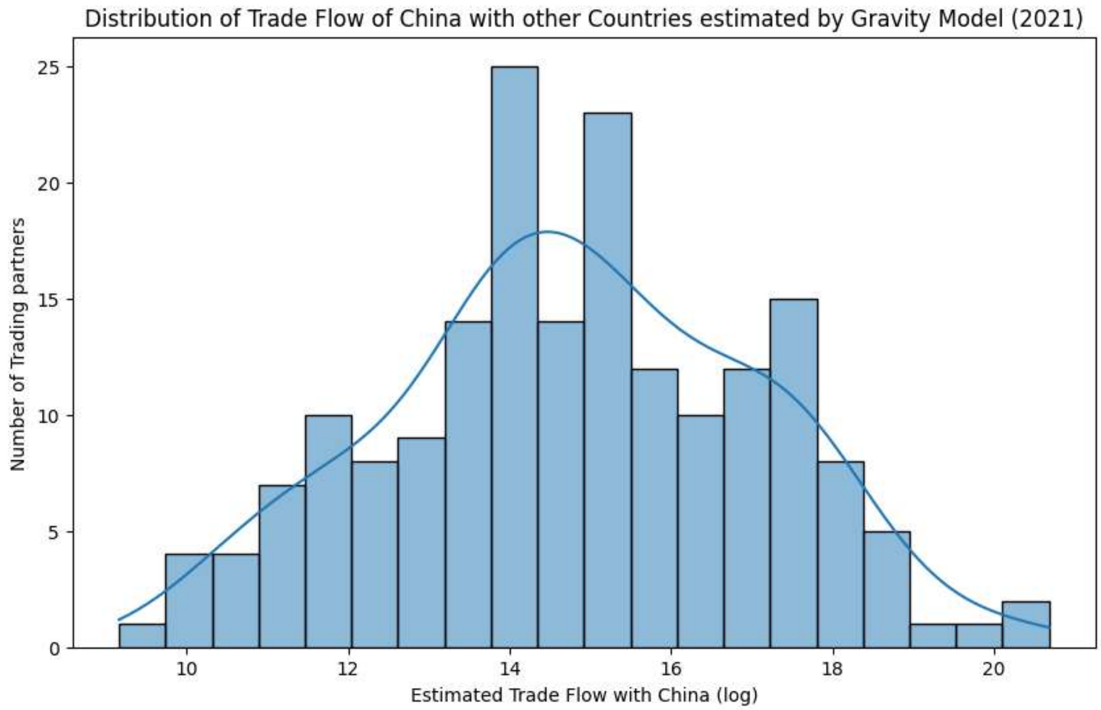


*Figure E1: Histogram of Trade Flow of China by Gravity Model*

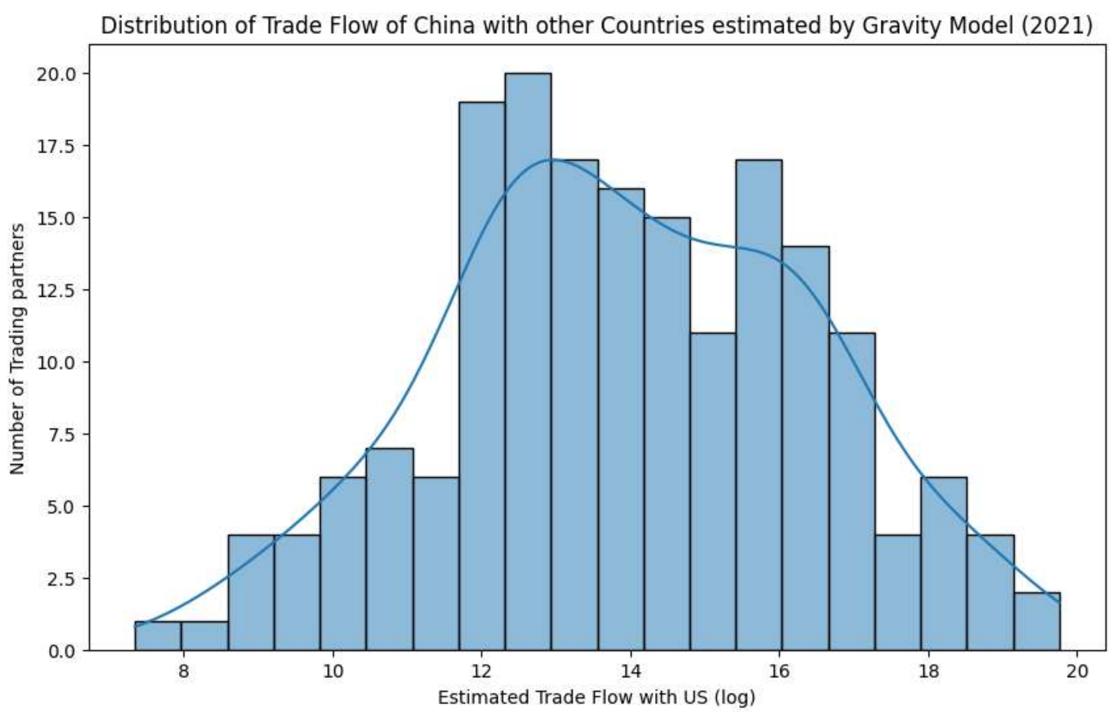


*Figure E2: Histogram of Trade Flows of the US by Gravity Model*

Appendix F: Regression Models Equation

*Table F: Equation for Comparative OLS Models and Logistic Models*

| ***Model*** | ***Equation*** |
|---:|---|
| *1* | Policy = Arm Transfer (US) + Arm Transfers (China) + Presidential + Parliamentary |
| *2* | Policy = Trade Flow (China)+ Trade Deficit (China)+ Presidential + Parliamentary |
| *3* | Policy = Arm Transfer (US) + Arm Transfers (China) + Trade Flow (China)+ Presidential + Parliamentary |
| *4* | Policy = Arm Transfer (US) + Arm Transfers (China) + Trade Deficit (China)+ Presidential + Parliamentary |
| *5* | Policy = Arm Transfer (US) + Arm Transfers (China) + Trade Flow (China)+ Trade Deficit (China)+ Presidential + Parliamentary |
| *Baseline (with Trade Flow (US))* | Policy = Arm Transfer (US) + Arm Transfers (China) + Trade Flow (China) + Trade Flow (US) + Trade Deficit (China)+ Presidential + Parliamentary |
| *Logistics 1* | Policy = Arm Transfer (US) + Arm Transfers (China) + Trade Flow (US) + Trade Flow (China)+ Trade Deficit (China)+ Presidential + Parliamentary |
| *Logistics 2* | Policy = Arm Transfer (US) + Arm Transfers (China) + Trade Flow (China)+ Trade Deficit (China) + Presidential + Parliamentary |

Appendix G: VIT Test and Correlations of Independent Variables

*Table G1: VIF of Variables in Baseline OLS Model*

| *Variable* | *Variance Inflation Factor* |
|---:|---:|
| *Arm Transfer (US)* | 1.898 |
| *Arm Transfers (China)* | 1.197 |
| *Trade Flow (US)* | 5.487 |
| *Trade Flow (China)* | 6.739 |
| *Trade Deficit (China)* | 1.077 |
| *Presidential* | 2.471 |
| *Parliamentary* | 2.507 |

