

The Effects of Political Institutions on the Extensive and Intensive Margins of Trade*

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Abstract

We present a model of political networks that integrates both the choice of trade partners (the extensive margin) and trade volumes (the intensive margin). Our model predicts regimes secure of their survival, including democracies and consolidated authoritarian regimes, will trade more on the extensive margin than vulnerable autocracies, which will block trade in products that would expand interpersonal contact among their citizens. We then apply a two-stage Bayesian LASSO estimator to detailed measures of institutional features, and highly disaggregated product-level data encompassing 131 countries over a half century. Consistently with our model (i) political institutions matter more for the extensive than the intensive margin of trade, (ii) while some characteristics of democracy promote trade, others tend to inhibit it, (iii) the effects of political institutions on trade vary across industries falling most heavily on manufactures and differentiated products. **Key Words:** extensive and intensive margins of trade, Polity, democracy, international trade, variable selection, LASSO

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1 Introduction

Countries' engagement with international trade includes both their choice of trading partners; the extensive margin¹, and the intensity with which they and their trading partners transact; the intensive margin. Any evaluation of the impact of political institutions on trade needs to consider their effects on both margins. On the extensive margin, democracies are more likely to trade with one another (Bliss and Russett, 1998), and countries with stable domestic property rights and contractual institutions are more likely to trade products with "relation-specific" inputs (Levchenko, 2007; Nunn and Treffer, 2014). On the intensive margin, some have argued that legislative constraints allow an executive to make a credible commitment to liberalization and mutual reduction in trade barriers (Mansfield, Milner and Rosendorff, 2000, 2002). Democratization has also been regarded to favor the owners of domestically abundant factors and to induce more trade in line with countries' comparative advantages (Milner and Kubota, 2005). In contrast, others argue that the large number of veto players and greater fragmentation of political authority in democracies makes them more sensitive than autocracies to protectionist demands (Frieden and Rogowski, 1996; Henisz, 2000; Tsebelis, 2002; Henisz and Mansfield, 2006; Mansfield, Milner and Pevehouse, 2007). That is, democracies might raise tariffs and erect non-tariff barriers to protect heterogeneous domestic interests (Kono, 2006, 2008; Tavares, 2008).

Despite the rich theoretical debates, there are few studies that simultaneously consider both the extensive and intensive margins when evaluating the effects of political institutions on international trade. The "gravity" model of international trade, focuses exclusively on bilateral trade volumes (i.e., the intensive margin) while political institutions of trading partners are often left out of the modeling stage even when the distinction between the extensive and intensive margins is made explicitly (Chaney, 2008; Helpman, Melitz and Rubinstein, 2008; ?). The lack of attention to political determinants of international trade on the two margins is pervasive in economic models ranging from the "old" to the "new" trade models (Arkolakis, Costinot and Rodríguez-Clare, 2012). Consequently, the vast majority of empirical studies of bilateral trade have also ignored the impacts of political institutions on whether countries trade at all (extensive margin) and how much they

¹Alternatively, extensive margin can be defined as the number of traded products or the number of firms that trade if researchers conduct country-level analysis. Our definition follows from product-level analysis in line with Broda and Weinstein (2006).

trade conditional on trading (intensive margin). In fact, in many important studies that examine institutional effects on trade, country pairs that do not trade are often *excluded* from empirical analyses (e.g., Mansfield, Milner and Rosendorff, 2000; Tomz, Goldstein and Rivers, 2007), a practice that disregards the extensive margin, thereby opening the door to selection bias in the analysis of the intensive margin.²

This paper develops a theoretical framework for analyzing the effects of political institutions that encompasses both margins of trade. Our theoretical model explicates the importance of political institutions in *choosing* trading partners. In the model, we consider several institutional frameworks; the first is an “open” society, in which actors can freely communicate and exchange. We also consider a continuum of “autocratic” societies that differ in their vulnerability to rebellion. In the autocratic societies of our model all activity must pass through a dictator, allowing him both to extract payoffs and to discourage rebellion. Our analysis focuses on the tradeoffs between economic gains and political costs that these societies face, respectively. In particular, vulnerable autocrats will be reluctant to trade if trade expands the network of contacts among people creating political “spillovers” by facilitating potential rebellion against them. In contrast, neither the open societies, whose citizens do not want to rebel, nor the invulnerable authoritarian societies, whose citizens are unable to do so, are deterred by the spillovers from trade.

