Trade Policy in the Shadow of Power

Theory and Evidence on Economic Openness and Coercive Diplomacy

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Abstract

This dissertation studies military coercion in the international political economy. I develop a framework to study how power politics affects the international economy and how conflicts of interest over economic policy affect states' propensity to fight wars with one another. I begin by building a theoretical model of "gunboat diplomacy," in which wars can be fought in order to open markets abroad. The shadow of military power liberalizes trade policy, and more protectionist governments are more likely to experience war. I then introduce an empirical model to measure the magnitude of policy-induced trade frictions, which I estimate on data describing trade flows, price levels, and freight costs in 2011. Finally, I rationalize the emergence of these barriers as the outcome of an N-country coercive bargaining game, in order to quantify empirically the effect of military coercion on international trade. In the aggregate, military coercion increases the value of global trade by 63 percent, suggesting that international power politics exerts substantial influence on the workings of the international economy.

Acknowledgements

I learned I wanted to become a political scientist as a junior at the University of North Carolina at Chapel Hill. Stephen Gent and Navin Bapat quickly taught me enough about the discipline to enable me convince one graduate admissions committee that I deserved a shot at a Ph.D.

When I arrived at Princeton, Saurabh Pant and Ted Enamorado introduced me to mathematical analysis and were models of competence and professionalism as graduate student instructors. Every course I took at Princeton – in Politics, Economics, or Operations Research – sparked new ideas or equipped me with tools I needed to do my research. The set of things that I knew I did not know continually expanded throughout my time in graduate school, even as I took courses well into my fourth year of graduate school in futile hope of reducing the number of these things.

The Politics Department maintained a culture that encouraged intellectual curiosity and collegiality. Corwin 127 was never a particularly functional classroom or seminar room yet I will remember it fondly as the embodiment of this culture. Richard Jordan, Ryan Brutger, and Austin Wright gave practice job talks there in my first year that served as exemplars for what I hoped to achieve in a dissertation for the rest of my time in graduate school.

In addition to engaging courses and a supportive culture, Princeton University provided substantial material support that faciliated the completion of this dissertation. The Fellowship of Woodrow Wilson Scholars relieved me of the responsibility to teach in my fourth and fifth years. The Program in Quantitative and Analytical Political Science and the Niehaus Center provided me with office space. The Research Program in Political Economy helped me purchase data. I did not anticipate needing to purchase Australian customs records when I started graduate school. The papers embedded in this dissertation also benefited from the feedback of audiences at many conferences: the American Political Science Association's annual meeting (2019, 2020), the Midwest Political Science Association's annual meeting (2018, 2019), the Southern Political Science Association's annual meeting (2019, 2020) the International Studies Association's annual meeting (2019) and Midwest meeting (2019), the Online Peace Science Colloquium (2019), and the Formal Models of International Relations conference at Vanderbilt (2020).

Learning how to do research often involved chaotic spurts of searching the internet for solutions to some thankless data analysis problem. This turned out to be a remarkably effective problem solving method, thanks to the public goods provision of a small army of programmers and researchers active on Github and Stack Exchange. I could not have completed this dissertation without the enormous ecosystem of open source software developed by this army and others. I have done my best to cite the software packages I used to produce this dissertation at the end of the manuscript. These are the but the tip of an incredibly useful iceberg.

I pitched the skeleton of the idea that would turn into this dissertation to Kris Ramsay at the beginning of my second year. Kris, who would become my adviser, encouraged me to take a course international trade in the Economics Department despite my reservations. I was extraordinarily fortunate to receive this guidance in retrospect. I quickly learned that trade was a far richer subfield than my training in political science had led me to believe, and trade models became the engines underneath my entire dissertation project. Matias Iaryczower taught me a new way to think about empirical social science. Helen Milner retained a healthy skepticism toward my ideas, pushed me to defend my assumptions, and continually referred me to others' research that made my work better. Melissa Lee did not serve on my dissertation committee but was nevertheless a constant sorce of encouragement and welcome diversionary chats about baseball.

My research ended up being somewhat strange by the standards of the discipline and sometimes struggled to find an academic community to call home. Several faculty members outside of Princeton went out of their way to support me nevertheless. Rob Carroll, Brenton Kenkel, Mike Gibilisco, Brad Smith, and Scott Abramson took interest in my work and served as helpful sounding boards for my ideas.

I was blessed to matriculate at Princeton with a cohort full of good people. Noam Reich, Mike Kistner, Elsa Voytas, Dan Gibbs, and Will Horne in particular made life outside of writing, coding, and coursework enjoyable. Poker games, barbequeues, and late night trips to the batting cages were always welcome distractions from work. Korhan Koçak and Naijia Liu made me happy to show up to the office every morning.

Despite all of this support, completing a dissertation remains a largely solitary endeavor. My friends and family outside of Princeton helped make it feel less so. The highlight of every year I spent in graduate school was a summer trip into the woods of California, Colorado, or upstate New York with Shawn, Joe, and Andy. Someday we will manage to implement all of the exceptional business ideas hatched on those trips. Central New Jersey was an ideal launch pad to visit my family, most of whom were dispersed between Boston and Washington, DC. My brothers remain my best friends. My parents, trained in science and engineering, were nothing but supportive of my decision to study a "soft" science.

I met Sarah for dinner on the Delaware River in New Hope, PA in on a cold February night in my second year and she quickly became the most important person in my life. I got turned around in the parking lot that night but have been headed in the right direction ever since.

Contents

Introduction

> The relationship between economics and politics...is a reciprocal one. On the one hand, politics largely determines the framework of economic activity and chanels it in directions intended to serve the interests of dominant groups; the exercise of power in all its forms is a major determinant of the nature of an economic system. On the other hand, the economic process itself tends to redistribute power and wealth; it transforms the power relationships among groups.
>
> ROBERT GILPIN, *U.S. Power and the Multinational Corporation*

Why does war recur? The field of international relations has remained preoccupied with this question since its genesis. This preoccupation is well-justified. Warfare's costs – measured in lives lost, property destroyed, and productive resources reallocated – are immense (Lacina and Gleditsch 2005; Coe 2011). Wars also reshape the international political order, redistributing political power and economic resources among states and affecting the material welfare of belligerents and non-belligerents alike (Gilpin 1981). The Second World War, for example, not only revealed mankind's destructive potential but also shaped the world that came after it, dividing it into distinct political orders and circumscribing the opportunities available to those living within each for decades thereafter (Ikenberry 2011).

Contemporary international relations theory conceptualizes war as an outcome of a bargaining process between governments (Schelling 1960; Fearon 1995). Wars recur because of *bargaining frictions*, information asymmetries or time consistency problems, that prevent the governments from finding a peaceful resolution to the conflict at hand. Diagnosing the cause of a given war requires identifying the bargaining friction that prevented the belligerents from settling their dispute peacefully (Lake 2010). Systematic variation in the intensity of these bargaining frictions explains variation in governments' propensity to experience war (Lemke and Werner 1996; Schultz 1999; Reed 2003; Reed et al. 2008).

The bargaining model is agnostic on the ends governments seek in international bargaining interactions. The existence of some conflict of interest, a disagreement about optimal joint behavior, is assumed by the model. Territory, or some other rival good, is often assumed to be the object of contention between governments. Yet states often forgo the opportunity to seize territory, even when doing so is costless (Schultz and Goemans 2019). This "territorial peace" (Gibler and Tir 2014) has not obviated international conflicts of interest. Diplomats remain engaged with one another on issues of trade, investment, monetary policy, and migration due to the externalities that governments' actions in these issue areas impose on other governments. Contemporary U.S.-China relations are plagued by hostility and the spectre of war between the two countries structures defense planning on both sides of the Pacific Ocean. However, neither Beijing nor Washington makes claims on the other's territory. Despite this territorial peace, conflicts over commercial policy, manifesting in a trade war in 2018, complicate Sino-U.S. diplomatic rapprochement.[1]

Negotiations over such economic issues are often relegated practically and analytically to the realm of "low politics." Ministries of foreign affairs maintain separate offices for the "high" political issues of territorial integrity and national security and the "low" political issues of international economics. The scholarly field of international relations enforces a division of labor between Security Studies and International Political Economy (IPE). These divisions suggest that high and low politics are largely separable – negotiations over trade, investment, monetary, and migration policy depend little on arms and military alliances.

The primary purpose of this dissertation is to demonstrate theoretically and empirically that the analytical distinction between high and low politics is unproductive. I provide a framework to study how international power politics affects the international economy and how conflicts of interest over economic policy affect states' propensity to fight wars with one another. High and low politics are inextricably intertwined.

I focus my attention on trade policy conflicts of interest in particular. There are practical and substantive reasons for doing so. Practically, dramatic advances in empirical trade economics have enabled researchers to study the effects of counterfactual trade policy regimes. I use these tools to measure the magnitude of aggregate trade policy distortions and rationalize their emergence as the outcome of a coercive bargaining process between governments. Substantively, patterns of international economic exchange dramatically affect human welfare. Aforementioned empirical trade models suggest that, for the average country, international exchange increases consumer welfare between 4 and 40 percent, relative to global autarky (Costinot and Rodríguez-Clare 2015). Perhaps

[1] Taplin, Nathaniel. "Meet the New Trade War. It's Not the Same as the Old Trade War." *The Wall Street Journal.* 7 May 2020.

more importantly, trade policy dramatically affects the distribution of welfare across individuals and firms within the same country (Autor, Dorn, and Hanson 2013; Fajgelbaum and Khandelwal 2016; Waugh 2019; Caliendo, Dvorkin, and Parro 2019). As a result, commercial policy at home and abroad attracts the attention of special interest groups, which seek to influence governments' policy choices (Mayer 1984; Rogowski 1987; Grossman and Helpman 1994; Osgood 2016; Kim 2017; Gulotty 2020). For firms and individuals alike, trade policy can be an existential question. Burgess and Donaldson (2010) document a relationship between trade costs and the prevalence of famine. For firms, tariff liberalizations affect the probability of market exit (Baggs 2005). The stakes of trade policy are high.

The "Wisconsin School" of diplomatic history places the domestic and international distributional effects of trade policy at the center of an account of U.S. foreign policy from the late 19th century through the Cold War (Williams 1959; LaFeber 1963; McCormick 1967; Fordham 1998, 2019). American foreign policy – the arms it procured and the wars it prosecuted – was designed largely to ensure U.S. trade policy autonomy against foreign influence or open markets abroad. Those influencing and crafting U.S. foreign policy did so at the behest of economic interests that stood to benefit from protectionist tariffs or reductions in barriers to enter foreign markets. Foreign policy served the ends of a broader commercial policy. Different combinations of organized interests enjoy access to governments outside the United States, but trade policy shapes their welfare in much the same way. Lake (2014) argues that the trade policy orientations of dominant interest groups in the United States and China will determine the tenor of Sino-U.S. relations in the 21st century.

Channeled through political institutions, economic interests affect foreign policy (Lake 2009). Governments' joint foreign policies in turn shape the international economy. The victors of World War II exploited their military position to impose rival sets of economic institutions, rules governing international trade, on other governments within their political orbits (McKenzie 2008). These economic institutions shaped the flow of world trade throughout the Cold War and the development prospects of the economies embedded within each regime (Gowa and Mansfield 1993).

The dissertation's first chapter connects low politics to high politics theoretically. I build a model of "gunboat diplomacy" in which wars can be fought in order to open markets abroad. Political economic incentives affect governments' incentives to fight wars – governments that place greater weight on firm profits relative to consumer welfare are more belligerent in their foreign policy orientation. Even when peace prevails, the shadow of military power affects trade policy. Militarily powerful governments need not succumb to foreign threats, resulting in more protectionist trade policies. The high politics of coercive diplomacy affects trade policy. The low politics of market access affects governments' incentives to prosecute wars.

Connecting high and low politics empirically requires first operationalizing the explicandum – trade policy. Tariffs levels are widely used as a measure of protectionism, but tariffs are but one method through which governments distort the flow of trade. In the dissertation's second chapter, I produce estimates of the magnitude of aggregate policy-induced trade distortions between pairs of countries. This measurement exercise involves developing a model of the international economy that connects latent trade policy distortions to cross-national price levels, trade flows, and freight costs between pairs of countries. With data on the latter quantities, the model can be used to quantify the magnitude of latent trade policy frictions. I find that policy barriers to trade are an order of magnitude larger than tariffs in ad valorem terms on average, and that market access conditions vary dramatically across the sample of countries studied. A subset of developed countries enjoy far lower barriers to their exports than do their developing peers.

I proceed to measure empirically the exercise of military power in international relations and quantify its effects on the international economy in the dissertation's final chapter. To borrow the definition of Dahl (1957), a government has power over another to the extent that it can get that government to do something it otherwise would not do. Attributing trade policy to the exercise of power requires knowledge of this counterfactual – what policy would the government enact in power's absence? Liberal trade policies might reflect domestic political economic incentives for openness. Alternatively, they may reflect the military constraints of the anarchic international system. To disentangle these competing explanations, I model observed trade policies as the outcome of an N-country coercive bargaining game. Trade policy favoritism – which countries are granted preferential market access – identify parameters governing the costs of war. I find that military power confers bargaining advantage by reducing the costs of war, promoting trade liberalization. In the aggregate, military coercion increases the value of global trade by 63 percent.

Calculating this change in the value of global trade requires conducting a counterfactual experiment, asking the model what would happen if coercion was impossible. Once estimated, the model allows me to answer this question and many others that empirically connect high and low politics. How would changing governments' underlying preferences for protectionism affect the probability of war? How would changing the distribution of military power in the international system affect trade policy and the international economy?

Answering these questions using quasi-experimental methods would be extremely challenging. Random variation in governments' preferences or military capabilities is difficult to come by. Even where such variation exists, the local effects of this variation may not generalize globally. My approach to these questions relies on theory to fill in gaps in the data. Taking this approach means that the answers I give to these questions take on a conditional form. If the assumptions embedded in the model obtain, then changes to model primitives (power or preferences) can be connected to changes in model output (trade policy and trade flows). This "structural" econometric approach has the virtue of transparency. Other researchers can examine the predictions made by my model, evaluate their fidelity to the data, and compare them to the predictions of alternative models. This process may highlight new empirical puzzles and shortcomings of existing theories, furthering the collective scholarly process of aligning theory and data.

War remains a rare event in contemporary international politics. However, as relations between the world's largest economies (China and the United States) demonstrate, antagonistic and militarized international relations persist. While governments actively design institutions to manage these conflicts short of war, our existing understanding of international conflict highlights how fragile such arrangements are – small changes to governments' information sets or their expected future strengths can trigger war. Achieving "perpetual peace" requires not only eliminating warfare, but the abolition of standing armies and international agreements that entertain the possibility of future conflict. In other words, achieving the Kantian ideal requires the elimination of conflicts of interest. Clearly, the peace we enjoy in the 21st century remains far from this Kantian ideal. This dissertation studies the conflicts of interest that undergird international antagonisms, in hopes of progress toward understanding the conditions that encourage their termination.

Chapter 1

Gunboat Diplomacy

Political Bias, Trade Policy, and War

1.1 Introduction

Countries with deep trading relationships rarely fight wars with one another. Some argue this "commercial peace" is due to the pacifying effect of trade — trade causes peace.[1] Others say amicable political relations cause trade.[2] Trade is usually considered to be exogenous to conflicts of interest in international relations. Governments are posited to fight wars over territorial, ideological, or other non-economic conflicts of interest. Preexisting trade relations make these conflicts more costly, and less likely as a result.

Yet, trade policy is itself a central object of contention in international relations. Governments are mercantilist to some extent (Gawande, Krishna, and Olarreaga 2009). They desire some degree of protection at home and "open doors" abroad and have historically been willing to fight wars to compel market openness abroad.[3] In the 1850s, the U.S. gunboats compelled an autarkic Japanese government to open its markets. Britain and France prosecuted the Opium Wars (1839-1842; 1856-1860) to compel a recalcitrant Chinese government to reform its trade policies. Recently, a proposal to integrate the economies of Ukraine and the European Union led to war between Ukraine and Russia.[4] These episodes highlight linkages between trade policy and war. But such linkages may be more common, as the absence of war need not imply the absence of coercive bargaining (Fearon

[1] This literature is vast. See Gartzke and Zhang (2015) for a complete survey. Angell (1911), Polachek (1980), and Philippe, Mayer, and Thoenig (2008) are representative of this view.

[2] See, for example, Pollins (1989b), Barbieri and Levy (1999), Benson and Niou (2007)

[3] See Findlay and O'Rourke (2007) for a chronicle of trade conflicts over the past millennium.

[4] In this case, Moscow conditioned its coercion on the trade policy choices of Kiev, see James Marson and Naftali Bendavid, "Ukraine to Delay Part of EU Pact Opposed by Russia," *The Wall Street Journal*, 12 September 2014.

1995).

Here, I develop a theory of trade policy bargaining in the shadow of military power, or "gunboat diplomacy." The value of international trade flows and the probability of peace are positively correlated in equilibrium. This correlation emerges not because trade causes peace. Rather, liberal trade policy preferences generate incentives for both trade and peace. When peace prevails, latent military threats influence equilibrium trade policies, which balance domestic political-economic interests against military threats from abroad. Militarily weak countries are more open to trade than powerful ones, all else equal.

The model considers the interaction between two governments (home and foreign), which each value a weighted average of consumer welfare and firm profits. These components of government utility themselves depend on the workings of an underlying "new trade" international economy (Krugman 1980; Venables 1987). Governments differ in how much influence consumers have over policymaking.[5] I refer to this variation as the governments' degree of political *bias*.[6] Tariffs help firms by shielding them from competition, but raise prices for consumers. *Low bias* or *liberal* governments prefer lower tariffs.

Governments care about trade policy choices abroad because of market access externalities (Ossa 2011, 2012). Firms' profits depend on their ability to access foreign markets. High tariffs shift profits from foreign to home firms. Therefore, firms on opposite sides of a border experience a conflict of interest over trade policy. Firms desire protection at home and liberalization abroad. The greater their bias, the more the governments internalize these interests.

As a consequence, governments themselves experience conflicts of interest over trade policy, which vary as a function of the governments' bias. When governments value consumer welfare, they prefer to adopt low barriers to trade. In doing so, they impose small market access externalities on their trading partners. When both governments hold liberal policy preferences, their relations are harmonious – there is no incentive for conflict, militarized or otherwise. As governments become less liberal, conflicts of interest become more severe.

If a government wins a war, it earns the right to impose regime change and install a "puppet" government abroad.[7] Puppets open their markets to foreign firms, allowing victorious governments to impose their trade policy preferences by force. This is the threat point governments leverage in bilateral trade policy negotiations. War sometimes occurs due to information frictions.

[5]This setup mirrors Grossman and Helpman (1994).

[6]This phraseology borrows from Jackson and Morelli (2007). In their model, political bias determines the extent to which the pivotal decision maker internalizes the costs of war. Conceptually, bias is similar to the size of the selectorate in the model of Bueno De Mesquita et al. (2003).

[7]See Owen IV (2002) for an empirical study of regime change.

Two primary insights emerge from this environment. First, governments' degree of bias affects their propensity to trade and fight wars. When both governments are liberal, the costs of regime change never exceed its policy benefits. As a result, highly liberal governments never fight wars with one another. Their liberal preferences also result in liberal equilibrium trade policies. Naturally, lowering barriers to trade increases trade itself. The governments' preference compatibility produces a relationship between trade and peace, but this relationship is spurious — trade itself has no pacifying effect. Second, even when governments avoid conflict, trade policies reflect the balance of military power between the governments. Powerful countries can credibly threaten to impose regime change. They leverage this power to extract trade policy concessions and resist liberalization. After bargaining, powerful countries are more protectionist than weaker ones.

The model rationalizes several well-established empirical facts in international relations. Bilateral trade tends to decrease before wars and rebound thereafter.[8] In the model, protectionist preference shocks decrease trade, but also increase the likelihood of war. As a consequence, periods of depressed trade correlate with war onset. Conversely, regime change following war causes a liberal preference shock to the losing country's government. Trade increases after wars, as in the data.

Some argue democracies have more liberal trade policy preferences than autocracies (Milner and Kubota 2005). Because consumers (voters) prefer free trade, they punish protectionist politicians (Mayer 1984; Grossman and Helpman 1996).[9] This provides a check on the protectionist influence of special interest groups. Translated into this framework, these theories deem democracies less biased than autocracies. If this "liberal democracy" hypothesis holds, the analysis of low bias governments extends to democratic dyads. The model then jointly rationalizes the democratic peace and democracies' propensity for trade openness.[10]

The theory's implications about power and protectionism are, as far as I know, novel. I consider these empirical implications in more detail in the Discussion section. There, I also relate the theory to militarism, imperialism, and territorial conflict.

Antràs and Padró i Miquel (2011) and Carroll (2018) are two closely related papers that merit some discussion. Antràs and Padró i Miquel (2011) consider a similar model, in which foreign governments can interfere in the domestic political economy of trade. As in this model, foreign influence has a liberalizing effect. In the anarchy of world politics, however such influence can always -– in principle -– take the form of threats, displays, or uses of military force (Fearon 1997).

[8]This relationship is shown in Figure 1.5 in the Appendix.

[9]For a skeptical take on this mechanism, see Guisinger (2009) and Betz and Pond (2019).

[10]These facts are depicted in Figure 1.6 in the Appendix. For a recent review on the relationship between democracy and peace, see Reiter (2017). Milner and Kubota (2005) show democratization tends to lead to decreased protectionism.

Analyzing this form of influence allows me to relate the domestic political economy of trade to military power and conflict propensity. Carroll (2018) unifies militarized competition and economic exchange in a more general setting. There, countries' convert commodities into military power, which can in turn be employed to seize others' commodities. Military power itself is endogenous to the general equilibrium of the international economy. I take power as exogenous and focus on competition over trade *policy*. This more narrow focus allows me to incorporate domestic political economy considerations and make empirical predictions about power, trade policy, and war.

Others have considered policy competition in the shadow of power more generally. Bils and Spaniel (2017) study a model of coercive bargaining over the location of a spatial policy. Like the model studied here, governments vary in the location of their ideal points. They study how uncertainty over the states' ideal points affects conflict propensity. Here, I microfound governments' preferences with a political economy of trade policy and explore how domestic political economic shocks affect the international bargaining environment. This generates unique comparative statics and empirical implications.

1.2 Environment

Here and in the Analysis section, I relegate proofs and derivations of key quantities to the Appendix, in order to ease exposition. I first present the context in which governments bargain, followed by the international economy. The general equilibrium of the economy determines how trade policies affect prices, wages, and trade flows. These in turn determine the welfare of consumers, firms, and the governments that represent them. Proposition 1, presented in this section, states that given our assumptions, an *economic equilibrium* (Definition 2) will exist for any feasible trade policy choices. This economy allows us to write government preferences as an indirect function of trade policy choices. As governments become more liberal, they prefer to adopt low barriers to trade. This variation affects how governments behave in the coercive bargaining game that follows.

1.2.1 International Bargaining

Two governments, home (i) and foreign (j) bargain over their joint trade policies $\boldsymbol{\tau} = (\tau_i, \tau_j) \in [1, \bar{\tau}]^2$.[11] By controlling the degree of market access afforded to foreign firms, governments' trade policies impose externalities on one another. Government preferences depend on an exogenous parameter $a_i \in [\underline{a}, \bar{a}]$, which controls the value these governments place on consumer welfare, relative

[11] Here, $\bar{\tau}$ is an arbitrary prohibitively high tariff that shuts down bilateral trade.

to firm profits.[12] Government utility is denoted $G_i(\boldsymbol{\tau}|a_i)$.[13] Higher tariffs increase firm profits by shifting market share to local firms. This comes at the expense of consumers, however, who benefit from having access to a variety of products, home and foreign. Higher tariffs also harm foreign firms and the foreign government. This is the model's core conflict of interest. Each government would like to implement some degree of protectionism at home, while maintaining access to markets abroad.

Bargaining occurs in the shadow of power. Government i makes a take-it-or-leave-it (TIOLI) offer $\tilde{\boldsymbol{\tau}} = (\tilde{\tau}_i, \tilde{\tau}_j)$ to Government j. Government j can either accept the offer or declare war, a choice denoted with $\omega \in \{\text{accept}, \text{war}\}$. This is a simple coercive bargaining framework following Fearon (1995).[14] Here, however, war results in *regime change*, rather than a simple costly division of a fixed surplus. Regime change is modeled as a change in a vanquished government's *preferences*. If government i wins a war, it replaces the government of its counterpart, fixing its preference parameter at $a^\star$. ρ denotes the probability that Government i is successful in a war for regime change.[15] c_i is the cost that government i must pay if a war occurs. $c_j > 0$ is held as private information. Government i believes c_j is distributed according to F where F is the uniform c.d.f. on $[\underline{c}_j, \bar{c}_j]$.

As is standard in bargaining models of war, the costs of war must be bounded, or the proposing country will never risk conflict. Assumption 1 formalizes this intuition.

Assumption 1: $\bar{c}_j \leq \kappa_j$ and $c_i < \kappa_i(\bar{c}_j)$ where κ_j and $\kappa_i(\bar{c}_j)$ are positive constants defined in the Appendix.

A strategy for Government i is an offer, $\tilde{\boldsymbol{\tau}}(a_i, c_i, \rho)$. A strategy for Government j, denoted $\omega(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho)$ is a mapping between this offer and a choice of whether or not to attempt regime change

$$\omega : \tilde{\boldsymbol{\tau}} \to \{\text{accept}, \text{war}\} .$$

Let $\tilde{G}_k(\tilde{\boldsymbol{\tau}}, \omega|a_k, c_k, \rho)$ denote government k's utility as a function of these choices. From these objects we can define a subgame perfect bargaining equilibrium.

Definition 1: A subgame perfect *bargaining equilibrium* is pair of strategies, $\tilde{\boldsymbol{\tau}}^\star(a_i, c_i)$ and

[12] $\bar{a}$ is defined below.

[13] I develop the international economy from the home country's perspective, but analogous primitives exist for the foreign country.

[14] While this bargaining protocol is restrictive, Fey and Kenkel (2019) show more complex bargaining processes are equivalent to a TIOLI offer in terms of their associated payoffs and probability of war.

[15] With complementary probability, the initiating government is overthrown. A more realistic formulation might allow for the possibility that no regime change occurs, with $\rho_i + \rho_j \leq 1$. While this "all or nothing" conception of war is stark, it simplifies the analysis and highlights the forces at play.

$\omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j)$ such that

$$\omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho) = \underset{\omega \in \{\text{accept}, \text{war}\}}{\arg\max} \; \tilde{G}_j\left(\tilde{\boldsymbol{\tau}}, \omega; a_j, c_j, \rho\right)$$

and

$$\tilde{\boldsymbol{\tau}}^\star(a_i, c_i, \rho) \in \underset{\boldsymbol{\tau} \in [1, \bar{\tau}]^2}{\arg\max} \, \mathbb{E}_{f(c_j)}\left[\tilde{G}_i\left(\tilde{\boldsymbol{\tau}}, \omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho); a_i, c_i, \rho\right)\right].$$

1.2.2 International Economy

Government preferences in the game described above depend on the mechanics of the international economy. To simplify the presentation and focus on the dynamics of coercive bargaining in this political economy, I consider the special case in which countries are mirror images of one another in terms of their economic primitives. Each country is inhabited by a representative consumer with labor endowment $L_i = L_j = L$. Consumers value varieties of manufactured goods and goods from an undifferentiated outside sector, which I'll call agriculture. By providing their labor to local producers of these goods, they earn an endogenous wage w_i. Consumers' income inclusive of tariff revenues $r_i(\tau_i)$ is $I_i(\tau_i) = w_i L_i + r_i(\tau_i)$. A unit of labor can produce one unit of both differentiated goods and agricultural goods. There is a mass of firms of measure 1 in each economy which produce differentiated manufactured goods, indexed ν_i.[16] Agricultural goods are produced competitively. The setup borrows from Venables (1987) and Ossa (2012).

Tariffs and Prices

Firms engage in monopolistic competition, setting prices in each market to maximize profits, given consumer demand. Governments can shift the prices that consumers pay for foreign goods by charging a uniform import tariff on manufactured goods, $\tau_i - 1$. This drives a wedge between the price set by foreign firms, $p_j(\nu_j)$, and the price paid by consumers for foreign goods. The price of foreign manufactured goods in the home market is $p_{ij}(\nu_j) = \tau_i p_j(\nu_j)$. The price in the agricultural sector serves as the numeraire, $p_i^y = 1$. The government collects the revenue raised from tariffs.

Consumption

Consumer preferences over agricultural goods Y_i and aggregated differentiated varieties X_i are Cobb-Douglas, where an exogenous parameter $\alpha \in [0, 1]$ controls the consumers' relative preference for

[16] In a completely general equilibrium, this quantity would also be an endogenous object. Fixing the number of firms allows each firm to derive positive profits, providing biased governments with an incentive to implement a positive tariff. In this sense, the model is in a "short run" equilibrium in which profits have not yet been competed away.

differentiated varieties. Consumers therefore solve the following problem

$$\begin{aligned} \max_{X_i, Y_i} \quad & X_i^{\alpha} Y_i^{1-\alpha} \\ \text{subject to} \quad & P_i X_i + Y_i \leq w_i L \end{aligned} \tag{1.1}$$

where X_i is a CES aggregate of manufactured goods x, à la Dixit and Stiglitz (1977). Consumers value each differentiated good equally. Home and foreign goods are distinguished only by their price. Let $x_{ij}(\nu_j)$ denote the quantity of differentiated goods produced in country j that are consumed in country i. Consumer's utility over differentiated goods is

$$X_i = \left(\int_{\nu_i} x_{ii}(\nu_i)^{\frac{\sigma-1}{\sigma}} d\nu_i + \int_{\nu_j} x_{ij}(\nu_j)^{\frac{\sigma-1}{\sigma}} d\nu_j \right)^{\frac{\sigma}{\sigma-1}} \tag{1.2}$$

where $\sigma > 1$ is the elasticity of substitution between varieties. The real price level of differentiated goods in each country is described by the CES exact price index

$$P_i(\tau_i) = \left(\int_{\nu_i} p_{ii}(\nu_i)^{1-\sigma} d\nu_i + \int_{\nu_j} p_{ij}(\nu_j)^{1-\sigma} d\nu_j \right)^{\frac{1}{1-\sigma}}. \tag{1.3}$$

Equilibrium demand for manufactured goods from j in i is

$$x_{ij}^{\star}(\nu_j) = p_{ij}(\nu_j)^{-\sigma} P_i(\tau_i)^{\sigma-1} \alpha I_i(\tau_i). \tag{1.4}$$

With prices of agricultural goods serving as numeraire, $Y_i = (1-\alpha) I_i(\tau_i)$ and consumer indirect utility is

$$V_i(\tau_i) = \alpha^{\alpha}(1-\alpha)^{1-\alpha} \frac{I_i(\tau_i)}{P_i(\tau_i)^{\alpha}}. \tag{1.5}$$

Production

Firms set prices to maximize profits across home and foreign markets, given consumer demand. Because all firms in country i face the same demand curves at home and abroad, they all set the same factory-gate price. The quantity that each firm i produces for market j is equal to the demand for i's goods in j, $x_{ij}^{\star}(\nu_j)$. It takes one unit of labor to produce each unit of a manufactured good.

The firms' problem is given by

$$\begin{aligned}
\max_{p_i(\nu_i)} \quad & \Pi_i\left(p_i(\nu_i)\right) = \left(p_i(\nu_i) - w_i\right)\left(x_{ii}^\star(\nu_i) + x_{ji}^\star(\nu_i)\right) \\
\text{subject to} \quad & x_{ii}^\star(\nu_i) = p_i(\nu_i)^{-\sigma} P_i(\tau_i)^{\sigma-1}\alpha I_i(\tau_i) \\
& x_{ji}^\star(\nu_i) = (\tau_j p_i(\nu_i))^{-\sigma} P_j(\tau_j)^{\sigma-1}\alpha I_i(\tau_j).
\end{aligned} \tag{1.6}$$

This problem yields equilibrium prices

$$p_i^\star(\nu_i) = \frac{\sigma}{\sigma-1} w_i. \tag{1.7}$$

Since prices are constant across firms, I suppress the variety indices and write $p_i^\star(\nu_i) = p_i^\star$. Total consumption of manufactured goods from i in j is

$$x_{ji}^\star(\tau_j) = \int_{\nu_i} x_{ji}^\star(\nu_i) d\nu_i.$$

Total profits for all firms in country i can then be computed as

$$\Pi_i(\tau_i, \tau_j) = \int_{v_i} \Pi_i(p_i(\nu_i)) = \left(p_i^\star - w_i\right)\left(x_{ii}^\star(\tau_i) + x_{ji}^\star(\tau_j)\right). \tag{1.8}$$

By raising the price of foreign varieties, tariffs shift profits from foreign to home producers. As tariffs get large ($\tau_j \to \bar{\tau}$), demand for imported manufactured goods contracts ($x_{ji}^\star(\tau_j) \to 0$). Consumers substitute toward home varieties ($p_j^\star x_{jj}^\star(\tau_j) \to \alpha I_j(\tau_j)$), increasing local profits. While consumers are harmed by the imposition of tariffs ($\frac{\partial V_j}{\partial \tau_j} < 0$), local producers benefit. The preferences of home consumers are aligned with those of *foreign* firms, both of which desire liberal trade policies from the home government.

I assume that firms' welfare is dependent only on their profits, and not influenced by the aggregate price level ($P_i(\tau_i)$) within the economy. This is consistent with the special case of Grossman and Helpman (1994) in which firm owners are "small" in the broader population. A more complex preference structure would emerge if this assumption were violated, or if firms employed intermediate goods in production.

Tariff Revenue

For every unit of manufactured goods imported, the government collects $(\tau_i - 1)p_j^\star$ in tariff revenue. Total tariff revenue can be written

$$r_i(\tau_i) = (\tau_i - 1)p_j^\star x_{ij}^\star(\tau_i p_j^\star). \tag{1.9}$$

Economic Equilibrium

Consumers lend their labor endowment to the manufacturing and agricultural sectors in order to maximize their income. If both sectors are active, then $w_i = 1$ because the agricultural sector is competitive and serves as numeraire. Let L_i^x denote the amount of labor i allocates toward manufacturing and L_i^y the amount of labor i allocates toward agriculture. Let $\boldsymbol{w} = (w_i, w_j)$ and $\boldsymbol{L} = (L_i^x, L_i^y)_{i \in \{i,j\}}$.

Definition 2: An *economic equilibrium* is a function $h : \boldsymbol{\tau} \rightarrow (\boldsymbol{w}, \boldsymbol{L})$ mapping trade policy choices to endogenous wages and labor allocations such that goods and factor markets clear given equilibrium prices and corresponding demands.

If the agricultural sector is active, it pins down wages and nullifies incentives for governments to employ tariffs for purposes of manipulating the terms of trade. Assumption 2 guarantees that the agricultural sector will remain active regardless of the governments' choices of trade policies. Substantively, it requires that consumers spend a large enough proportion of their income on agricultural goods to prevent the specialization of either country in the production of manufactured goods. This allows me to focus analysis on profit shifting incentives for trade policy, as in Ossa (2012).

Assumption 2:

$$\alpha < \frac{2}{3} \frac{\sigma}{\sigma - 1}.$$

Proposition 1: If Assumption 2 is satisfied, then a unique economic equilibrium exists with $L_i^x, L_i^y, L_j^x, L_j^y > 0$ and $w_i = w_j = 1$ for all $\boldsymbol{\tau} \in [1, \bar{\tau}]^2$.

Government Preferences

Governments value a combination of consumer welfare and producer profits. With these quantities derived, we can write

$$G_i(\boldsymbol{\tau} | a_i) = a_i V_i(\tau_i) + \Pi_i(\tau_i, \tau_j). \tag{1.10}$$

The exogenous parameter a_i controls the relative weight the government places on consumer welfare, relative to profits and revenue. This conception of government preferences follows Grossman and Helpman (1994), in which a_i represents the value the government places on campaign contributions relative to consumer welfare.[17]

I take a_i as a measure of the representativeness of i's government. When a_i is small (high bias), the government privileges the narrow interests of firms and its own revenue. As a_i gets larger (low bias), the welfare of consumers plays a larger role in determining the governments' preferences. If democracies are more sensitive to the interests of consumers, then we would expect them to have higher values of a_i than autocracies.

Assumption 3 guarantees that the government prefers an interior tariff ($\tau_i < \bar{\tau}$). This requires that the government's weight on consumer welfare be sufficiently large.

Assumption 3: $a_i \in (\underline{a}, \bar{a}]$ for all i where $\underline{a}$ is a positive constant defined in Appendix C and $\bar{a}$ is an arbitrarily large but finite number.

Notably, $\underline{a}$ depends positively on the consumers' elasticity of substitution, σ. As σ increases, manufactured varieties become more substitutable, and foreign varieties become less valuable to consumers. Governments therefore prefer higher tariffs, all else equal. $\underline{a}$ increases with σ in order to ensure that no government prefers prohibitive tariffs.

Lemma 1 formalizes the claims that ideal points, denoted $\tau_i^\star(a_i)$, are interior to the policy space.

Lemma 1: $\tau_i^\star(a_i) \in (1, \bar{\tau})$.

1.3 Analysis

Recall from Definition 1 that a bargaining equilibrium is a trade policy offer from the home country, and a decision of whether or not to declare war, given this offer, from the foreign country. This section analyzes how these equilibrium choices vary as a function of the governments' bias types.

The results can be summarized as follows. Because they internalize the welfare of consumers, liberal governments prefer to adopt lower tariffs (Lemma 2). If governments were unable to bargain, a non-cooperative equilibrium (Definition 3) would emerge in which governments simply implemented their ideal tariffs. This non-cooperative equilibrium serves as a baseline from which governments compare offers in a bargaining equilibrium (Definition 1). As governments' degree of bias increases, they impose larger and larger externalities on one another in a non-cooperative equilibrium. This increases the degree of conflict of interest between the governments (Definition 4), and makes regime

[17]In their model, firms lobby for protective tariffs (or export subsidies), promising campaign contributions in exchange for policy deviations from the consumer welfare-maximizing ideal. Grossman and Helpman (1996) provide additional microfoundations for this objective function in a model of electoral competition, in which the government can employ campaign contributions to influence the vote choice of "uneducated" voters.