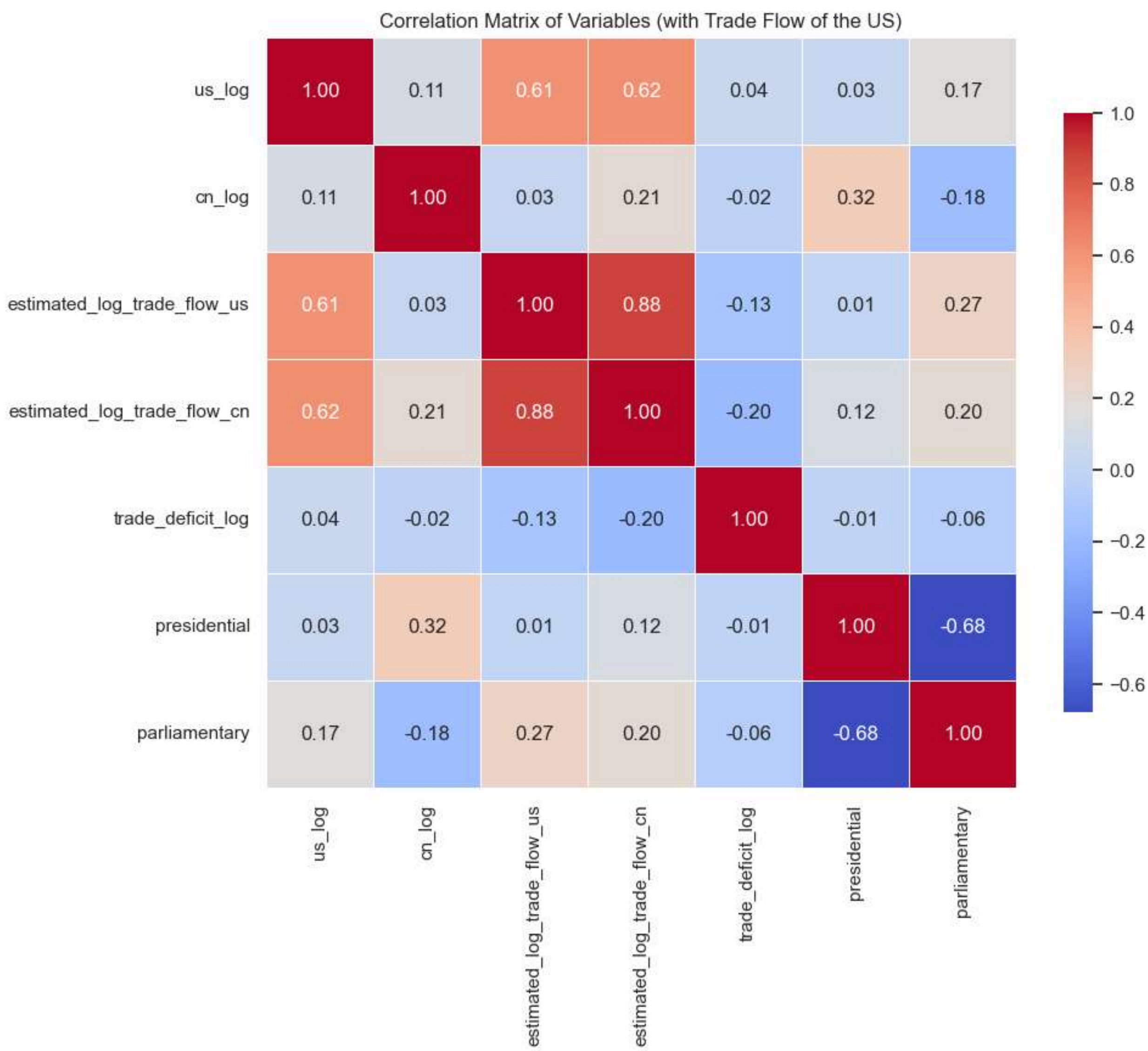


*Figure G2: Correlation Matrix of Variables in baseline OLS Model*

*Table G3: VIT of Independent Variables without Trade Flows of the US*

| *Variable* | *Variance Inflation Factor* |
|---:|---:|
| *Arm Transfer (US)* | 1.758 |
| *Arm Transfers (China)* | 1.075 |
| *Trade Flow (China)* | 2.014 |
| *Trade Deficit (China)* | 1.049 |
| *Presidential* | 2.466 |
| *Parliamentary* | 2.500 |