In our model, these spillovers will vary across products. For example, we might expect fewer spillovers from commodities traded on organized exchanges such as crude oil where transactions often take place at arms length, whereas differentiated products with global manufacturing and marketing networks might have greater spillovers as trade entails more cross-border interactions and communications among citizens (Russett and Oneal, 2000). In fact, Rauch (1999) finds that trading differentiated products relies heavily on political networks between sellers and buyers because search barriers to trade are higher for differentiated products than for homogeneous commodities. We characterize the conditions under which trade occurs for each product at the extensive margin as they affect society’s network structure differentially. Furthermore, on the intensive margin, we distinguish the direct and indirect effects of political institutions on trade volume in which the latter operates through the selection of trading partners on the extensive margin.

Taking our model to the data, we turn to a two-stage Tobit model (Heckman, 1979; Amemiya,

²See Dutt, Mihov and Van Zandt (2013) and Chan and Manova (2015) for notable exceptions.

1984) for empirical analysis. The model fits a first-stage probit for the extensive margin, whether a dyad trades at all on a given good, and then uses a bias-correction term in the second stage linear model of the intensive margin. Our theoretical model provides us with a powerful exclusion restriction—the political institutional variables enter the second stage intensive margin equation only by way of the bias correction term. We assess the validity of this restriction by calculating the Bayes Factor that compares the model in which our variables for political institutions enter the model separately with the non-nested alternative in which they enter only by way of the Heckman’s bias correction term.

Because our model works at the product-level, we analyze trade flows of 449 SITC (Standard International Trade Classification) 4-digit products,³ across 17,030 directed dyads (including those with no trade) comprising 131 countries for 51 years, resulting in approximately 390 million observations. Our covariates consist of a myriad of both time-varying and time-constant covariates including the elements of the standard “gravity” model of trade as well as a battery of institutional variables. Our model highlights a subset of authoritarian countries as being averse to trade, whereas the trade promoting regimes will include an assortment of stable authoritarian governments and democracies. Thus, instead of seeking a *portmanteau* measure of trade promoting political institutions, our empirical analysis incorporates a set of disaggregated *Polity IV* component variables (Gurr, Marshall and Jagers, 2010), allowing us to estimate which are relevant in explaining trade flows.

We observe severe multicollinearity among various institutional features, limiting researchers’ ability to draw sharp inference. Numerous factors that might affect bilateral trade flows are also correlated with political institutions and with each other, a partial list includes economic size (Tinbergen et al., 1962); preferential trading blocks (Frankel, Stein and Wei, 1997); membership in GATT/WTO (Rose, 2004; Gowa and Kim, 2005; Goldstein, Rivers and Tomz, 2007; Subramanian and Wei, 2007); other domestic institutions (Nunn and Trefler, 2014); security alliances (Gowa, 1989); trade resistance (Anderson, 1979); and multilateral resistance (Anderson and Wincoop, 2003) to say nothing of importer, exporter, year, and even dyad-specific effects. In order to select from a set of highly collinear covariates, we turn to recent advances in variable selection (Ratkovic and Tingley, 2017). The proposed two-stage Bayesian LASSO (Least Absolute Shrinkage and Selection

³An example of a four digit product is provided by SITC 6532: “fabrics, woven, of synthetic staple fibers, containing 85% or more by weight of such fibers (other than chenille fabrics).”

Operator) estimator selects a small subset from a large set of correlated effects, returning a linear model with irrelevant effects zeroed out, and has been shown to be a reliable and powerful means of selecting from a large set of possible predictors.

Four main findings emerge. First, and as we would expect from the existing literature, we find that the standard list of “gravity” variables from trade models, have consistent effects on both margins. Secondly, and in keeping with the implications of our theoretical model, we find that political institutions matter on the extensive margin, while after correcting for selection bias, they exercise an attenuated influence the intensive margin, with the intensive margin coefficients for some important institutional variables changing sign.