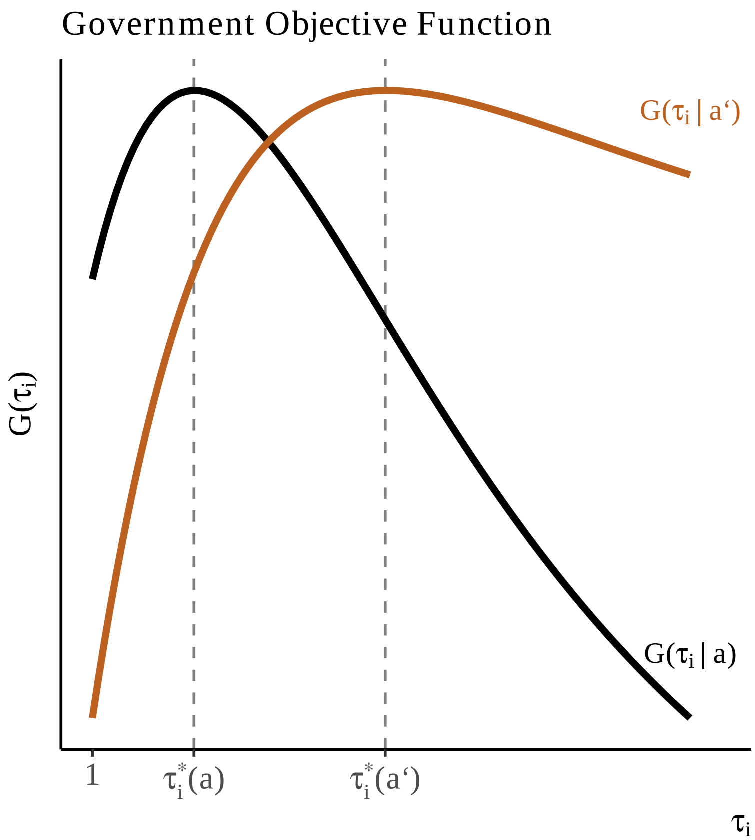


Figure 1.1: Government preferences over own tariff rates with $a > a'$

change relatively more appealing. Liberal governments experience smaller conflicts of interest with one another (Proposition 3) which makes them unwilling to initiate wars (Proposition 4). Because they prefer lower trade barriers, trade also increases as governments become more liberal so long as the shadow of war is absent (Proposition 5). Finally, militarily powerful governments adopt higher barriers to trade in equilibrium (Proposition 6)

1.3.1 Preferences

Figure 1.1 depicts the governments' objective functions as a function of their own tariff choice, τ_i. As the government becomes more representative, the peak of the curve shifts to the left, indicating that the government prefers a lower tariff. This is a natural result. As the government becomes more representative, it values the welfare of the consumer more and more. This pushes the government to adopt a policy that is closer to the consumer's ideal.

Figure 1.2 depicts the government's welfare in (τ_i, τ_j) space. By decreasing the market access afforded to firms in i, non-zero tariffs in j strictly decrease the government's welfare. For any given τ_i, the government's welfare is increasing as τ_j decreases.

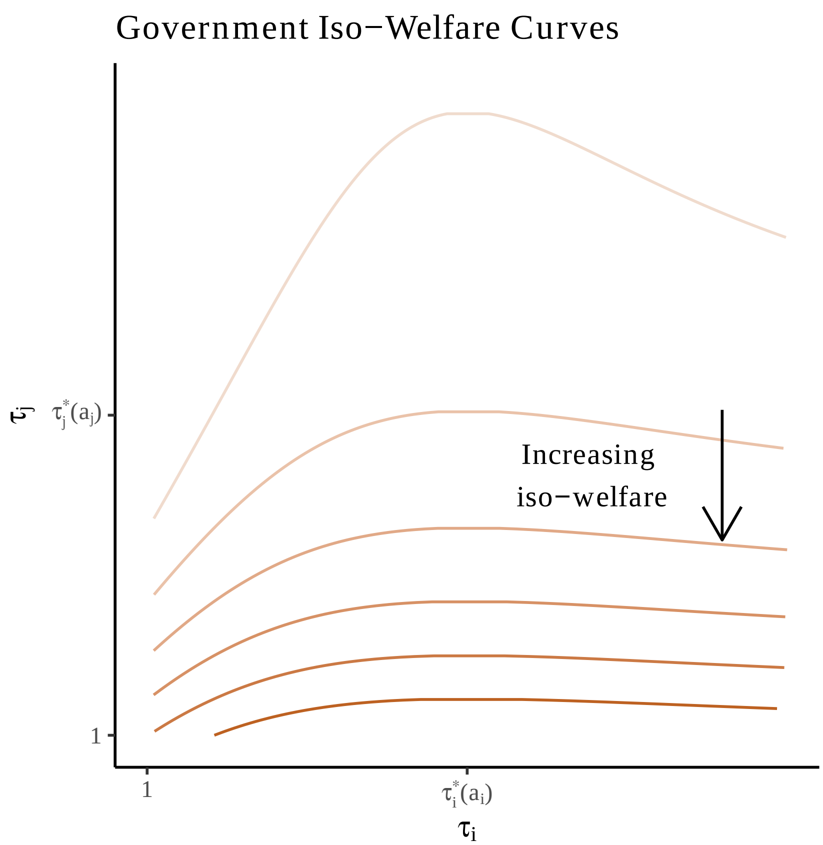


Figure 1.2: Government iso-welfare curve over home and foreign tariff rates

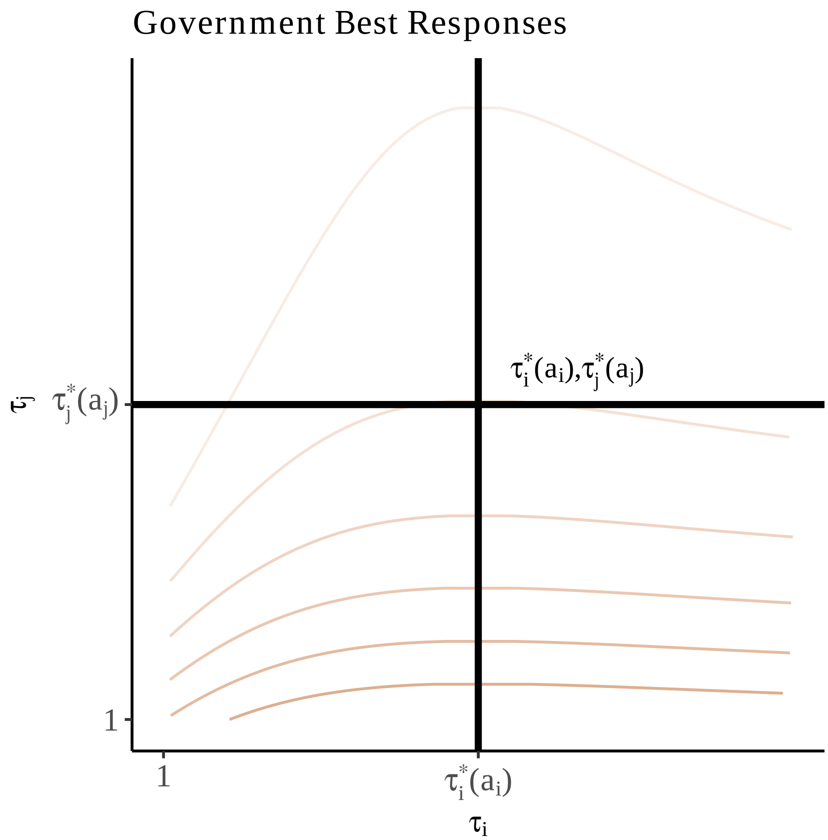


Figure 1.3: Government best response functions

Lemma 2: $G_i(\tau_j)$ is strictly decreasing in τ_j.

If the governments were prohibited from bargaining, they would each simply choose the policy that maximized their utility, taking the other country's policy choice as given.

Definition 3: A *noncooperative equilibrium* is a pair of policies $\left(\tau_i^\star(a_i), \tau_j^\star(a_j)\right)$ such that

$$\tau_i^\star(a_i) = \underset{\tau_i \in [1, \bar{\tau}]}{\arg\max}\, G_i(\tau_i; a_i)$$

and

$$\tau_j^\star(a_j) = \underset{\tau_j \in [1, \bar{\tau}]}{\arg\max}\, G_j(\tau_j; a_j).$$

Our next result shows that as governments become more liberal, their optimal tariffs fall.

Lemma 3: $\tau_i^\star(a_i)$ is strictly decreasing in a_i.

Figure 1.3 depicts each governments' best response curves through the policy space. Because the governments' optimal choices do not depend on one another's policy choice, their best response curves are straight lines. Their intersection constitutes the noncooperative equilibrium. As the governments' preferences become more biased, these curves shift outward, resulting in a more autarkic noncooperative equilibrium.

1.3.2 Regime Change

It is now clear that each government cares indirectly about the preferences of its bargaining partner. More welfare-conscious governments adopt lower barriers to trade (Lemma 3) in a non-cooperative equilibrium, which benefits governments abroad by providing greater market access to their firms. If each government were able to choose the preferences of their negotiating partner, they would do so in order to minimize trade barriers. This is the purpose of regime change in this model. If a government wins a war, it earns the right to replace the government with a puppet with more "dovish" preferences. Regime change is therefore used instrumentally to pry open international markets. Let $a^\star \in (\underline{a}, \bar{a}]$ denote the type of the optimal puppet government.

The optimal puppet's type solves

$$\max_{a_j \in (\underline{a}, \bar{a}]} G_i(\tau_i^\star(a_i), \tau_j^\star(a_j); a_i).$$

Proposition 2: $a^\star = \bar{a}$.

If a government wins a war, it will replace the vanquished government with a maximally-responsive puppet. This government will adopt no trade barriers, providing maximal market access for the victorious country's firms. This is the threat point that governments leverage in international coercive bargaining.

1.3.3 Conflicts of Interest

If a government wins a war it adopts its optimal policy and enjoys complete access to the markets of its trading partner. This best case scenario yields the government utility

$$\bar{G}_i(a_i) = G_i(\tau_i^\star(a_i), \tau_j^\star(\bar{a}); a_i).$$

If a government loses a war, it is replaced by a puppet and must suffer under the policies implemented by the puppet regime. This is consistent with a notion of the government as a particular amalgamation of social actors that continues to exist at the conclusion of a war. The vanquished government yields utility

$$\underline{G}_i(a_i, a_j) = G_i(\tau_i^\star(\bar{a}), \tau_j^\star(a_j); a_i).$$

These outcomes represent upper and lower utility bounds on the outcome of any coercive negotiation. Each government can be made no worse off than if it were to lose a war. And each government can secure no better bargaining outcome than if they were to (costlessly) win a war for regime change. The welfare difference between these two scenarios is taken to be i's *conflict of interest* with j. Note that this conflict of interest, unlike standard models of bargaining and war, need not be symmetric. The "pie" at stake in the negotiation over trade policies may be valued differently by each government — i's preference intensity may be stronger than j's or vice versa. This variation in preference intensity, combined with variable military power, determines bargaining outcomes.

Definition 4: The magnitude of government i's *conflict of interest* with government j is

$$\Gamma_i(a_i, a_j) = \bar{G}_i(a_i) - \underaccent{\bar}{G}_i(a_i, a_j). \tag{1.11}$$

Proposition 3: $\Gamma_i(a_i, a_j)$ is decreasing in a_i and a_j .

Proposition 3 states that as government i becomes more welfare-conscious, the magnitude of its conflict of interest decreases. Likewise, as government j becomes more welfare-conscious, i's conflict of interest with it decreases. As government i becomes more welfare-conscious, it prefers less protectionism. This decreases the difference between i's ideal policy and the (free trading) policy that will be imposed upon it if j is victorious in a war. As j becomes more welfare-conscious, it imposes smaller market access externalities on i. Regime change becomes relatively less appealing, because the distance between j's preferred policy and the policy that a puppet would impose shrinks. In the corner case where $a_i = a_j = \bar{a}$, the conflict of interest evaporates – puppets would implement the exact same policies as the sitting governments.

1.3.4 Bargaining

These conflicts of interest structure what sets of policies i will offer and what offers j will prefer to war. Working backward, recall from Definition 1 that $\omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho)$ is a function that takes an offer from i and returns a choice of whether or not to declare war. j's utility for war is given by

$$\hat{G}_j(a_j, a_i) = \underbrace{(1-\rho)\bar{G}_j(a_j) + \rho \underaccent{\bar}{G}_j(a_j, a_i)}_{W_j(a_j, a_i)} - c_j = (1-\rho)\Gamma_j(a_j, a_i) + \underaccent{\bar}{G}_j(a_j, a_i) - c_j.$$

Note that j's utility can be written in terms of its conflict of interest with i. j will prefer war to

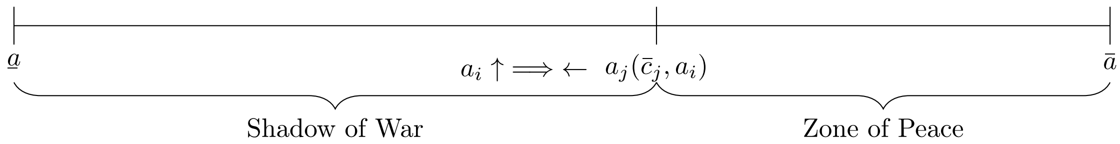


Figure 1.4: As the home government becomes more liberal, the set of foreign types that accept its ideal point expands.

i's offer whenever

$$\hat{G}_j(a_j, a_i) \geq G_j(\tilde{\boldsymbol{\tau}}; a_j).$$

This condition allows us to characterize $\omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho)$.

Lemma 4:

$$\omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho) = \begin{cases} \text{war} & \text{if } \hat{G}_j(a_j, a_i) \geq G_j(\tilde{\boldsymbol{\tau}}; a_j) \\ \text{accept} & \text{otherwise} \end{cases}$$

If j's conflict of interest with i is small enough, then i can simply offer its ideal point and all cost types of j will accept.

Lemma 5: If

$$W_j(a_j, a_i) - G_j(\tau_j^\star(\bar{a}), \tau_i^\star(a_i); a_j) = \Gamma_j(a_j, a_i) \leq \underline{c}_j$$

then

$$\tilde{\boldsymbol{\tau}}^\star = (\tau_i^\star(a_i), \tau_i^\star(\bar{a}))$$

and

$$\omega^\star(\tau_i^\star(a_i), \tau_j^\star(\bar{a}); a_j, c_j, \rho) = \text{accept}$$

for all $c_j \in [\underline{c}_j, \bar{c}_j]$.

Given our assumptions on the costs of war, we can always find a cutpoint bias type for the foreign country such that all types more liberal than the cutpoint accept i's ideal point.

Lemma 6 (Zone of Peace): For every $\underline{c}_j \in [0, \bar{c}_j)$ there exists a $a_j(\underline{c}_j, a_i)$ such that for all $a_j \in [a_j(\underline{c}_j, a_i), \bar{a})$ the probability of war is 0.

Lemma 6 proves the existence of a "Zone of Peace" – a set of foreign bias types that never fight in equilibrium. Combining this observation with the fact that j's conflict of interest with i is decreasing in i's bias type yields our first core result. Namely, that the size of this zone of peace is increasing as i becomes more liberal in its policy preferences. Figure 1.4 depicts this result.

Proposition 4 (Liberal Peace): $a_j(\underline{c}_j, a_i)$ is weakly decreasing in a_i.

Whenever $a_j \geq a_j(\underline{c}_j, a_i)$, i offers its ideal point which is accepted by j. This guarantees peace.

j is more willing to accept i's ideal point as it becomes more liberal, because i's ideal policy imposes smaller and smaller externalities on j. This generates a "Liberal Peace." When peace prevails, liberal governments also settle on more open trade policy regimes overall. Naturally, reducing trade costs increases trade between the governments.

Proposition 5 (Liberal Trade): If $a_j \geq a_j(\underline{c}_j, a_i)$ then trade in manufactured goods is increasing in a_i.

If $a_j < a_j(\underline{c}_j, a_i)$, however, then i faces a risk-return tradeoff (Powell 1999). Offers closer to i's ideal point yield higher utility conditional on acceptance, but also generate a higher risk of war. Here, the shadow of power affects equilibrium policies.

For any offer, the probability that j will declare war is given by

$$\Pr\left(c_j \leq W_j(a_j, a_i) - G_j(\tilde{\boldsymbol{\tau}}; a_j) | \tilde{\boldsymbol{\tau}}, a_i, a_j\right) = F\left(W_j(a_j, a_i) - G_j(\tilde{\boldsymbol{\tau}}; a_j)\right). \tag{1.12}$$

With this quantity known, we can work to characterize i's offer function, $\tilde{\boldsymbol{\tau}}^{\star}(a_i)$. If war occurs, i receives utility

$$\hat{G}_i(a_i, a_j) = \rho\Gamma_i(a_i, a_j) + \underline{G}_i(a_i, a_j) - c_i.$$

With the probability of war given in Equation 1.12, we can write i's utility for any offer as

$$\begin{aligned} \tilde{G}_i\left(\tilde{\boldsymbol{\tau}}, \omega^{\star}(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho); a_i, c_i, \rho\right) = & \underbrace{\left(1 - F\left(W_j(a_j, a_i) - G_j(\tilde{\boldsymbol{\tau}}; a_j)\right)\right)\left(G_i(\tilde{\boldsymbol{\tau}}; a_i)\right)}_{\neg\text{war}} + \\ & \underbrace{F\left(W_j(a_j, a_i) - G_j(\tilde{\boldsymbol{\tau}}; a_j)\right)\left(\hat{G}_i(a_i, a_j)\right)}_{\text{war}}. \end{aligned} \tag{1.13}$$

By Definition 1, i's equilibrium offer will maximize this objective function. Lemmas 7 and 8 state that an offer will lie inside the pareto set and that proposed trade policies will be weakly more liberal than those in a noncooperative equilibrium (Definition 3).

Definition 5: The *pareto set* is given by

$$\mathcal{P} = \left\{ \tilde{\boldsymbol{\tau}} \in [1, \bar{\tau}]^2 | \tilde{\boldsymbol{\tau}} \in \underset{\tilde{\boldsymbol{\tau}} \in [1, \bar{\tau}]^2}{\arg\max}\, \lambda G_i(\tilde{\boldsymbol{\tau}}; a_i) + (1 - \lambda) G_j(\tilde{\boldsymbol{\tau}}; a_j) \right\}$$

for some $\lambda \in [0, 1]$.

Lemma 7: $\tilde{\boldsymbol{\tau}}^{\star}(a_i, c_i, \rho) \in \mathcal{P}$.

Lemma 8: $\tilde{\boldsymbol{\tau}} = \left(\tilde{\tau}_i^{\star}, \tilde{\tau}_j^{\star}\right) \leq \left(\tau_i^{\star}(a_i, c_i, \rho), \tau_j^{\star}(a_i, c_i, \rho)\right)$ with $\leq$ the natural vector order.

These Lemmas establish that any policy proposal is efficient and that tariffs are weakly lower than those in the noncooperative equilibrium. How i chooses to resolve the risk-return tradeoff depends on its military power. Relatively powerful governments can implement their ideal point with high probability through war. They run little risk that the foreign government would reject an offer close to their ideal point. Conversely, weak governments are likely to lose a war over market access, and therefore must concede more to their counterpart. Military power therefore affects trade policy. Because i's ideal point features more protection of its own market than j's ideal point, as i becomes more powerful, it proposes higher levels of protection for itself. If this offer is accepted and peace prevails, powerful countries will be more closed to international trade.

Proposition 6 (Power and Protection): If $a_j < a_j(\underline{c}_j, a_i)$ and peace prevails, government i's trade barriers are increasing in its military strength, i.e. $\tilde{\tau}_i^\star(a_i, c_i, \rho)$ is increasing in ρ.

1.4 Discussion

Jointly, Propositions 4 and 5 establish that the most liberal governments never fight and also trade more than illiberal governments. Contra the commercial peace framework, trade is endogenously determined by governments trade policy choices. These endogenous trade policies determine trade flows and generate conflicts between governments. Economic integration is not exogenously given. Rather, participation in the international economy is a choice. Even in today's globalized era, such policy frictions persist (Anderson and Van Wincoop 2004; Cooley 2019a).

These policy choices are the object of contention between governments in the model. Protectionist barriers cause conflicts of interest between market access-motivated governments. McDonald (2004) shows that measures of protection are better predictors of conflict than trade.[18] Trade can persist in the presence of trade barriers. For example, World War I broke out during an era of rapid globalization. McDonald and Sweeney (2007) show that the great powers maintained high protective tariffs during this era, which provided a rationale for conflict over market access conditions, despite high trade volumes. Chatagnier and Kavakli (2015) examine governments whose firms compete in the same export markets. They show these governments are more likely to experience international conflicts.

Firms are the source of belligerent foreign policies in the theory. In Imperial Germany, "iron and rye" advocated for protectionism and expansionist foreign policies (Gerschenkron 1943). Similar domestic political coalitions emerged in the United States. Fordham (2019) traces the development of the United States as a naval power in the 19th century. He finds protectionist interests were

[18] His analysis covers the years 1960-2000.

the strongest advocates for the nascent U.S. fleet. At the time, U.S. trade policy was protectionist. Washington also sought preferential market access in developing countries, particularly in Latin America. The fleet served to protect these objectives against military interference from Europe. Commercial objectives also motivated Washington at the dawn of the Cold War (Fordham 1998). Under Soviet influence, Eastern Europe became closed to trade with the United States. Congressmen representing export-oriented districts tended to support an aggressive military posture toward the Soviet Union. The goal of export-oriented firms, argues Fordham, was to secure market access in Europe and Japan. In the post-Cold War era, Congressmen representing import-exposed districts have tended to support hostile foreign policies toward China, whose exports (plausibly) harm their constituent firms (Kleinberg and Fordham 2013).

Domestic political institutions connect these underlying economic interests to government preferences. I treat these institutions in reduced form, focusing on variation in consumers' ability to influence policy. Consumers pacify foreign policy preferences. If democratic political institutions privilege the interests of consumers, then Propositions 4 and 5 support a commercial-democratic peace. Observational analyses uncover positive correlations between democracy, trade, and peace because of the trade policy preferences of democracies.[19] Liberal preferences increase trade and reduce conflict.

Observed trade policies are not a sufficient statistic for government preferences, however. Proposition 6 states that relative military power effects trade policy in peacetime. Governments' trade policies reflect their preferences only up to a war constraint. Liberal *policies* do not imply liberal *preferences*. Several studies have employed Grossman and Helpman (1994) and Grossman and Helpman (1995) to structurally estimate governments' welfare-consciousness (Goldberg and Maggi 1999; Mitra, Thomakos, and Ulubasoglu 2006; Gawande, Krishna, and Olarreaga 2009, 2012, 2015; Ossa 2014). International strategic considerations are effectively absent from these models. The domestic political economy determines outcomes. Therefore, a simple inversion on the policy function recovers preferences. The model developed here highlights the importance of the war constraint. Militarily weak, illiberal governments adopt the same policies as liberal governments.

Territory plays a central role in theories and empirical studies of interstate conflict.[20] Wars often redraw international borders. In doing so, they also relocate customs barriers and modify the trade policies of captured regions. Gunboat diplomacy and territorial conflict are plausibly substitutes

[19] See Oneal and Russett (1999) for a representative study.

[20] The "pie" at stake in bargaining models of war is often motivated as the distribution of territory between the countries. Empirical studies of territorial conflict often conceptualize territorial control as a consumption good, rather than a means to implement policy. See, for example, Caselli, Morelli, and Rohner (2015). For a review of this literature, see Schultz (2015).

for one another. Governments can acquire foreign market access through territorial annexation or regime change. Territory and trade policy are not exclusive realms of international conflict.

1.5 Conclusion

The model envisions a stylized world. Two governments preside over identical economies exogenous military capacities and political bias types. If the countries were heterogeneous in market size (L_i), the economically larger country would possess an additional source of bargaining power. Whether this outside option affects bargaining outcomes would depend on the distribution of economic and military strength. This analysis might shed light the substitutability of economic and military coercion (Hirschman 1945).

Military power (ρ) is also treated as exogenous here. If military investment was possible, ρ would depend on economic and political primitives.[21] Because they have more at stake in bargaining, illiberal governments might invest more in their militaries. This result would hold especially if the costs of militarization are borne by consumers (Jackson and Morelli 2007; Chapman, McDonald, and Moser 2015). This variant might explain why democracies spend less on their militaries (Fordham and Walker 2005).

If the game developed here was dynamic, regime type itself would be an endogenous object. Wars impose puppet governments more liberal than those that preceded them. The world would democratize over time, as conquering powers installed liberal governments abroad. (McDonald 2015).

While imperial powers sometimes seek to democratize defeated countries, they often instead install allied strongmen or colonial administrations. If the liberal democracy hypothesis holds, these actions are puzzling. Controlling these governments presents agency problems absent in relations with liberal regimes. Liberal regimes adopt liberal trade policies of their own accord. Conquerors must incentivize their agents to adopt these policies.

A multi-country variant of this framework might provide a rationale for this behavior. Consider a world populated with three countries — A, B, and C. For firms in A, an ideal policy for B is one that is open to trade with A but closed to trade from C. This allows A's firms to maximize their share of B's market.[22] In other words, firms seek *preferential* access to foreign markets. It is immediate that a low bias government would not provide such preferential access. Coercing governments might be willing to suffer the agency costs of obtaining preferential access to B if B's market was valuable

[21] See, for example, Jackson and Morelli (2009a).

[22] This assumes, of course, that B cannot tax its own firms.

enough. This framework might be profitably applied to the study of imperialism (Gallagher and Robinson 1953).

Finally, the theory highlights an underappreciated prerequisite for international conflict. For governments to war with one another, they must both 1) possess conflicts of interest large enough to justify the costs of conflict and 2) be unable to resolve these conflicts peacefully (Jackson and Morelli 2009b). Theoretical research on international conflict has focused on the latter. In abstracting away from the exact nature of the dispute at hand, these models direct our attention away from the question of why international disputes emerge in the first place. What do governments want, and why do their objectives bring them into conflict with one another (Moravcsik 1997; Coe, n.d.)? While war is rare in international politics, antagonistic and militarized political relations are common. Focusing attention on the conflicts of interest underlying these antagonisms might help explain their emergence and termination.

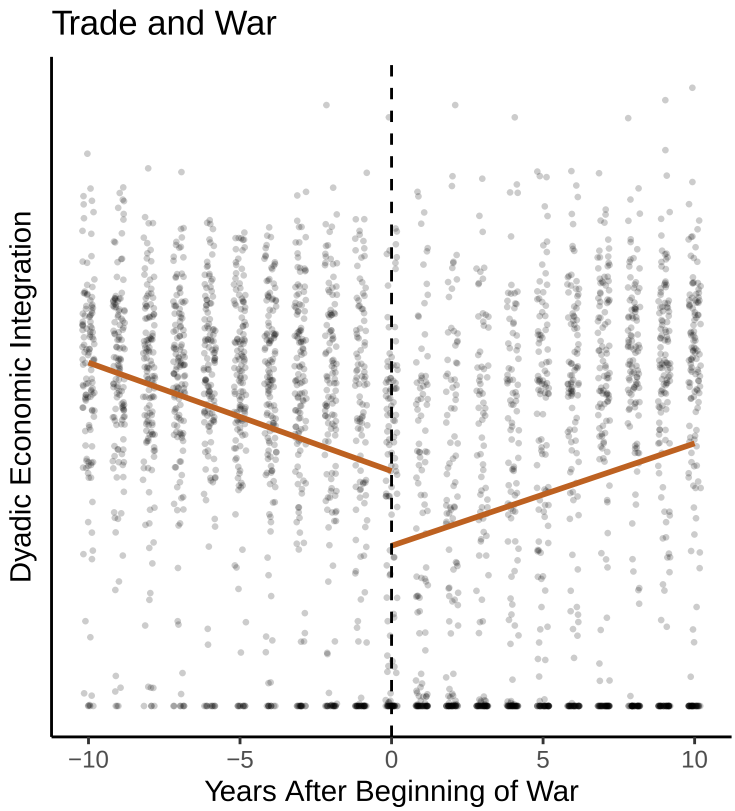
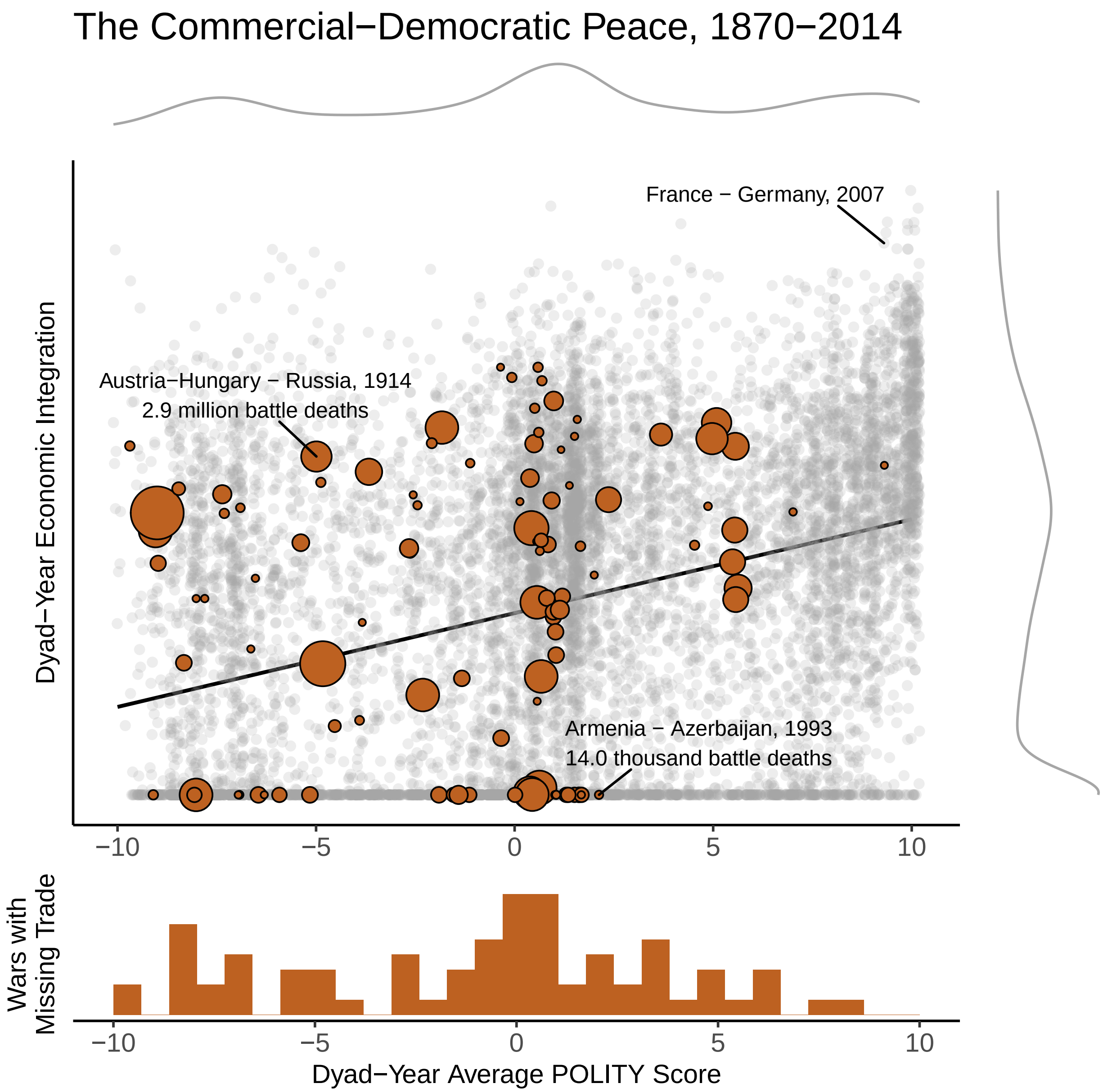


Figure 1.5: Plot depicts trade relations between dyads that experienced wars, 10 years prior to and 10 years following the outbreak of hostilities. Economic integration is measured as the average of the countries' directed imports to gdp ratio. An inverse hyperbolic sine transformation was applied to normalize this measure. Data from Barbieri, Keshk, and Pollins (2008), Barbieri, Keshk, and Pollins (2009), Sarkees and Wayman (2010), Bolt et al. (2018).

1.6 Appendix

1.6.1 A: Trade, War, and Democracy: Empirical Facts



Notes: Each point is one dyad−year. Red−orange points are dyad−years in which a war began, sized by the number of battle deaths each side incurred during that war. Light blue points are a sample of 10,000 dyad−years in which no wars occured. Economic integration is measured as the average of the countries' directed imports to gdp ratio. An inverse hyperbolic sine transformation was applied to normalize the economic integration measure. Economic Integration score lagged by one year. Margin plots show the density of the transformed economic integration measure and the average POLITY score. A trend line shows the correlation between economic integration and average POLITY score in the sample of peaceful dyads. The distribution of average POLITY scores for war dyads for which trade or gdp data were not available is plotted in a histogram below the scatterplot.

Figure 1.6: Data from Marshall, Jaggers, and Gurr (2002), Barbieri, Keshk, and Pollins (2008), Barbieri, Keshk, and Pollins (2009), Sarkees and Wayman (2010), Bolt et al. (2018).

1.6.2 B: International Economy

Demand for Manufactured Goods: Total expenditure on manufactured goods is $\alpha I_i = P_i X_i$. Cobb Douglas preferences ensure that consumers will spend an α-share of their income on manufactured goods. We can derive Equation 1.4 by solving Equation 3.10 subject to the constraint

$$\int_{\nu_i} p_{ii}(\nu_i)x_{ii}(\nu_i)d\nu_i + \int_{\nu_j} p_{ij}(\nu_j)x_{ij}(\nu_j) \leq \alpha w_i L. \tag{1.14}$$

For any two domestic varieties, ν_i and ν_i', we must have

$$\begin{aligned} x_{ii}^{\star}(\nu_i)p_{ii}(\nu_i)^{\sigma}p_{ii}(\nu_i')^{1-\sigma} &= p_{ii}(\nu_i')x_{ii}^{\star}(\nu_i') \\ x_{ii}^{\star}(\nu_i)p_{ii}(\nu_i)^{\sigma}\int_{\nu_i'} p_{ii}(\nu_i')^{1-\sigma}d\nu_i' &= \int_{\nu_i'} p_{ii}(\nu_i')x_{ii}^{\star}(\nu_i')d\nu_i'. \end{aligned}$$

The same must hold for foreign varieties:

$$x_{ij}^{\star}(\nu_j)p_{ij}(\nu_j)^{\sigma}\int_{\nu_j'} p_{ij}(\nu_j')^{1-\sigma}d\nu_j' = \int_{\nu_j'} p_{ij}(\nu_j')x_{ij}^{\star}(\nu_j')d\nu_j'.$$

Summing these conditions and noting $x_{ij}^{\star}(\nu_j)p_{ij}(\nu_j)^{\sigma} = x_{ii}^{\star}(\nu_i)p_{ii}(\nu_i)^{\sigma}$ at equilibrium consumption gives

$$\begin{aligned} x_{ii}^{\star}(\nu_i)p_{ii}(\nu_i)^{\sigma}\left(\int_{\nu_i'} p_{ii}(\nu_i')^{1-\sigma}d\nu_i' + \int_{\nu_j'} p_{ij}(\nu_j')^{1-\sigma}d\nu_j'\right) &= \int_{\nu_i'} p_{ii}(\nu_i')x_{ii}^{\star}(\nu_i')d\nu_i' + \int_{\nu_j'} p_{ij}(\nu_j')x_{ij}^{\star}(\nu_j')d\nu_j' \\ x_{ii}^{\star}(\nu_i)p_{ii}(\nu_i)^{\sigma}P_i(\tau_i)^{1-\sigma} &= \alpha I_i(\tau_i) \\ x_{ii}^{\star}(\nu_i) &= p_{ii}(\nu_i)^{-\sigma}P_i(\tau_i)^{\sigma-1}\alpha I_i(\tau_i). \end{aligned}$$

Indirect Utility: Indirect utility is $X_i^{\alpha}Y_i^{\alpha}$ evaluated at equilibrium consumption. Substituting our demand equations 1.4 into Equation 3.10 gives

$$\begin{aligned} X_i^{\star} &= \left(\int_{\nu_i} x_{ii}^{\star}(\nu_i)^{\frac{\sigma-1}{\sigma}}d\nu_i + \int_{\nu_j} x_{ij}^{\star}(\nu_j)^{\frac{\sigma-1}{\sigma}}d\nu_j\right)^{\frac{\sigma}{\sigma-1}} \\ &= P_i(\tau_i)^{\sigma-1}I_i(\tau_i)\left(\int_{\nu_i} p_{ii}(\nu_i)^{1-\sigma} + p_{ij}(\nu_j)^{1-\sigma}\right)^{\frac{\sigma}{\sigma-1}} \\ &= \alpha\frac{I_i(\tau_i)}{P_i(\tau_i)}. \end{aligned}$$

Because they serve as numeraire, equilibrium consumption of agricultural goods is equivalent to expenditure: $Y_i^{\star} = (1-\alpha)I_i(\tau_i)$. Substituting these into the consumer's utility function yields

Equation 3.17.

Prices: The firms' first order condition is

$$\frac{\partial \Pi\left(p_i^\star(\nu_i)\right)}{\partial p_i^\star(\nu_i)} = \left(p_i^\star(\nu_i) - w_i\right)\left(\frac{\partial x_{ii}^\star(\nu_i)}{\partial p_i^\star(\nu_i)} + \frac{\partial x_{ji}(\nu_i)}{\partial p_i^\star(\nu_i)}\right) + x_{ii}^\star(\nu_i) + x_{ji}^\star(\nu_i) = 0$$

where

$$\frac{\partial x_{ii}(\nu_i)}{\partial p_i(\nu_i)} = -\sigma p_i^(\nu_i)^{-\sigma-1} P_i^{\sigma-1}\alpha I_i$$

and

$$\frac{\partial x_{ji}(\nu_i)}{\partial p_i(\nu_i)} = -\sigma\tau_j^{-\sigma} p_i^(\nu_i)^{-\sigma-1} P_j^{\sigma-1}\alpha I_i.$$

Note that

$$-\frac{\sigma}{p_i^\star(\nu_i)}\left(x_{ii}^\star(\nu_i) + x_{ji}^\star(\nu_i)\right) = \frac{\partial x_{ii}(\nu_i)}{\partial p_i^\star(\nu_i)} + \frac{\partial x_{ji}(\nu_i)}{\partial p_i^\star(\nu_i)}.$$

The first order condition then becomes

$$\begin{aligned}
\sigma\frac{w_i}{p_i^\star(\nu_i)}\left(x_{ii}^\star(\nu_i) + x_{ji}^\star(\nu_i)\right) - \sigma\left(x_{ii}^\star(\nu_i) + x_{ji}^\star(\nu_i)\right) + \left(x_{ii}^\star(\nu_i) + x_{ji}^\star(\nu_i)\right) &= 0 \\
\sigma\frac{w_i}{p_i^\star(\nu_i)} - \sigma + 1 &= 0 \\
\frac{\sigma}{\sigma-1}w_i &= p_i^\star(\nu_i).
\end{aligned}$$

Economic Equilibrium:

With unit costs of production in manufacturing and agriculture, goods market clearing requires

$$\begin{aligned}
L_i^y + L_j^y &= (1-\alpha)\left(I_i(\tau_i) + I_j(\tau_j)\right) \\
L_i^x &= \left(x_{ii}^\star(\tau_i) + x_{ji}^\star(\tau_j)\right) \\
L_j^x &= \left(x_{ij}^\star(\tau_i) + x_{jj}^\star(\tau_j)\right) \\
L_i^x + L_j^x + \Pi_i(p_i^\star) + \Pi_j(p_j^\star) &= \alpha\left(I_i(\tau_i) + I_j(\tau_j)\right).
\end{aligned}$$

Domestic factor market clearing requires

$$\begin{aligned}
L_i^x + L_i^y &= L \\
L_j^x + L_j^y &= L.
\end{aligned}$$

1.6.3 C: Constant Definitions

Assumption 1

I restrict j's costs of war such that there exists some government j with $a_j \in (\underline{a}, \bar{a}]$ that would be willing to fight if victory were certain and i offered its ideal point. Formally, this requires

$$\kappa_j = \Gamma_j(\underline{a}, a_i).$$

I then restrict i's costs of war to ensure that it never offers j's ideal point – an interior solution exists outside of the zone of peace. Formally, this requires

$$\kappa_i(\bar{c}_j, a_i) = \min_{\tilde{\boldsymbol{\tau}} \in \mathcal{P}} -\bar{c}_j \left(1 - F\left(W_j(\underline{a}, a_i) - G_j(\cdot, \tilde{\tau}_i; a_j)\right)\right) \frac{\frac{\partial G_i(\tau_i, \cdot; a_i)}{\partial \tau_i}}{\frac{\partial G_j(\cdot, \tau_i; a_i)}{\partial \tau_i}}.$$

Because $\frac{\partial G_j(\cdot, \tau_i; a_i)}{\partial \tau_i} < 0$, this quantity is guaranteed to be positive.