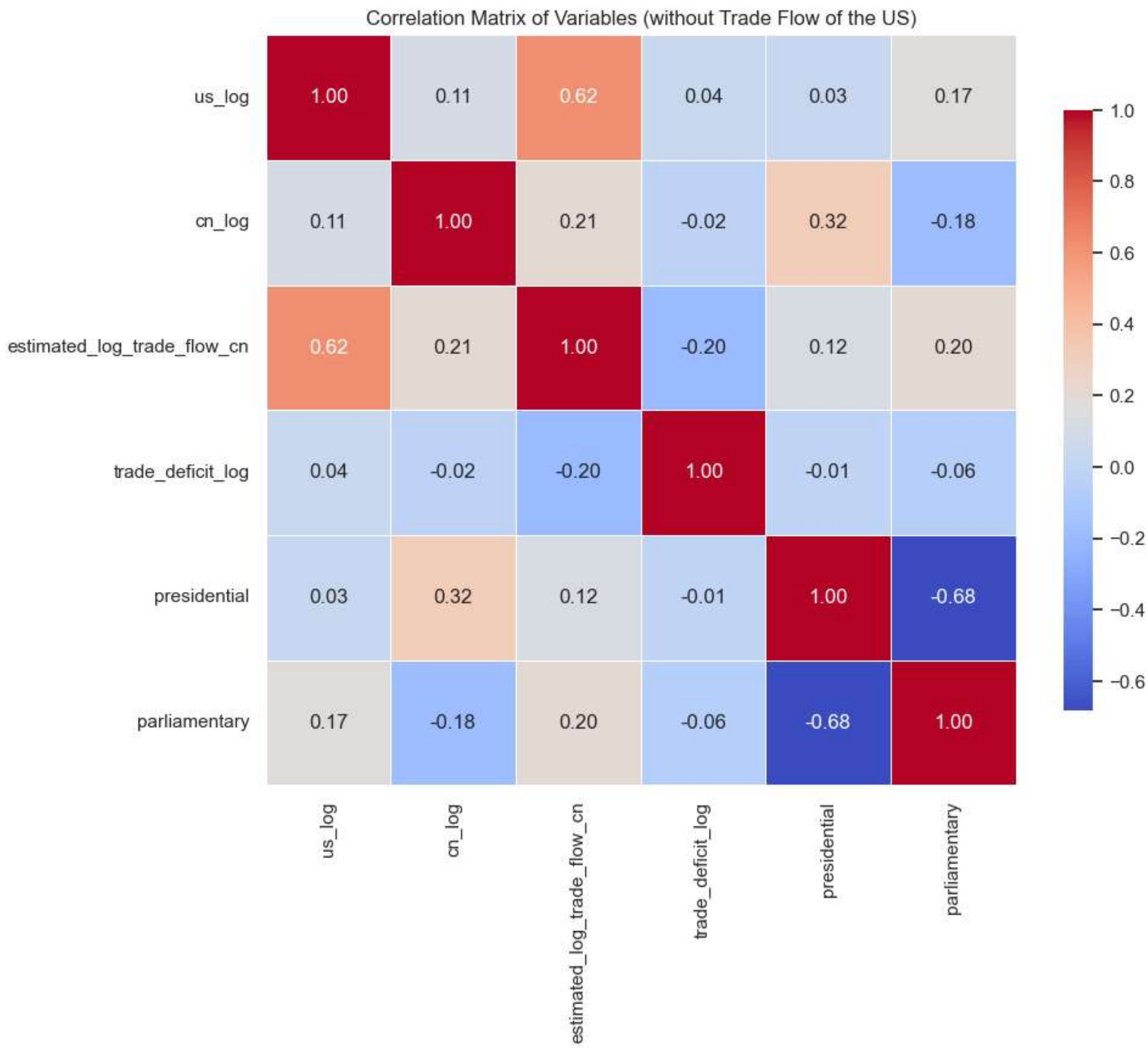


*Figure G4: Correlation Matrix of Independent Variables without Trade Flows of the US*

Appendix H: Baseline OLS Model with Trade Flow with US

*Table H: Baseline OLS Model of Arms Transfers and Trade Variables*

*Baseline OLS Model of Arms Transfers and Trade Variables*

| | **Coefficient** | **σ** | **t** | **P>\|t\|** | **[0.025** | **0.975]** |
|---|---|---|---|---|---|---|
| *Intercept* | -0.668 | 0.168 | -3.983 | 0.000 | -0.999 | -0.337 |
| *Arm Transfer (US)* | 0.011 | 0.003 | 3.665 | 0.000 | 0.005 | 0.017 |
| *Arm Transfers (China)* | -0.012 | 0.003 | -3.897 | 0.000 | -0.019 | -0.006 |
| *Trade Flow (US)* | 0.000 | 0.019 | 0.014 | 0.989 | -0.037 | 0.038 |
| *Trade Flow (China)* | 0.055 | 0.022 | 2.504 | 0.013 | 0.012 | 0.098 |
| *Trade Deficit (China)* | 0.005 | 0.002 | 2.654 | 0.009 | 0.001 | 0.008 |
| *presidential* | -0.187 | 0.062 | -3.029 | 0.003 | -0.308 | -0.065 |
| *parliamentary* | 0.181 | 0.066 | 2.750 | 0.007 | 0.051 | 0.310 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.522 |
| *Adjusted R-squared* | | | | | | 0.503 |
| *AIC* | | | | | | 61.540 |
| *BIC* | | | | | | 87.310 |
| *F-statistic* | | | | | | 27.630 |

Appendix I: Comparative OLS Models Specification

*Table I1: OLS Model 1*

*OLS Model of Arms Transfers (Model 1)*

| | Coefficient | σ | t | P>\|t\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| *Arm Transfer (US)* | 0.019 | 0.002 | 7.688 | 0.000 | 0.014 | 0.024 |
| *Arm Transfers (China)* | -0.010 | 0.003 | -3.347 | 0.001 | -0.017 | -0.004 |
| *presidential* | -0.122 | 0.062 | -1.966 | 0.051 | -0.244 | 0.000 |
| *parliamentary* | 0.255 | 0.065 | 3.906 | 0.000 | 0.126 | 0.384 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.465 |
| *Adjusted R-squared* | | | | | | 0.453 |
| *AIC* | | | | | | 76.350 |
| *BIC* | | | | | | 92.450 |
| *F-statistic* | | | | | | 39.150 |