Third, the regimes that most enthusiastically embrace trade will consist of an intermixture of democracies and secure authoritarian regimes. This claim is corroborated by our finding that the unidimensional POLITY measure of whether a country fits on an authoritarian to democratic continuum is not a sufficient statistic for political institutions. Fourth, we find that political institutions exert heterogeneous effects across different types of products. For example, the positive effects of democratic institutions on the selection of trading partners are particularly pronounced in manufacturing industries while they have relatively small effects on the exchange of crude materials. Our findings cast serious doubt on the implicit assumption undergirding much of the empirical literature on trade which holds that that trade volumes of different products are equally affected by the standard gravity variables. All of these results are robust to interacting the importers’ and exporters’ political institutions, and across various subperiods of the half century spanned by our data.

2 Modeling Political Institutions and the Margins of Trade

We first present a network model that examines the effects of political institutions on the two margins of trade. We highlight how the decisions whether to trade and how much to trade differ. The decision to trade at all is *political* hinging on the threat posed to the regimes of the potential trading partners by the prospect of increasing communication among actors both within and between countries. The decision of how much to trade if one trades at all is economic.

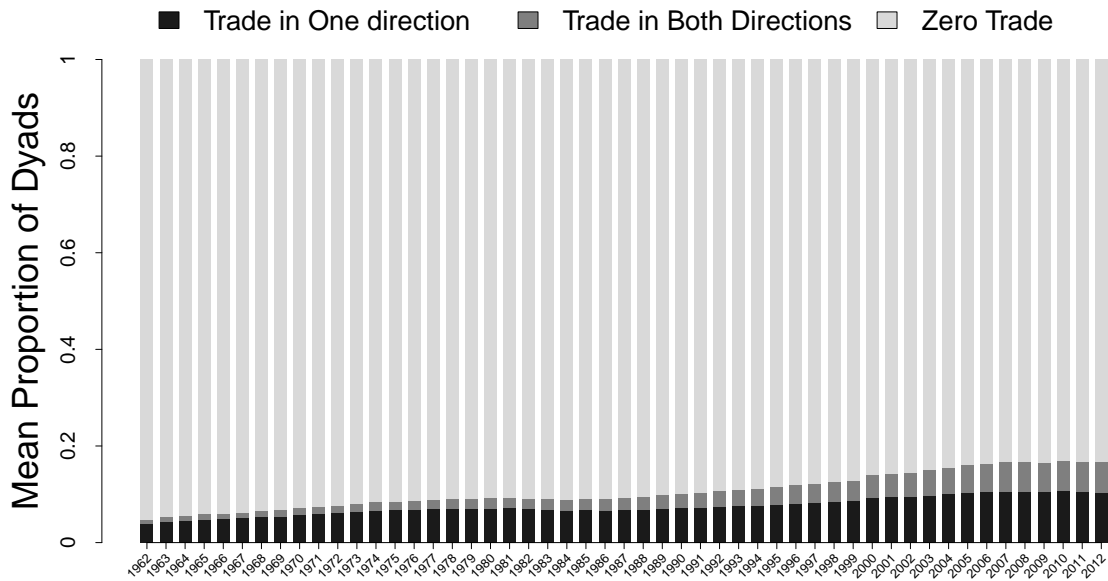


Figure 1: **Distribution of Dyads Based on the Direction of Trades:** This figure demonstrates the prevalence of zero trade in SITC 4-digit data across 131 countries. On average, more than 80% of dyads do not trade.

2.1 Modeling Extensive Margin and Political Networks

Our model is motivated by three consistent empirical findings in the literature. First, the prevalence of zero trade flows constitutes the overarching empirical regularity in international trade. According to Helpman, Melitz and Rubinstein (2008), more than half of country pairs do not engage in any trade at all! Even among trading partners, most products are not traded. Figure 1 shows just how prominent zero trade is at the product-level.⁴ We group each country pair for a given product into three categories: (1) only one country exports the product, (2) both countries export it, and (3) no country in the dyad exports the given product to its partner. The figure displays relative frequency of these three categories, starkly revealing the absence of positive trade across most product-specific country dyads. The graph also shows an interesting trend: more dyads are engaged in some level of trade by the end of the sample period than at the beginning. Yet even during the years with the most extensive diffusion of trade, we see that fewer than twenty percent of product-specific dyads actively trade. Amongst those goods that are traded, a majority of country-years exhibit unidirectional trade.