Assumption 3

Let

$$\underline{a} = (\sigma - 1)k(\alpha)^{-1}(p^\star)^\alpha(1 - (p^\star)^{-1})$$

where

$$k(\alpha) = \alpha^\alpha(1 - \alpha)^{1-\alpha}.$$

This quantity is derived by letting

$$\underline{a} = \left\{ a_i \,\middle|\, \lim_{\tau_i \to \infty} a_i V_i'(\tau_i) + \Pi_i'(\tau_i) = 0 \right\}.$$

Note that it is positive.

1.6.4 D: Proofs

Restatements of results from the main text proceed all proofs. Lemmas 2, and 3 exploit the following definitions:

$$A(\tau_i) = p^\star x_{ij}^\star(\tau_i)(\alpha I(\tau_i))^{-1} = \left(1 + \tau_i^{1-\sigma}\right)^{-1} \tau_i^{-\sigma}$$

$$B(\tau_i) = (\sigma - 1)A(\tau_i) - \sigma\tau_i^{-1}.$$

Proposition 1: If Assumption 2 is satisfied, then a unique economic equilibrium exists with $L_i^x, L_i^y, L_j^x, L_j^y > 0$ and $w_i = w_j = 1$ for all $\boldsymbol{\tau} \in [1, \bar{\tau}]^2$.

Proof: A competitive agricultural sector guarantees that agricultural producers make zero profits. This zero profit condition implies

$$(1 - w_i)\, Y_i = 0$$

which implies $w_i = 1$ whenever the agricultural sector is active, $Y_i > 0$. From Equation 1.7, this implies $p_i^\star = p_j^\star = p^\star = \frac{\sigma}{\sigma - 1}$. Suppose for now that the agricultural sector is active in both countries, implying wages are equalized across countries and sectors. Below, we verify that this is the case if Assumption 2 is satisfied.

Labor allocations to each sector depend on tariff levels. The labor allocation in country i to sector $k \in \{x, y\}$ can then be written $L_i^k(\boldsymbol{\tau})$. The total labor allocation to the manufacturing sector in country i is

$$L_i^x(\boldsymbol{\tau}) = x_{ii}^\star(\tau_i) + x_{ji}^\star(\tau_j).$$

Because $x_{ii}^\star(\tau_i)$ is increasing in τ_i and $x_{ji}^\star(\tau_j)$ is decreasing in τ_j (see Lemma 2.), $L_i^x(\boldsymbol{\tau})$ is monotone increasing in τ_i and monotone decreasing in τ_j. This implies $L_i^x(\boldsymbol{\tau})$ attains its maximum at $(\bar{\tau}, 1)$:[23]

$$\begin{aligned}
L_i^x(\bar{\tau}, 1) &= p^{-\sigma} P_i(\bar{\tau})^{\sigma-1} \alpha L + (1p)^{-\sigma} P_j(1)^{\sigma-1} \alpha L \\
&= \frac{p^{-\sigma} \alpha L}{p^{1-\sigma}} + \frac{p^{-\sigma} \alpha L}{2p^{1-\sigma}} \\
&= \frac{\alpha L}{p} + \frac{1}{2} \frac{\alpha L}{p} \\
&= \frac{3}{2} \frac{\sigma - 1}{\sigma} \alpha L.
\end{aligned}$$

Allocation to the agricultural sector is then, by the labor market clearing condition,

$$L_i^y(\bar{\tau}, 1) = L - L_i^x(\bar{\tau}, 1).$$

If $\alpha < \frac{2}{3} \frac{\sigma}{\sigma - 1}$, then $L_i^y(\bar{\tau}, 1) > 0$. Because total labor allocation to the manufacturing sector achieves its maximum at $(\bar{\tau}, 1)$, $L_i^y(\boldsymbol{\tau}) > 0$ for all $\boldsymbol{\tau} \in [1, \bar{\tau}]^2$. Moreover, $L_i^x(\boldsymbol{\tau}) > 0$ for all $\boldsymbol{\tau} \in [1, \bar{\tau}]^2$.[24] This demonstrates the proposition. ■

Lemma 1: $\tau_i^\star(a_i) \in (1, \bar{\tau})$.

Proof: The first order condition is

$$0 = -\alpha a_i V_i(\tau_i) A(\tau_i) + a_i r_i'(\tau_i) P_i(\tau_i)^{-\alpha} + \Pi_i'(\tau_i). \tag{1.15}$$

[23]Here we note the dependence of the price index on the home tariff $P_i(\tau_i)$.

[24]This follows from the fact that $L_i^x(1, \bar{\tau}) > 0$ and the monotonicities established above.

By construction,

$$\lim_{\tau_i \to \infty} \frac{\partial G_i}{\partial \tau_i} < 0$$

for all $a_i > \underline{a}$. Additionally,

$$\frac{\partial G_i}{\partial \tau_i}\Big|_{\tau_i=1} = \frac{\partial \Pi(\tau_i)}{\partial \tau_i}\Big|_{\tau_i=1} > 0.$$

This precludes $\tau_i \in \{1, \bar{\tau}\}$ from being optimal. From each corner point, the directional derivative toward the interior of the policy space is positive. ■

Lemma 2: $G_i(\tau_j)$ is strictly decreasing in τ_j.

Proof: It is sufficient to show that

$$\frac{\partial G_i(\tau_j)}{\partial \tau_j} < 0.$$

Note that

$$\frac{\partial G_i(\tau_j)}{\partial \tau_j} = \frac{\partial \Pi_i(\tau_i, \tau_j)}{\partial \tau_j} = (p^\star - 1) x_{ji}^{\star\prime}(\tau_j).$$

The derivative of home exports with respect to the foreign tariff is

$$\begin{aligned}
x_{ji}^{\star\prime}(\tau_j) &= B(\tau_j) x_{ji}^\star(\tau_j) + \frac{x_{ji}^\star(\tau_j)}{I(\tau_j)} r_j'(\tau_j) \\
&= B(\tau_j) x_{ji}^\star(\tau_j) + \frac{x_{ji}^\star(\tau_j)}{I(\tau_j)} \left((\tau_j - 1) p^\star x_{ji}^{\star\prime}(\tau_j) + p^\star x_{ji}^\star(\tau_j)\right) \\
&= B(\tau_j) x_{ji}^\star(\tau_j) + \frac{x_{ji}^\star(\tau_j)}{I(\tau_j)} \left(\frac{r_j(\tau_j)}{x_{ji}^\star(\tau_j)} x_{ji}^{\star\prime}(\tau_j) + p^\star x_{ji}^\star(\tau_j)\right) \\
&= B(\tau_j) x_{ji}^\star(\tau_j) + \lambda(\tau_j) x_{ji}^{\star\prime}(\tau_j) + p^\star x_{ji}^\star(\tau_j) + \frac{x_{ji}^\star(\tau_j)}{I(\tau_j)} \\
(1 - \lambda(\tau_j)) x_{ji}^{\star\prime}(\tau_j) &= x_{ji}^\star(\tau_j) \left(B(\tau_j) + p^\star x_{ji}^\star(\tau_j) I(\tau_j)^{-1}\right) \\
&= x_{ji}^\star(\tau_j) \left(B(\tau_j) + \alpha A(\tau_j)\right) \\
&< x_{ji}^\star(\tau_j) \left(B(\tau_j) + A(\tau_j)\right) \\
&= \sigma \tau^{-1} \underbrace{\left(\left(1 + \tau_j^{1-\sigma}\right)^{-1} \tau_j^{-\sigma-1} - 1\right)}_{<0}.
\end{aligned}$$

■

Lemma 3: $\tau_i^\star(a_i)$ is strictly decreasing in a_i.

Proof: Government i's optimal policy does not depend on the policy choice of j. As such, it is sufficient to show that the government's objective function has a negative cross partial with respect to τ_i, a_i, or

$$\frac{\partial^2 G_i}{\partial a_i \partial \tau_i} < 0.$$

This can be written

$$\begin{aligned}
\frac{\partial^2 G_i}{\partial a_i \partial \tau_{ij}} &= V_i'(\tau_i) \\
&= r'(\tau_i)P_i(\tau_i)^\alpha - \alpha P_i(\tau_i)^\alpha I(\tau_i)A(\tau_i) \\
&= \alpha P_i(\tau_i)^\alpha I(\tau_i)\left((\alpha I(\tau_i))^{-1} r'(\tau_i) - A(\tau_i)\right) \\
&= \alpha P_i(\tau_i)^\alpha I(\tau_i)\left((\alpha I(\tau_i))^{-1}\left((\tau_i - 1)p^\star x_{ij}^{\star\prime}(\tau_i) + p^\star x_{ij}^\star(\tau_i)\right) - A(\tau_i)\right) \\
&= P_i(\tau_i)^\alpha I(\tau_i)\left((\alpha I(\tau_i))^{-1}(\tau_i - 1)p^\star x_{ij}^{\star\prime}(\tau_i) + A(\tau)_i - A(\tau_i)\right) \\
&= P_i(\tau_i)^\alpha \alpha^{-1}(\tau_i - 1)p^\star \underbrace{x_{ij}^{\star\prime}(\tau_i)}_{<0}
\end{aligned}$$

where the final inequality follows from Lemma 2. ■

Proposition 2: $a^\star = \bar{a}$.

Proof: Follows immediately from Lemma 2 and Lemma 3. ■

Proposition 3: $\Gamma_i(a_i, a_j)$ is decreasing in a_i and a_j .

Proof: To establish that $\Gamma_i(a_i, a_j)$ is decreasing in a_i, note that derivative of $\Gamma_i(a_i, a_j)$ taken with respect to a_i is

$$\begin{aligned}
\frac{\partial \Gamma_i(a_i, a_j)}{\partial a_i} = &\left.\frac{\partial G_i(\tau_i^\star(a_i), \tau_i^\star(\bar{a}); a_i)}{\partial a_i}\right|_{\left(\tau_i^\star(a_i), \tau_j^\star(\bar{a})\right)} + \underbrace{\frac{\partial G_i(\tau_i^\star(a_i), \tau_j^\star(\bar{a}); a_i)}{\partial \tau_i^\star(a_i)}}_{=0} \frac{\partial \tau_i^\star(a_i)}{\partial a_i} - \\
&\left.\frac{\partial G_i(\tau_i^\star(\bar{a}), \tau_j^\star(a_j); a_i)}{\partial a_i}\right|_{\left(\tau_i^\star(\bar{a}), \tau_j^\star(a_j)\right)} \\
= &\underbrace{V_i(\tau_i^\star(a_i)) - V_i(\tau_i^\star(\bar{a}))}_{<0}
\end{aligned}$$

where the final inequality holds because $\tau_i^\star(a_i) > \tau_i^\star(\bar{a})$ for all $a_i < \bar{a}$. To see that $\Gamma_i(a_i, a_j)$ is decreasing in a_j, note

$$\frac{\partial \Gamma_i(a_i, a_j)}{\partial a_j} = -\underbrace{\frac{\partial G_i(\tau_i^\star(\bar{a}), \tau_j^\star(a_j); a_i)}{\partial \tau_j^\star(a_j)}}_{<0} \underbrace{\frac{\partial \tau_j^\star(a_j)}{\partial a_j}}_{<0}$$

where the inequalities follow from Lemmas 2 and 3. ■

Lemma 5: If

$$W_j(a_j, a_i) - G_j(\tau_j^\star(\bar{a}), \tau_i^\star(a_i); a_j) = \Gamma_j(a_j, a_i) \leq \underline{c}_j$$

then

$$\tilde{\boldsymbol{\tau}}^\star = (\tau_i^\star(a_i), \tau_i^\star(\bar{a}))$$

and

$$\omega^\star(\tau_i^\star(a_i), \tau_j^\star(\bar{a}); a_j, c_j, \rho) = \text{accept}$$

for all $c_j \in [\underline{c}_j, \bar{c}_j]$.

Proof: By Lemma 4, $\tilde{\boldsymbol{\tau}} = (\tau_i^\star(a_i), 1)$ will be accepted for all cost types $c_j \in [\underline{c}_j, \bar{c}_j]$. Since this offer maximizes i's utility conditional on peace,

$$\tilde{\boldsymbol{\tau}}^\star = \left(\tau_i^\star(a_i), \tau_j^\star(\bar{a})\right).$$

■

Lemma 6: For every $\underline{c}_j \in [0, \bar{c}_j)$ there exists a $a_j(\underline{c}_j, a_i)$ such that for all $a_j \in [a_j(\underline{c}_j, a_i), \bar{a})$ the probability of war is 0.

Proof: Government j will accept i's ideal point so long as

$$W_j(a_j, a_i) - G_j(\tau_j^\star(\bar{a}), \tau_i^\star(a_i); a_j) \leq \underline{c}_j.$$

Note that this condition can be rewritten as

$$\Gamma_j(a_j, a_i) \leq \underline{c}_j.$$

If $\Gamma_j(a_j, a_i) \leq \underline{c}_j$ for all $a_j \in [0, \bar{a})$, set $a_j(\underline{c}_j, a_i) = 0$. Otherwise, let $a_j(\underline{c}_j, a_i)$ solve

$$\Gamma_j(a_j(\underline{c}_j, a_i), a_i) = \underline{c}_j.$$

Recall from Proposition 3 that $\Gamma_j(a_j, a_i)$ is decreasing in both arguments. By Assumption 1,

$$\underline{c}_j < \bar{c}_j \leq \kappa_j = \Gamma_j(\underline{a}, a_i).$$

Since $\Gamma_j(a_j, a_i)$ is continuous and decreasing in a_j, a solution exists for $\underline{c}_j$ large enough. Then, by construction,

$$\Gamma_j(a_j, a_i) \leq \underline{c}_j$$

for all $a_j \geq a_j(\underline{c}_j, a_i)$ and j accepts i's ideal point. By Lemma 5, this guarantees peace. ■

Proposition 4: $a_j(\underline{c}_j, a_i)$ is weakly decreasing in a_i.

Proof: We have two cases, either $a_j(\underline{c}, a_i) = \underline{a}$ or

$$a_j(\underline{c}, a_i) = \Gamma_j^{-1}(\underline{c}; a_i).$$

Since $\Gamma_j(a_j, a_i)$ is decreasing in a_i (Proposition 3), so is its inverse. This is sufficient to guarantee that $a_j(\underline{c}_j, a_i)$ is decreasing in a_i. ■

Lemma 7: $\tilde{\boldsymbol{\tau}}^\star(a_i, c_i, \rho) \in \mathcal{P}$.

Proof: Suppose $\tilde{\boldsymbol{\tau}}^\star(a_i) \notin \mathcal{P}$. It is straightforward to show that this produces a contradiction, namely

$$\tilde{\boldsymbol{\tau}}^\star(a_i, c_i, \rho) \notin \underset{\tilde{\boldsymbol{\tau}} \in [1, \bar{\tau}^2]}{\arg\max}\, \tilde{G}_i\left(\tilde{\boldsymbol{\tau}}, \omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho); a_i, c_i, \rho\right).$$

First, if $\tilde{\boldsymbol{\tau}}^\star \notin \mathcal{P}$, then there exists $\tilde{\boldsymbol{\tau}}' \in [1, \bar{\tau}]^2$ such that either 1) $G_i(\tilde{\boldsymbol{\tau}}') > G_i(\tilde{\boldsymbol{\tau}}^\star)$ and $G_j(\tilde{\boldsymbol{\tau}}') \geq G_j(\tilde{\boldsymbol{\tau}}^\star)$ or 2) $G_j(\tilde{\boldsymbol{\tau}}') > G_j(\tilde{\boldsymbol{\tau}}^\star)$ and $G_i(\tilde{\boldsymbol{\tau}}') \geq G_i(\tilde{\boldsymbol{\tau}}^\star)$.

Take the first case and recall

$$\begin{aligned}\tilde{G}_i\left(\tilde{\boldsymbol{\tau}}, \omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho); a_i, c_i, \rho\right) = \left(1 - F\left(W_j(a_j, a_i) - G_j(\tilde{\boldsymbol{\tau}}; a_j)\right)\right)\left(G_i(\tilde{\boldsymbol{\tau}}; a_i)\right) + \\ F\left(W_j(a_j, a_i) - G_j(\tilde{\boldsymbol{\tau}}; a_j)\right)\left(\hat{G}_i(a_i, a_j)\right).\end{aligned}$$

In the proof of Proposition 6 (below), I show $G_i(\tilde{\boldsymbol{\tau}}^\star) > W_i(a_i, a_j) \geq \hat{G}_i(a_i, a_j)$. Also, $F(\tilde{\boldsymbol{\tau}}^\star) \leq F(\tilde{\boldsymbol{\tau}}')$. Then, if 1) or 2), then $\tilde{G}_i\left(\tilde{\boldsymbol{\tau}}', \omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho)|a_i, c_i, \rho\right) > \tilde{G}_i\left(\tilde{\boldsymbol{\tau}}^\star, \omega^\star(\tilde{\boldsymbol{\tau}}; a_j, c_j, \rho); a_i, c_i, \rho\right)$, producing the desired contradiction. ■

Lemma 8: $\tilde{\boldsymbol{\tau}} = \left(\tilde{\tau}_i^\star, \tilde{\tau}_j^\star\right) \leq \left(\tau_i^\star(a_i, c_i, \rho), \tau_j^\star(a_i, c_i, \rho)\right)$ with $\leq$ the natural vector order.

Proof: Suppose, for sake of contradiction, that for some $\tilde{\boldsymbol{\tau}}^\star$, $\tilde{\tau}_i^\star > \tau_i^\star(a_i)$. By Lemma 7, $\tilde{\boldsymbol{\tau}}^\star$ must lie in the pareto set. By the definition of $\tau_i^\star(a_i)$, $G_i(\tilde{\tau}_i^\star, \cdot; a_i) < G_i(\tau_i^\star(a_i), \cdot; a_i)$. By Lemma 2, $G_j(\cdot, \tilde{\tau}_i^\star; a_j) < G_j(\cdot, \tau_i^\star(a_i); a_i)$. Thus, a pareto improvement exists, contradicting the hypothesis that $\tilde{\boldsymbol{\tau}}^\star$ is an equilibrium offer. ■

Proposition 6: If $a_j < a_j(\underline{c}_j, a_i)$ and peace prevails, government i's trade barriers are increasing in its military strength, i.e. $\tilde{\tau}_i^\star(a_i, c_i, \rho)$ is increasing in ρ.

Proof: By Assumption 1, i's first order condition must characterize $\tilde{\tau}_i^\star$ when $a_j < a_j(\underline{c}_j, a_i)$.

Here, we have

$$\frac{\partial \tilde{G}_i(\tilde{\tau}_i)}{\partial \tilde{\tau}_i} = (1 - F\left(W_j(a_j, a_i) - G_j(\cdot, \tilde{\tau}_i | a_j)\right)) \frac{\partial G_i(\tilde{\tau}_i)}{\partial \tau_i} + \frac{1}{\bar{c}_j - \underline{c}_j} \frac{\partial G_j(\tilde{\tau}_i)}{\partial \tilde{\tau}_i} \left(G_i(\tilde{\tau}_i) - \hat{G}_i(a_i, a_j) \right) = 0.$$

Rearranging,

$$\begin{aligned}
(1 - F\left(W_j(a_j, a_i) - G_j(\cdot, \tilde{\tau}_i; a_j)\right)) \frac{\partial G_i(\tilde{\tau}_i)}{\partial \tau_i} &= \frac{1}{\bar{c}_j - \underline{c}_j} \frac{\partial G_j(\tilde{\tau}_i)}{\partial \tilde{\tau}_i} \left(\hat{G}_i(a_i, a_j) - G_i(\tilde{\tau}_i) \right) \\
(1 - F\left(W_j(a_j, a_i) - G_j(\cdot, \tilde{\tau}_i; a_j)\right)) \frac{\partial G_i(\tilde{\tau}_i)}{\partial \tau_i} &= \frac{1}{\bar{c}_j - \underline{c}_j} \frac{\partial G_j(\tilde{\tau}_i)}{\partial \tilde{\tau}_i} \left(W_i(a_i, a_j) - c_i - G_i(\tilde{\tau}_i) \right) \\
(1 - F\left(W_j(a_j, a_i) - G_j(\cdot, \tilde{\tau}_i; a_j)\right)) \frac{\partial G_i(\tilde{\tau}_i)}{\partial \tau_i} &= \frac{1}{\bar{c}_j - \underline{c}_j} \frac{\partial G_j(\tilde{\tau}_i)}{\partial \tilde{\tau}_i} \left(W_i(a_i, a_j) - c_i - G_i(\tilde{\tau}_i) \right) \\
(\bar{c}_j - \underline{c}_j) (1 - F\left(W_j(0, a_i) - G_j(\cdot, \tilde{\tau}_i; a_j)\right)) \frac{\frac{\partial G_i(\tau_i, \cdot; a_i)}{\partial \tau_i}}{\frac{\partial G_j(\cdot, \tau_i; a_i)}{\partial \tau_i}} + c_i &= W_i(a_i, a_j) - G_i(\tilde{\tau}_i).
\end{aligned}$$

By Assumption 1, the LHS of this expression must be negative, this ensures that i's payoff at the solution is higher than its war value,[25]

$$W_i(a_i, a_j) < G_i(\tilde{\tau}_i).$$

Now note that

$$\frac{\partial W_j}{\partial \rho} = \underline{G}_j - \bar{G}_j < 0$$

and

$$\frac{\partial \hat{G}_i}{\partial \rho} = \Gamma_i > 0.$$

We have

$$\frac{\partial^2 \tilde{G}_i(\tilde{\tau}_i)}{\partial \tilde{\tau}_i \partial \rho} = -\frac{1}{\bar{c}_j - \underline{c}_j} \underbrace{\frac{\partial G_i(\tilde{\tau}_i)}{\partial \tilde{\tau}_i}}_{>0} \underbrace{\frac{\partial W_j}{\partial \rho}}_{<0} - \frac{1}{\bar{c}_j - \underline{c}_j} \underbrace{\frac{\partial G_j(\tilde{\tau}_i)}{\partial \tilde{\tau}_i}}_{<0} \underbrace{\frac{\partial \hat{G}_i}{\partial \rho}}_{>0} > 0$$

which implies

$$\frac{\partial \tilde{\tau}_i^\star(a_i)}{\partial \rho} > 0$$

as desired. ■

Proposition 5: If $a_j \geq a_j(\underline{c}_j, a_i)$ then trade in manufactured goods is increasing in a_i.

Proof: If $a_j \geq a_j(\underline{c}_j, a_i)$ then $\tilde{\boldsymbol{\tau}}^\star = \left(\tau_i^\star(a_i), \tau_j^\star(\bar{a}) \right)$ by Lemma 5. Equilibrium trade in manufac-

[25] Note also that by applying the definition of W_i, wwe see this condition implies $G_i(\tilde{\boldsymbol{\tau}})$ is concave about the pareto set.

tured goods is then

$$x_{ij}^{\star}(\tau_i^{\star}(a_i)) + x_{ji}^{\star}(\tau_j^{\star}(\bar{a})).$$

By Lemma 3, $\tau_i^{\star}(a_i)$ is decreasing in a_i and $x_{ij}^{\star}(\tau_i)$ is decreasing in τ_i. Then, within the zone of peace, equilibrium trade in manufactured goods is increasing in a_i. ■

Chapter 2

Estimating Policy Barriers to Trade

2.1 Introduction

Is international trade free and fair? For trade to be free, firms must not face government-imposed burdens to foreign market access. I refer to these burdens as policy barriers to trade. For trade to be fair, any policy barriers that do exist must treat products from all origin countries equally.[1]

Examining tariff rates produces a qualified "yes," on both counts. Despite recent threats to the world trading system,[2] tariffs remain at historically low rates (less than five percent on most trade (Baldwin 2016)), suggesting trade is relatively free. Moreover, World Trade Organization (WTO) member countries, accounting for the vast majority of the world economy, commit to the principle of nondiscrimination (or most-favored-nation (MFN)) in tariff policy, applying the same tariff rates to the imports of all member countries. At first glance, adherence to this principle suggests international trade is also fair.

However, tariffs are but one instrument by which governments can influence the flow of trade. *Direct* barriers to trade are imposed at national borders or ports of entry. In addition to tariffs, governments also impose many non-tariff regulations on imports. Often referred to collectively as nontariff measures (NTMs), these regulations require that prospective importers comply with these price controls, quotas, quality and safety requirements, and other rules in order to access foreign markets.[3]

[1] Of course, there are many competing conceptions of what a free and fair international trading system should look like. These are the definitions of free and fair I use here.

[2] See Bown, Chad P. "Is the Global Trade System Broken?" *Peterson Institute for International Economics.* 8 May 2018.

[3] For studies of these kinds of barriers, see Mansfield and Busch (1995); Lee and Swagel (1997); Gawande and Hansen (1999); Kono (2006); Rickard (2012); Maggi, Mrázová, and Neary (2018).

Indirect, or "behind-the-border", barriers are economic policies not assessed at the border that nevertheless disproportionately affect imported goods. Government procurement rules often explicitly privilege domestic suppliers, resulting in increased domestic purchases and reduced imports (Evenett and Hoekman 2004; Kono and Rickard 2014). Excise taxes, while implemented uniformly on a single good, may primarily fall on imports if targeted at goods with high foreign content.[4] Subsidies and tax credits made available to domestic firms allow less productive firms to survive, supplanting importers in home markets and reducing trade. The burden of complying with health, safety, and environmental regulations may also fall disproportionately on foreign firms, reducing their sales and distorting trade.

All of these instruments can in principle be targeted to generate *de facto* discrimation. For example, the MFN principle is enforced at the tariff line level, allowing importers to target duties at products exported by specific countries, without running afoul of WTO rules. Through high agricultural duties, the United States, Europe, and Japan effectively discriminate against the developing world, which specializes in the production of these products (Anderson and Martin 2005). NTMs and behind-the-border barriers can produce effective discrimination in the same manner.

Even armed with data on all such trade-distorting policy instruments, estimating the magnitude of aggregate policy barriers to trade would be challenging. Here, I propose and implement a new method to estimate policy barriers to trade with minimal data requirements. I construct a parsimonious model of international trade subject to frictions, following Eaton and Kortum (2002).[5] I show that the magnitude of trade frictions between two countries i and j is related by the theoretical model to price levels in both countries, trade flows between them, and the market shares of domestic producers in home markets. I then decompose these barriers into their economic (transportation costs) and political (policy barriers) components. Finally, I calibrate this relationship to the data on prices, trade, and freight costs in 2011.

The intuition underlying the model is straightforward. Cross-national price gaps inform about the existence of arbitrage opportunities, and imply that large trade flows should exist from countries with low prices toward those with high prices. The extent to which these flows are realized in the

[4] Sin taxes on alcohol and cigarettes might distort trade if these products are generally imported.

[5] In their technology-based model, trade frictions enter as variable costs, introducing a wedge between the price of a good when it leaves an exporting country and when it is sold in an importing country. Gulotty (2020) argues that many of the regulatory barriers discussed above are better conceptualized as fixed costs, applied on firms as a condition for market entry. Head and Mayer (2014) show that this distinction is important for modeling the effects of trade costs on trade flows. Namely, the elasticity of trade with respect to changes in fixed costs is different than the elasticity governing the responsiveness of trade to changes in variable costs (Melitz 2003; Chaney 2008; Arkolakis, Costinot, and Rodriguez-Clare 2012). The presence of fixed costs of exporting have also been used to rationalize the sparsity of the empirical trade flow matrix (Helpman, Melitz, and Rubinstein 2008). Methods developed in Helpman, Melitz, and Rubinstein (2008) could in principle be used to separately measure fixed and variable policy barriers to trade.

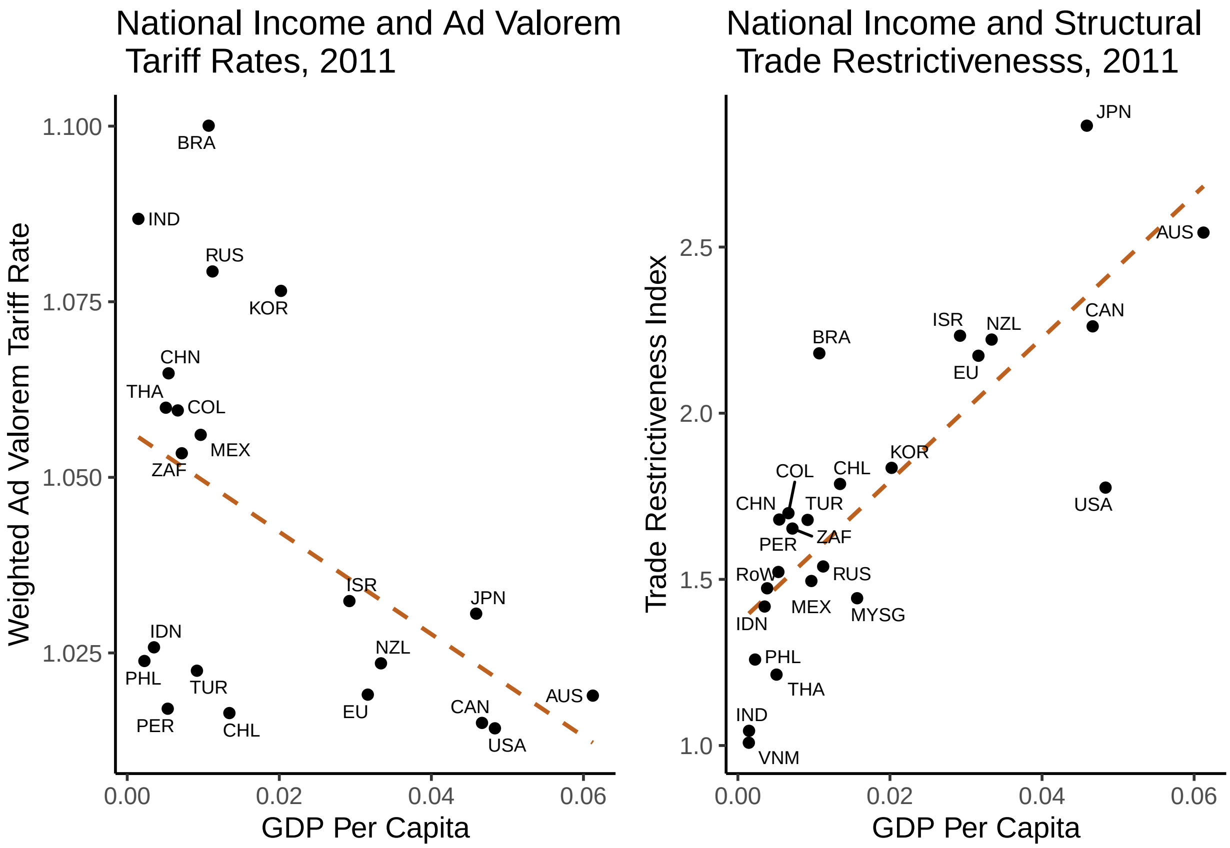


Figure 2.1: Tariff rates (left) and structural trade restrictiveness (right) against GDP per capita

data informs about the magnitude of trade costs. If the cost of freight between countries is known, then the component of these costs that cannot be attributed to purely economic frictions can be independently identified. The remaining "missing trade" is attributed to the existence of policy distortions, broadly defined.

The logic behind the approach employed here is also articulated in Leamer (1988). If consumers are homogenous across countries, they will consume the same basket of goods when trade is frictionless (and prices equalize across markets).[6] Observed heterogeneity in consumption baskets is then informative about the magnitude of trade frictions. Leveraging advances in the structural gravity literature, I am able to empirically connect Leamer's basic insight more tightly to theory.

The results point to far more policy distortion and effective discrimination than would be inferred from the tariff data. Tariff equivalents of implied policy barriers are generically more than an order of magnitude larger than observed tariffs. Moreover, exporters in a subset of favored countries enjoy far superior market access conditions than their peers in unfavored countries.

[6]Empirical studies of trade rely heavily on the (dubious) assumption of consumer homogeneity. For a prominent counterexample, see Fajgelbaum and Khandelwal (2016). I hold consumers' preferences over tradable goods constant, but allow for heterogeneity in consumers' taste for tradable versus nontradable goods.

The trade policy openness attributed to developed countries also depends strongly on the metric used to evaluate openness.[7] As shown in Figure 2.1, there is a negative association between economic development (per capita GDP) and applied tariff rates. This relationship is reversed if trade policy restrictiveness is measured as proposed here. Countries with higher per capita incomes tend to have higher Trade Restrictiveness Indices.[8] This is consistent with Kono (2006) and Queralt (2015), which suggest that developed countries offset tariff reductions with increases in non-tariff direct barriers and (potentially distortionary) domestic taxes.

This paper is most closely related to the international economics literature on the estimation of trade costs, beginning with Anderson and Van Wincoop (2004). The particular methodology adopted here draws on several studies that link price gaps to these trade costs (Eaton and Kortum 2002; Waugh 2010; Simonovska and Waugh 2014; Sposi 2015; Waugh and Ravikumar 2016). I build on these studies by disentangling policy barriers to trade and freight costs, and connecting the implied policy barriers to observable trade policy instruments. A parallel literature focuses on the estimation of trade costs under the assumption that they are symmetric (Head and Ries 2001; Novy 2013).[9] While transportation costs may be nearly symmetric, policy barriers are less likely to be (Kono 2008; Tavares 2008). Such estimates therefore average over meaningful policy heterogeneity.

The paper is also related to efforts to use observable barriers to trade to construct indices of trade openness (Sachs and Warner 1995; Anderson and Neary 1996; Kee, Nicita, and Olarreaga 2009). These observable barriers may be a non-random sample from the universe of protectionist instruments, however. Here, I take advantage of the structure of the theoretical model to infer the magnitude of policy barriers from the price and trade data, rather than attempting to quantify observable barriers. Hiscox and Kastner (2002) construct country-level measures of aggregate trade openness using a fixed effects approach. Martini (2018) constructs industry-level measures of trade restrictiveness, under the assumption that policy barriers are nondiscriminatory within industry. I sacrifice industry-level granularity in order to assess discrimination in the international trade policy regime.

The fields of comparative and international political economy rely heavily on imperfect measures of trade protectionism. Political economic theories of protectionism generally relates primitives of the economic and political environment to a government's choice of trade policy, broadly construed. In evaluating these theories, however, researchers generally resort to examining observable barriers

[7] See Rodríguez and Rodrik (2000), Dollar and Kraay (2004), and Tavares (2008) for discussions of this phenomenon.

[8] See Equation 2.18.

[9] Bergstrand, Egger, and Larch (2013) provide an alternative method to estimate the asymmetric barriers targeted here.

to trade, such as applied tariff rates, NTM coverage ratios, or simply the volume of trade.[10] The measure constructed here is arguably closer to the theoretical quantity of interest of many of these studies.

The broad policy barriers recovered here are also the objects that governments seek to influence in international negotiations, particularly in today's era in which tariffs rates are historically low.[11] Governments desire foreign market access for the firms whose interests they represent (Gawande, Krishna, and Olarreaga 2009; Ossa 2011, 2012). Acquiring foreign market access requires dismantling policy barriers to trade, direct and indirect. This places governments in a complex multilateral bargaining game that has attracted the attention of many studies.[12] Evaluating and assessing the outcomes of this game requires measurement of its outcomes – governments' trade policy choices.

Finally, many argue that international institutions, the WTO and its predecessor General Agreements on Tariffs and Trade (GATT) in particular, structure this bargaining game in important ways (Bagwell and Staiger 1999; Maggi 1999; Steinberg 2002; Davis 2006; Carnegie 2014; Bagwell, Staiger, and Yurukoglu 2018a). GATT signatories committed in principle to convert protective policy measures into tariff-equivalents and subsequently negotiated primarily over tariff barriers (Bagwell and Staiger 2004). Theories of international trade institutions generally take this commitment seriously, assuming commitments to reduce tariffs cannot be subsequently "undone" through the implementation of non-tariff or behind-the-border barriers to trade. Statements about the efficacy of the principles of reciprocity and nondiscrimination in achieving efficient outcomes rest on this premise.

I proceed in three steps. The next section specifies a model of international trade and demonstrates how it relates observables to the magnitude of trade policy distortions. I then discuss the data that I use to calibrate the model. Finally, I present the results of this exercise and discuss their implications for the question posed at the beginning of this paper – is international trade free and fair?

[10] For a few examples, see Goldberg and Maggi (1999); Mansfield, Milner, and Rosendorff (2000); Milner and Kubota (2005); Tavares (2008); Kono (2009); Gawande, Krishna, and Olarreaga (2009); Betz (2017); Barari, Kim, and Wong (2019).

[11] For example, Trans Pacific Partnership (TPP) negotiations focused overwhelmingly on non-tariff liberalization efforts. Fergusson, Ian F. and Brock R. Williams. "The Trans-Pacific Partnership (TPP): Key Provisions and Issues for Congress." 14 June, 2016. Congressional Research Service.

[12] See, for example, Hirschman (1945); Pollins (1989a); Gowa and Mansfield (1993); Milner (1997); Aghion, Antràs, and Helpman (2007); Head, Mayer, and Ries (2010); Antràs and Padró i Miquel (2011); Dube, Kaplan, and Naidu (2011); Berger et al. (2013); Ossa (2014).

2.2 Model

In 2011, tradable goods were, on average, twice as expensive in Japan than in Malaysia.[13] If trade were frictionless, Malaysian merchants could exploit this price difference by shipping goods to Japan, making more than twice what they would be selling their goods in their home market. Factually, however, Malaysian exporters made up less than one percent of the market for tradables in Japan in 2011. The model explicated below allows me to infer that these prospective exporters must have faced high costs to sell in the Japanese market and to quantify the exact magnitude of these costs. If freight costs are known, then the component of these costs attributable to policy distortions can be recovered separately.

Eaton and Kortum (2002) and Waugh (2010) show that these forces are related in a simple equation. Let $d_{ij} \geq 1$ denote the iceberg cost of shipping goods from j to i,[14] λ_{ij} denote j's market share in i, and P_i denote the aggregate price of tradables in i. Then,

$$d_{ij} = \left(\frac{\lambda_{ij}}{\lambda_{jj}}\right)^{-\frac{1}{\theta}} \frac{P_i}{P_j} \tag{2.1}$$

where $\theta > 1$ is the trade elasticity.[15] If θ, price levels, and market shares are known, then this equation can be used to measure trade frictions exporters in j face when selling in market i (d_{ij}). If aggregate prices are equal in both markets ($P_i = P_j$), then j's relative market penetration informs directly about trade barriers. As λ_{ij} goes up, the implied barrier d_{ij} goes down. When j's share in i's market is equivalent to its share in its own market ($\lambda_{ij} = \lambda_{jj}$), we infer that j faces no barriers to export to i ($d_{ij} = 1$).[16] Now, assume that aggregate prices in i and j differ. Specifically, let $P_i > P_j$. In the absence of trade costs, this would generate an arbitrage opportunity for high-productivity producers in j – they can profit by shipping goods to i and taking advantage of higher prices. If trade were frictionless, then we must have ($\lambda_{ij} > \lambda_{jj}$). The extent to which this relationship holds in the data informs about the magnitude of barriers to trade.