*Table I2: OLS Model 2*

*OLS Model of Trade Variables (Model 2)*

| | Coefficient | σ | t | P>\|t\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| *Trade Flow (US)* | 0.031 | 0.019 | 1.634 | 0.104 | -0.006 | 0.069 |
| *Trade Flow (China)* | 0.05 | 0.021 | 2.145 | 0.033 | 0.004 | 0.088 |
| *Trade Deficit (China)* | 0.006 | 0.002 | 3.089 | 0.002 | 0.002 | 0.009 |
| *presidential* | -0.231 | 0.065 | -3.550 | 0.000 | -0.359 | -0.102 |
| *parliamentary* | 0.185 | 0.070 | 2.636 | 0.009 | 0.047 | 0.324 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.447 |
| *Adjusted R-squared* | | | | | | 0.432 |
| *AIC* | | | | | | 84.510 |
| *BIC* | | | | | | 103.800 |
| *F-statistic* | | | | | | 28.950 |

*Table I3: OLS Model 3*

*OLS Model of Arm transfer and Trade Volume (Model 3)*

| | **Coefficient** | **σ** | **t** | **P>\|t\|** | **[0.025** | **0.975]** |
|---|---|---|---|---|---|---|
| *Arm Transfer (US)* | 0.013 | 0.003 | 4.224 | 0.000 | 0.007 | 0.018 |
| *Arm Transfers (China)* | -0.012 | 0.003 | -3.735 | 0.000 | -0.018 | -0.006 |
| *Trade Flow (China)* | 0.043 | 0.022 | 1.957 | 0.052 | 0.000 | 0.086 |
| *Trade Flow (US)* | 0.004 | 0.019 | 0.190 | 0.849 | -0.034 | 0.042 |
| *presidential* | -0.185 | 0.063 | -2.955 | 0.004 | -0.309 | -0.061 |
| *parliamentary* | 0.178 | 0.067 | 2.658 | 0.009 | 0.046 | 0.309 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.503 |
| *Adjusted R-squared* | | | | | | 0.486 |
| *AIC* | | | | | | 66.760 |
| *BIC* | | | | | | 89.310 |
| *F-statistic* | | | | | | 30.040 |

*Table I4: OLS Model 4*

*OLS Model of Arms Transfers and Trade Deficit (Model 4)*

| | **Coefficient** | **σ** | **t** | **P>\|t\|** | **[0.025** | **0.975]** |
|---|---|---|---|---|---|---|
| *Arm Transfer (US)* | 0.019 | 0.002 | 7.591 | 0.000 | 0.014 | 0.024 |
| *Arm Transfers (China)* | -0.010 | 0.003 | -3.324 | 0.001 | -0.016 | -0.004 |
| *Trade Deficit (China)* | 0.003 | 0.002 | 1.495 | 0.137 | -0.001 | 0.006 |
| *presidential* | -0.115 | 0.062 | -1.862 | 0.064 | -0.237 | 0.007 |
| *parliamentary* | 0.265 | 0.065 | 4.052 | 0.000 | 0.136 | 0.394 |
| *N* | | | | | | 185 |
| *R-squared* | | | | | | 0.472 |
| *Adjusted R-squared* | | | | | | 0.457 |
| *AIC* | | | | | | 76.050 |
| *BIC* | | | | | | 95.370 |
| *F-statistic* | | | | | | 31.990 |

Appendix J: Logistic Model 2

*Table 6 Logistic Model including Trade Flows of the US*

| | ***Coefficient*** | ***σ*** | ***z*** | ***P>\|z\|*** | ***[0.025*** | ***0.975]*** |
|---|---|---|---|---|---|---|
| *Arm Transfer (US)* | 0.160 | 0.051 | 3.164 | 0.002 | 0.061 | 0.260 |
| *Arm Transfers (China)* | -0.313 | 0.095 | -3.310 | 0.001 | -0.499 | -0.128 |
| *Trade Flow (China)* | 0.564 | 0.416 | 1.355 | 0.175 | -0.252 | 1.380 |
| *Trade Flow (US)* | 0.339 | 0.349 | 0.973 | 0.330 | -0.344 | 1.023 |
| *Trade Deficit (China)* | 0.080 | 0.035 | 2.304 | 0.021 | 0.012 | 0.148 |
| *presidential* | -3.251 | 1.197 | -2.715 | 0.007 | -5.597 | -0.904 |
| *parliamentary* | 2.158 | 1.084 | 1.990 | 0.047 | 0.033 | 4.282 |
| *N* | | | | | | 185 |
| *Pseudo R-squared* | | | | | | 0.705 |

*Note: Possibly complete quasi-separation: A fraction 0.15 of observations can be perfectly predicted. This might indicate that there is complete quasi-separation. In this case some parameters will not be identified.*