A second prevalent finding in the literature is the significance of networks of personal contacts

⁴We use the fine-grained SITC 4-digit product level, as described in Section 3.1 below.

on international trade (Rauch, 1999). Specifically, networks of informal contacts convey information about trading opportunities, market structure, and previous violations of trade-related contracts, information that makes it possible for producers to overcome trade barriers even as it allows informal enforcement of agreements (Greif, 1989; Greif, Milgrom and Weingast, 1994). The system of informal contacts has various spillover effects such as transfers of technology and learning through increased interaction (Pavcnik, 2002; Blalock and Gertler, 2004; Van Biesebroeck, 2005; Bloom and Van Reenen, 2007). As noted by Rauch and Trindade (2002, p.116), actors engaged in international trade will serve as “nodes for information exchange” (see also Russett and Oneal (2000) for how trade exposes citizens to the ideas and perspectives of foreign citizens). But these spillovers do not take place in a political vacuum. Transparency and free communication have constitute one of the most theoretically-relevant dimensions that distinguish various political institutions (Hollyer, Rosendorff and Vreeland, 2011; Chen and Xu, 2016; Shadmehr and Bernhardt, 2015; Lorentzen, 2014; Gelbach and Sonin, 2014; Egorov, Guriev and Sonin, 2009).

Heterogeneity at the product-level constitutes a third important feature of the data on trade (Schott, 2004; Eaton, Kortum and Kramarz, 2011). In particular, a large number of manufactured goods are produced through complex global production networks involving many countries and firms from different countries. This differs from the exchanges of raw materials and agricultural products in terms of the magnitude of informational exchange involved in trade as well as potential political links among actors engaged in trade (Johns and Wellhausen, 2016).

Taken together, our model reflects the prevalence of zero-trade by incorporating both the choice of trading partners (Section 2.3) and the volume of trade (Section 2.4). In doing so, we contrast the social networks of free societies with the more restricted network of a society dominated by an autocrat who faces the “dictator’s dilemma” (Kedzie, 1997), balancing the economic benefits of trade against the threat it poses to his monopoly on power as it creates network connections amongst subjects that they can repurpose as avenues of political communication. Furthermore, our model allows for heterogeneity both among authoritarian regimes, which differ in their vulnerability to rebellion through effective control of political communication (King, Pan and Roberts, 2013), and among traded products. Because the importance of networks varies among products, we allow for different degrees of political spillovers (“narrow” vs. “broad”) across products, while holding their economic effects constant.