This relationship between cross national tradable prices, trade flows, and trade costs follows from the competitive framework of Eaton and Kortum (2002), adapted to the study of trade costs by Waugh (2010). In the model presented below, I modify their underlying framework in order to minimize the conceptual distance between the theory and the data. However, the result is not unique to competitive international economies. Quantitative trade models with market imperfections

[13] See The World Bank, International Comparison Program (ICP)

[14] By the iceberg assumption, for every d_{ij} units shipped from j to i, 1 unit arrives. $d_{ij} - 1$ is the ad valorem value of the aggregate tax firms in j face to export to i.

[15] Here, λ_{jj} is the share of j's market for tradables that is captured by producers within j.

[16] This is a natural result of the assumption of consumer homogeneity.

generate related “gravity” equations that imply the same relationship between prices, trade, and trade costs (Melitz 2003; Chaney 2008; Costinot and Rodríguez-Clare 2015).

2.2.1 Environment

There are N countries in the international economy, indexed $i \in \{1, ..., N\}$. Within each country resides a representative consumer, with labor endowment L_i. The setup follows closely Eaton and Kortum (2002), so I omit some derivations of the quantities presented here and direct readers to their paper. To match the data on consumer expenditure on tradable goods, I consider a variant of their model which consumers value both tradable goods and nontradable services. Then, gross consumption of tradables in the economy is simply gross consumption (including final and intermediate goods) minus consumer expenditure on services. This is the denominator I use in calculating trade shares when calibrating the model.

Consumption

Each consumer values aggregate tradable goods Q_i and aggregate nontradable services S_i, which are combined in a Cobb-Douglas utility function

$$U_i = Q_i^{\nu_i} S_i^{1-\nu_i}. \tag{2.2}$$

A country-specific parameter $\nu_i \in [0, 1]$ governs the consumer's relative preference for goods over services. Wages are denoted w_i, which implies country gross domestic products are given by

$$I_i = w_i L_i.$$

Cobb-Douglas preferences imply consumers will spend a fraction ν_i of their income on tradable goods.[17] Equilibrium consumer expenditure on tradables is then

$$E_i^q = \nu_i I_i + D_i$$

where D_i is the value of exogenously given trade deficits.

There is a continuum of tradable varieties, indexed by $\omega \in [0, 1]$. There is a set $\mathcal{K}$ of tradable

[17] In calibrating the model, I choose ν_i to match the factual expenditure shares on tradables in each country, as reported by the ICP.

good categories indexed $k \in \{0, ..., K-1\}$. Let

$$h : \Omega \to \mathcal{K}$$

be a function that associates varieties with good categories. The set of goods in category k is Ω_k where

$$\Omega_k = \{\omega : h(\omega) = k\}.$$

The mass of each tradable good category is $1/K$.

Consumer utility over these varieties exhibits constant elasticity of substitution (CES)

$$Q_i = \left(\int_{[0,1]} \tilde{\alpha}_{i,h(\omega)}^{\frac{1}{\sigma}} q_i(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} \tag{2.3}$$

with $\sigma > 0$. $\tilde{\alpha}_{ik} = \epsilon_{ik}\alpha_k$ is a stochastic preference parameter that modulates country i's consumer's relative preference for goods in category i. These preferences are constant across consumers in different countries up to a shock, ϵ_{ik}, with $\mathrm{E}[\epsilon_{ik}] = 1$.

With expenditure on tradables fixed by the Cobb Douglas upper level preference structure, consumers simply maximize Q_i subject to their tradable budget constraint, $\int_{[0,1]} p_i(\omega) q_i(\omega) d\omega \leq E_i^q$, where $p_i(\omega)$ is the (endogenous) price of variety ω in country i. The aggregate price of tradables in country i is as in Dixit and Stiglitz (1977)

$$P_i = \left(\int_{[0,1]} \tilde{\alpha}_{i,h(\omega)} p_i(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}. \tag{2.4}$$

Production

Every country can produce every tradable variety ω. Each country has an underlying mean productivity level T_i, but ω-specific productivities $z_i(\omega)$ are modeled as the realization of a random variable drawn from a Frechet distribution. Production requires both labor and a composite intermediate good that is exactly analogous to an aggregate consumption good Q_i. The cost of producing a unit of variety ω is

$$c_i(\omega) = \frac{1}{z_i(\omega)} w_i^{1-\beta} P_i^{\beta} \tag{2.5}$$

where the global parameter $\beta \in [0, 1]$ governs the share of intermediates required in production.[18] Let X_i denote the value of tradable production in country i. A constant share, β, of this value will

[18] Services are produced at cost $c_i^s = \frac{w_i}{A_i}$, where A_i is a country-specific services productivity.

be spent on intermediates

$$E_i^x = \beta X_i.$$

Countries require $1/z_i(\omega)$ labor-intermediate bundles to produce one unit of variety ω. Markets are competitive, so prices are equal to marginal costs. The local price $(p_{ii}(\omega))$ of variety ω is therefore

$$p_{ii}(\omega) = c_i(\omega). \tag{2.6}$$

ω-specific productivities are stochastic. Let $F_i(z)$ denote the probability that country i's productivity is less than or equal to z, formally

$$F_i(z) = \Pr\left(z_i(\omega) \leq z\right).$$

When $F_i(z)$ is distributed Frechet,

$$F_i(z) = \exp\left(-T_i z^{-\theta}\right). \tag{2.7}$$

The country-wide technology level T_i shifts country i's productivity distribution – higher values of T_i imply higher productivity values on average. $\theta > 1$ is a global parameter that governs the variance of the productivity draws.[19]

Exporters pay iceberg costs $(d_{ji} \geq 1)$ to ship goods abroad. The price in country j of varieties produced in i is therefore

$$p_{ji}(\omega) = d_{ji} p_{ii}(\omega).$$

These costs are affected by transportation infrastructure at home and abroad, international freight costs, and policy distortions. Below, I present a framework for disentangling these costs and isolating the magnitude of distortions attributable to policy.

Domestic consumers and producers alike search around the world for the cheapest source of each variety ω. The equilibrium price of variety ω in country i must satisfy

$$p_i^\star(\omega) = \min_{j \in \{1,\ldots,N\}} \left\{p_{ij}\right\}.$$

[19] In equilibrium, it serves as the elasticity of trade flows to trade costs. As producers become more heterogeneous, trade becomes more sensitive to changes in costs.

2.2.2 Equilibrium

For national accounts to balance, gross output and gross consumption, inclusive of trade deficits D_i, must be equal.

$$I_i + \beta X_i + D_i = E_i^q + E_i^x + (1 - \nu_i) I_i \tag{2.8}$$

Total income is given by the sum of domestic payments for services and labor payments from the global sales of tradables, X_i, or

$$I_i = w_i L_i = (1 - \beta) X_i + (1 - \nu_i) I_i.$$

Substituting into Equation 2.8 requires

$$X_i = E_i^q + E_i^x - D_i \tag{2.9}$$

or that trade less deficits is balanced.

Total expenditure on tradables is the sum of expenditures from consumers and producers[20]

$$E_i = E_i^q + E_i^x.$$

Let $\lambda_{ij}(\boldsymbol{w})$ denote the share of expenditure on tradables country i spends on goods from j and

$$\Omega_{ij}^\star = \left\{ \omega \in [0, 1] \mid p_{ij}(\omega) \leq \min_{k \neq j} \{p_{ik}\} \right\}.$$

Then

$$\lambda_{ij}(\boldsymbol{w}) = \frac{1}{E_i} \int_{\Omega_{ij}^\star} p_{ij}(\omega) q_i \left(p_{ij}(\omega) \right) d\omega \tag{2.10}$$

where $q_i \left(p_{ij}(\omega) \right)$ is equilibrium consumption of variety ω from both producers (intermediates) and consumers (final goods).

This quantity depends on wages everywhere, stored in the vector $\boldsymbol{w} = \{w_1, ..., w_N\}$. Note that given exogenous labor endowments (L_i), trade costs (d_{ij}), technologies (T_i), and parameters $\{\sigma, \theta, \nu_i, \beta\}$, endogenous wages completely determine the pattern of trade. Gross income in country

[20] Note that expenditure on tradables can be written

$$E_i = I_i + \beta X_i + D_i - (1 - \nu_i) I_i$$

or gross consumption less consumer expenditure on services. This is the empirical quantity for E_i I use when calibrating the model.

i from the sale of tradables can be written

$$X_i = \sum_{j=1}^{N} \lambda_{ji}(\boldsymbol{w}) E_j. \tag{2.11}$$

Definition: An *international equilibrium* is a vector of wages $\boldsymbol{w}$ such that Equations 2.9, 2.10, and 2.11 hold for all $i \in \{1, ..., N\}$.

Alvarez and Lucas (2007) provide an argument for the existence and uniqueness of such an equilibrium. In the unique equilibrium, trade shares satisfy

$$\lambda_{ij}(\boldsymbol{w}) = \frac{T_j \left(d_{ij} w_j^{1-\beta} P_j^{\beta} \right)^{-\theta}}{\Phi_i} \tag{2.12}$$

where

$$\Phi_i = \sum_j T_j \left(d_{ij} w_j^{1-\beta} P_j^{\beta} \right)^{-\theta}.$$

The equilibrium price index in country i is

$$P_i = \gamma \Phi_i^{-\frac{1}{\theta}} \tag{2.13}$$

where γ is a function of exogenous parameters.[21]

The numerator of Equation 2.12 is a measure of the overall competitiveness of country j. Naturally, increasing average productivity increases j's market penetration everywhere. Decreasing wages in j has the same effect. Decreasing trade costs between i and j (d_{ij}) also increases λ_{ij}. The denominator is a "multilateral resistance" (Anderson and Van Wincoop 2003) term that captures the overall level of competitiveness in country i. All else equal, it is easier to penetrate the market in country i if others struggle to penetrate it, due to inferior technology, high wages, and/or high bilateral trade costs.

2.2.3 Isolating Policy Barriers

To get from the factory gates of a firm located in an exporting country and the market located overseas, goods incur a bevy of costs, both economic and political in nature. Our goal is to recover the proportion of these costs attributable to *policy* barriers to trade. I assume that trade costs are

[21] Specifically,

$$\gamma = \Gamma \left(\frac{\theta + 1 - \sigma}{\theta} \right)^{\frac{1}{1-\sigma}}$$

and Γ is the gamma function.

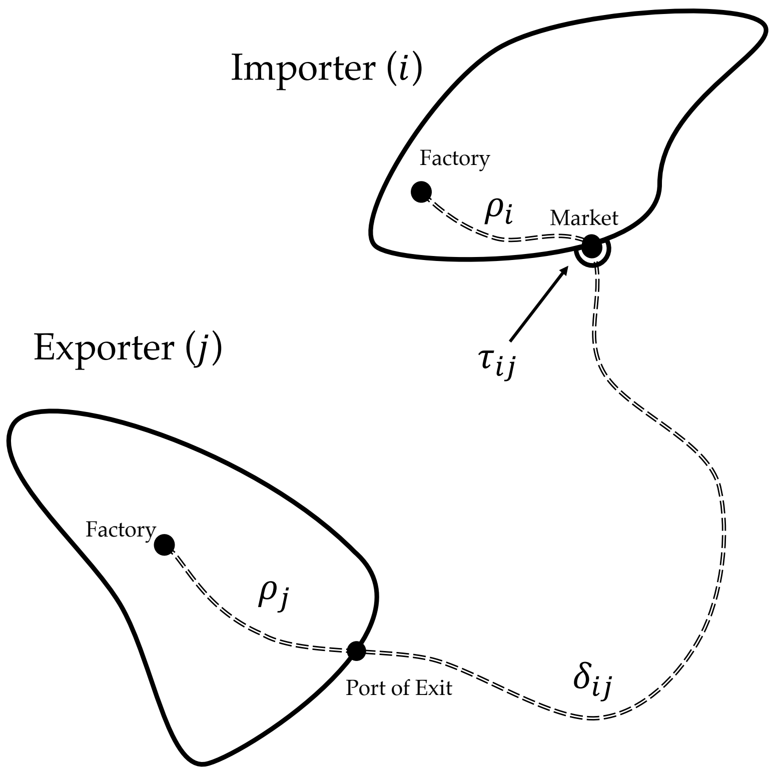


Figure 2.2: Trade cost decomposition.

multiplicatively decomposable into exporter-specific costs,[22] international freight costs, and policy barriers to trade. Note that I do not model heterogeneity in costs common to all traders within *importing* countries. This framework yields

$$d_{ij} = \rho_j \delta_{ij}(\boldsymbol{Z}_{ij})\tau_{ij} \tag{2.14}$$

where ρ_j denotes exporter-specific costs, δ_{ij} denotes international freight costs, and τ_{ij} denotes policy barriers. δ_{ij} is a function, which takes a vector of bilateral geographic covariates $\boldsymbol{Z}_{ij}$ and outputs bilateral freight costs.[23] I normalize $\delta_{ii} = \tau_{ii} = 1$.

Figure 2.2 traces the path goods must travel from a factory in country j to a market in country i. Goods first travel from the factory in j to j's border. Upon reaching the border (airport, port, or border crossing), goods must travel by land, sea, or air to the border of their destination country. Along the way, they incur freight costs δ_{ij}. The market in i is protected by a policy barrier τ_{ij} that can vary across importers. Once goods cross this border, they arrive at the market and are

[22]This includes both costs associated with transportation within the exporting country and any taxes and regulatory costs that are common to all traders in the country (Limao and Venables (2001)).

[23]I discuss how I model these costs in more detail in Appendix B.

consumed at a price inclusive of the factory gate price $p_{jj}(\omega)$ and these transportation and policy costs. Substituting Equation 2.14 into the gravity equation 2.12 gives

$$\lambda_{ij} = \frac{T_j \left(\rho_j \delta_{ij}(\boldsymbol{Z}_{ij})\tau_{ij} w_j^{1-\beta} P_j^{\beta}\right)^{-\theta}}{\Phi_i}.$$

The problem with taking this equation straight to the data is that it contains unobserved technologies and wages. This would also require taking a stance on several structural parameters. Comparing j's import penetration in i to its share of the home market λ_{jj} solves this problem, however. To see this, note

$$\frac{\lambda_{ij}}{\lambda_{jj}} = \left(\delta_{ij}(\boldsymbol{Z}_{ij})\tau_{ij}\right)^{-\theta} \frac{\Phi_j}{\Phi_i}.$$

Rearranging and substituting from Equation 2.13 gives the familiar relationship in Equation 2.1 discussed above, modified to separate trade barriers from freight costs:[24]

$$\tau_{ij} = \left(\frac{\lambda_{ij}}{\lambda_{jj}}\right)^{-\frac{1}{\theta}} \frac{P_i}{P_j} \frac{1}{\delta_{ij}(\boldsymbol{Z}_{ij})}. \tag{2.15}$$

If the trade elasticity is known, data on trade shares, relative prices, and freight costs are sufficient to calculate policy barriers to trade, τ_{ij}. In the next section, I discuss how these data are constructed to match the model presented here.

2.3 Calibration and Estimation

I present results from a calibration on a set of 24 of the world's largest economies in 2011.[25] These in-sample countries collectively made up 87 percent of world GDP. I treat the rest of the world as an aggregate outside economy. The calibration requires me to take a stance on a single structural parameter, the Frechét parameter, θ. I set $\theta = 6$, in line with the estimates from the structural gravity literature (Head and Mayer 2014).

Price indices and freight costs estimated below are measured with error. I employ a nonparametric bootstrap to quantify the uncertainty surrounding the implied magnitude of policy barriers. This entails sampling product-level prices and observed freight costs with replacement and recomputing τ_{ij} many times.

[24]Note that given prices, freight costs, and λ_{jj}, trade flows are a "sufficient statistic" for the magnitude of policy barriers to trade. In the face of opaque policy instruments, this provides a rationale for simply demanding bilateral trade deficit reductions in trade negotiations, a tactic utilized by the Trump administration in negotiations with China. Wei, Lingling. "U.S. and China Make Scant Progress in Trade Talks." *The Wall Street Journal.* 4 May, 2018.

[25]The list of the economies in the sample is included in Appendix E.

2.3.1 Prices and Consumer Expenditures

In order to calculate policy barriers to trade, I require an empirical analogue of the Equation 2.4, the country-specific price index. This quantity summarizes the overall level of competition in the economy, summarized in the market price of tradable varieties. Data on cross-national prices comes from the World Bank's International Comparison Program, used to calculate Purchasing Power Parities (PPP).[26]

The ICP surveys prices of hundreds of products and services across 146 countries, and chooses product lists to maximize comparability across markets. They also report the share of GDP that is allocated toward purchases of different product categories, termed "basic headings." After using the prevailing exchange rate to convert prices into U.S. dollars, various (largely atheoretical) statistical methods are used to compute internationally comparable price indices across basic headings.[27] I classify each basic heading as tradable or nontradable and report the results of this classification in Appendix F.[28]

I take these basic headings as the empirical analogue to good categories k in the model. I assume that the local price of each variety in category k is constant, $p_i(\omega) = p_i(\omega') = p_{ik}$ for all $\omega, \omega' \in \Omega_k$. Then, the price index in Equation 2.4 can be written

$$P_i = \left(\int_\omega \tilde{\alpha}_{i,h(\omega)} p_i(\omega)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} = \frac{1}{K} \left(\sum_k \tilde{\alpha}_{ik} p_{ik}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} .$$

The ICP reports prices relative to their levels in the United States. In Appendix A, I show consumers' demand for each good is a function their preferences ($\tilde{\alpha}_{ik}$), the good's price (p_{ik}), and the price level in the country (P_i). Differencing this demand equation with respect to its analogue in the United States eliminates the constant portion of the preference parameter, α_k. Then, demand relative to the United States is a function of the stochastic preference shocks (ϵ_{ik}), the price of the good, and the overall price level in the country. I estimate this differenced equation on observed prices and relative expenditure shares by minimizing the squared magnitudes of the preference shocks. This generates estimates for the country-specific price indices, $\hat{P}_i$.

I plot the distribution of estimated price indices and tradable expenditure shares on tradables that emerge from this procedure against per capita GDPs in Figure 2.3. Within my sample, consumers in wealthier countries tend to face higher prices. The total share of consumer expenditure on tradable

[26] Rao (2013) details the underlying data and methodology. Deaton and Heston (2010) discusses challenges in working with these data.

[27] See Redding and Weinstein (2018) for a discussion of the conditions under which these price indices correspond to their theoretical counterparts.

[28] Simonovska and Waugh (2014) undertake the same exercise. My classification differs slightly from theirs.

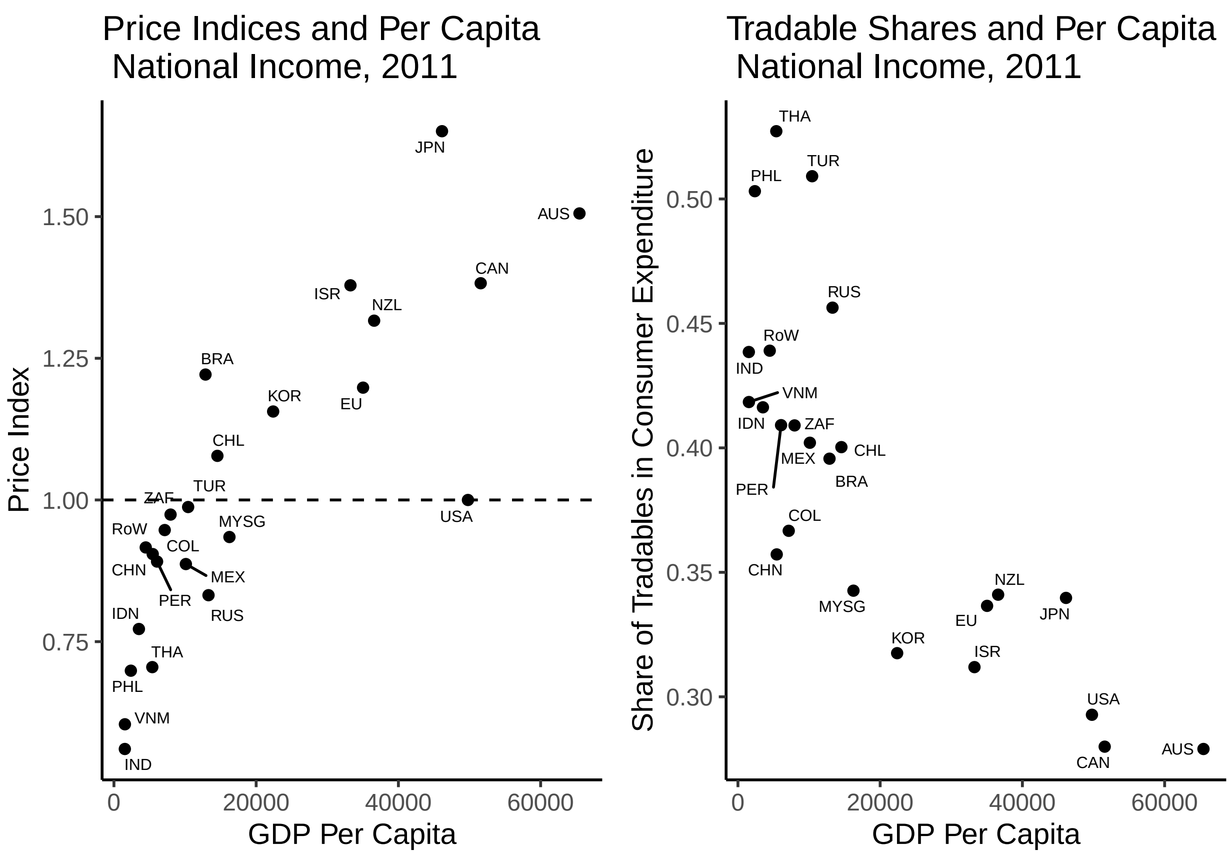


Figure 2.3: Price index estimates and tradable expenditure shares

goods ($\sum_{k=0}^{K-1} x_{ik}$) is the empirical analogue to ν_i. On average, consumers spend 40 percent of their income on tradable goods.

2.3.2 Expenditure Shares

The theory makes predictions about the share of consumer expenditure that will be devoted to products from each country. In the data, however, I only observe the value of imports *at the border*. Price distortions due to policy barriers to trade are not included in the valuations of shipments. Let $\lambda_{ij}^{\text{cif}}$ denote the share of i's expenditure on tradables spent on goods from j, inclusive of freight rates and exclusive of policy barriers.[29] We can then write $\lambda_{ij} = \tau_{ij}\lambda_{ij}^{\text{cif}}$ and

$$\lambda_{jj}(\boldsymbol{\tau}_j) = \left(1 - \sum_{i \neq j} \tau_{ji}\lambda_{ji}^{\text{cif}}\right). \tag{2.16}$$

This formulation requires that policy barriers to trade are assessed "behind the border," as discussed in the introduction.

Substituting this relationship into 2.15 gives a modified equation relating observed trade flows, prices, and freight rates to unobserved policy barriers to trade

$$\tau_{ij} = \left(\frac{\lambda_{ij}^{\text{cif}}}{\lambda_{jj}(\boldsymbol{\tau}_j)}\right)^{-\frac{1}{\theta+1}} \left(\frac{P_i}{P_j}\right)^{\frac{\theta}{\theta+1}} \left(\frac{1}{\delta_{ij}(\boldsymbol{Z}_{ij})}\right)^{\frac{\theta}{\theta+1}}. \tag{2.17}$$

Then, to calculate $\lambda_{ij}^{\text{cif}}$ and λ_{jj}, I need data on international trade flows as well as the market share of domestic tradables producers in their home market. Data on trade flows comes from the United Nations' COMTRADE, cleaned and harmonized by CEPII's BACI. BACI denominates trade flows in free on board (f.o.b. or pre-shipment) value, so predicted cost, insurance, and freight (c.i.f. or post-shipment) values can be calculated simply by multiplying these flows by δ_{ij}, estimated below. Total domestic consumption on tradables can then be inferred from national accounts data, which report gross output, gross consumption, and GDP.[30] I simply subtract the share of consumer expenditure on services implied by the ICP data from each country's gross consumption, which provides a measure of gross consumption on tradables, the empirical analogue to $E_i = \nu_i I_i$. These national accounts data are taken from the World Input Output Database (WIOD) (Timmer et al. 2015) and the OECD's National Input Output Tables.

[29]While tariffs are usually assessed on the f.o.b. value of shipments, non-tariff barriers cannot be tailored in this manner. For this reason, I assume the costs of policy barriers are assessed on shipments' c.i.f. values.

[30]Gross consumption includes consumer final expenditure as well as producers' expenditure on intermediates and is inclusive of trade deficits.

Note that implicit domestic consumption in Equation 2.16 depends on the magnitude of policy barriers to trade. This is because consumers' expenditure on foreign goods inclusive of policy barriers is greater than the value of these purchases observed at the border. Because $\lambda_{jj}(\boldsymbol{\tau}_j)$ is a decreasing function, a unique solution to Equation 2.17 is guaranteed to exist, so I simply iterate on the values of $\boldsymbol{\tau}$ and $\boldsymbol{\lambda}$ until convergence.

2.3.3 Freight Costs

Freight costs are observed for only a subset of my sample. As depicted in Figure 2.5, all freight costs I observe cover the cost of shipments from border-to-border. They do not include costs that are incurred during intranational transit (ρ_i), which are differenced out of Equation 2.15.

I build a simple model of the transportation sector in order to estimate freight costs out of sample, using data on observed freight costs and modes of transportation along with geographic covariates. I assume there is a competitive transportation sector in each mode (generating constant freight costs) and that the costs of transportation within a mode depend on dyadic geography. Observing these costs, a continuum of exporters in each country-sector choose the mode with which to ship their products to market abroad. Exporter-specific shocks lead to utilization of all modes by some exporters. This model generates a simple multinomial logistic functional form for predicted mode shares (Mcfadden 1974), which can be estimated given data on predicted freight costs. Predicted freight costs and mode shares can be aggregated to predict total trade costs, which serve as the δ_{ij} in Equation 2.15. This model, and the data used to estimate it, are discussed in more detail in Appendices B and C, respectively.

There are two limitations of this simple model of the transportation sector. First, Takahashi (2011), Behrens and Picard (2011), and Brancaccio, Kalouptsidi, and Papageorgiou (2020) show that there are significant scale economies in international shipping. This contradicts the assumption of elastic supply of transportation services. Moreover, non-freight trade costs may affect the attractiveness of different ports and the prices demanded by transportation services providers. For example, Brancaccio, Kalouptsidi, and Papageorgiou (2020) show that the level of tariffs applied on a countries *exports* affect its desirability as a shipping destination, affecting the price of freight to that country. This implies that δ_{ij} depends on τ_{ij}, a feature my framework is unable to capture.[31]

Accounting for these features of the market for transportation services would add considerable complexity to the framework developed here. Moreover, the simple model I consider produces rea-

[31] These features also rationalize asymmetric freight costs. Because the bilateral covariates used to estimate my model are symmetric between any two countries, predicted freight costs are nearly symmetric as well ($\delta_{ij} \approx \delta_{ji}$). Differences in the product-level makeup of trade are the only asymmetry introduced in my framework.

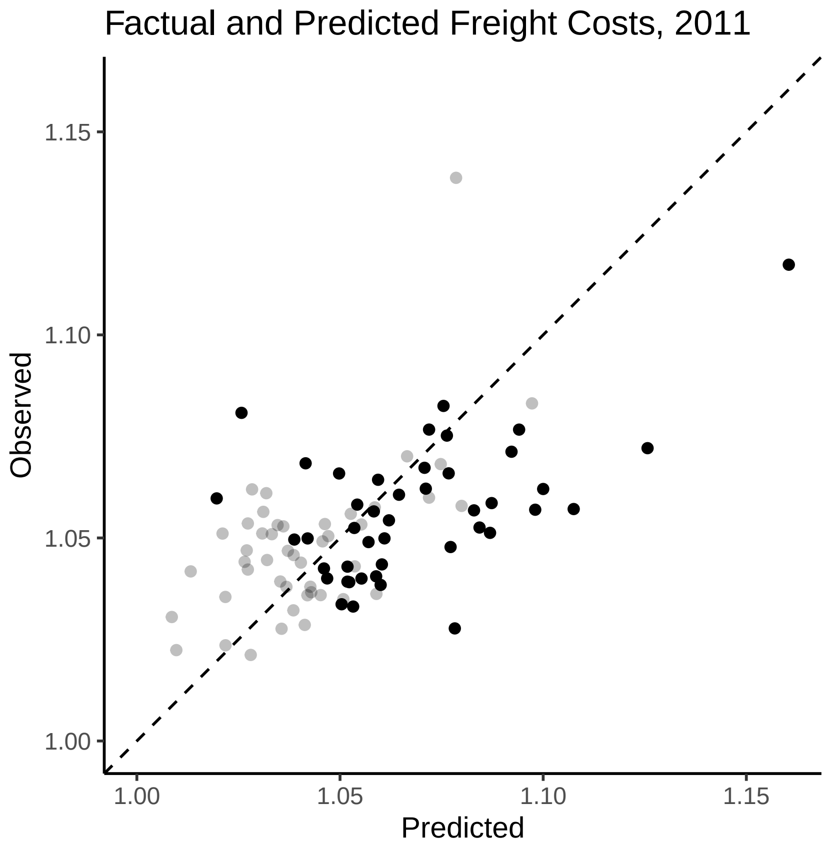


Figure 2.4: Factual versus predicted freight costs. In-sample observations are shown in grey. Out-of-sample observations are shown in black.

sonable out-of-sample fit, and estimated freight costs are small relative to estimated policy barriers. Figure 2.4 depicts factual and predicted freight costs for the United States, Australia, New Zealand, and Chile in 2011. The observations for New Zealand and Chile are out of sample – the model was not trained on these data.[32] Chile and New Zealand's predicted bilateral freight costs have a mean absolute error of 2 percentage points. Overall, predicted freight costs average 7 percent the value of shipments and are positively correlated with distance.

2.4 Results

The results of this exercise reveal substantial unobserved policy barriers to trade. In 2011, across all in-sample markets, exporters faced an average τ of 2.4, equivalent to a 140 percent import tariff.[33] The magnitude of these barriers dwarfs that of applied aggregate tariffs, which average

[32]The model of aggregate freight costs relies on information on transportation mode shares, which were not available for these countries. They do report c.i.f.-f.o.b. ratios, however.

[33]Of course, this result is sensitive to my stance on the trade elasticity. Doubling the trade elasticity to 12 cuts the average τ to 1.62

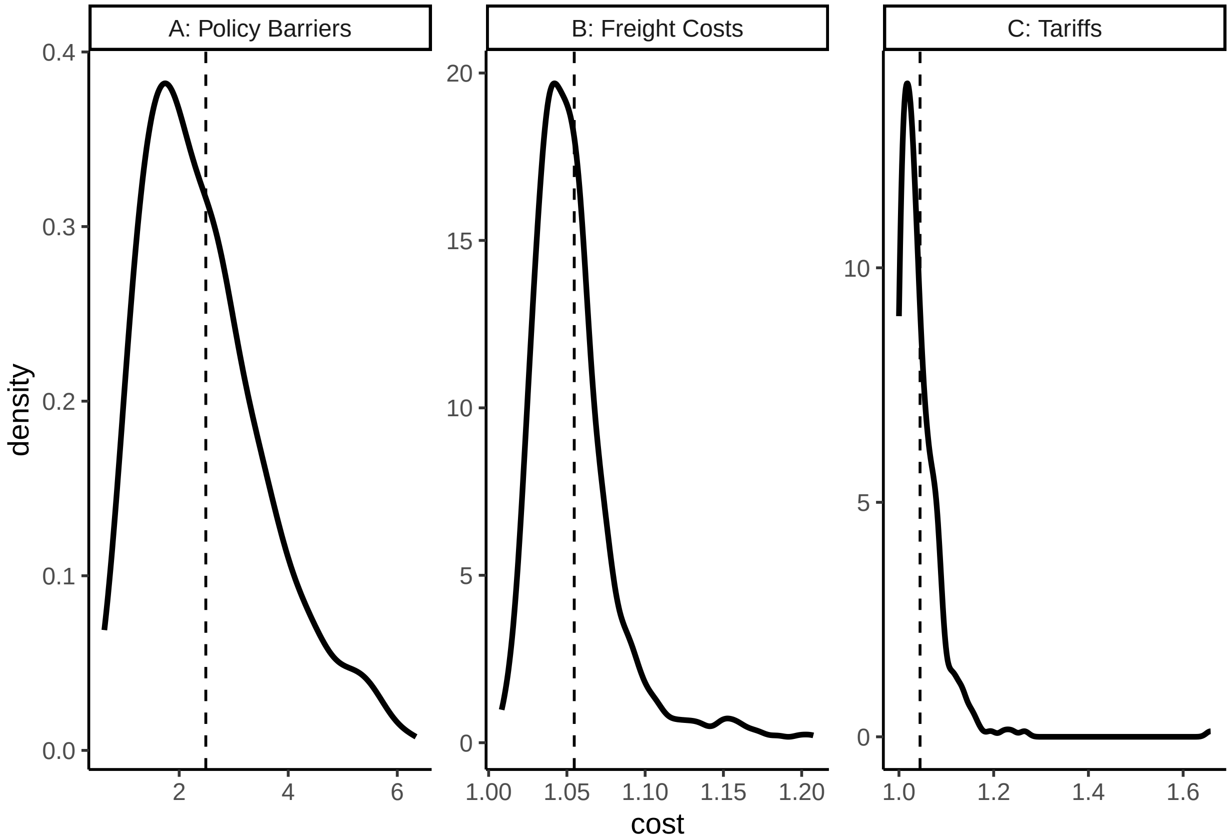


Figure 2.5: Distribution of freight costs, tariff barriers, and structural policy barriers to trade (τ_{ij}). Dashed lines show the mean of each distribution.

only 4 percent within my sample. This result is consistent with Anderson and Van Wincoop (2003), Bradford (2003), De Sousa, Mayer, and Zignago (2012), and Waugh and Ravikumar (2016) which also uncover large implied trade costs using indirect measurement methods. Figure 2.5 shows the distribution of implied policy barriers (panel A), relative to tariffs and predicted freight costs.

The model and data jointly suggest that international trade remains far from free, even taking into account unavoidable freight costs. Returning to Equation 2.15, this result suggests that the observed international price gaps and trade flows are inconsistent with a trade barrier-less world, given predicted freight costs. The model suggests that if implied policy barriers were removed, some combination of increases in trade flows and the reduction of price gaps would occur.

International trade is also far from fair. A fair international trading system might allow for trade restrictions, but require that these restrictions affect all trading partners equally. In fact, policy barriers to trade are quite discriminatory. In 2011, the mean within-country standard deviation of τ_{ij} is 0.86, representing a significant preferential margin for preferred trade partners. For example, in 2011, U.S. trade with Canada ($\tau_{ij} = 1.19$), Japan (1.21), and the European Union (1.4) was relatively

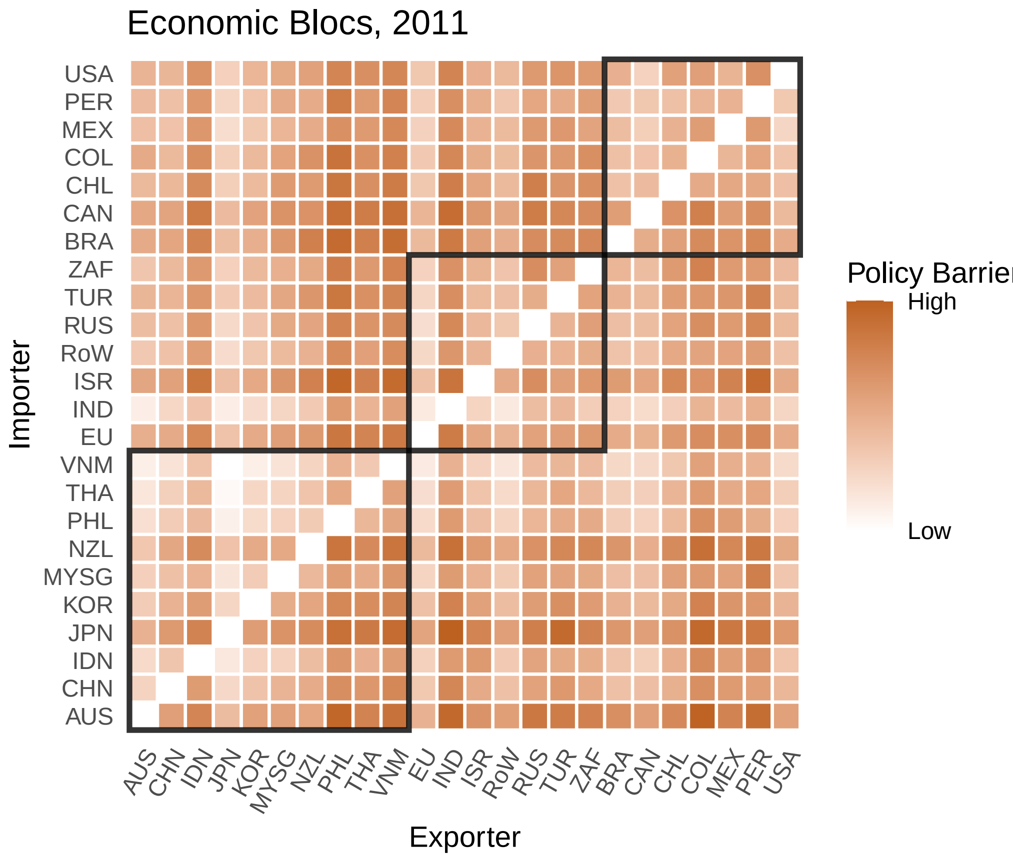


Figure 2.6: Distribution of policy barriers to trade. Each cell reports the magnitude of the policy barrier each importing country (y-axis) imposes on every exporting country (x-axis). Countries are partitioned into 3 groups through K-means clustering. Black rectangles enclose each cluster. An interactive version of this plot is available at `https://brendancooley.shinyapps.io/epbt`.

unhindered. Conversely, U.S. trade with Peru (3.11) and Vietnam (3.6) was highly restricted.

Figure 2.6 shows the distribution of directed policy barriers to trade in the data. The latent trade discrimination implemented by the United States is not unique – openness varies significantly at the importer-exporter level. Clustering countries by the similarity of their trade policy vectors uncovers regional biases in trade policy. I sort countries into economic blocs through a K-means procedure with 3 groups. Pacific countries (East and Southeast Asia and Australasia) are grouped together, as are North and South American countries. The European Union is grouped with Russia and Turkey. Because freight costs are not included in these measures, these economic blocs are not the result of mere geographic proximity. Rather, these countries have undergone political-economic union by reducing policy barriers to trade on one anothers' products.

Figure 2.7 plots uncertainty intervals surrounding the magnitude of policy barriers for each importing country in the sample. These intervals are asymmetric around the point estimates due to nonlinearities in the estimating equation (2.15).