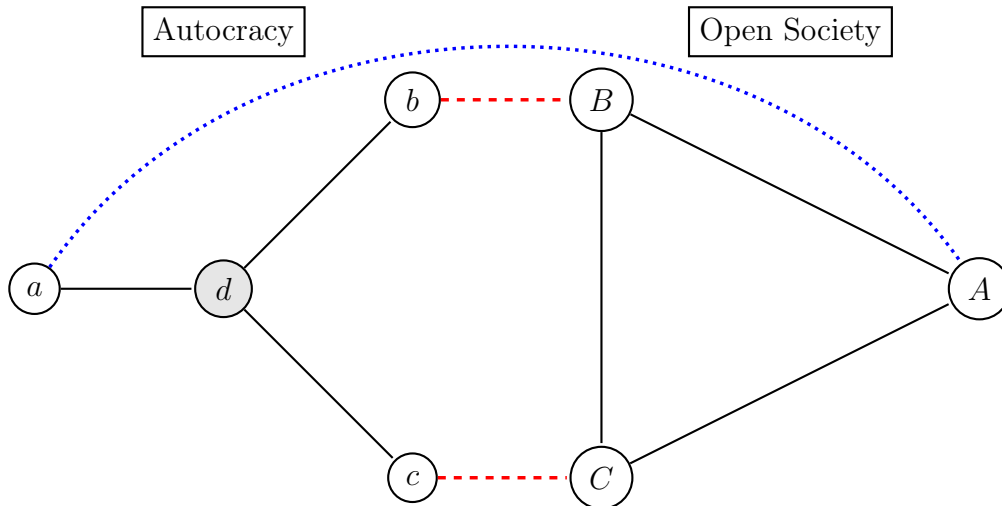


Figure 2: **Political Networks and International Trade:** This figure describes the network structure of our model in two regime types: autocracy (left) and open society (right). In autocratic society, actors (a, b, c) are linked through the autocrat (d) who blocks communication across them. In contrast, in an open society, citizens (A, B, C) are directly communicating with each other. The red dashed line and the blue dotted line represent potential spillover effects of trade between the two nations.

2.2 The Model

We now present a parsimonious network model with two regime types: an “open” society and an “autocratic” society. In the open society each individual is free to communicate and exchange with every other member of society. In the autocratic society, all communication and trade must pass through a single individual, the autocrat, who decides how the individuals’ endowments will be allocated. The autocrat’s power comes at a price: the people he exploits can, at some cost to themselves, rebel against his exactions.

Model Specification

Consider two countries. The first is an autocracy with three productive citizens and an autocrat who consumes but does not produce. The second country is an open society with three productive citizens. The autocracy is marked by a “star-shaped” network structure with the dictator, d , in the middle and the subjects, a, b , and c , connected to the middle but disconnected from each other; see the left-hand side of Figure 2 where the links are represented by solid lines. The open society has a different network structure, depicted on the right-hand side of Figure 2; the three inhabitants A, B , and C are located at the nodes of a triangle, so that each is directly linked to each of the others.

Every person except the dictator has an initial endowment of 1 unit of output, for a total economy of size 3 in each country. This endowment may be magnified through mutually beneficial trade, but some portion may be seized by the autocrat or lost to a failed rebellion. The basic choice faced by each government is whether to establish trade with a neighbor.⁵

Autarky

In the absence of trade, each inhabitant of the open society consumes her endowment for a payoff of 1. The autocracy faces a decidedly different dynamic. The autocrat seizes $1 - s_i$ from citizen $i \in \{a, b, c\}$, for a total consumption of $3 - \sum_{i \in \{a, b, c\}} s_i$, while each citizen retains s_i . The autocrat also faces a threat of rebellion. Any subset \mathbb{W} of subjects of the autocracy can band together to rebel, provided they can reach one another along a network path, of any length, and passing through any number of intermediate nodes, that do not include the autocrat. If the rebellion succeeds, the autocrat receives no transfers, while each individual retains her entire endowment of 1. If the rebellion fails, each rebel gets a payoff of 0 whereas the leader's payoff is unaffected.

A rebellion with r participants prevails with probability given by $\frac{\rho^r}{1+\rho^r}$, where $\rho \geq 0$ calibrates the odds of a successful rebellion. We can think of ρ as a measure of the vulnerability of the authoritarian regime; at $\rho = 0$ the autocrat will be invulnerable to rebellion, free to confiscate the entire income of his country.

If instead there are multiple but uncoordinated rebellions $j = \{1, \dots, R\}$, such that there are r_j participants in rebel faction j , then the success probability for rebellion j is $\frac{\rho^{r_j}}{1+\rho^{r_j}}$. If rebellion j succeeds, it only benefits the participants of that faction. When there are multiple rebellions they are resolved independently and in random order. The payoff to the autocrat if any or all of the rebellions succeed is 0.⁶

⁵In principle, WTO members are also constrained by the rules of “non-discrimination.” However, our dyad-level analysis is motivated by targeted use of various tariff and non-tariff barriers that countries employ (e.g., ?). Furthermore, even within WTO, negotiators focus on a series of bilateral negotiations based on the “principal supplier rule” on specific products resulting in a 22,500-page document listing the commitments of each country with their partners on specific goods. See https://www.wto.org/english/tratop_e/serv_e/serv_commitments_e.htm

⁶In the wake of a successful partial rebellion, we can think of the autocrat being replaced by another of his kind, with whom he has no empathy, at the resolution of the first successful rebellion. The successor continues to hold sway over those who did not rebel, and over the $1 - s_i$ share of any failed rebels: “The creatures outside looked from pig to man, and from man to pig, and from pig to man again; but already it was impossible to say which was which”(Orwell, 1945, p.112), see also Townshend et al. (1971).

Under autarky, the subjects of the autocracy cannot communicate since all pathways pass through the autocrat’s node. If they rebel, each is compelled to do so on her own. The minimum share the autocrat must offer a subject not to rebel is $s_{min} = \frac{\rho}{1+\rho}$, which results in a payoff to the autocrat⁷ of $U_3 = \frac{3}{1+\rho}$. This payoff dominates what the autocrat can get from offering nothing to some subset of subjects, and appeasing the rest.⁸ Thus, with autarky, the autocrat will always choose to appease.

We summarize autarkic payoffs as follows: each citizen of the open society receives 1, each subject of the autocrat gets $s_{min} = \frac{\rho}{1+\rho}$, while the autocrat garners $U_3 = \frac{3}{1+\rho}$.

2.3 Choosing to Trade: The Extensive Margin

Suppose that an opportunity emerges for trade between the two countries. The value of a unit of domestic endowment in the autocratic country is worth $(1 + \alpha)$ to its potential open society trading partner. Likewise, each unit of domestic output in the open society is worth $(1 + \alpha)$ to inhabitants of the autocracy. The parameter α represents economic gains of trade (Arkolakis, Costinot and Rodríguez-Clare, 2012). We capture heterogeneity among products by treating α as a random draw from a probability distribution with density function f , and cumulative density F , and with positive support everywhere on the real line. Before they decide whether to trade, both countries observe α , whose realized value is common knowledge. If the two countries enter into a trade agreement, so that individual d and each citizen of the open society consent to the deal, then each society exports its entire endowment to the other, thereby increasing *per capita* consumption in each country by a factor of $1 + \alpha$. We assume that d continues to have an endowment of 0 to be consistent with the setting under autarky.

However, opening to trade also entails a degree of opening to political “spillovers”: the network of connections is augmented with links joining citizens of the two countries. We consider different versions. For some pairs of products the opening will be relatively narrow, typified by the new links joining b with B and c with C (see the red dashed lines in Figure 2), this might correspond with trade in a product such as newsprint in rolls/sheets (SITC 6411) that can be transacted at arms

⁷Given his preferences, the autocrat will never pay more than the minimum needed to forestall rebellion.

⁸The payoff to appeasing no subjects is $U_0 = \frac{3}{(1+\rho)^3} < \frac{3}{1+\rho} = U_3$ provided $\rho > 0$, the expected payoff to appeasing two and sustaining a rebellion from the third is $U_2 = \frac{3+2\rho}{(1+\rho)^2} < \frac{3}{1+\rho} = U_3$ again provided $\rho > 0$, while still assuming that $\rho > 0$, the expected payoff to appeasing only one subject is $U_1 = \frac{3+2\rho}{(1+\rho)^3} < \frac{3}{1+\rho} = U_3$.

length.⁹ For other products, such as sports footwear (SITC 8517) there will be broader political spillovers as the transaction entails more open avenues for communication with the outside.¹⁰ In the model this corresponds to *augmenting* the red links from the figure with a link between a and A (see the blue dotted line in Figure 2). This allows us to examine the incentives of leaders who foresee distinct spillover effects from trade in different products as they open to international trade. It is also consistent with the literature that finds heterogeneous effects of political institutions on trade across various products (Nunn, 2007).

Open Societies and Trade

The decision by an open society to trade provides a benchmark against which to compare the impact of authoritarian rule on trade. We have already seen, in Section 2.2, that in autarky each citizen of a democracy garners a payoff of 1. If instead the country negotiates a trading arrangement, each citizen of the democracy gets a payoff of $(1 + \alpha)$, so the threshold for an open society to engage in trade is simply $\alpha_o = 0$: the free society will ink any trade deal provided only that:

$$\alpha > \alpha_o(\rho) \equiv 0 \tag{1}$$

where the dependency on ρ is trivial.