These barriers can be aggregated into two numbers – a Trade Restrictiveness Index (TRI) and a Market Access Index (MAI) – that summarize each country's import restrictiveness and international market access conditions, respectively. The TRI is simply a weighted average of the policy barriers an importing country imposes on all other countries, where the weights are the gross tradable expenditures of these other countries.[34]

$$\mathrm{TRI}_i = \frac{1}{\sum_{j \neq i} E_j} \sum_{j \neq i} \tau_{ij} E_j \tag{2.18}$$

Similarly, the market access index is an expenditure weighted average of the barriers that all importing countries impose on the exports of a given country.

$$\mathrm{MAI}_j = \frac{1}{\sum_{i \neq j} E_i} \sum_{i \neq j} \tau_{ij} E_i \tag{2.19}$$

Higher values of the TRI correspond to higher aggregate trade restrictiveness. Conversely, higher values of the MAI correspond to lower aggregate market access (a high tax on a country's exports).

Figure 2.8 plots the TRIs and MAIs jointly. A negative correlation between these indices emerges naturally from the structure of the model. High domestic prices imply arbitrage opportunities, raising the TRI. They also imply high opportunity costs for domestic exporting firms that forgo these high prices. To rationalize these flows, the model infers that these firms must face relatively friendly market access conditions abroad, raising the MAI.

2.4.1 Correlates of Unobserved Policy Barriers to Trade

Figure 2.5 shows that tariffs cannot account for the magnitude of trade protection implied by the model. What, then, is the source of these policy distortions? As discussed in the introduction, governments have a dizzying slate of policy instruments at their disposal which can have direct or indirect effects on trade. Existing studies of trade protection generally leverage these observable proxies of the broader, unobservable, aggregate policy barrier that is the target of this study (Kee, Nicita, and Olarreaga 2009).

Such observable proxies include tariffs, but also NTMs and preferential trade agreements (PTAs). NTMs are simply regulations that affect what kinds of products can and cannot be imported. Some

[34] I use gross consumption, rather than observed flows, as weights for consistency with the theoretical framework. Trade flows are endogenous to each country's trade policy decisions. In a friction-less world, exporters would capture a constant share of every market's gross expenditure on tradables.

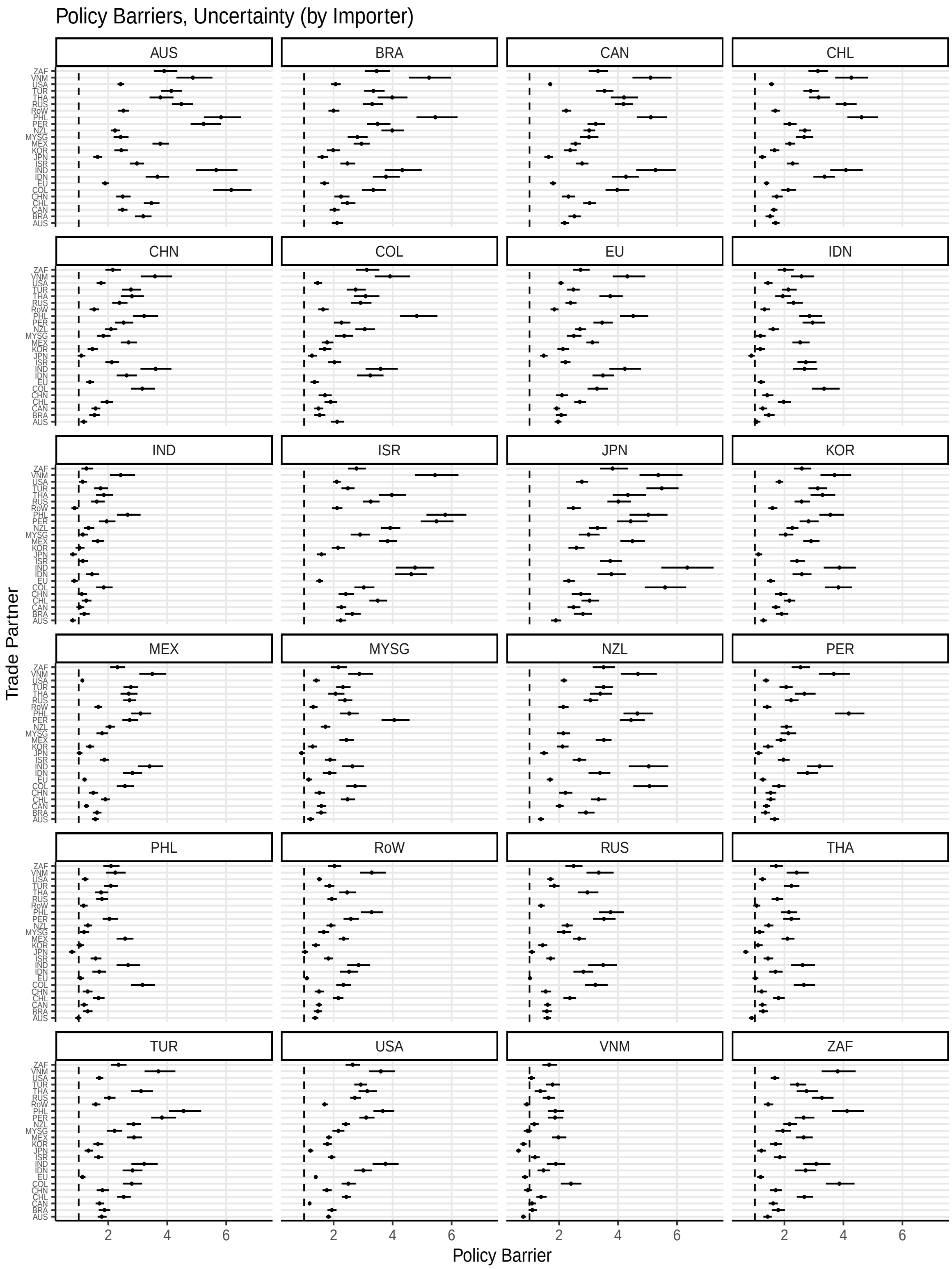


Figure 2.7: Policy barrier estimates, magnitudes and uncertainty intervals. Each panel displays the estimated policy barriers applied by an importing country on products from every in-sample source country. An interactive version of this plot is available at `https://brendancooley.shinyapps.io/epbt`.

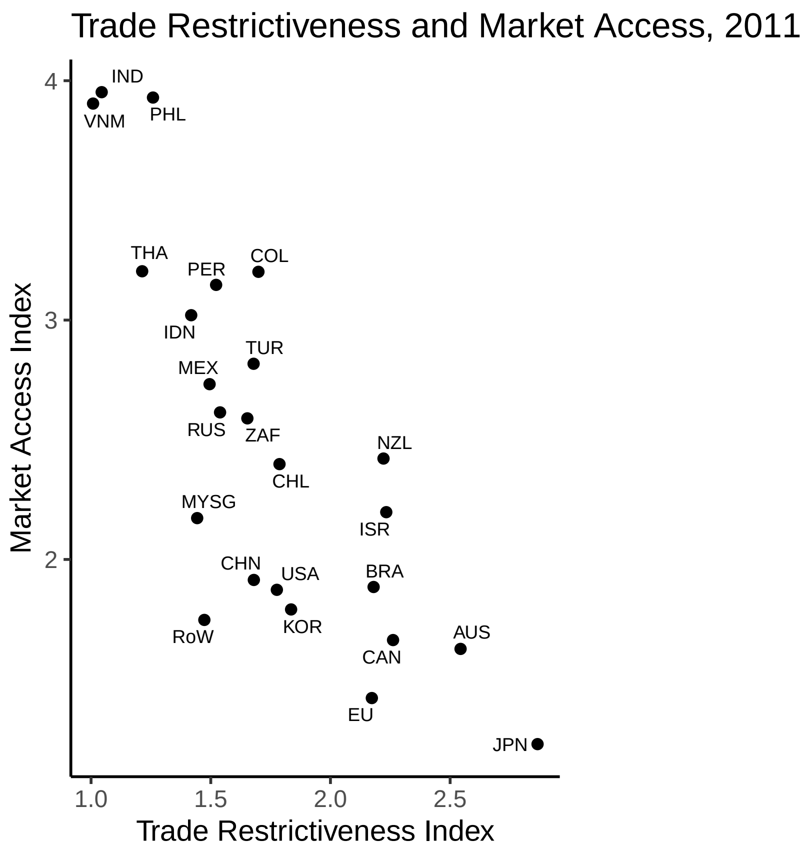


Figure 2.8: Trade restrictiveness and market access conditions by country

NTMs, such as quotas, are rather blunt in their impact, while others, such as health and safety regulations, are more subtle. PTAs usually lower tariff rates beyond WTO commitments within a bloc of signatory countries. Increasingly, these agreements also work to harmonize regulatory environments and reduce "behind-the-border" barriers to trade (Baccini 2019). If in fact NTMs impede trade and PTAs facilitate trade, they should be correlated with the aggregate policy barriers to trade captured here.

To evaluate this proposition, I gather data on applied tariff rates, NTMs, and PTAs, and run a simple regression to evaluate the correlation between these observable indicators of trade restrictiveness and my metric.

I measure aggregate tariff protection with a trade-weighted average of applied tariff rates, taken from UN Conference on Trade and Development's (UNCTAD) TRAINS database.[35] UNCTAD also tracks the incidence of NTMs in governments official trade regulations. As is standard in the literature on NTMs,[36] I employ NTM coverage ratios as a measure of aggregate NTM protection. A coverage ratio is simply the proportion of Harmonized System (HS) 6-digit tariff lines that are subject to an NTM. I group NTMs into three categories, price/quota (core), health/safety, and other, and calculate coverage ratios for each category.[37] Finally, I construct a binary indicator that takes the value of one if two countries are members of a bilateral or multilateral PTA, and zero if not, employing the DESTA database (Dür, Baccini, and Elsig 2014). I include importer and exporter fixed effects in order to make comparisons relative to mean levels of protection and market access.

The results are shown in Table 2.1. Estimated policy barriers are positively correlated with observed tariffs. Independently of tariff rate reductions, policy barriers are negatively correlated with the existence of a PTA. This is consistent with PTAs as a tool of "deep liberalization" that reduce trade costs in excess of those imposed by tariffs. In particular, the existence of a PTA is associated with a tariff-equivalent decrease in τ_{ij} of 32 percentage points. Policy barriers show no significant association with any category of NTMs. However, coverage ratios are an extremely coarse measure of the magnitude of NTMs, and the TRAINS data are of imperfect quality (Kono 2008).

2.4.2 A Placebo Test: Intra-European Union Barriers

In the preceding analysis, the European Union (EU) member states were treated as a single economic entity. Within the EU, goods face few policy barriers to trade. The EU customs union eliminates

[35] This allows the measure to vary at the trade partner level, as exporters with different product portfolios are differentially exposed to tariff lines.

[36] See, for example, Anderson and Van Wincoop (2004).

[37] Due to data availability constraints, data for the European Union is taken from 2012, while the rest of the NTM data is taken from 2011. NTM data for South Korea is unavailable, so it is dropped from the analysis.

Table 2.1: Correlates of Structural Policy Barriers, 2011

	Dependent variable:
	Structural Policy Barrier
Tariffs	1.194**
	(0.570)
PTAs	−0.316***
	(0.063)
Core NTM	0.097
	(0.163)
Health/Safety NTM	0.171
	(0.152)
Other NTM	−0.082
	(0.205)
Importer Fixed Effects	✓
Exporter Fixed Effects	✓
Observations	361
R^2	0.876
Note:	*p<0.1; **p<0.05; ***p<0.01

direct barriers to trade assessed at the border, and regulatory harmonization efforts seek to minimize indirect barriers. For this reason, intra-EU policy barriers to trade should be substantially lower than external barriers. Because the EU documents internal trade and the ICP collects price data for each EU member state, I can test this hypothesis in the data. To do so, I first employ my freight cost model to predict shipping costs within EU member states. European Union policy barriers to trade can then be disaggregated by member state.[38]

Figure 2.9 depicts the results of this exercise.[39] EU policy barriers toward other EU member states are on average 56 percent the size of barriers with non-EU states.[40] Barriers are far from nonexistent, however. On average, EU countries implement a tariff-equivalent barrier of 69 percent on other EU member states, compared to 119 percent on non-EU states.[41] From the perspective

[38]There were 27 members of the European Union in 2011, and Turkey participated in the economic bloc through a customs union. Due to inconsistencies between its trade and national accounts data, I drop Malta from the analysis.

[39]In Appendix D, I reproduce Figure 2.6 with the European Union disaggregated and re-implement K-means clustering, with $K = 4$. The Asian and American blocs remain largely intact. The clustering uncovers 2 distinct European blocs – a Western bloc consisting of Great Britain,France, Germany, and their neighbors as well as an Eatern bloc consisting of mostly post-Cold War EU entrants. Interestingly, Russia and Turkey are grouped with the Western bloc, rather than the more geographically proximate Eastern countries.

[40]This comparison was made by taking weighted means of tariff-equivalent policy barriers where the weights are the expenditures on tradable goods of the exporting countries.

[41]These are unweighted averages of EU member states' TRIs, calculated with respect to EU and non-EU members respectively.

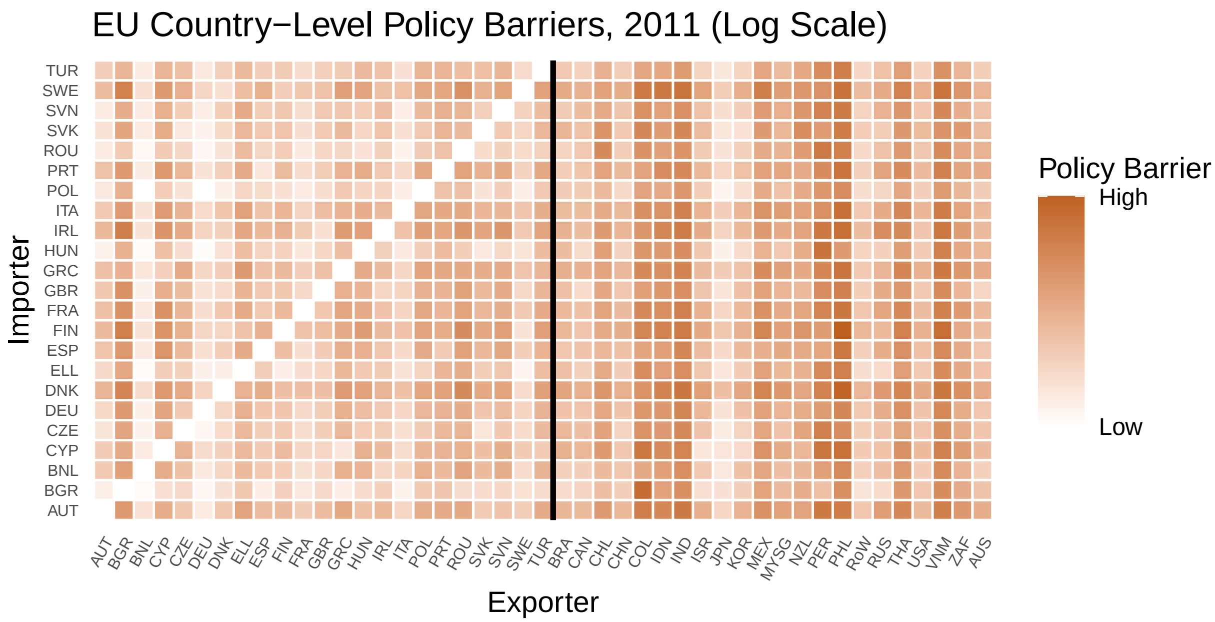


Figure 2.9: Intra and extra-European Union policy barriers to trade. Each cell reports the magnitude of the policy barrier each EU importing country (y-axis) imposes on every exporting country (x-axis). Barriers toward EU countries are on the left hand side of the solid line. Barriers toward non-EU countries are on the right hand side of the solid line. BNL is an aggregate of Belgium, Luxembourg, and the Netherlands (Benelux). ELL is an aggregate of the Baltic countries: Estonia, Latvia, and Lithuania.

of the model, there remained substantial policy-related trade frictions within the EU in 2011. This finding is consistent with the existence of "border effects" within the EU (Comerford and Mora 2015). Of course, these inferences might be driven by features of the model itself. I discuss these limitations in more detail in the paper's conclusion.

2.4.3 Discussion

In the introduction, I noted that richer countries tend to have higher policy barriers to trade, contrary to their relatively liberal tariff regimes. From this fact, some conclude that political institutions in developed countries are more "welfare-conscious" than those in their developing counterparts (Gawande, Krishna, and Olarreaga 2009, 2015). These results are consistent with an alternative approach, emphasizing state capacity, articulated in Acemoglu (2005), Rodrik (2008), and Queralt (2015). Here, tariffs emerge as a "second-best" solution to a revenue-raising problem facing low-capacity governments, which struggle to raise revenue through other channels. As capacity grows, governments employ alternative instruments to raise revenues. As shown here, these governments do not necessarily become less protectionist in the process. In fact, they may become more closed

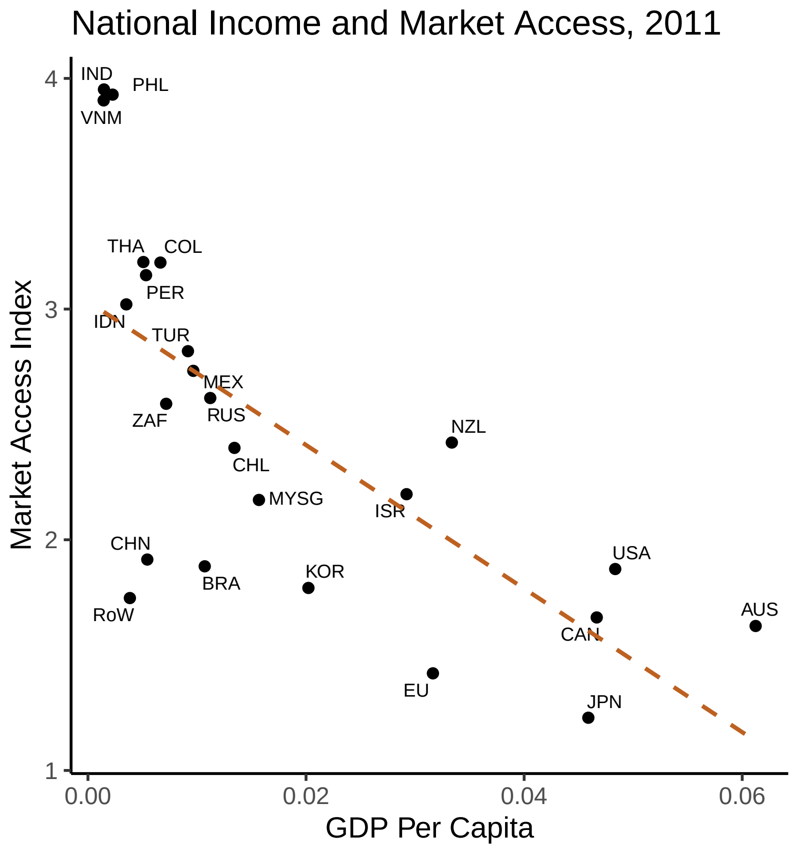


Figure 2.10: Market access conditions and per capita national income

to international trade.

Due to the restrictiveness and discrimination inherent in developed countries' trade policies, poor countries also struggle to access international markets, shown in Figure 2.10. Several studies examining trade costs as a whole replicate this finding, and suggest that this explains some of the variation in cross-national income per capita (Redding and Venables 2004; Romalis 2007; Waugh 2010). These results suggest that even complete tariff liberalization on the part of developed countries would still leave developing countries confronting substantial market access barriers.

2.5 Conclusion

The structure of global tariff rates suggests that international trade is relatively free and fair. Does this conclusion extend to non-tariff barriers to trade? I have shown that the policy barriers to trade implied by observed prices, trade flows, and freight costs are quite large and are implemented in a discriminatory manner. In particular, developed countries implement high non-tariff barriers to trade and tend to discriminate against their less-developed trading partners.

I should qualify these conclusions on three counts. First, like most studies of international trade, they are model-dependent. My approach accounts for trade in intermediate inputs, but does so rather bluntly. Global value chains are complex and respond non-linearly to changes in trade costs (Yi 2003), a feature not captured here. The nested CES preferences ascribed to consumers are also rather rigid. This inflexibility may affect the proportion of distortions attributed to trade costs, rather than consumer heterogeneity, a point noted by Waugh (2010). Second, my conclusions depend on the accuracy of the ICP's price data, and on the assumption that producers face the same prices as consumers. If the price level in Japan is factually less than twice that of Malaysia, Japan's implied policy barriers to trade will also fall. Similarly, if intermediate input prices differ systematically from the prices of final goods, this will change my conclusions on the magnitude of policy barriers to trade. Finally, the simple calibration exercise conducted here cannot speak to uncertainty about the magnitude of policy barriers to trade. From the perspective of Equation 2.15, measurement error in prices and trade flows and estimation error in the trade elasticity and predicted trade costs will aggregate to produce a window of uncertainty the true value of τ_{ij}. Some combination of better theory and better data will strengthen the precision of the conclusions made here.

2.6 Appendix

2.6.1 A: Empirical Price Index: Estimating Consumers' Price Elasticity and Taste Parameters

Demand for variety ω is

$$q_i(\omega) = \tilde{\alpha}_{i,h(\omega)} p_i(\omega)^{-\sigma} E_i^q P_i^{\sigma-1}$$

and expenditure is

$$x_i(\omega) = p_i(\omega) q_i(\omega) = \tilde{\alpha}_{i,h(\omega)} p_i(\omega)^{1-\sigma} E_i^q P_i^{\sigma-1}.$$

With constant prices in each basic heading, total spending on goods in category k is

$$\begin{aligned} x_{ik} &= \int_{\omega \in \Omega_k} \tilde{\alpha}_{i,h(\omega)} p_i(\omega)^{1-\sigma} E_i^q P_i^{\sigma-1} d\omega \\ &= \int_{\omega \in \Omega_k} i,\tilde{\alpha}_k p_{ik}^{1-\sigma} E_i^q P_i^{\sigma-1} d\omega \\ &= \frac{1}{K} \tilde{\alpha}_{ik} p_{ik}^{1-\sigma} E_i^q P_i^{\sigma-1} \end{aligned}$$

and the share of i's tradables expenditure spent on goods in category k is

$$\lambda_{ik} = \frac{x_{ik}}{E_i^q} = \frac{1}{K} \tilde{\alpha}_{ik} p_{ik}^{1-\sigma} P_i^{\sigma-1}.$$

With the United States as the base country, $p_{\mathrm{US},k} = 1$ for all k. Differencing by $\lambda_{\mathrm{US},k}$ then gives

$$\begin{aligned} \frac{\lambda_{ik}}{\lambda_{\mathrm{US},k}} &= \frac{\tilde{\alpha}_{ik}}{\tilde{\alpha}_{\mathrm{US},k}} p_{ik}^{1-\sigma} P_i^{\sigma-1} \\ &= \frac{\epsilon_{ik}}{\epsilon_{\mathrm{US},k}} p_{ik}^{1-\sigma} P_i^{\sigma-1} \end{aligned}$$

where I enforce the normalization that $P_{US} = 1$. Taking logs,

$$\ln\left(\frac{\lambda_{ik}}{\lambda_{\mathrm{US},k}}\right) = \ln\left(\frac{\epsilon_{ik}}{\epsilon_{\mathrm{US},k}}\right) + (1-\sigma)\ln(p_{ik}) + (\sigma-1)\ln(P_i)$$

which can be rearranged as

$$\ln p_{ik} = \frac{1}{1-\sigma} \ln\left(\frac{\lambda_{ik}}{\lambda_{\mathrm{US},k}}\right) + \ln(P_i) + \frac{1}{\sigma-1} \ln\left(\frac{\epsilon_{ik}}{\epsilon_{\mathrm{US},k}}\right).$$

Because $\mathrm{E}[\epsilon_{ik}] = 1$,

$$\mathrm{E}\left[\ln p_{ik}\right] = \frac{1}{1-\sigma}\ln\left(\frac{\lambda_{ik}}{\lambda_{\mathrm{US},k}}\right) + \ln\left(P_i\right)$$

which gives a moment condition that I estimate via ordinary least squares.

2.6.2 B: Modeling Freight Costs

I build a simple model of demand for transportation services in order to estimate freight costs. There are M sectors, indexed $m \in \{1, ..., M\}$ and K modes of transportation (air, sea, land), indexed $k \in \{1, ..., K\}$. There is a mass of exporters within each country-sector. The cost of shipping a good from sector m from country i to country j via mode k is $\delta_{ij}^{mk}(\boldsymbol{Z}_i j)$ where $\boldsymbol{Z}_{ij}$ is a vector storing geographic covariates including indicators of air and sea distances between i and j, and whether or not i and j are contiguous.

Exporters have preferences over the mode of transit and cost of freight. Let

$$V_{ij}^{mk} = \tilde{\beta}_0 \delta_{ij}^{mk}(\boldsymbol{Z}_{ij}) + \tilde{\beta}_k + \eta_{ij}^{km}$$

where η_{ij}^{km} is a Type-I extreme value-distributed preference shock with $\mathrm{E}[\eta_{ij}^{km}] = 0$. $\tilde{\beta}_k$ modulates exporters' relative preference for mode k, independent of its cost. This is a simple logit model of mode choice a la Mcfadden (1974). Under these assumptions, the share of exporters in sector k that choose to ship from j to i via mode m is

$$\zeta_{ij}^{mk} = \frac{\exp\left(\tilde{\beta}_0 \delta_{ij}^{mk}(\boldsymbol{Z}_{ij}) + \tilde{\beta}_k\right)}{\sum_{k'=1}^{K} \exp\left(\tilde{\beta}_0 \delta_{ij}^{mk'}(\boldsymbol{Z}_{ij}) + \tilde{\beta}_{k'}\right)}. \tag{2.20}$$

I impose natural technological constraints on this function, prohibiting shipment by sea to landlocked countries and shipment by land to islands or across continents.[42]

I model $\delta_{ij}^{mk}(\boldsymbol{Z}_{ij})$ as linear in distance and contiguity and sector (HS2) fixed effects.[43] Parameter estimates for each mode are reported in the next section.

I obtain estimates for $\tilde{\beta}_0$ and $\tilde{\beta}_k$ by taking the log of 2.20, differencing with respect to a base transportation mode, and estimating the resulting linear equation via ordinary least squares. With parameter estimates in hand, I can compute predictions for total trade costs by aggregating over sectors and projecting out of sample.

The total free on board (f.o.b.) value of imports of country i from country j is given by X_{ij}.

[42] Where Eurasia is treated as an aggregate.

[43] I also smooth the model's predictions over years using a polynomial spline.

The cost, insurance, and freight (c.i.f.) value of these goods is $\delta_{ij}X_{ij}$. These c.i.f. costs can be decomposed by product and mode of transportation as follows

$$\delta_{ij}X_{ij} = \sum_{m=1}^{M} \delta_{ij}^{m} x_{ij}^{m}$$

where

$$\delta_{ij}^{m} x_{ij}^{m} = \sum_{k=1}^{K} \delta_{ij}^{mk} x_{ij}^{mk} \implies \delta_{ij}^{m} = \sum_{k=1}^{K} \delta_{ij}^{mk} \frac{x_{ij}^{mk}}{x_{ij}^{m}}.$$

Recall that ζ_{ij}^{mk} is the share of imports by i from j of good m that travel by mode k

$$\zeta_{ij}^{mk} = \frac{x_{ij}^{mk}}{x_{ij}^{m}}.$$

With these terms defined, total predicted freight costs can be computed as

$$\hat{\delta}_{ij}\left(\boldsymbol{Z}_{ij}\right) = \frac{1}{X_{ij}} \sum_{m=1}^{M} x_{ij}^{m} \sum_{k=1}^{K} \zeta_{ij}^{mk}\left(\delta_{ij}^{mk}(\boldsymbol{Z}_{ij})\right) \delta_{ij}^{mk}(\boldsymbol{Z}_{ij}).$$

2.6.3 C: Freight Cost Data Sources and Results

To estimate freight costs and mode share choice, I employ data from the United States Census Bureau and the Australian Bureau of Statistics on the c.i.f. and f.o.b. values of its imports.[44] The ratio of the c.i.f. value of goods to their f.o.b. value can then be taken as a measure of the ad valorem freight cost. I supplement these values with international data on the costs of *maritime* shipments from the OECD's Maritime Transport Cost Dataset (Korinek 2011). I also observe the transportation modes of imports (air, land, or sea) to the European Union, Japan, Brazil, Australia and the United States .[45]

To model the cost of transport via sea, I take sea distances from CERDI (Bertoli, Goujon, and Santoni 2016). For land and air distances, I use CEPII's GeoDist database (Mayer and Zignago 2011).

Parameter estimates for mode-specific freight cost models are reported in the following three tables. Across modes, distance is estimated to significantly increase freight costs. Contiguity is estimated to decrease costs for land and air shipments while increasing costs for seaborne shipments.

[44] The Australian data are also used by Shapiro (2016) and Adao, Costinot, and Donaldson (2017).

[45] Data from the United States come from the Census Bureau and are available on the website of Peter Schott. Data from the European Union are from Eurostat. Data from Japan are from the government's statistical agency, e-Stat. Data from Brazil come from the ministry of trade and industry. Data from Australia are from the Australian Bureau of Statistics.

Maritime Freight Costs

Table 2.2: Maritime Cost Model

	Dependent variable:
	Freight Cost
CERDI seadist (log, std)	0.010***
	(0.0002)
Contiguity	0.013***
	(0.0004)
Product fixed effects?	✓
Cubic time spline?	✓
Observations	156,135
R^2	0.388
Note:	*p<0.1; **p<0.05; ***p<0.01

Land Freight Costs

Table 2.3: Land Cost Model

	Dependent variable:
	Freight Cost
CEPII distw (log, std)	0.003***
	(0.0003)
Contiguity	−0.016***
	(0.001)
Product fixed effects?	✓
Cubic time spline?	✓
Observations	26,455
R^2	0.500
Note:	*p<0.1; **p<0.05; ***p<0.01

Air Freight Costs

Table 2.4: Air Cost Model

	Dependent variable:
	Freight Cost
CEPII distw (log, std)	0.028^{***}
	(0.001)
Contiguity	-0.030^{***}
	(0.002)
Product fixed effects?	✓
Cubic time spline?	✓
Observations	58,346
R^2	0.351
Note:	*p<0.1; **p<0.05; ***p<0.01

Transportation Mode Shares

With $\delta_{ij}(\boldsymbol{Z}_{ij})$ estimated I can compute predicted sector-level freight costs for all country pairs. I use these predicted freight prices to estimate the parameters of the mode choice model, using all observed mode share choices.

I take air transport as the baseline category for the transportation modes model. Price increases in mode k are estimated to decrease that mode's relative market share. Sea is estimated to be the most popular mode, holding prices fixed, followed by air and land respectively. Holding these preferences (captured in $\tilde{\beta}_k$) fixed at estimated values for all modes and assuming transport via all modes is equally costly, a one percent increase in the relative cost of seaborne trade decreases its expected market share from 70.7 percent to 68.8 percent.

Table 2.5: Mode Share Model

	Dependent variable:
	(Log) Relative Share
Predicted Price Ratio	-9.039^{***}
	(0.090)
Sea FE	1.115^{***}
	(0.013)
Land FE	-1.338^{***}
	(0.017)
Observations	145,846
R^2	0.263
Note:	*p<0.1; **p<0.05; ***p<0.01

2.6.4 D: Economic Blocs, Disaggregated European Union

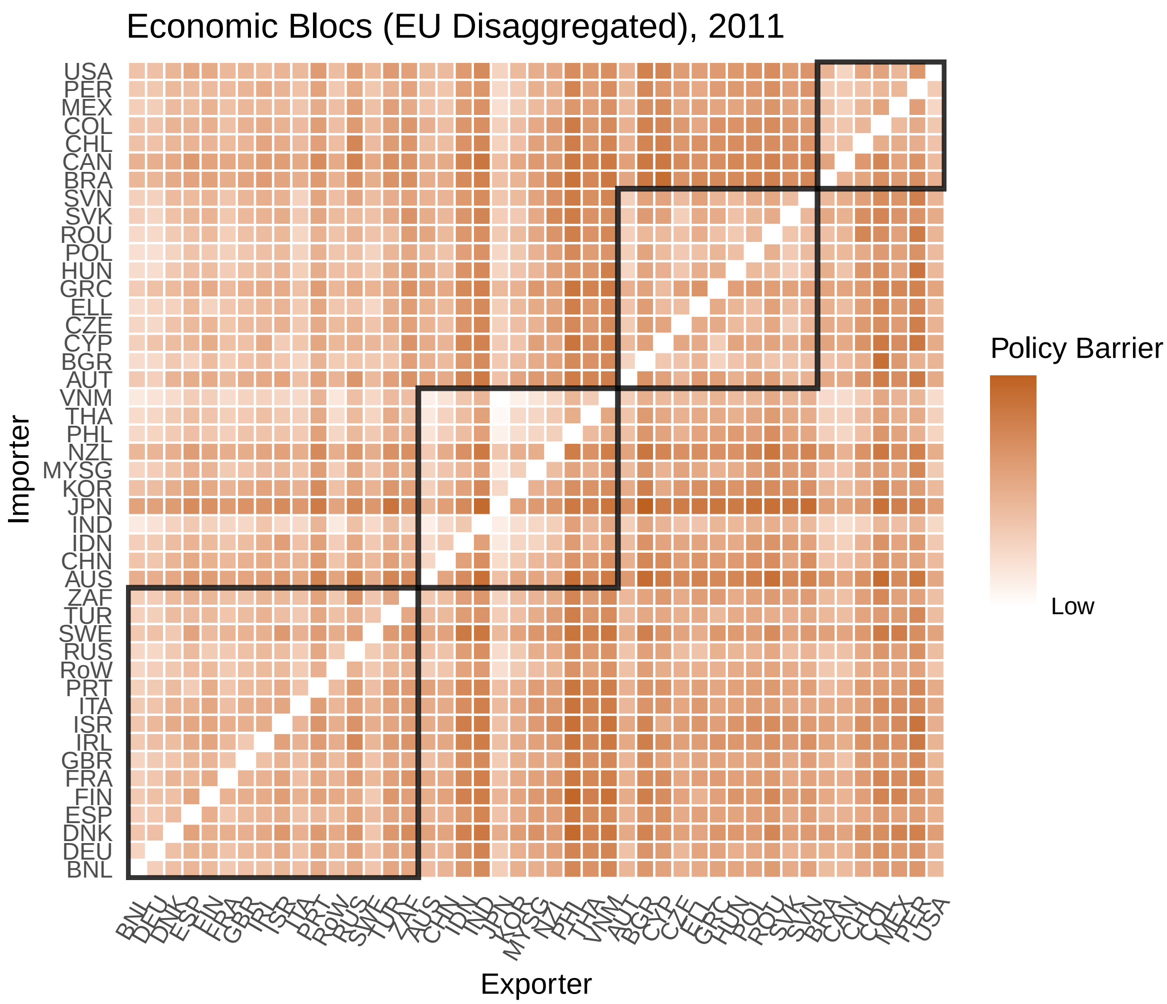


Figure 2.11: Distribution of policy barriers to trade with individual EU countries. Each cell reports the magnitude of the policy barrier each importing country (y-axis) imposes on every exporting country (x-axis). Countries are partitioned into 4 groups through K-means clustering. Black rectangles enclose each cluster.

2.6.5 E: Sample Countries

iso3	Country Name
AUS	Australia
BRA	Brazil
CAN	Canada
CHL	Chile
CHN	China
COL	Colombia
EU	European Union
IDN	Indonesia
IND	India
ISR	Israel
JPN	Japan
KOR	South Korea
MEX	Mexico
MYSG	NA
NZL	New Zealand
PER	Peru
PHL	Philippines
RoW	Rest of the World
RUS	Russia
THA	Thailand
TUR	Turkey
USA	United States
VNM	Vietnam
ZAF	South Africa

2.6.6 F: International Comparison Program Expenditure Categories

Code	Basic Heading	Tradable?
1101111	Rice	✓
1101112	Other cereals, flour and other products	✓

(continued)

Code	Basic Heading	Tradable?
1101113	Bread	✓
1101114	Other bakery products	✓
1101115	Pasta products	✓
1101121	Beef and veal	✓
1101122	Pork	✓
1101123	Lamb, mutton and goat	✓
1101124	Poultry	✓
1101125	Other meats and meat preparations	✓
1101131	Fresh, chilled or frozen fish and seafood	✓
1101132	Preserved or processed fish and seafood	✓
1101141	Fresh milk	✓
1101142	Preserved milk and other milk products	✓
1101143	Cheese	✓
1101144	Eggs and egg-based products	✓
1101151	Butter and margarine	✓
1101153	Other edible oils and fats	✓
1101161	Fresh or chilled fruit	✓
1101162	Frozen, preserved or processed fruit and fruit-based products	✓
1101171	Fresh or chilled vegetables other than potatoes	✓
1101172	Fresh or chilled potatoes	✓
1101173	Frozen, preserved or processed vegetables and vegetable-based products	✓
1101181	Sugar	✓
1101182	Jams, marmalades and honey	✓
1101183	Confectionery, chocolate and ice cream	✓
1101191	Food products nec	✓
1101211	Coffee, tea and cocoa	✓
1101221	Mineral waters, soft drinks, fruit and vegetable juices	✓
1102111	Spirits	✓
1102121	Wine	✓
1102131	Beer	✓

(continued)

Code	Basic Heading	Tradable?
1102211	Tobacco	✓
1102311	Narcotics	
1103111	Clothing materials, other articles of clothing and clothing accessories	✓
1103121	Garments	✓
1103141	Cleaning, repair and hire of clothing	
1103211	Shoes and other footwear	✓
1103221	Repair and hire of footwear	
1104111	Actual and imputed rentals for housing	
1104311	Maintenance and repair of the dwelling	
1104411	Water supply	
1104421	Miscellaneous services relating to the dwelling	
1104511	Electricity	✓
1104521	Gas	✓
1104531	Other fuels	✓
1105111	Furniture and furnishings	✓
1105121	Carpets and other floor coverings	✓
1105131	Repair of furniture, furnishings and floor coverings	
1105211	Household textiles	✓
1105311	Major household appliances whether electric or not	✓
1105321	Small electric household appliances	✓
1105331	Repair of household appliances	
1105411	Glassware, tableware and household utensils	✓
1105511	Major tools and equipment	✓
1105521	Small tools and miscellaneous accessories	✓
1105611	Non-durable household goods	✓
1105621	Domestic services	
1105622	Household services	
1106111	Pharmaceutical products	✓
1106121	Other medical products	✓
1106131	Therapeutic appliances and equipment	✓

(continued)

Code	Basic Heading	Tradable?
1106211	Medical Services	
1106221	Dental services	
1106231	Paramedical services	
1106311	Hospital services	
1107111	Motor cars	✓
1107121	Motor cycles	✓
1107131	Bicycles	✓
1107141	Animal drawn vehicles	✓
1107221	Fuels and lubricants for personal transport equipment	✓
1107231	Maintenance and repair of personal transport equipemnt	
1107241	Other services in respect of personal transport equipment	
1107311	Passenger transport by railway	
1107321	Passenger transport by road	
1107331	Passenger transport by air	
1107341	Passenger transport by sea and inland waterway	
1107351	Combined passenger transport	
1107361	Other purchased transport services	
1108111	Postal services	
1108211	Telephone and telefax equipment	✓
1108311	Telephone and telefax services	
1109111	Audio-visual, photographic and information processing equipment	✓
1109141	Recording media	✓
1109151	Repair of audio-visual, photographic and information processing equipment	
1109211	Major durables for outdoor and indoor recreation	✓
1109231	Maintenance and repair of other major durables for recreation and culture	
1109311	Other recreational items and equipment	✓
1109331	Garden and pets	
1109351	Veterinary and other services for pets	
1109411	Recreational and sporting services	
1109421	Cultural services	

(continued)

Code	Basic Heading	Tradable?
1109431	Games of chance	
1109511	Newspapers, books and stationery	✓
1109611	Package holidays	
1110111	Education	
1111111	Catering services	
1111211	Accommodation services	
1112111	Hairdressing salons and personal grooming establishments	
1112121	Appliances, articles and products for personal care	✓
1112211	Prostitution	
1112311	Jewellery, clocks and watches	✓
1112321	Other personal effects	✓
1112411	Social protection	
1112511	Insurance	
1112611	Financial Intermediation Services Indirectly Measured (FISIM)	
1112621	Other financial services	
1112711	Other services nec	
1113111	Final consumption expenditure of resident households in the rest of the world	
1113112	Final consumption expenditure of non-resident households in the economic territory	
1201111	Individual consumption expenditure by NPISHs	
1301111	Housing	
1302111	Pharmaceutical products	✓
1302112	Other medical products	✓
1302113	Therapeutic appliances and equipment	✓
1302121	Out-patient medical services	
1302122	Out-patient dental services	
1302123	Out-patient paramedical services	
1302124	Hospital services	
1302211	Compensation of employees	
1302221	Intermediate consumption	
1302231	Gross operating surplus	

(continued)

Code	Basic Heading	Tradable?
1302241	Net taxes on production	
1302251	Receipts from sales	
1303111	Recreation and culture	
1304111	Education benefits and reimbursements	
1304211	Compensation of employees	
1304221	Intermediate consumption	
1304231	Gross operating surplus	
1304241	Net taxes on production	
1304251	Receipt from sales	
1305111	Social protection	
1401111	Compensation of employees	
1401121	Intermediate consumption	
1401131	Gross operating surplus	
1401141	Net taxes on production	
1401151	Receipts from sales	
1501111	Fabricated metal products, except machinery and equipment	✓
1501121	General purpose machinery	✓
1501131	Special purpose machinery	✓
1501141	Electrical and optical equipment	✓
1501151	Other manufactured goods nec	✓
1501211	Motor vehicles, trailers and semi-trailers	✓
1501212	Other road transport	✓
1501221	Other transport equipment	✓
1502111	Residential buildings	
1502211	Non-residential buildings	
1502311	Civil engineering works	
1503111	Other products	
1601111	Opening value of inventories	
1601112	Closing value of inventories	
1602111	Acquisitions of valuables	

(continued)

Code	Basic Heading	Tradable?
1602112	Disposals of valuables	
1701111	Exports of goods and services	
1701112	Imports of goods and services	

Chapter 3

Trade Policy in the Shadow of Power

Quantifying Military Coercion in the International System

3.1 Introduction

Military power holds a central position in international relations (IR) theory. Governments exist in a state of anarchy — there is no world authority tasked with preventing the use of violence in settling policies disputes between them. As a result, powerful governments can employ force against others to secure more favorable policy outcomes. This does not necessarily imply that international relations are uniquely violent, however. Threatened governments can adjust their policy choices to accommodate the interests of the powerful, avoiding costly conflict (Brito and Intrilagator 1985; Fearon 1995). This setting raises an inference problem — do observed policies reflect the preferences of the governments that adopted them, or the military constraints of the anarchic international system?