Trading Products with Narrow Spillovers

Now consider the decision of autocracy whether to trade with an open society, in the case of an exchange involving products with narrow spillovers, so that individuals b and c are now linked to each other along multiple pathways involving citizens of the open society. The shortest such pathway passes through the nodes for individuals B and C , and we assume that this enables b and c to coordinate if they both decide to rebel.¹¹ While individual a can still be appeased with a share $\frac{\rho}{1+\rho}$ of output, the other two now pose a more potent threat. If b and c rebel jointly, each gets an expected payoff of $\frac{2\rho}{1+2\rho}(1 + \alpha)$ if they pool their resources. Thus, each must receive an

⁹Rauch (1999) identifies this product category as being a “reference priced good,” and posits that trade in such products leads to relatively little direct personal contact among market participants.

¹⁰In contrast with SITC 6411, Rauch (1999) finds that transacting differentiated products such as this one involves more extensive interpersonal contact.

¹¹Of course, this connection involves at least two intermediaries, and the links to the other country may be “longer” than domestic connections, but in our model neither the length of the contact nor the number of intermediaries are material: all that matters is whether or not contact can be made without having to use the dictator as an intermediary.

appeasing payoff of at least $(1 + \alpha)s_{2,\min}$, where $s_{2,\min} = \frac{2\rho}{1+2\rho}$, while individual d can be placated with a transfer of $(1 + \alpha)s_{\min}$.

We have already shown that it is cheaper to appease a than it is to face her rebellion. The maximum share of income the autocrat will allocate to each of b and c rather than endure their joint insurrection is $s_{2,\max} = \frac{\rho(3+2\rho)}{(1+\rho)(1+2\rho)}$, which exceeds $s_{2,\min}$ by $\frac{\rho}{(1+\rho)(1+2\rho)}$, so the autocrat will prefer appeasement. Thus, the payoff to the autocrat if he opens to trade is:

$$(1 + \alpha) \frac{3 + 4\rho}{(1 + \rho)(1 + 2\rho)}.$$

This exceeds his payoff in autarky only if:

$$\alpha > \alpha_n(\rho) = \frac{2\rho}{3 + 4\rho}. \quad (2)$$

Notice that the trade threshold $\alpha_n(\rho)$ is an increasing function of ρ .¹²

That some products fail to meet the threshold is more than a theoretical possibility. Consider the “temporarily” closed Kaesong Industrial complex, once-heralded as a substantial form of economic cooperation between northern and southern Korea. The regime in the north made an enormous effort to maintain tight control over communications not only across the border but also among its own workers (b and c) and their friends (a). All of these were harder to monitor as people from both sides of the border encountered one another in the course of their work in the operating complex, corresponding to the links between b and B and c and C in our model. One interpretation of the northern regime’s continuous provocation at the expense of closing the complex is that it realized the cost of maintaining control in the more open environments has outweighed economics gains.

Trading a Product with Broad Spillovers

With broad spillovers, trade means that all three subjects, rather than two, of the autocracy are linked along pathways that bypass the autocrat, leaving them free to coordinate. If they do, each receives an expected payoff of $(1 + \alpha)s_{3,\min} = (1 + \alpha)\frac{3\rho}{1+3\rho}$, whereas the autocrat’s expected payoff if he must confront a coordinated rebellion is $\frac{3(1+\alpha)}{1+3\rho}$, so he will pay a maximum share of $s_{3,\max} = \frac{3\rho}{1+3\rho}$. Since $s_{3,\min} = s_{3,\max}$ whether the autocrat chooses to appease or to confront his subjects is immaterial to his ambivalence toward trade. In either case, his payoff if he opens to trade is:

$$3 \frac{1 + \alpha}{(1 + 3\rho)}.$$

¹² $\frac{d\alpha_n}{d\rho} = \frac{6}{(3+4\rho)^2} > 0$

This exceeds his payoff in autarky only if:

$$\alpha > \alpha_b(\rho) = \frac{2\rho}{1 + \rho}. \quad (3)$$

As with $\alpha_n(\rho)$, the threshold with broad spillovers, $\alpha_b(\rho)$, is an increasing function of ρ .¹³ Notice that for very low values of ρ , autocracies will lose their aversion to trade; In the extreme case $\alpha_n(0) = \alpha_b(0) = 0$ so that autocracies are invulnerable to rebellions, they will be just as willing to trade as are open societies.