In this paper, I propose and implement a method to assess the effect of military power on trade policy choices. Trade is a natural issue area in which to undertake such an investigation. For a variety of reasons, governments' endeavor to protect their home market to some extent. Governments also seek access to foreign markets (Grossman 2016). These preferences put governments into conflict with one another – each would like to erect some barriers to imports while dismantling barriers to trade abroad. Given dictatorial power, governments would protect their home market and enforce openness elsewhere. Moreover, aggregate policy-induced trade frictions are large (Cooley 2019a) and have large effects on the distribution and level of welfare within and across countries (Autor, Dorn, and Hanson 2013; Costinot and Rodríguez-Clare 2015; Goldberg and Pavcnik 2016). These effects may be particularly salient for politically influential groups (Grossman and Helpman 1994; Osgood et al. 2017). Governments therefore have incentives to use force to shape trade policy abroad to their liking. Historically, they have been willing to fight wars to realize such goals (Findlay and O'Rourke 2007).

Assessing the effect of military power on trade policy requires imagining what policy choices governments would have made in the absence of coercion. Uncoerced policies can be taken as a measure of the government's ideal point, representing its true underlying preferences. When coercion is possible, however, weaker governments must consider the effect of their policy choices on the powerful. If a particular policy choice harms a threatening government enough, it can choose to impose an alternative policy by force. Recognizing this threat, weaker governments adjust their policies to avoid war. In an anarchic world, policies are jointly determined by both power and preferences.

I proceed in three steps to untangle power and preferences as determinants of trade policies. First, I model a coercive international political economy in which governments propose trade policies, observe others proposals, and choose whether or not to fight wars to win the right to modify these. The model's equilibrium depends on a vector of parameters governing governments' preferences for protectionism and costs of war, which in turn depend on the military strengths of potential belligerents and the geographic distance between them. I then estimate these parameters by minimizing the distance between the model's predictions and observed policies in the year 2011. Finally, I answer the question posed here: how does military coercion affect trade policy? With estimates for the model's parameters in hand, this question can be answered by a simple counterfactual experiment — eliminate governments' military capacity, and recalculate the model's equilibrium. The difference between counterfactual equilibrium policies and the factual policies represents the net effect of military coercion on trade policy.

I find that there are increasing returns to military advantage in international trade policy bargaining. Governments that are militarily powerful are estimated to enjoy lower costs of war, which they exploit to coerce policy concessions from their trade partners. In this sense, military might is a force for trade liberalization, inducing reductions in barriers to trade that governments would be unwilling to undertake in the absence of coercion. These reductions in barriers to trade stimulate international economic exchange. Counterfactually eliminating militaries reduces the value of global trade to 61.4 percent of its model-estimated value. I estimate that the effectiveness of military coercion does not degrade across space – in fact, governments are estimated to enjoy lower average costs of war against geographically distant adversaries. This may reflect the peculiarities of the technology of war in the era under study, in which geographic distance represents a minimal impediment to the projection of power.

In the model, governments choose trade policies to maximize a country-specific social welfare function. Each government's trade policy is a set of taxes, one for each importing country, imposed on imports. Notably, trade policies can be discriminatory, affecting certain source countries disproportionately. A model of the international economy connects trade policy choices to social welfare.[1] After observing trade policies, governments may choose to fight wars against other governments in order to impose free trade. The threat of war constrains threatened governments and affects their trade policy choices. The dyadic costs of war, held as private information to potential attackers, depend on observable features of the attacking and defending countries, including the potential belligerents' relative military strengths' and the geographic distance between them. Governments' ideal policies depend on a country-specific parameter governing the ease with which policy distortions are converted into revenues. I show that these preference parameters and the elasticities that convert military strength and geographic distance into war costs can be estimated given data on directed policy barriers to trade – or the magnitude of policy distortion each government imposes on imposes on imports from each other country.[2]

Within-country variation in trade policy identifies the model. Consider the ideal set of trade policies of a government whose preferences are known. The policies that achieve this objective can be readily calculated given knowledge of parameters governing international economic relations. Policies adopted toward imports from countries that pose no military threat will reflect this objective. Conversely, the imports of threatening countries will encounter lower barriers to trade, in order to satisfy the threatener's war constraint. This favoritism is informative about the effectiveness of military threats. The level of barriers toward non-threatening countries is informative about the government's preferences. Differential responses to the same level of threat from different geographic locations identifies parameters governing the effectiveness of power projection across space.

The identified model enables two classes of counterfactuals. First, it allows me to quantify the "shadow of power" by comparing factual policies to those that would prevail if governments' counterfactually possessed zero military capability. These policies can then be fed into the model of the international economy to calculate the effect on trade flows, prices, and wages around the world. Would different trade blocs emerge in a coercion-free world? Which governments would

[1] The model of the international economy is a variant of the workhorse model of Eaton and Kortum (2002). Costinot and Rodríguez-Clare (2015) study a broader class of structural gravity models that connect trade frictions (such as trade policy) to trade and welfare outcomes.

[2] I use data on aggregate directed trade policy distortions from Cooley (2019a), a companion paper to this study. These data are discussed in more detail below.

benefit the most? In the model, consumers benefit from the liberalizing effect of foreign military coercion (Antràs and Padró i Miquel 2011; Cooley 2019b). How large are these benefits? Whose citizens benefit the most from international power politics? How would relative changes to U.S. and Chinese military strength affect the functioning of the international economy?

I also examine how domestic political economic changes (changes to government preferences) affect the salience of military coercion. Governments that value the welfare of consumers prefer to adopt lower barriers to trade. The returns to coercing these governments are smaller, because their ideal policies impose relatively small externalities on potential threatening governments. Military coercion plays a smaller role in influencing trade policy when governments are relatively liberal. Domestic political institutions are believed to affect trade policy preferences (Rodrik 1995; Milner 1999; Milner and Kubota 2005). The model facilitates exploration of how domestic political change affects the quality of international relations and governments' propensity to threaten, display, and use military force against one another.

3.2 Literature

Conflicts of interest and the specter of coercive diplomacy emerge in the model due to governments' protectionist preferences. Trade theory reserves a role for small trade policy distortions for governments that seek to maximize aggregate societal wealth (Johnson 1953; Broda, Limao, and Weinstein 2008). Empirically, governments implement larger trade distortions than predicted in theory, however. This regularity motivated the study of the political economics of trade policy. While nearly free trade may be good for a society as a whole, owners of specific factors of production may prefer protectionism. If these groups have better access to the policymaking process, trade policy may be more protectionist than is optimal for society (Mayer 1984; Rogowski 1987; Grossman and Helpman 1994). A family of studies uses these theoretical insights to estimate governments' sensitivity to narrow versus diffuse interests (Goldberg and Maggi 1999; Mitra, Thomakos, and Ulubasoglu 2006; Gawande, Krishna, and Olarreaga 2009, 2012, 2015; Ossa 2014). Because these models incorporate no theory of international military coercion, these estimates reflect the assumption that policy choices reflect the outcome of non-cooperative policy choice or non-militarized bargaining. Fiscal pressures might also drive protectionism. Some governments are constrained in their ability to raise revenue through taxes on domestic economic activities. Tariffs and other trade distortions may substitute as a revenue-raising strategy in these cases (Rodrik 2008; Queralt 2015).

I take no stance on the domestic political origins of protectionist preferences. I induce these by varying the ease with which governments can collect revenues from trade distortions. Each government is characterized by a revenue threshold parameter. Trade distortions above the level of this threshold generate revenue while distortions below this level require subsidies. Governments with higher threshold parameters therefore prefer higher barriers to trade, all else equal. This simple formulation induces heterogeneity in the governments' ideal levels of protectionism and the magnitude of the externalities they would impose on other governments when choosing individually optimal policies.

These externalities motivate the lobbying efforts of domestic special interests and structure international negotiations over trade policy. In contemporary political economic accounts, large and productive firms pressure their own governments to secure market access abroad in order to increase profit opportunities (Ossa 2012; Osgood 2016; Kim 2017). By contrast, in my model, lower barriers to trade abroad increase wages at home (helping consumers) and stimulate trade (increasing revenue). Modeling government preferences in this manner captures market access incentives tractably while avoiding ascribing a particular domestic political process to their origin.

Because of these preferences for foreign trade liberalization, governments have incentives to influence others' policy choices. Analyzing governments' foreign policy in the 17th and 18th centuries, Viner (1948) concludes "important sources of national wealth... were available... only to countries with the ability to acquire or retain them by means of the possession and readiness to use military strength." Powerful governments established colonies and threatened independent governments in order to shape policy abroad to their liking (Gallagher and Robinson 1953). While formal empires died quickly after World War II, softer forms of influence remained. Lake (2013) terms the resulting order a "hierarchy" in which weaker countries exchanged sovereignty for international political order, provided by a hegemonic United States. Berger et al. (2013) show that this hierarchy has not always been benevolent — U.S. political influence was used to open markets abroad, a form of "commercial imperialism." An earlier literature ascribed international economic openness to the presence of such a hegemon (Krasner 1976; Gilpin 1981; Kindleberger 1986). In conceptualizing openness as a public good, these theories made stark predictions about the distribution of military power and the international economy. In reality, the benefits of changes to trade policy are quite excludable. The model developed here reflects this reality by allowing governments to adopt discriminatory trade policies. Power can therefore be exercised to secure benefits not shared by other governments. The resulting international economic orders defy characterization as "open" or "closed." In a stylized version of the model developed here, I show that latent coercive threats can be used to open foreign markets. Militarily weak countries adopt lower barriers to trade than their powerful counterparts, all else equal (Cooley 2019b). Antràs and Padró i Miquel (2011) consider a similar model in which governments influence elections abroad. Again, this influence has a liberalizing effect on the foreign government's trade policy.

Nevertheless, debate persists about the efficacy of military power in achieving economic benefits (Mastanduno 2009; Drezner 2013; Bove, Elia, and Sekeris 2014; Stokes and Waterman 2017). These studies all confront the inference problem discussed here — does economic policy reflect governments' underlying preferences or the shadow of foreign military power? When redistribution is an alternative to war and bargaining is frictionless, war is not necessary to achieve coercive effects (Brito and Intrilagator 1985; Fearon 1995; Art 1996). I assume that the effectiveness of military coercion depends on governments' relative military advantage and the geographic distance between an attacking and defending country. Existing studies examine wars and militarized disputes to estimate the relationship between military spending and geographic distance on coercive capacity.[3] The number of disputes used to fit these models is relatively small and the nature of military technology changes over time. This dynamic technology and strategic selection into wars and disputes may confound estimates of these relationships. While I study a small sample of countries in a single year in this paper, I expand the universe of cases that can be used to estimate coercive capability by examining the responsiveness of policy to foreign threats.

Several studies have examined trade policy bargaining theoretically and empirically. Grossman and Helpman (1995) extend the protection for sale model to a two-country bargaining setting. Maggi (1999) and Bagwell and Staiger (1999) focus on the effect of the institutional context in which trade policy negotiations take place, relative to an un-institutionalized baseline. Ossa (2014) and Bagwell, Staiger, and Yurukoglu (2018b) quantify these theories in structural models. Of course, the continued functioning of international institutions requires either a) that complying with the rules of the institution be incentive compatible for each member state, given others' strategies or b) that an external authority punish deviations from the institutions' rules sufficiently to induce compliance (Powell 1994). Given the absence of such an external authority and the stark international distributional implications of alternative trade policy regimes, it is natural to consider how the ability to employ military force colors trade policy bargaining.

Trade and trade policy are often theorized as tools governments can leverage to achieve political objectives (Hirschman 1945; Gowa and Mansfield 1993; Martin, Mayer, and Thoenig 2012; Seitz,

[3] On the relationship between military expenditure and military power, see Kadera and Sorokin (2004), Beckley (2010), Beckley (2018), Carroll and Kenkel (2019), and Anders, Fariss, and Markowitz (2020). On the loss of strength gradient, see Boulding (1962), Bruce Bueno de Mesquita (1980), Diehl (1985), Lemke (1995), Gartzke and Braithwaite (2011), and Markowitz and Fariss (2013).

Tarasov, and Zakharenko 2015). Yet, affecting trade policy and concomitant prices, wages, and trade flows is also a central government objective in international relations. Moreover, the political objectives that ostensibly motivate governments in these "trade as means" models are loosely defined (e.g. "security") and themselves means to achieving other ends. Studying trade policy as a strategic end allows the analyst to leverage a family of empirical methods in international economics to construct counterfactual trade regimes and analyze their welfare implications (Eaton and Kortum 2002; Head and Mayer 2014; Costinot and Rodríguez-Clare 2015; Ossa 2016). Government objectives can be defined flexibly as a function of general equilibrium outputs (prices, wages, revenues).

A handful of other theoretical studies examine how power affects exchange in market environments (Skaperdas 2001; Piccione and Rubinstein 2007; Garfinkel, Skaperdas, and Syropoulos 2011; Carroll 2018). Where property rights are assumed in classical models of the economy, these authors consider exchange and violence as coequal means to acquire goods from others. I instead direct attention to coercive bargaining over endogenous trade frictions (trade policy). These in turn affect the distribution of goods and welfare in the international economy.

3.3 Data and Calibration of Economy

I estimate the model on a set of 9 governments in the year 2011.[4] These governments are listed in Table 3.1. I aggregate all European Union governments into a single entity and collapse all countries not included in the analysis into a "Rest of World" (RoW) aggregate.[5] Non-RoW countries make up 72 percent of world GDP.

Estimating the model and conducting the subsequent counterfactual exercises requires knowledge of governments' trade policies, disaggregated at the directed dyadic level. While detailed data on a particular policy instrument (tariffs) are available to researchers, these are but one barrier governments can use to influence the flow of trade. In a companion paper (Cooley 2019a), I show how to measure aggregate directed trade policy distortions given data on national accounts (gross consumption, gross production, and gross domestic product), price levels, trade flows, and freight costs. This method produces a matrix of trade barriers, in which the i, jth entry is the magnitude of policy barriers to trade an importing country i imposes on goods from an exporting country j. In

[4] Focusing on a small set of governments is necessary for computational tractability. However, the largest countries (by GDP) are the most attractive targets for coercion, as changes to their trade policies return the largest welfare gains.

[5] Such an aggregation is necessary in order to calculate fully general equilibrium effects of counterfactual trade policies. However, I prohibit other countries from invading RoW and likewise prohibit RoW from invading others. This ensures that estimates of military parameters depend almost entirely on interactions between countries within my sample.

Table 3.1: In-Sample Countries

iso3	Country Name
AUS	Australia
CAN	Canada
CHN	China
EU	European Union
JPN	Japan
KOR	South Korea
RoW	Rest of World
RUS	Russia
USA	United States

2011, the estimated barriers were large, equivalent to an 81 percent import tariff on average.[6] They also reveal substantial trade policy discrimination, with a subset of developed exporters facing far more favorable market access conditions than their less-developed peer countries.

I take these estimated trade policies as the equilibrium output of the model developed here. I assume these policies are measured with error and construct an estimator that minimizes the magnitude of the resulting error vector. I sample from bootstrapped iterations of the trade policy estimation routine and re-compute parameter estimates many times in order to construct confidence intervals around my point estimates.

Estimating the magnitude of these trade policies and tracing their impact on government welfare requires specifying a model of the international economy. This model, which follows closely that of Eaton and Kortum (2002), can be represented succinctly as a mapping $h(\boldsymbol{\tau}, \boldsymbol{Z}_h; \boldsymbol{\theta}_h) = \boldsymbol{w}$ where $\boldsymbol{\tau}$ is a vector of trade policies, $\boldsymbol{Z}_h$ is a vector of economic data (including information on national accounts, price levels, trade flows, and freight costs), and $\boldsymbol{\theta}_h$ is a vector of parameters to be calibrated to match empirical analogues or taken from extant literature. $\boldsymbol{w}$ is a vector of wage levels, one for every country, from which equilibrium trade flows and price levels can be calculated. Government welfare is modeled below as a function of the outputs of this economy. I employ the same model of the international economy used to estimate trade policies in Cooley (2019a) to calculate the welfare effects of trade policies in this study. The economy, the data required to calibrate it, and parameter calibration are discussed in more detail in Appendix B.

In the coercive political economy developed below, governments' relative directed war costs are modeled as a function of the military capability ratio between the attacker and defender, the geographic distance between the belligerents, and the gross domestic product of the attacking country.

[6]These results and the calibration choices that produce this value are discussed in more detail in Appendix B.

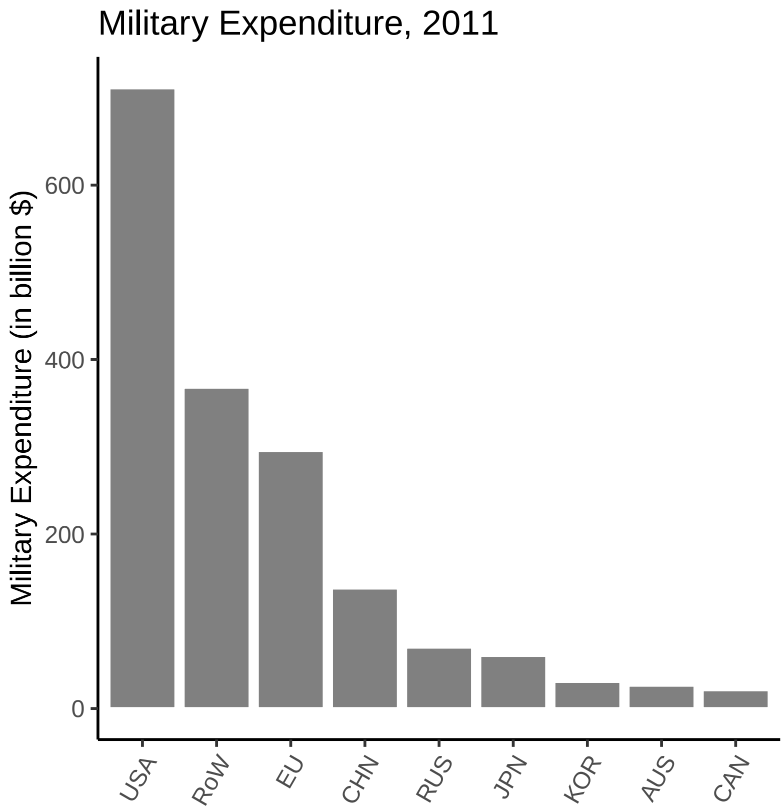


Figure 3.1: Military expenditure for in-sample governments. Values for ROW and EU are obtained by summing expenditure of all member countries.

I store these observable features in the vector $\boldsymbol{Z}_m$. To measure military capability ratios, I employ SIPRI‘s data on military expenditure to measure governments' military capacity. These values are displayed in Figure 3.1. I use data from Weidmann, Kuse, and Gleditsch (2010) to calculate centroid-centroid geographic distance between all countries in my sample. Data on gross domestic production comes from the World Input-Output Database (WIOD) (Timmer et al. 2015).

3.3.1 Reduced Form Evidence on Coercion and Trade Policy

To assist in the interpretation of the data, consider a simple bilateral coercive bargaining setting. Governments 1 and 2 bargain over a pie of size 1. Let $x \in [0, 1]$ denote the share of the pie awarded to government 1 (with the remainder, $1 - x$, going to government 2). In the trade setting studied here, $x = 1$ might correspond to government 1 implementing optimal tariffs and government 2 liberalizing fully. Each government's valuation of the pie is given by an increasing, weakly concave utility function $u_i(x)$. The value of each government's outside option is given by a war function, $w_i(M_i/M_j)$, which depends on their relative military capabilities, $\frac{M_i}{M_j}$. Assume w_i is increasing in this military capability ratio – that is, more powerful governments enjoy better outside options.

For simplicity, assume the pie is divided via the Nash Bargaining Solution, satisfying

$$\begin{aligned} x^{\star} \in \arg\max_{x} \quad & \left(u_1(x) - w_1(M_1/M_2)\right)\left(u_2(x) - w_2(M_2/M_1)\right) \\ \text{subject to} \quad & u_1(x) \geq w_1(M_1/M_2) \\ & u_2(x) \geq w_2(M_2/M_1). \end{aligned} \tag{3.1}$$

Taking first order conditions, it is straightforward to show that the allocation to government 1, $x^{\star}$, satisfies

$$u_1(x^{\star}; M_1, M_2) = \frac{u_1'(x^{\star})}{u_2'(1-x^{\star})}\left(u_2(1-x^{\star}) - w_2(M_2/M_1)\right) + w_1(M_1/M_2).$$

Differentiating this equation with respect to government 1's military capacity, M_1, we see that $u_1(x^{\star}; M_1, M_2)$ is increasing in M_1,

$$\frac{\partial u_1(x^{\star}; M_1, M_2)}{\partial M_1} = \underbrace{-\frac{u_1'(x^{\star})}{u_2'(1-x^{\star})}\frac{\partial w_2(M_2/M_1)}{\partial M_1}}_{>0} + \underbrace{\frac{\partial w_1(M_1/M_2)}{\partial M_1}}_{>0} > 0.$$

In other words, the distance between government 1's equilibrium utility and the utility it receives at its ideal point is decreasing in its relative military advantage.

Suppose that governments endeavor to maximize the welfare of the representative consumer.[7] With the economy, h, calibrated, I can calculate the change in utility each representative consumer would experience when each other government adopts free trade, relative to their utility at the baseline set of policies. Taking this as an empirical measure of the ratio $u_1(x^{\star}; M_1, M_2)/u_1(1)$, the model implies this quantity will be increasing in M_1, country 1's military capacity. I will refer to this quantity as government 1's inverse *conquest value* vis-à-vis government 2.

Figure 3.2 plots the empirical relationship between military capability ratios and inverse conquest values. Each potential "attacking" country's military capability ratio vis-à-vis every "defending" country is plotted on the x-axis. On the y-axis is the attacking inverse country's value for conquering each defending country. Consistent with the predictions of this simple model, government's inverse conquest values correlate positively with their relative military power. Table 3.2 and Figure 3.3 display the results of a series of linear models that estimate the conditional correlations between the inverse conquest value and the military capability ratio, distance between the countries, and country-specific constants.

[7] I will relax this assumption in the structural model developed below.

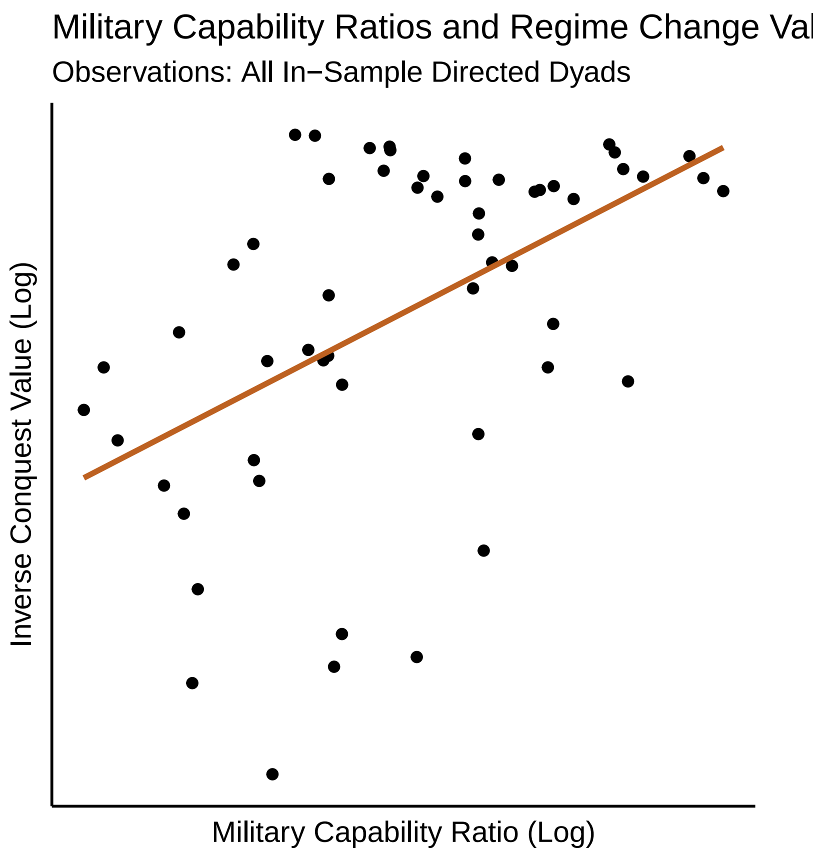


Figure 3.2: Correlation between military capability ratios and inverse conquest values, all pairs of in-sample countries.

Table 3.2: Inverse Conquest Values and Military Capability Ratios

	Base	Base (Attacker FE)	Loss of Strength	Loss of Strength (Attacker FE)
Log Mil Capability Ratio	0.016***	0.033***	0.026	0.045
	(0.004)	(0.004)	(0.052)	(0.039)
Log Distance			0.003	0.002
			(0.010)	(0.008)
(Log Mil Capability Ratio) X (Log Distance)			-0.001	-0.001
			(0.006)	(0.004)
Num.Obs.	56	56	56	56
R2	0.247	0.676	0.249	0.677
R2 Adj.	0.233	0.621	0.205	0.605
F	17.720	12.251	5.739	9.421
Attacker FE?		✓		✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

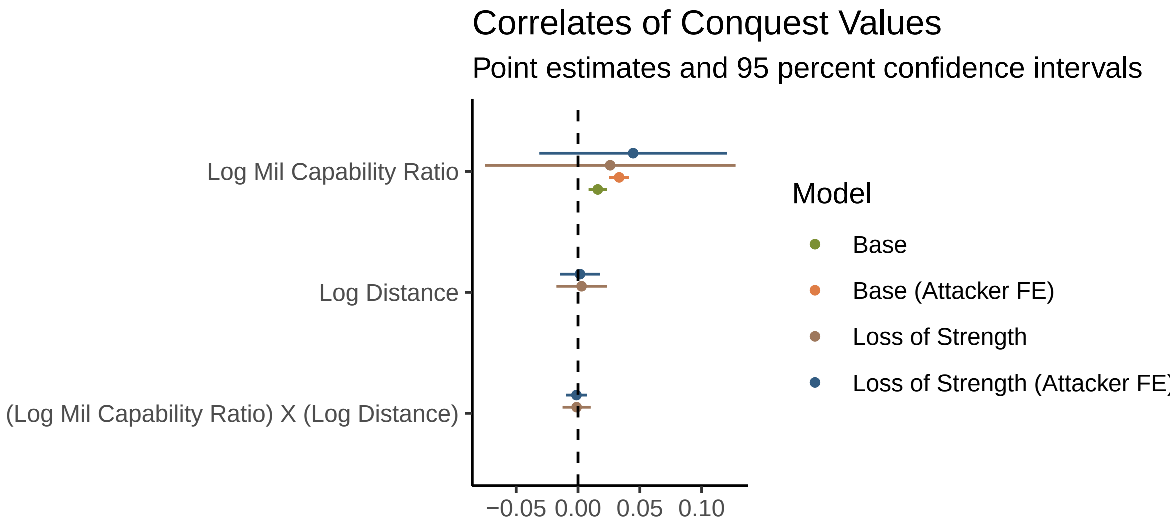


Figure 3.3: Conditional correlations between inverse conquest values and military capability ratios, geographic distance, and country-specific constants.

The first model confirms the statistical significance of the correlation shown in Figure 3.2. The second model estimates this correlation within potential "attacking" countries. Here, inverse conquest values continue to rise as military advantage rises. The final two models interact the military capability ratio with a measure of distance between the attacker and defender. The estimated correlation between military capability is not attenuated, but does lose statistical significance in these specifications. Distance and the interaction of distance with military capability does not covary with the inverse conquest values, whether or not country-specific factors are included. These raw correlations are informative about the role of coercion in the formation of trade policy but suggestive at best. Trade policy bargaining is a multilateral endeavor in which third party externalities loom large. Moreover, governments may vary in their preferences for protectionism, changing their ideal policies and their valuations for conquering others. The model developed below accounts explicitly for these features of trade policy bargaining, delivering interpretable estimates of the effects of military capability and geographic distance on trade policy outcomes.

3.4 Model

There are N governments, indexed $i \in \{1, ..., N\}$. Governments choose trade policies $\boldsymbol{\tau}_i = (\tau_{i1}, ..., \tau_{iN}) \in [1, \bar{\tau}]^N$ which affect their welfare indirectly through changes in the international economy.[8] An entry of the trade policy vector, τ_{ij} is the tax country i imposes on imports from j.[9] The economy, detailed

[8] $\bar{\tau}$ is an arbitrarily large but finite value sufficient to shut down trade between any pair of countries.

[9] Costs enter in an "iceberg" fashion, and I normalize $\tau_{ii} = 1$. Then, if the price of a good in country j is p_{jj}, its cost (less freight) in country i is $\tau_{ij} p_{jj}$. The ad valorem tariff equivalent of the trade policy is $t_{ij} = \tau_{ij} - 1$. I employ

in Appendix A, can be succinctly characterized by a function $h : \boldsymbol{\tau} \rightarrow \mathbb{R}_{++}^N$ mapping trade policies to wages in each country, denoted $\boldsymbol{w} = (w_1, ..., w_N)$. These in turn determine trade flows between pairs of countries and price levels around the world.[10]

Throughout, I will use $\boldsymbol{\theta}_m$ to denote the vector of all non-economic parameters to be estimated and $\boldsymbol{Z}_m$ to denote the vector of all non-economic data observed by the researcher. $\boldsymbol{\theta}_h$ denotes parameters associated with the economy, h, which will be calibrated. $\boldsymbol{Z}_h$ denotes data associated with the economy. I will explicate the elements of these vectors in the proceeding sections and the Appendix.

Government welfare depends on the economic consequences of trade policy choices. Governments value the welfare of a representative consumer that resides within each country. The consumer's welfare in turn depends on net revenues accrued through the government's trade policy distortions, which are redistributed to the consumer. Revenues and induced welfare can be computed given knowledge of the general equilibrium function $h(\boldsymbol{\tau})$. Each government's welfare is given by $V_i\left(h(\boldsymbol{\tau}); v_i\right)$ where v_i is a revenue threshold parameter. This value of this function depends on the consumer's net income and is characterized fully in the Appendix. The consumer's net income can be written as a function of the governments' policy choices

$$\tilde{Y}_i(h_i(\boldsymbol{\tau})) = h_i(\boldsymbol{\tau})L_i + r_i(h(\boldsymbol{\tau}); v_i).$$

L_i is the country's labor endowment, $r_i(h(\boldsymbol{\tau}); v_i)$ is trade policy revenues, and $h_i(\boldsymbol{\tau})$ are equilibrium wages in i. $v_i \in [1, \infty)$ is a structural parameter that modulates the government's ability to extract trade policy rents.

Adjusted revenues are given by

$$r_i(h(\boldsymbol{\tau}), v_i) = \sum_j (\tau_{ij} - v_i) X_{ij}(h(\boldsymbol{\tau})) \tag{3.2}$$

and $X_{ij}(h(\boldsymbol{\tau}))$ are country i's imports from country j.[11] When v_i is close to one, small policy distortions are sufficient to generate revenue for the government. Conversely when v_i is high, the government must erect large barriers to trade before revenues begin entering government coffers

structural estimates of these costs from Cooley (2019a) to estimate the model, which are described in more detail in Appendix A.

[10]The economy is a variant of the workhorse model of Eaton and Kortum (2002).

[11]This object does not correspond empirically to governments' factual tariff revenues, as τ_{ij} incorporates a larger set of trade policy distortions than tariffs alone. Yet, non-tariff barriers to trade also generate rents that do not accrue directly to the government's accounts (see, for example, Anderson and Neary (1992) for the case of quotas). This revenue function is designed to capture this broader set of rents.

and returning to the pockets of the consumer. Because consumers' consumption possibilities depend on revenue generation, increasing v_i induces governments' to become more protectionist. This formulation provides substantial flexibility in rationalizing various levels of protectionism, while avoiding assuming specific political economic motivations for its genesis. From the perspective of the consumers, rents extracted from imports are valued equally, regardless of their source. Ex ante, governments are not discriminatory in their trade policy preferences. Optimal policies for government i maximize $V_i\left(h(\boldsymbol{\tau}_i; \boldsymbol{\tau}_{-i}); v_i\right)$.

These optimal policies impose externalities on other governments. By controlling the degree of market access afforded to foreign producers, trade policies affect the wages of foreign workers and the welfare of the governments that represent them. They also partially determine trade flows, which affect other governments' ability to collect rents. In this sense, protectionism is "beggar thy neighbor." Governments' joint policy proposals are denoted $\tilde{\boldsymbol{\tau}}$.

Wars are fought in order to impose free trade abroad. After observing policy proposals, governments decide whether or not to launch wars against one another. Wars are offensive and *directed*. If government j decides to launch a war against i it pays a dyad-specific cost, c_{ji}, and imposes free trade on the target. These war costs are modeled as realizations of a random variable from a known family of distributions and are held as private information to the prospective attacker. The shape of these distributions is affected by the governments' relative power resources, denoted $\frac{M_j}{M_i}$, as well as the geographic distance between them, W_{ji}. These inverse value of these costs are distributed with c.d.f. F_{ji} which is described in more detail below. I normalize the cost of defending against aggression to zero.

If i is not attacked by any other government its announced policies are implemented. Otherwise, free trade is imposed, setting $\boldsymbol{\tau}_i = (1, \ldots, 1) = \mathbf{1}_i$. Substituting these policies into j's utility function gives $V_j(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i})$ as j's *conquest value* vis-à-vis i. Note that I prohibit governments from imposing discriminatory policies on conquered states. Substantively, this assumption reflects the difficulty in enforcing sub-optimal policies on prospective client states, relative to reorienting their political institutions to favor free trade. This also ensures that the benefits of conquest are public. However, it does not guarantee non-discrimination in times of peace. Governments that pose the most credible threat of conquest can extract larger policy concessions from their targets in the form of directed trade liberalization.

Government j therefore prefers not to attack i so long as

$$
\begin{aligned}
V_j\left(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i}\right) - c_{ji} &\leq V_j\left(\tilde{\boldsymbol{\tau}}\right) \\
c_{ji}^{-1} &\leq \left(V_j\left(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i}\right) - V_j\left(\tilde{\boldsymbol{\tau}}\right)\right)^{-1}
\end{aligned}
$$

or if the benefits from imposing free trade on i are outweighed by the costs, holding other governments' policies fixed. The probability that no government finds it profitable to attack i can then be calculated as

$$
H_i\left(\tilde{\boldsymbol{\tau}}; \boldsymbol{Z}_m, \boldsymbol{\theta}_m\right) = \prod_{j \neq i} F_{ji}\left(\left(V_j\left(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i}\right) - V_j\left(\tilde{\boldsymbol{\tau}}\right)\right)^{-1}\right)
$$

I am agnostic as to the process by which the coordination problem is resolved in the case in which multiple prospective attackers find it profitable to attack i. I assume simply that i is attacked with certainty when it is profitable for any government to do so. This event occurs with probability $1 - H_i(\tilde{\boldsymbol{\tau}}; \boldsymbol{Z}_m, \boldsymbol{\theta}_m)$.

Because of strategic interdependencies between trade policies, optimal policy proposals are difficult to formulate. Governments face a complex problem of forming beliefs over the probabilities that they and each of their counterparts will face attack and the joint policies that will result in each contingency. For simplicity, I assume governments solve the simpler problem of maximizing their own utility, assuming no other government faces attack. I denote this objective function with $G_i(\tilde{\boldsymbol{\tau}})$ which can be written

$$
G_i(\tilde{\boldsymbol{\tau}}) = H_i(\tilde{\boldsymbol{\tau}}; \boldsymbol{Z}_m, \boldsymbol{\theta}_m) V_i(\tilde{\boldsymbol{\tau}}) + \left(1 - H_i(\tilde{\boldsymbol{\tau}}; \boldsymbol{Z}_m, \boldsymbol{\theta}_m)\right) V_i(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i}) \tag{3.3}
$$

where $V_i(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i})$ denotes i's utility when free trade is imposed upon it. This objective function makes clear the tradeoff i faces when making policy proposals. Policies closer to i's ideal point deliver higher utility conditional on peace, but raise the risk of war. Lowering barriers to trade on threatening countries increases $H_i(\tilde{\boldsymbol{\tau}}; \boldsymbol{Z}, \boldsymbol{\theta}_m)$, the probability i avoids war, at the cost of larger deviations from policy optimality.

Policy proposals are made simultaneously. Let $\tilde{\boldsymbol{\tau}}_i^{\star}(\tilde{\boldsymbol{\tau}}_{-i})$ denote a solution to this problem and $\tilde{\boldsymbol{\tau}}^{\star}$ a Nash equilibrium of this policy announcement game.

3.4.1 Policy Equilibrium in Changes

The equilibrium of the international economy depends on a vector of structural parameters and constants $\boldsymbol{\theta}_h$ defined in Appendix A. Computing the economic equilibrium $h(\boldsymbol{\tau}; \boldsymbol{\theta}_h)$ requires knowing these values. Researchers have the advantage of observing data related to the equilibrium mapping for one particular $\boldsymbol{\tau}$, the factual trade policies.

The estimation problem can be therefore partially ameliorated by computing the equilibrium in *changes*, relative to a factual baseline. Consider a counterfactual trade policy τ'_{ij} and its factual analogue τ_{ij}. The counterfactual policy can be written in terms of a proportionate change from the factual policy with $\tau'_{ij} = \hat{\tau}_{ij}\tau_{ij}$ where $\hat{\tau}_{ij} = 1$ when $\tau'_{ij} = \tau_{ij}$. By rearranging the equilibrium conditions, I can solve the economy in changes, replacing $h(\boldsymbol{\tau}; \boldsymbol{\theta}_h) = \boldsymbol{w}$ with $\hat{h}(\hat{\boldsymbol{\tau}}; \boldsymbol{\theta}_h) = \hat{\boldsymbol{w}}$. Counterfactual wages can then be computed as $\boldsymbol{w}' = \boldsymbol{w} \odot \hat{\boldsymbol{w}}$.

This method is detailed in Appendix A. Because structural parameters and unobserved constants do not change across equilibria, parameters that enter multiplicatively drop out of the equations that define this "hat" equilibrium. This allows me to avoid estimating these parameters, while enforcing that the estimated equilibrium is consistent with their values. The methodology, introduced by Dekle, Eaton, and Kortum (2007), is explicated further in Costinot and Rodríguez-Clare (2015) and used to study trade policy in Ossa (2014) and Ossa (2016).

It is straightforward to extend this methodology to the game studied here. Consider a modification to the policy-setting game described above in which governments propose changes to factual trade policies, denoted $\hat{\tilde{\boldsymbol{\tau}}}$. Note that this modification is entirely cosmetic – the corresponding equilibrium in levels can be computed by multiplying factual policies by the "hat" equilibrium values ($\tau'_{ij} = \hat{\tau}_{ij}\tau_{ij}$). I can then replace the equilibrium conditions above with their analogues in changes.

Let $\hat{V}_j(\hat{\tilde{\boldsymbol{\tau}}})$ denote changes in j's consumer welfare under proposed policy changes. Prospective attackers' peace conditions can be written in changes as

$$\hat{c}_{ji}^{-1} \leq \left(\hat{V}_j \left(\mathbf{1}_i; \hat{\tilde{\boldsymbol{\tau}}}_{-i} \right) - \hat{V}_j \left(\hat{\tilde{\boldsymbol{\tau}}} \right) \right)^{-1}$$

where

$$\hat{c}_{ji} = \frac{c_{ji}}{V_j(\boldsymbol{\tau})}$$

measures the share of j's utility lost to wage a war with i. I assume the inverse relative cost of war

j incurs when attacking i is distributed Frechét with

$$\Pr\left(\frac{1}{\hat{c}_{ji}} \leq \frac{1}{\hat{c}}\right) = \hat{F}_{ji}\left(\frac{1}{\hat{c}}\right) = \exp\left(-\frac{1}{\hat{C}}\left(\frac{M_j}{M_i}\right)^{\gamma} W_{ji}^{-\alpha_1} Y_j^{\alpha_2} \hat{c}^{\eta}\right). \tag{3.4}$$

The parameters α_1 and γ govern the extent to which military advantage and geographic proximity are converted into cost advantages. If γ is greater than zero, then military advantage reduces the costs of war. Similarly, if α_1 is greater than zero, then war costs increase with geographic distance, consistent with a loss of strength gradient. Because costs are now measured relative to baseline utility, I include a measure of the attacking country's g.d.p., Y_j in the cost distribution. If α_2 is positive, larger countries sacrifice a smaller percentage of their welfare when prosecuting wars. $\hat{C}$ and η are global shape parameters that shift the cost distribution for all potential attackers and are calibrated.[12]

Each government's objective function (3.3) in changes is

$$\hat{G}_i(\hat{\tilde{\boldsymbol{\tau}}}) = \hat{H}_i(\hat{\tilde{\boldsymbol{\tau}}}; \boldsymbol{Z}, \boldsymbol{\theta}_m)\hat{V}_i(\hat{\tilde{\boldsymbol{\tau}}}) + \left(1 - \hat{H}_i(\hat{\tilde{\boldsymbol{\tau}}}; \boldsymbol{Z}, \boldsymbol{\theta}_m)\right)\hat{V}_i(\mathbf{1}_i; \hat{\tilde{\boldsymbol{\tau}}}_{-i}) \tag{3.5}$$

where

$$\hat{H}_i\left(\hat{\tilde{\boldsymbol{\tau}}}; \boldsymbol{Z}, \boldsymbol{\theta}_m\right) = \prod_{j \neq i} \hat{F}_{ji}\left(\left(\hat{V}_j\left(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i}\right) - \hat{V}_j\left(\hat{\tilde{\boldsymbol{\tau}}}\right)\right)^{-1}\right).$$

With Frechét-distributed relative costs this equation has a closed functional form, with

$$\hat{H}_i\left(\hat{\tilde{\boldsymbol{\tau}}}; \boldsymbol{Z}, \boldsymbol{\theta}_m\right) = \exp\left(-\sum_{j \neq i} -\frac{1}{\hat{C}}\left(\frac{M_j}{M_i}\right)^{\gamma} W_{ji}^{-\alpha_1} Y_j^{\alpha_2}\left(\hat{V}_j\left(\mathbf{1}_i; \tilde{\boldsymbol{\tau}}_{-i}\right) - \hat{V}_j\left(\hat{\tilde{\boldsymbol{\tau}}}\right)\right)^{-\eta}\right).$$

Let $\hat{\tilde{\boldsymbol{\tau}}}_i^{\star}(\hat{\tilde{\boldsymbol{\tau}}}_{-i})$ denote a solution to policy change proposal problem and $\hat{\tilde{\boldsymbol{\tau}}}^{\star}(\boldsymbol{\theta}_m; \boldsymbol{Z}_m)$ a Nash equilibrium of this policy change announcement game.

3.5 Estimation

The model's equilibrium, $\hat{\tilde{\boldsymbol{\tau}}}^{\star}$ depends on a vector of unobserved parameters $\boldsymbol{\theta}_m = (\boldsymbol{v}, \alpha_1, \alpha_2, \gamma)$. I assume observed policies are generated by the model up to measurement error

$$\tilde{\boldsymbol{\tau}} = \tilde{\boldsymbol{\tau}}^{\star}(\boldsymbol{\theta}_m, \boldsymbol{Z}_m) + \boldsymbol{\epsilon}.$$

[12] I set $\hat{C} = 25$ and $\eta = 1.5$. By shifting all potential attackers' war costs, $\hat{C}$ modulates the probability of war in the data and could be estimated on data describing the likelihood of war between in-sample countries in any given year. Because no wars occur in the period I study, I do not undertake this exercise.

$\boldsymbol{\epsilon}$ is an $N \times N$ matrix with $\epsilon_{ii} = 0$ for all i and $\mathrm{E}[\epsilon_{ij}] = 0$ for all $i \neq j$. Recall that $\tilde{\boldsymbol{\tau}}^{\star}$ can be reconstructed from $\hat{\tilde{\boldsymbol{\tau}}}^{\star}$, the model's equilibrium, by simply multiplying equilibrium policies by factual policies, $\boldsymbol{\tau}$.

Following the assumption that measurement error is mean-zero, I seek an estimator that solves

$$\min_{\boldsymbol{\theta}_m} \sum_i \sum_j \left(\epsilon_{ij}(\boldsymbol{\theta}_m, \boldsymbol{Z}_m)\right)^2 . \tag{3.6}$$

Solving this problem presents two computational challenges. First, computing government welfare changes for any given $\hat{\boldsymbol{\tau}}$ requires solving the system of equations characterizing the equilibrium of the international economy, $\hat{h}(\hat{\boldsymbol{\tau}})$. These changes must be computed for both the proposed policies and for policies imposed by each potential war. Second, computing $\tilde{\boldsymbol{\tau}}^{\star}(\boldsymbol{\theta}_m)$ requires iteratively solving each government's best response problem until convergence at a Nash equilibrium. I sidestep both of these by recasting the best response problem and estimation problem as mathematical programs with equilibrium constraints (MPECs) (Su and Judd 2012; Ossa 2014, 2016).

To reformulate the best response problem, I consider an equivalent formulation in which each government chooses trade policies and wages, subject to the additional constraint that chosen wages are consistent with the general equilibrium of the international economy ($\hat{h}(\hat{\tilde{\boldsymbol{\tau}}}) = \hat{w}$). Let $\hat{\boldsymbol{x}}_i = \left(\hat{\tilde{\boldsymbol{\tau}}}_i, \hat{\boldsymbol{w}}\right)$ store i's choice variables in this problem. Then, this problem can be rewritten as follows, noting explicitly dependencies on $\boldsymbol{\theta}_m$

$$\begin{aligned} \max_{\hat{\boldsymbol{x}}_i} \quad & \hat{G}_i(\hat{\boldsymbol{w}}; \boldsymbol{\theta}_m) \\ \text{subject to} \quad & \hat{\boldsymbol{w}} = \hat{h}(\hat{\tilde{\boldsymbol{\tau}}}). \end{aligned} \tag{3.7}$$

Let $\mathcal{L}_i(\hat{\boldsymbol{x}}_i, \boldsymbol{\lambda}_i)$ denote the associated Lagrangian. This formulation allows me to quickly compute best responses $\hat{\tilde{\boldsymbol{\tau}}}_i(\hat{\tilde{\boldsymbol{\tau}}}_{-i})$ without iteratively solving $h(\hat{\tilde{\boldsymbol{\tau}}})$.

I then reformulate the estimation problem (3.6) in a similar manner. At an interior Nash equilibrium, the gradient of the Lagrangian is null

$$\nabla_{\hat{\tilde{\boldsymbol{\tau}}}_i} \mathcal{L}_i(\hat{\boldsymbol{x}}_i, \boldsymbol{\lambda}_i; \boldsymbol{\theta}_m) = \mathbf{0}$$

for each government i. In the reformulated estimation problem, I seek to choose parameters, trade policies, multipliers, and general equilibrium response variables for the proposed policies and imposed policies in order to minimize measurement error while enforcing these equilibrium constraints, in addition to general equilibrium constraints. Let $\hat{\boldsymbol{x}}_i' = \left(\mathbf{1}_i, \hat{\tilde{\boldsymbol{\tau}}}_{-i}, \hat{\boldsymbol{w}}_i'\right)$ store general equilibrium equilibrium policies and wages when free trade is imposed on i.

Formally, I solve

$$\begin{aligned} \min_{\boldsymbol{\theta}_m, \hat{\tilde{\boldsymbol{\tau}}}, \hat{\boldsymbol{w}}, \hat{\boldsymbol{w}}', \boldsymbol{\lambda}} \quad & \sum_i \sum_j (\epsilon_{ij})^2 \\ \text{subject to} \quad & \nabla_{\hat{\tilde{\boldsymbol{\tau}}}_i} \mathcal{L}_i(\hat{\boldsymbol{x}}_i, \boldsymbol{\lambda}_i; \boldsymbol{\theta}_m) = \mathbf{0} \text{ for all } i \\ & \hat{\boldsymbol{w}} = \hat{h}\left(\hat{\tilde{\boldsymbol{\tau}}}\right) \\ & \hat{\boldsymbol{w}}_i' = \hat{h}\left(\mathbf{1}_i, \hat{\tilde{\boldsymbol{\tau}}}_{-i}\right) \text{ for all } i \end{aligned} \tag{3.8}$$

The constraints collectively ensure $\hat{\tilde{\boldsymbol{\tau}}} = \tilde{\boldsymbol{\tau}}^\star(\boldsymbol{\theta}_m)$ – or that the policies are consistent with Nash equilibrium in policies, given estimated parameters.

This procedure produces point estimates $\tilde{\boldsymbol{\theta}}_m$. I then construct uncertainty intervals through nonparametric bootstrap, taking 250 bootstrapped samples from the distribution of estimated policy barriers in Cooley (2019a) and re-solving (3.6).

3.6 Results

Figure 3.4 displays results from the estimation. Recall that v_i governs the ease with which governments can extract revenues from trade policy distortions. When v_i is higher government i prefers higher barriers to trade, all else equal. When $v_i = 1$ the government acts as a classical social welfare maximizer. There is considerable heterogeneity in governments' estimated preferences for protectionism. The United States and Russia are estimated to be relatively liberal, while Australia and Canada are quite protectionist.

An attacking country's military advantage and g.d.p. are estimated to reduce war costs, facilitating coercion. There are increasing returns to both of these features in reducing the average costs of war ($\gamma, \alpha_2 > 1$). Economically large and military powerful countries are the most effective at coercion, holding the distance of their adversary constant. Figure 3.5 displays estimated average war costs, relative to those of the United States, holding the distance to the adversary constant. Given its large economy and military, the United States is estimated to enjoy the smallest average war costs. The European Union, China, and Russia pay between 3 and 6 times the costs of the United States to prosecute wars on average. Wars are estimated to cost at least an order of magnitude more than U.S. wars for other countries in the sample.

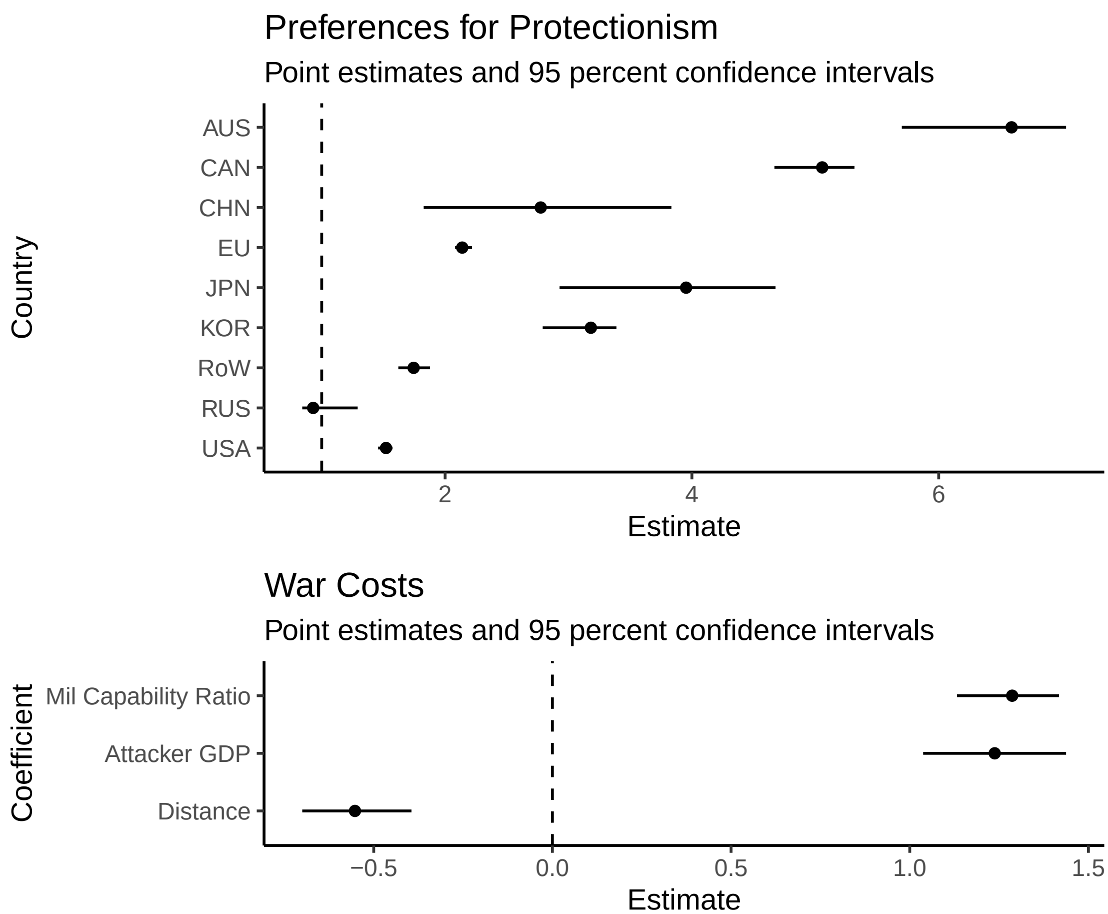


Figure 3.4: Model parameter estimates and 95 percent confidence intervals. The top panel shows protectionism preference parameter estimates (v_i) for each country. The bottom panel shows parameter estimates for observables affecting costs of war ($\gamma, \alpha_1, \alpha_2$).

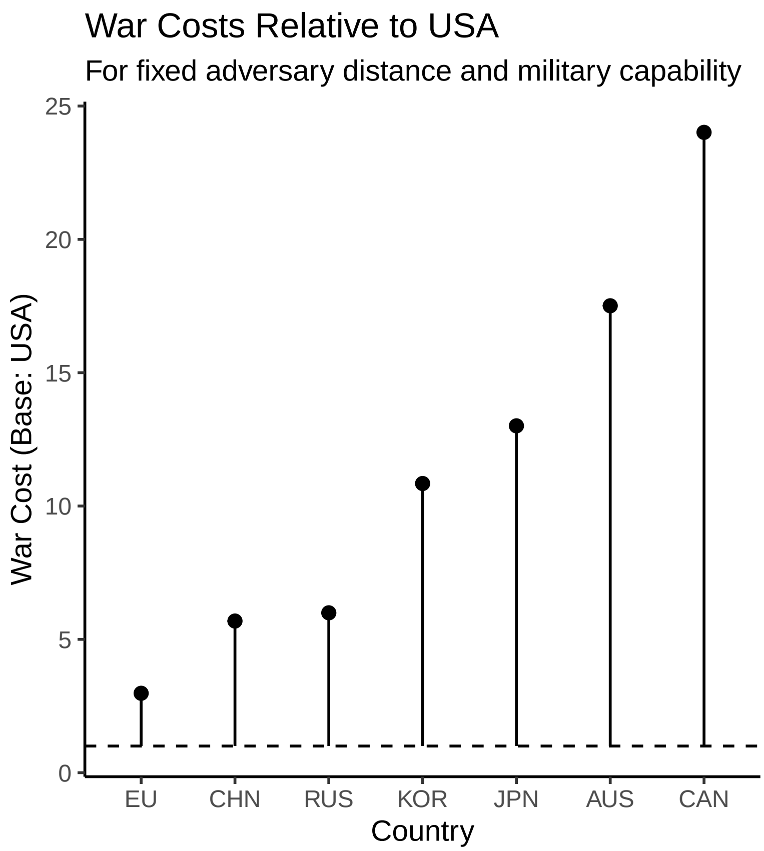


Figure 3.5: Estimated relative war costs against a fixed adversary. The United States' costs serve as baseline ($c = 1$).

War costs are estimated to depend on the distance between the attacker and potential adversary. Attackers that are more distant from their adversaries are estimated to enjoy smaller war costs. In other words, model estimates imply an inverse loss of strength gradient. This may emerge due to the peculiarities of military technology in 2011, a period in which geographic distance represents a uniquely small impediment to the projection of force.

The model estimates can be readily transformed to deliver empirical quantities that measure the salience of military coercion in international relations. Figure 3.6 plots the estimated conquest value for each potential attacking country vis-à-vis each potential defending country. These quantities differ from those analyzed in the reduced form section above in that they account explicitly for the attacking government's preferences for protectionism. Russia's conquest values are estimated to be among the highest in the sample. This reflects the relatively poor market access conditions it enjoys at the estimated equilibrium. Because their economies are the largest in the sample, the gains that accrue from successfully conquering the United States, China and the European Union tend to be larger than the gains from conquering other countries. Australia, Canada, and China benefit little from conquering others. This result obtains because of their governments' estimated preferences for protectionism. Conquest stimulates trade that is disadvantageous for a government i when v_i is high and i's trade barriers are lowered below the revenue threshold due to the effects of coercion. This variation in conquest values highlights the dependence of the coercive environment on the underlying international economy and government preferences.

It is also straightforward to calculate the equilibrium probability of war once the model has been estimated by simply plugging parameter estimates back into the inverse cost distribution given in Equation 3.4.[13] Figure 3.7 plots point estimates and uncertainty intervals surrounding the likelihood of war between all pairs of countries in the sample. In general, governments run very small risks of invasion from other governments. However, the threat of war with the United States looms large in the sample. The probabilities the United States attacks each other country in the sample are highlighted in orange in the Figure. The European Union is also estimated to impose substantial threats.

It is worth noting that the countries with the highest estimated risk of war with the United States, Japan and Australia, happen to be U.S. allies. The security guarantees encapsulated in these alliances are not explicitly modeled. One way to interpret these results is that Australian and Japanese security would deteriorate rapidly in the absence of U.S. military protection, representing

[13] These estimated probabilities of war should be interpreted only in relative terms. The overall probability of war is governed by the calibrated parameter $\hat{C}$. Higher values of this parameter would scale down each probability of war but would not shift their relative values.

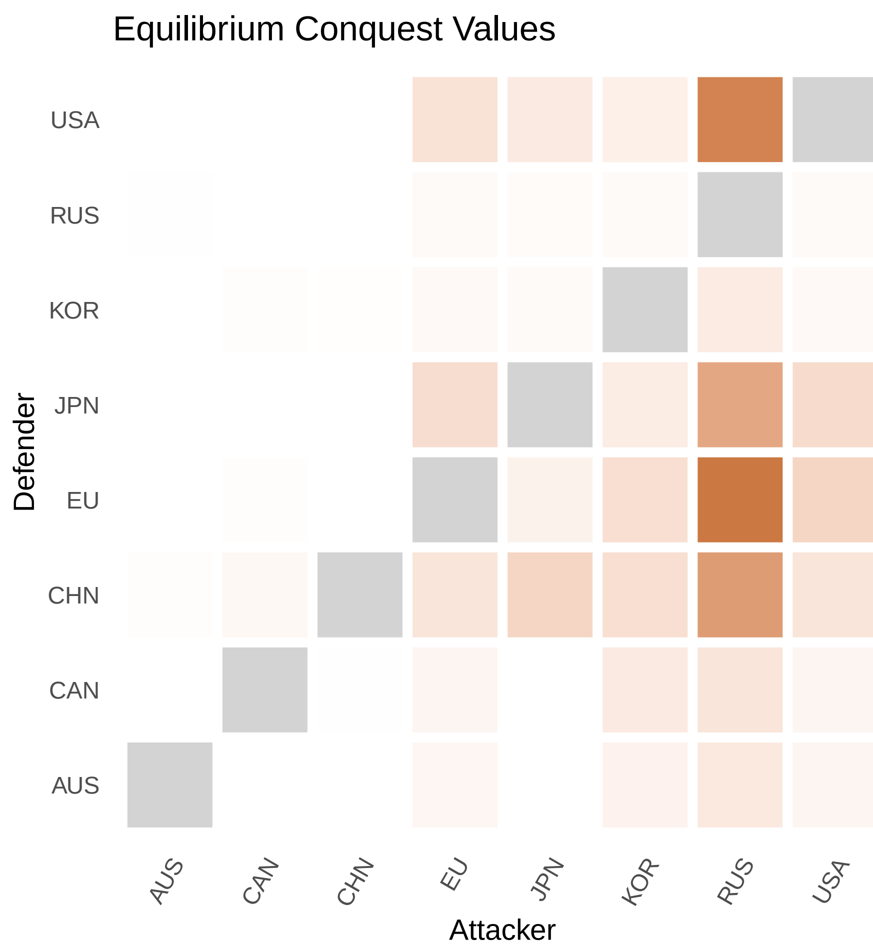


Figure 3.6: Estimated conquest value for each potential attacking country vis-à-vis each potential defending country. Darker colors indicate higher conquest values.

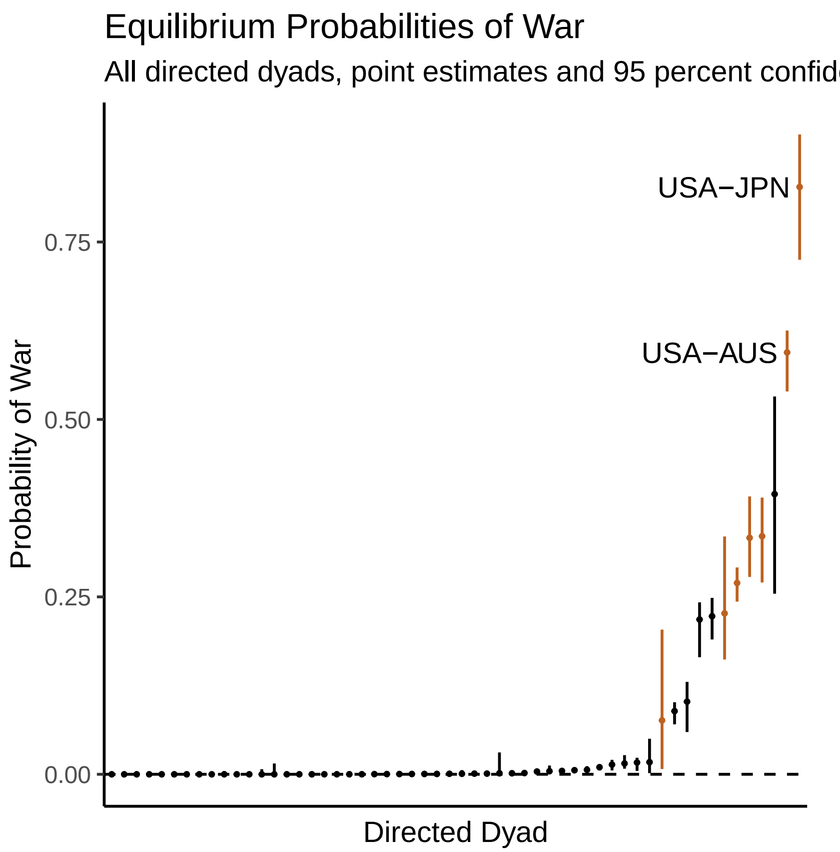


Figure 3.7: Estimated equilibrium probabilities of war, point estimates and 95 percent confidence intervals. Probabilities the United States attacks each other country highlighted in orange.

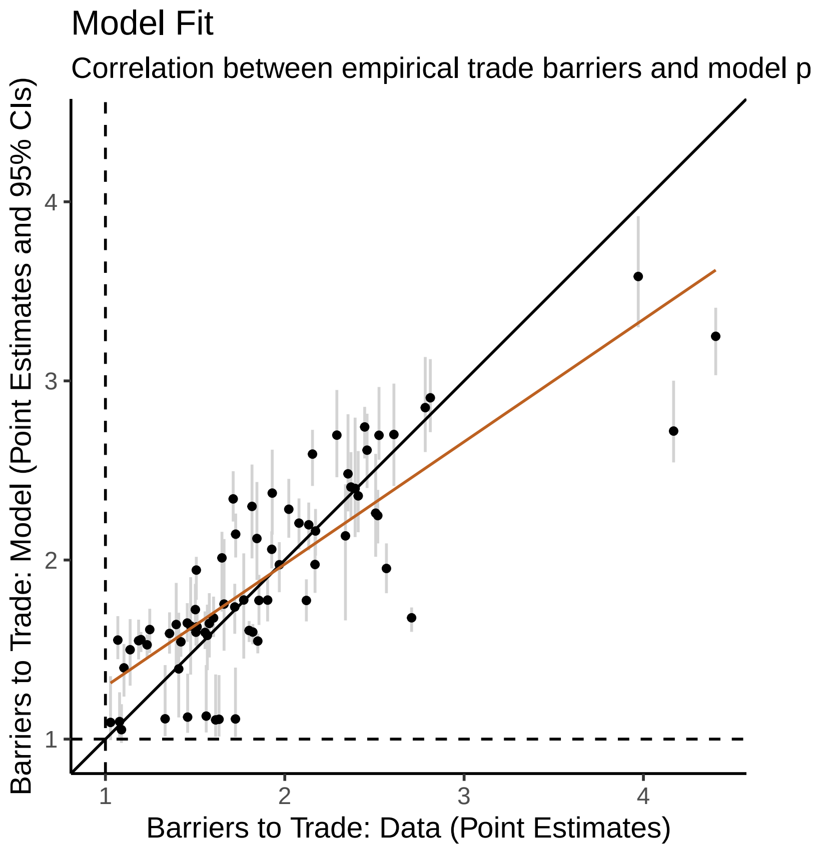


Figure 3.8: Correlation between trade barrier data and model predictions.

an implicit threat the United States can leverage to affect trade policy.[14]

3.6.1 Model Fit and Inferences about Policy Preferences

Figure 3.8 evaluates the ability of the estimated model to predict the level of trade barriers. The model's mean absolute error is 0.27, equivalent to a 27 percent ad valorem tariff. The model's predictions are fairly well correlated with the trade barrier data ($\rho = 0.68$). In Appendix C I plot the model's predictive error for each directed dyad in the sample, highlighting which observations are well explained by the model and which are not. Of note, Russia faces uniquely poor market access conditions in the data that the model does not fully replicate.

Modeling coercion explicitly both improves model fit and alters inferences about government's underlying preferences for protectionism. I re-estimate the model under the assumption that coercion is impossible. In this model, equilibrium policies reflect only governments' underlying preferences, v_i. Estimated preferences for protectionism under this model are shown in Figure 3.9. The es-

[14]Lake (2007) would label these relationships "hierarchical" and based on the authority of the United States to dictate the policy of its subordinates. Still, in Lake's conceptualization, "authority is buttressed by the capacity for coercion" (p. 53).

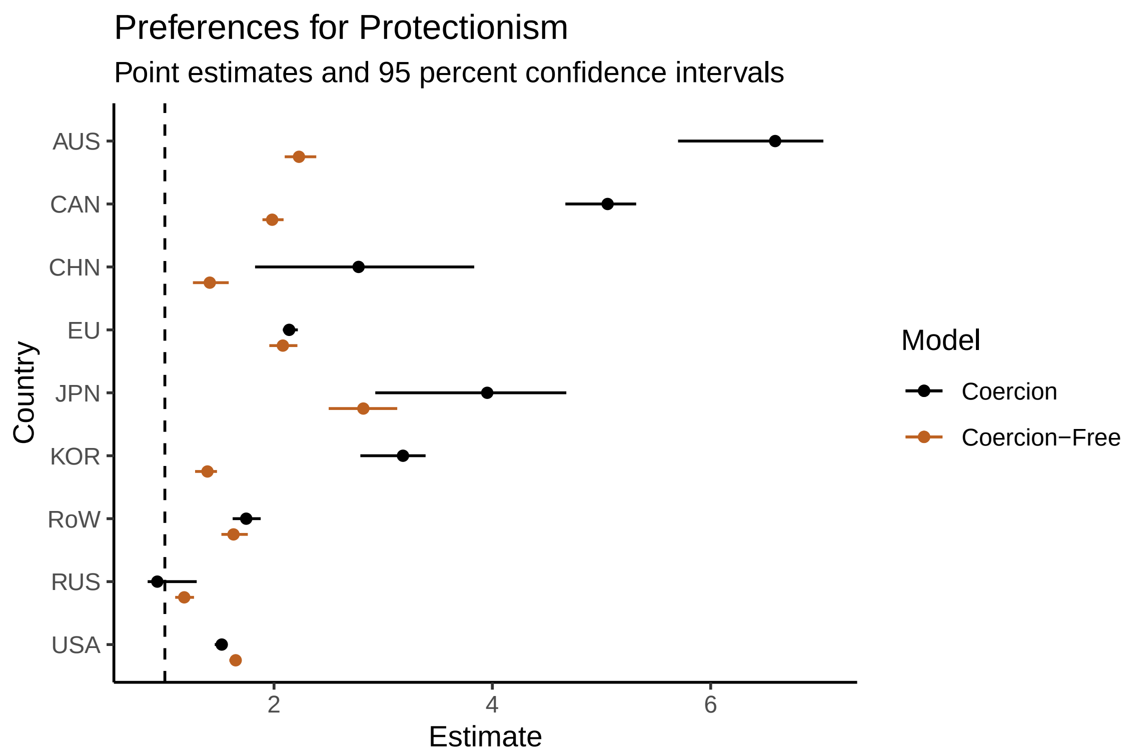


Figure 3.9: Effect of modeling military coercion on inferences about governments' preferences for protectionism. Figure plots point estimates and 95 percent confidence intervals for preference parameters under baseline model and model in which coercion is impossible.

timated preferences of militarily powerful countries are largely unchanged across models. This is not true for less powerful countries. The estimated preferences of Australia, Canada, and China move dramatically when coercion is prohibited. The model developed here rationalizes their trade barriers as the result of highly protectionist latent preferences tempered by the effects of international coercion. The coercion-free model instead infers instead that they are relatively liberal in their preferences. Leaving coercion out of the model exerts downward bias on estimates of governments' welfare-mindedness. A large literature employs the equilibrium trade policies of Grossman and Helpman (1994) or Grossman and Helpman (1995) to estimate the weight governments place on the welfare of special interests relative to that of society at large (Goldberg and Maggi 1999; Mitra, Thomakos, and Ulubasoglu 2006; Gawande, Krishna, and Olarreaga 2009, 2012, 2015; Ossa 2014). Because the "protection for sale" model incorporates no theory of international coercion, these studies over-estimate governments' social welfare consciousness.

Modeling coercion explicitly also improves model fit substantially. The correlation coefficient between model predictions and observed trade barriers falls to 0.45 when coercion is prohibited. The mean absolute error increases 19.9 percent to 0.32. In Appendix C I replicate Figure 3.8 for the coercion-free model.

3.7 Counterfactuals: Coercion and the World Economy

How does the shadow of coercion affect the functioning of the world economy? How would patterns of trade and trade protectionism change if governments' power resources or preferences were modified? With model estimates computed, this class of questions can be addressed through recomputing the model's equilibrium at alternative sets of parameters or data. In other words, compute $\tilde{\boldsymbol{\tau}}^\star(\boldsymbol{\theta}_m'; \boldsymbol{Z}_m')$ where $\boldsymbol{\theta}_m'$ and $\boldsymbol{Z}_m'$ are alternative arrangements of parameters and observable model primitives, respectively. Changes to the economy can then be computed by substituting these counterfactual equilibrium policies into the model of the world economy, solving $h\left(\tilde{\boldsymbol{\tau}}^\star(\boldsymbol{\theta}_m'; \boldsymbol{Z}_m')\right)$. I consider three counterfactual scenarios here. First, I quantify the aggregate effects of military coercion by conducting a counterfactual in which military coercion is prohibited. Second, I quantify the effects of the diffusion of military power on trade policy and the international economy by recomputing the model's equilibrium at projected levels of military spending in 2030. Finally, I quantify the effects of liberalizing Chinese trade policy preferences on the probability of various wars.

3.7.1 A Coercion-Free World

First, I calculate the net economic effects of coercion by calculating the equilibrium to a game in which coercion is impossible, holding governments' preferences at their estimated values. The shadow of coercion is a substantial force for trade liberalization. Moving from this counterfactual "pacifist" world to the coercive equilibrium delivers a 63 percent increase in the value of total global trade. Figure 3.10 disaggregates these changes in trade flows, showing the change in imports induced by demilitarization for each importer-exporter pair. It also shows the changes in equilibrium trade policy that generate these changes in trade flows.

U.S. and Russian trade policies remain largely unchanged. Yet their trade patterns are still affected by others' changes in trade policy behavior. Australia, Canada, China, and South Korea become substantially more protectionist, reducing their own trade volumes and shifting patterns of international exchange elsewhere. Trade policies in the coercion-free world are largely homogenous within adopting countries, reflecting the model's ex-ante incentives against policy discrimination. The exception to this rule is for large countries like the United States and European Union, whose counterfactual trade policies reflect dependence on the size of their trading partners, consistent with optimal taxation (Johnson 1953; Ossa 2014).

Figure 3.11 plots the changes in government and consumer welfare due to coercion, calculated as the difference between the coercion-free equilibrium and the baseline equilibrium. The measure of consumer welfare is calculated by setting $v_i = 1$ for all governments and evaluating the representative consumer's indirect utility at equilibrium policies, consistent with the interpretation of v_i as a political economy parameter capturing government incentives to deviate from socially optimal trade policies. Consumers benefit substantially from the trade liberalization induced by military coercion, but highly protectionist governments suffer. Australia, Canada, China, and South Korea suffer welfare losses when military coercion is permitted, relative to the counterfactual "pacifist" world. The United States government gains the most from coercion among non-RoW countries.

3.7.2 Multipolarity, Trade Policy, and International Trade

Military power in 2011 was highly concentrated in the hands of the United States (see Figure 3.1). Since 2011, other countries, China in particular, have begun to close this military capability gap with the United States. How would the continued diffusion of military power affect trade policy and patterns of international economic exchange? To answer this question I project each in-sample government's military spending in 2030, assuming military budgets grow (shrink) at their average

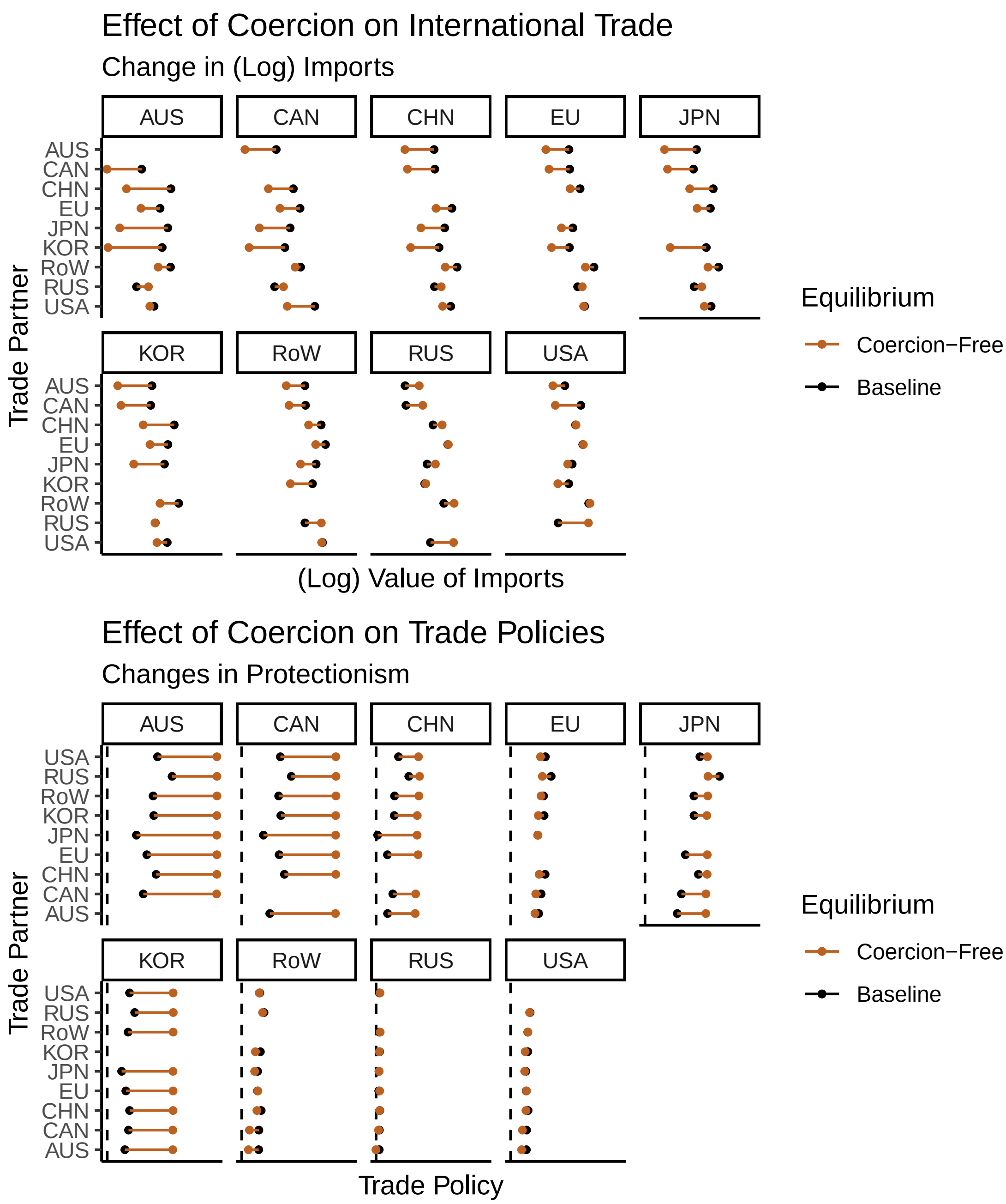


Figure 3.10: Changes in trade flows and trade policy when military coercion is counterfactually prohibited. Top plot shows changes in the (log) value of imports for each country in the sample, disaggregated by trade partner. Bottom plot shows changes in equilibrium trade policies for each country in the sample, again disaggregated by trade partner. Counterfactual import values and trade policies are shown in orange.

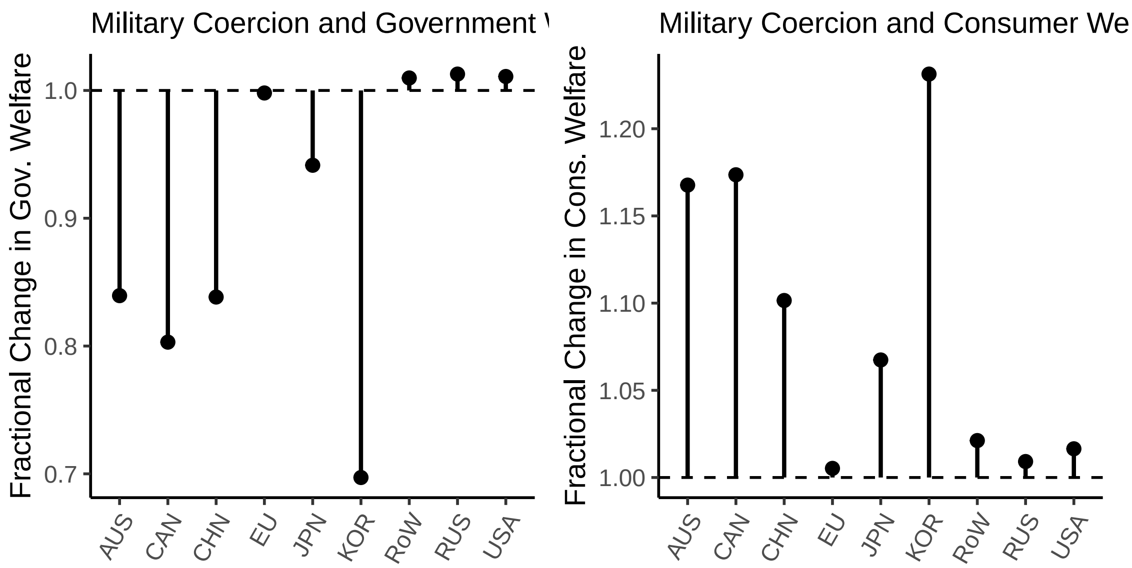


Figure 3.11: Changes in government welfare and consumer welfare (calculated by setting $v_i = 1$ for all i) induced by moving from coercion-free equilibrium to baseline equilibrium.

rate between 2011 and 2018. Projected military spending for 2030 is shown in Figure 3.12. The largest change is the shift in relative military power from the United States and European Union toward China.

Multipolarization impacts globalization in two ways. On the one hand, newly militarily powerful countries can resist others' demands to liberalize, leading to a less-integrated global economy. On the other hand, the diffusion of military power increases the coercive capacity of some states in the system, allowing them to make greater liberalization demands of others and contributing to global economic integration. These effects are mediated by governments' preferences for protectionism, which determine governments' ideal policies and the returns to coercion. In this "multipolarization" scenario, China leverages these increases in military might to adopt more restrictive trade policies. Figure 3.13 displays the changes in Chinese trade policies that result under multipolarization. On net, multipolarization is a force for liberalization. The value of global trade under multipolarization is 110.3 percent its baseline value.

3.7.3 Chinese Preference Liberalization and the Risk of War

Reducing governments' incentives for protectionism can also decrease the risk of war. By reducing governments incentives to adopt high trade barriers, preference liberalization reduces others' incentives for conquest, in turn, reducing the probability of war. To quantify these effects, I consider a liberalization of Chinese policy preferences, setting their revenue collection parameter to that of

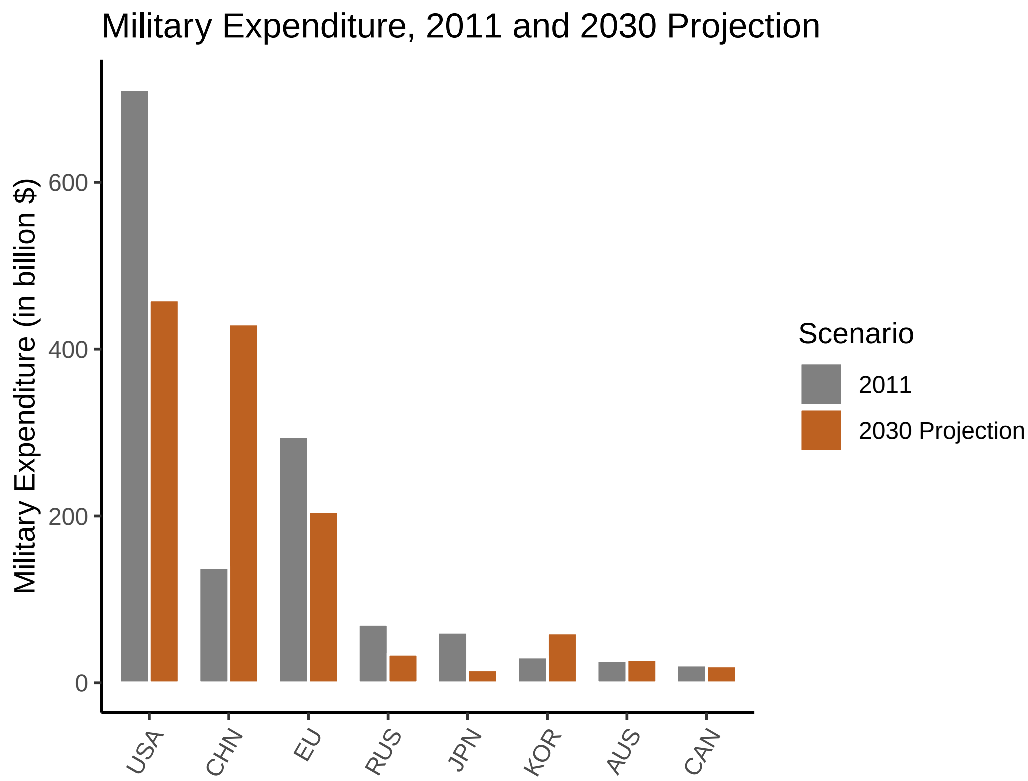


Figure 3.12: Projected military spending in 2030, assuming military budgets grow at observed average growth rate between 2011 and 2018.

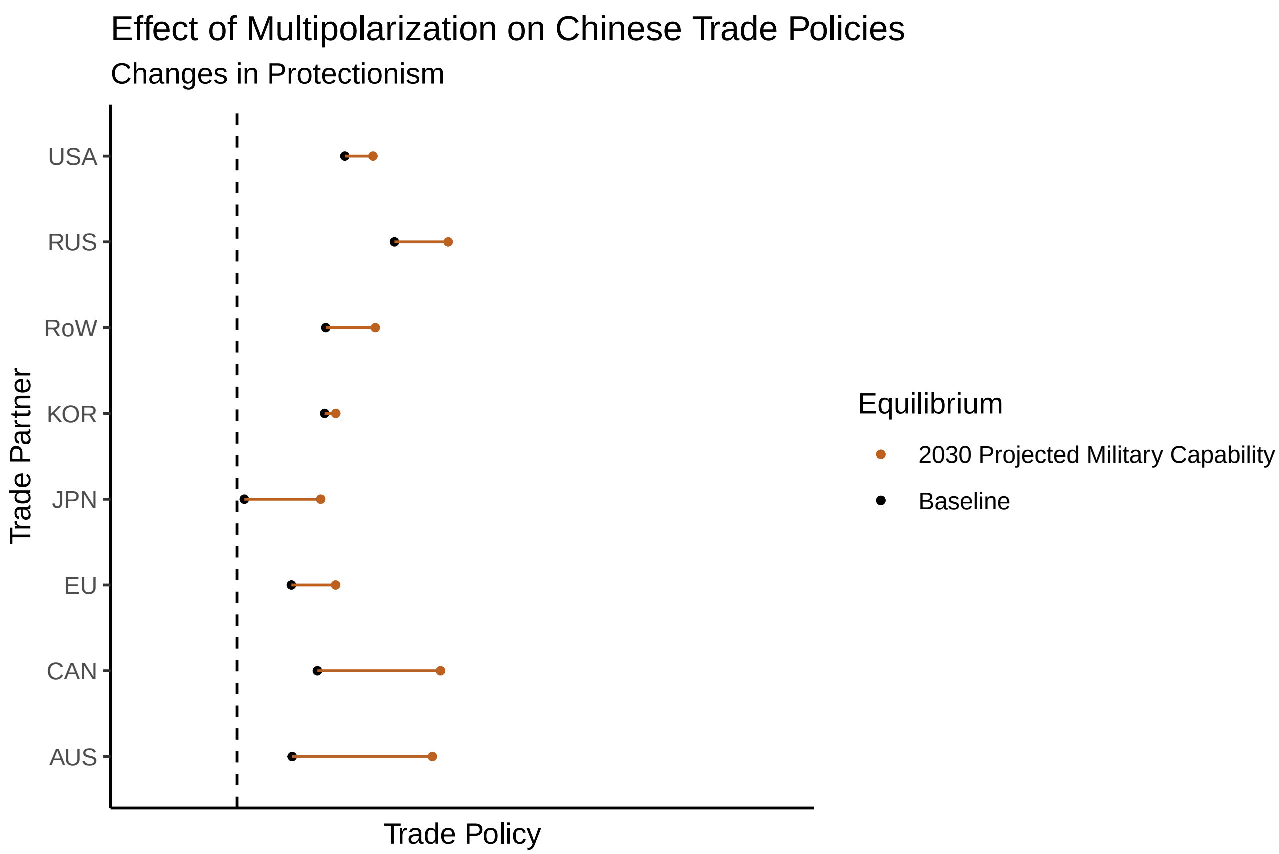


Figure 3.13: Changes in Chinese trade policies under multipolarization.

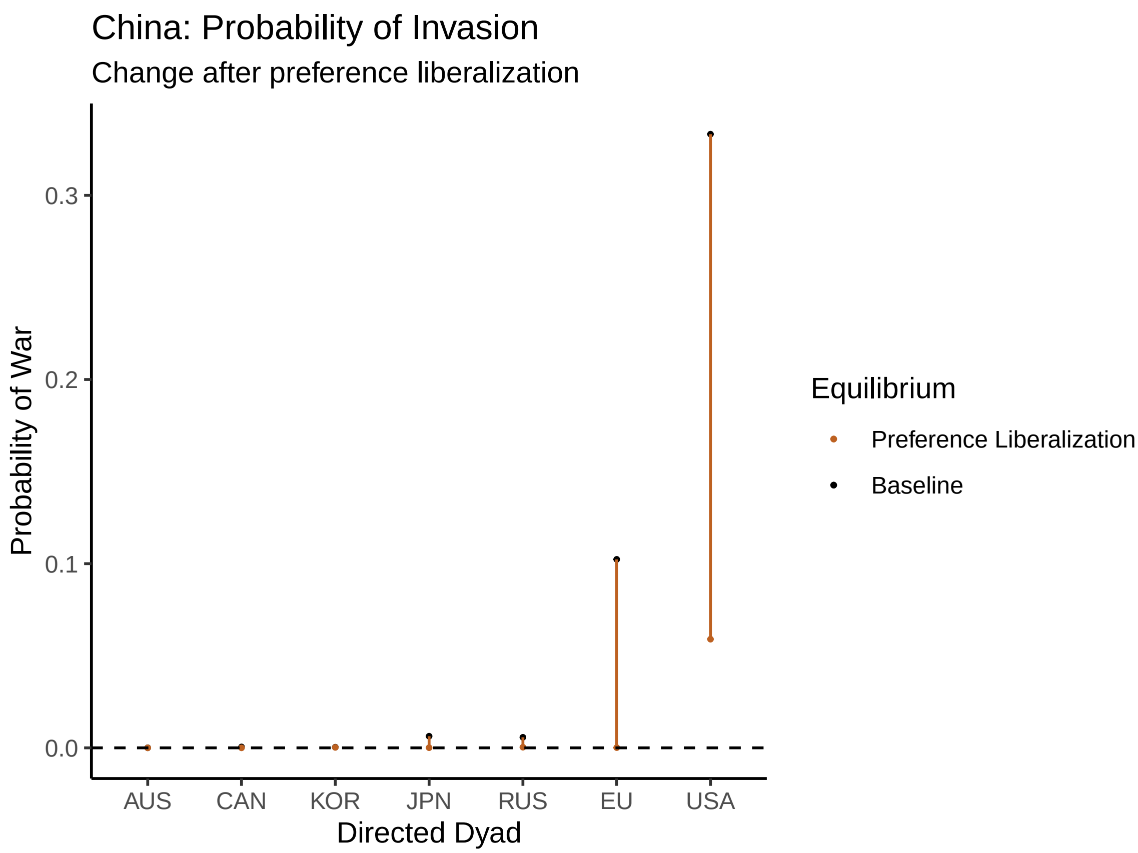


Figure 3.14: Changes in probability of war against China after Chinese preference liberalization.

the United States ($\hat{v}_{\text{CHN}} = 2.77$, $v'_{\text{CHN}} = 1.52$). Figure 3.14 shows the change in the probability of war against China that occurs as the result of this change in preferences. The United States still poses a threat of war, but the probability the United States launches a war against China is reduced substantially from 33.3 percent to 5.9 percent. The probability China faces attack from another source is virtually eliminated.

3.8 Conclusion

The shadow of power plays a central role in international relations theory, but measuring its effects has proved challenging. It is axiomatic that if governments forgo war, then they must at least weakly prefer the policy status quo to the expected policy outcomes that would result from potential wars. In this paper, I have shown that a flexible model of government preferences over trade outcomes can serve to quantify government welfare under this policy counterfactual. I then leverage the difference between factual government welfare and its conquest values to identify parameters governing the technology of coercion in international relations.

The preliminary estimates of these parameters suggest that military power indeed constrains governments' policy choice in international relations. Military spending advantage translates into battlefield advantage. These military constraints serve to contort trade policy toward the interests of the powerful as well as the resolved — those whose benefits from conquest are the largest. Military threats structure the workings of the international economy.

Drawing these conclusions requires taking seriously extant theoretical models of international conflict and international political economy. On the one hand, this limits the credibility and generalizability of the conclusions reached here — if the models are flawed, so too will our inferences about the world. On the other hand, this provides a foundation upon which empirical and theoretical research in these subfields can progress in tandem. Otherwise intractable empirical questions can be answered, leveraging the identifying assumptions embedded in these theories. And theories can be revised to account for anomalous or unreasonable empirical results that rest on these assumptions. Taking the models seriously provides answers to hard empirical questions, along with a transparent edifice upon which those answers rest.

3.9 Appendix

3.9.1 A: Economy

The economy is a variant of that of Eaton and Kortum (2002). I present the model here for clarity, but refer interested readers to their paper and Alvarez and Lucas (2007) for derivations and proofs of the existence of a general equilibrium of this economy.

Consumption

Within each country resides a representative consumer which values tradable goods and nontradable services which are aggregated in Cobb-Douglas utility function, U_i.

Consumer utility is Cobb-Douglas in a tradable goods aggregate Q_i and non-tradable services

$$U_i = Q_i^{\nu_i} S_i^{1-\nu_i} \tag{3.9}$$

ν_i determines the consumer's relative preference for tradables versus services. Total consumer expenditure is $\tilde{E}_i = E_i^q + E_i^s$ where the Cobb-Douglas preference structure imply $E_i^q = \nu_i \tilde{E}_i$ and $E_i^s = (1 - \nu_i)\tilde{E}_i$.

There is a continuum of tradable varieties indexed $\omega \in [0, 1]$ aggregated into Q_i through a constant elasticity of substitution function

$$Q_i = \left(\int_{[0,1]} q_i(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} \tag{3.10}$$

with $\sigma > 0$. With E_i^q fixed by the upper-level preference structure, consumers maximize Q_i subject to their tradable budget constraint

$$\int_{[0,1]} p_i(\omega) q_i(\omega) d\omega \leq E_i^q$$

where $p_i(\omega)$ is the price of variety ω in country i. Let $Q_i^\star$ denote a solution to this problem. The tradable price index P_i^q satisfies $P_i^q Q_i^\star = E_i^q$ with

$$P_i^q = \left(\int_{[0,1]} p_i(\omega)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Production

Consumers are endowed with labor L_i and earn wage w_i for supplying labor to producers. Services are produced competitively at cost

$$k_i^s = \frac{w_i}{z_i^s}$$

where z_i^s is country i's productivity in services. All countries can produce each tradable variety ω. Production requires labor and a tradable goods bundle of intermediate inputs (Q_i). Producing a unit of variety ω costs

$$k_i(\omega) = \frac{1}{z_i(\omega)} w_i^{1-\beta} \left(P_i^q\right)^\beta$$

with $\beta \in [0, 1]$ controlling the share of labor required in production. Total expenditure on intermediates in country i is E_i^x. $z_i(\omega)$ controls i's productivity in producing variety ω. $z_i(\omega)$ is a Fréchet-distributed random variable. $F_i(z)$ is the probability i's productivity in producing a tradable variety is less than or equal to z. With $F \sim$ Fréchet,

$$F(z) = \exp\left\{-T_i z^{-\theta}\right\}$$

where T_i is a country-specific productivity shifter and $\theta > 1$ is a global parameter that controls the variance of productivity draws around the world. When θ is large, productivity is less stochastic.

Trade Frictions

Let $p_{ij}(\omega)$ denote the price in i of a variety ω produced in j. With competitive markets in production, local prices are equal to local costs of production,

$$p_{ii}(\omega) = k_i(\omega)$$

When shipped from i to j, a variety incurs iceberg freight costs δ_{ji} and policy costs τ_{ji}, meaning

$$p_{ji}(\omega) = \tau_{ji}\delta_{ji}p_{ii}(\omega)$$

Producers and consumers alike search around the world for the cheapest variety ω, inclusive of shipping and policy costs. Equilibrium local prices therefore satisfy

$$p_i^\star(\omega) = \min_{j \in \{1,\ldots,N\}} \{p_{ij}\}$$

The set of varieties i imports from j is

$$\Omega^{\star}_{ij} = \left\{ \omega \in [0,1] \mid p_{ij}(\omega) \leq \min_{k \neq j} \{p_{ik}\} \right\}$$

Total expenditure in country i on goods from j (inclusive of freight costs and policy costs) is X_{ij}. At the border, the cost, insurance, and freight (c.i.f.) value of these goods is $X^{\text{cif}}_{ij} = \tau^{-1}_{ij} X_{ij}$. Before shipment, their free on board (f.o.b.) value is $X^{\text{fob}}_{ij} = \left(\delta_{ij}\tau_{ij}\right)^{-1} X_{ij}$

Tariff Revenue (Policy Rents)

Governments collect the difference between each variety's final value and its c.i.f. value. Total rents for government i are

$$r_i = \sum_j (\tau_{ij} - 1) X^{\text{cif}}_{ij} \tag{3.11}$$

This revenue is returned to the consumer, but is valued by the government independent of its effect on the consumer's budget.[15]

Equilibrium

In equilibrium, national accounts balance and international goods markets clear. Total consumer expenditure is equal to the sum of labor income, tariff revenue, and the value of trade deficits D_i

$$\tilde{E}_i = w_i L_i + r_i + D_i$$

Labor income is equal to the labor share of all sales of tradables globally and local services sales

$$w_i L_i = \sum_j (1 - \beta) X^{\text{cif}}_{ji} + X^s_i \tag{3.12}$$

where

$$X^s_i = E^s_i = (1 - \nu_i)(w_i L_i + r_i)$$

The remainder of consumer expenditure is spent on tradables

$$E^q_i = \nu_i (w_i L_i + r_i) + D_i$$

[15]This formulation requires the "representative consumer" to encompass individuals that have access to rents and those that do not. It avoids "burning" these rents, as would be implied by a model in which the government valued rents but the consumer did not have access to them.

A β-fraction of producer income is spent on intermediates

$$E_i^x = \sum_j \beta X_{ji}^{\text{cif}}$$

and total tradable expenditure is

$$E_i = E_i^q + E_i^x \tag{3.13}$$

The share of i's tradable expenditure spent on goods from j is

$$x_{ij}(\boldsymbol{w}) = \frac{1}{E_i} \int_{\Omega_{ij}^\star} p_{ij}(\omega) q_i^\star \left(p_{ij}(\omega) \right) d\omega = \frac{T_j \left(\tau_{ij} \delta_{ij} w_j^{1-\beta} P_j^\beta \right)^{-\theta}}{\frac{1}{C} \left(P_i^q(\boldsymbol{w}) \right)^{-\theta}} \tag{3.14}$$

$q_i^\star \left(p_{ij}(\omega) \right)$ is equilibrium consumption of variety ω from both consumers and producers. C is a constant function of exogenous parameters. The tradable price index is

$$P_i^q(\boldsymbol{w}) = C \left(\sum_j T_j \left(d_{ij} w_j^{1-\beta} P_j^\beta \right)^{-\theta} \right)^{-\frac{1}{\theta}} \tag{3.15}$$

Finally, I normalize wages to be consistent with world gdp in the data. Denoting world gdp with Y, I enforce

$$Y = \sum_i w_i L_i \tag{3.16}$$

The equilibrium of the economy depends on policy choices $\boldsymbol{\tau}$, trade deficits $\boldsymbol{D}$, and a vector of structural parameters and constants $\boldsymbol{\theta}_h = \{L_i, T_i, \boldsymbol{\delta}, \sigma, \theta, \beta, \nu_i,\}_{i \in \{1,\dots,N\}}$.

Definition F1: An *international economic equilibrium* is a mapping $h : \{\boldsymbol{\tau}, \boldsymbol{D}, \boldsymbol{\theta}_h\} \to \mathbb{R}_{++}^N$ with $h(\boldsymbol{\tau}, \boldsymbol{D}; \boldsymbol{\theta}_h) = \boldsymbol{w}$ solving the system of equations given by 3.11, 3.12, 3.13, 3.14, 3.15, and 3.16.

Alvarez and Lucas (2007) demonstrate the existence and uniqueness of such an equilibrium, subject to some restrictions on the values of structural parameters and the magnitude of trade costs.

Welfare

With the equilibrium mapping in hand, I can connect trade policies to government welfare given in Equation 3.3. Consumer indirect utility is

$$V_i(\boldsymbol{w}) = \frac{\tilde{E}_i(\boldsymbol{w})}{P_i(\boldsymbol{w})} \tag{3.17}$$

where P_i is the aggregate price index in country i and can be written

$$P_i(\boldsymbol{w}) = \left(\frac{P_i^q(\boldsymbol{w})}{\nu_i} \right)^{\nu_i} \left(\frac{P_i^s(\boldsymbol{w})}{1-\nu_i} \right)^{1-\nu_i}$$

P_i^q is given in equation 3.15 and $P_i^s = \frac{w_i}{A_i}$. Substituting $\boldsymbol{w}$ with its equilibrium value $h(\boldsymbol{\tau}, \boldsymbol{D}; \boldsymbol{\theta}_h)$ returns consumer indirect utility as a function of trade policies. Equilibrium trade flows can be computed as

$$X_{ij}^{\text{cif}}(\boldsymbol{w}) = \tau_{ij}^{-1} x_{ij}(\boldsymbol{w}) E_i(\boldsymbol{w})$$

Substituting these into the revenue equation (3.11) gives the revenue component of the government's objective function.

Equilibrium in Changes

In "hats," the equilibrium conditions corresponding to 3.11, 3.12, 3.13, 3.14, 3.15, and 3.16 are

$$\hat{r}_i = \frac{1}{r_i} \left(E_i \hat{E}_i(\hat{\boldsymbol{w}}) - \sum_j X_{ij}^{\text{cif}} \hat{X}_{ij}^{\text{cif}}(\hat{\boldsymbol{w}}) \right) \tag{3.18}$$

$$\hat{w}_i = \frac{1}{\nu_i w_i L_i} \left(\sum_j \left((1-\beta) X_{ji}^{\text{cif}} \hat{X}_{ji}^{\text{cif}}(\hat{\boldsymbol{w}}) \right) + (1-\nu_i) r_i \hat{r}_i(\hat{\boldsymbol{w}}) \right) \tag{3.19}$$

$$\hat{E}_i(\hat{\boldsymbol{w}}) = \frac{1}{E_i} \left(E_i^q \hat{E}_i^q(\hat{\boldsymbol{w}}) + E_i^x \hat{E}_i^x(\hat{\boldsymbol{w}}) \right) \tag{3.20}$$

$$\hat{x}_{ij}(\hat{\boldsymbol{w}}) = \left(\hat{\tau}_{ij} \hat{w}_j^{1-\beta} \hat{P}_j(\hat{\boldsymbol{w}})^{\beta} \right)^{-\theta} \hat{P}_i(\hat{\boldsymbol{w}})^{\theta} \tag{3.21}$$

$$\hat{P}_i(\hat{\boldsymbol{w}}) = \left(\sum_j x_{ij} \left(\hat{\tau}_{ij} \hat{w}_j^{1-\beta} \hat{P}_j(\hat{\boldsymbol{w}})^{\beta} \right)^{-\theta} \right)^{-\frac{1}{\theta}} \tag{3.22}$$

$$1 = \sum_i y_i \hat{w}_i \tag{3.23}$$

where

$$y_i = \frac{w_i L_i}{\sum_j w_j L_j}$$

This transformation reduces the vector of parameters to be calibrated to $\boldsymbol{\theta}_h = \{\theta, \beta, \nu_i, \}_{i \in \{1,\dots,N\}}$.

Definition A2: An *international economic equilibrium in changes* is a mapping $\hat{h} : \left\{ \hat{\boldsymbol{\tau}}, \hat{\boldsymbol{D}}, \boldsymbol{\theta}_h \right\} \to \mathbb{R}_{++}^N$ with $\hat{h}(\hat{\boldsymbol{\tau}}, \hat{\boldsymbol{D}}; \boldsymbol{\theta}_h) = \hat{\boldsymbol{w}}$ solving the system of equations given by 3.18, 3.19, 3.20, 3.21, 3.22, and 3.23.

Welfare in Changes

Now changes in consumer welfare can be calculated for any set of trade policy changes $\hat{\boldsymbol{\tau}}$. Manipulating 3.17, changes in consumer indirect utility are

$$\hat{V}_i(\boldsymbol{w}) = \frac{\hat{\hat{E}}_i(\hat{\boldsymbol{w}})}{\hat{P}_i(\hat{\boldsymbol{w}})} \tag{3.24}$$

where

$$\hat{P}_i(\hat{\boldsymbol{w}}) = \hat{P}_i^q(\hat{\boldsymbol{w}})^{\nu_i} \hat{P}_i^s(\hat{\boldsymbol{w}})^{\nu_i - 1}$$

and $\hat{P}_i^q(\hat{\boldsymbol{w}})$ is given by equation 3.22 and $\hat{P}_i^s(\hat{\boldsymbol{w}}) = \hat{w}_i$. Changes in policy rents are given by equation 3.18.

3.9.2 B: Calibration of Economy

Solving for an international equilibrium in changes (Definition A2) requires data on national accounts (E_i, E_i^q, E_i^x, $w_i L_i$), and international trade flows (X_{ij}^{cif}) (collectively, $\boldsymbol{Z}_h$), the magnitude of observed policy barriers to trade (τ_{ij}), and the structural parameters θ, β, and $\boldsymbol{\nu}$ (collectively, $\boldsymbol{\theta}_h$). Policy barriers are estimated using the methodology developed in Cooley (2019a). To maintain consistency with the model developed there, I employ the same data on the subset of countries analyzed here. I refer readers to that paper for a deeper discussion of these choices, and briefly summarize the calibration of the economy here.

Data

Trade flows valued pre-shipment (free on board) are available from COMTRADE. I employ cleaned data from CEPII's BACI. To get trade in c.i.f. values, I add estimated freight costs from Cooley (2019a) to these values. Total home expenditure ($X_{ii} + X_i^s$) and aggregate trade imbalances D_i can then be inferred from national accounts data (GDP, gross output, and gross consumption). GDP gives $w_i L_i$ and gross consumption gives $E_i^s + E_i^q + X_i^x$. To isolate expenditure on services, I use data from the World Bank's International Comparison Program, which reports consumer expenditure shares on various good categories. I classify these as tradable and nontradable, and take the sum over expenditure shares on tradables as the empirical analogue to ν_i. Then, expenditure on services is $X_i^s = (1 - \nu_i) w_i L_i$.

Structural Parameters

I set $\theta = 6$, in line with estimates reported in Head and Mayer (2014) and Simonovska and Waugh (2014). A natural empirical analogue for β is intermediate imports $(E_i - w_i L_i)$ divided by total tradable production. This varies country to country, however, and equilibrium existence requires a common β. I therefore take the average of this quantity as the value for β, which is 0.86 in my data. This means that small changes around the factual equilibrium result in discontinuous jumps in counterfactual predictions. I therefore first generate counterfactual predictions with this common β, and use these as a baseline for analysis.

Trade Imbalances

As noted by Ossa (2014), the assumption of exogenous and fixed trade imbalances generates implausible counterfactual predictions when trade frictions get large. I therefore first purge aggregate deficits from the data, solving $\hat{h}(\hat{\boldsymbol{\tau}}, \mathbf{0}; \boldsymbol{\theta}_h)$, replicating Dekle, Eaton, and Kortum (2007). This counterfactual, deficit-less economy is then employed as the baseline, where $\hat{h}(\hat{\boldsymbol{\tau}}; \boldsymbol{\theta}_h)$ referring to a counterfactual prediction from this baseline.

Trade Barrier Estimates

3.9.3 C: Other Measures of Model Fit

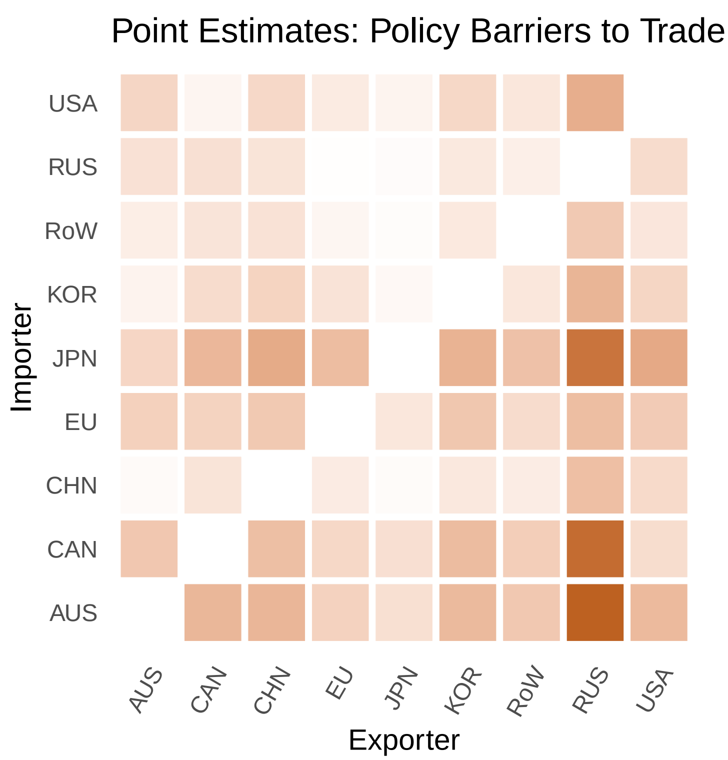


Figure 3.15: Distribution of policy barriers to trade. Each cell reports the magnitude of the policy barrier each importing country (y-axis) imposes on every exporting country (x-axis).

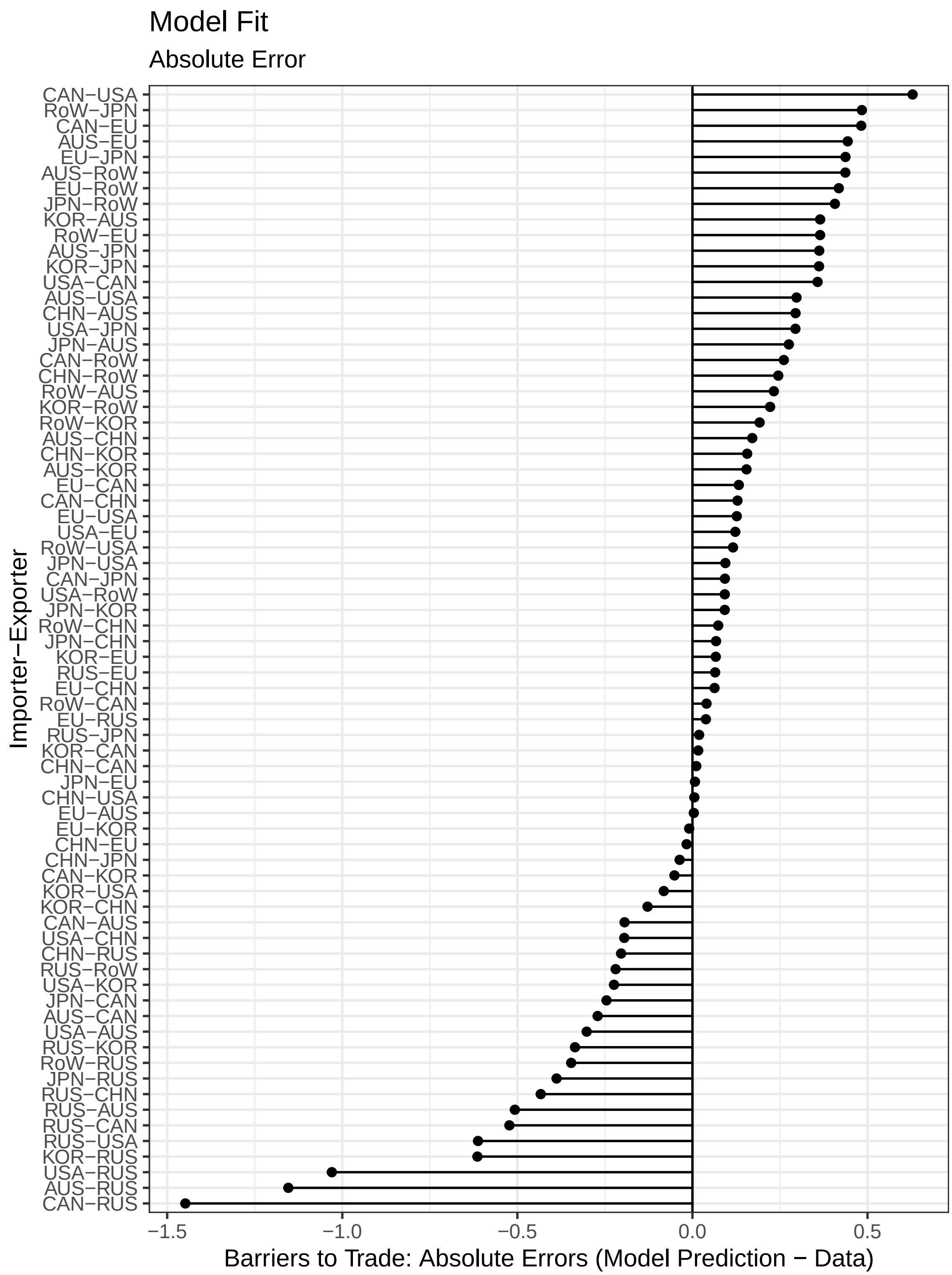


Figure 3.16: Absolute errors for each directed dyad in the sample. Positive values indicate that the model predicts a higher trade barrier than is observed in the data (point estimate).

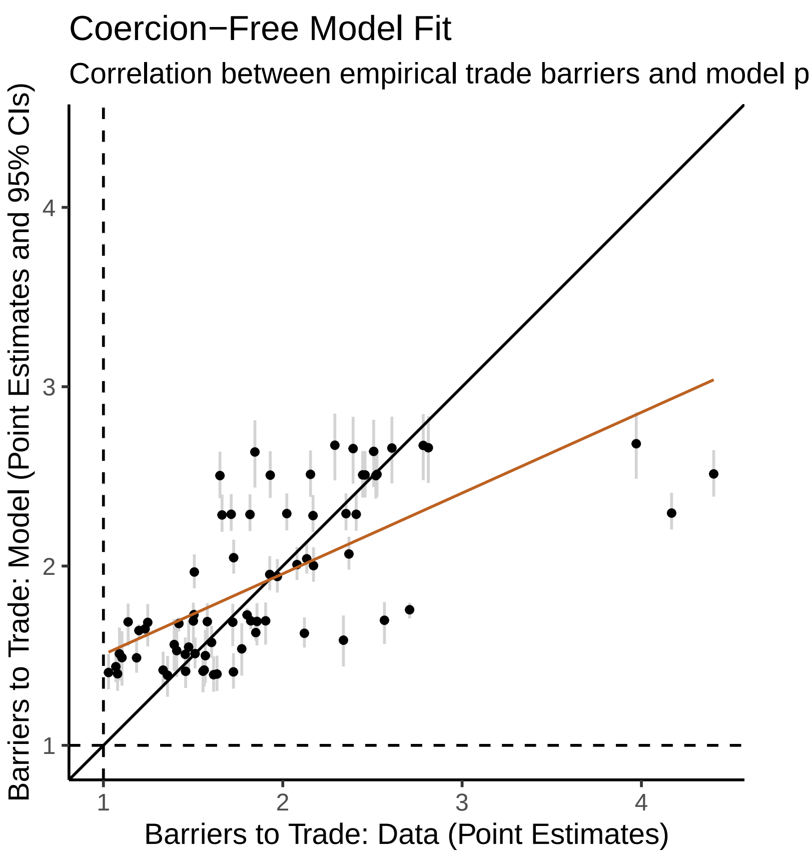


Figure 3.17: Correlation between trade barrier data and coercion-free model predictions.

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