We now compare the autocrat’s incentives to open for products with narrow and broad spillovers:

PROPOSITION 1 (TRADING PRODUCTS WITH NARROW VS. BROAD POLITICAL SPILLOVERS)

For a given positive level of domestic vulnerability, as calibrated by $\rho > 0$, the threshold for trade will be higher for products involving broad rather than narrow political spillovers:

$$\alpha_b(\rho) > \alpha_n(\rho). \quad (4)$$

Asymmetrical Network Spillovers

Of course, network spillovers may be less symmetrical than in the “narrow” and “broad” cases we have considered so far. For example, multiple individuals from one national network might make contact with the same individual in the other network. Such a situation is depicted in Figure 3 which portrays two autocratic potential trading partners with different levels of vulnerability to rebellion: ρ_I and ρ_{II} . Country I exhibits narrow spillovers similar to those shown in Figure 2, with two citizens, b and c placed in contact with each other, by way of the intermediation of citizen b' in Country II. However, Country II suffers no internal network consequences from trade whatsoever: citizen b' is now able to communicate with citizens of Country I, but she is still unable to coordinate rebellion with her country women in Country II, leading to a trading threshold of $\alpha_{\text{no-spill}}(\rho_{II}) = 0$. As an example of such a product, consider “fuses, primers and detonators” (SITC 5712). We would expect any authoritarian regime to already have the domestic distribution of this product category thoroughly “locked down” and under surveillance, whereas exporters of fuses and people involved in marketing detonators abroad might make indirect contact with each other through their overseas clients, beyond the watchful eyes of homeland “security.” This example shows that the same trading relationship can generate different network effects for distinct participants in the same exchange, even when both countries have the same type of autocratic regime. This motivates our separate

¹³ $\frac{d\alpha_b}{d\rho} = \frac{2}{(1+\rho)^2} > 0$

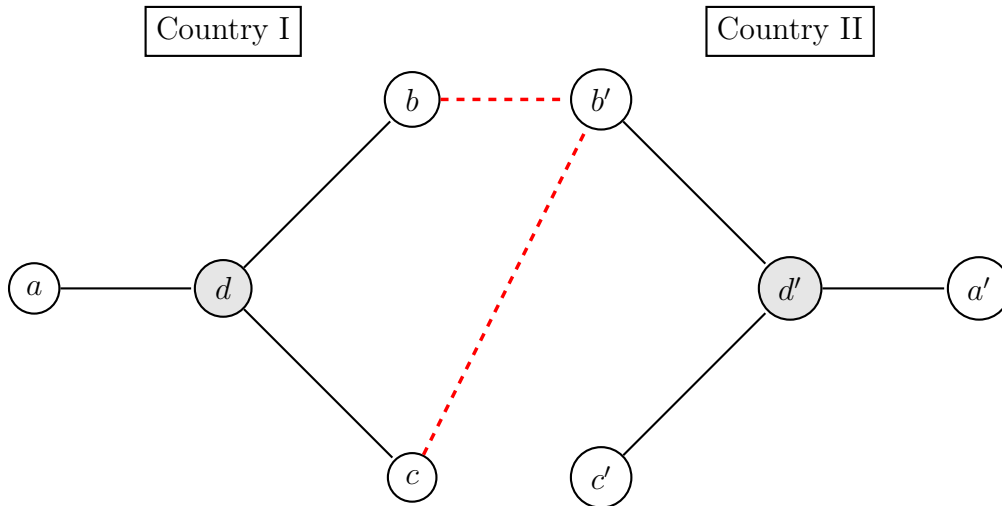


Figure 3: **Asymmetric Effects of Trade on Networks:** Suppose that two autocracies have the opportunity to trade with one another. Trade creates two new links, one between b and b' , and another between c and b' (red dashed lines). In this case the effects of trade are asymmetric; facilitating communication between b and c , and so attenuating the grip on power enjoyed by the dictator of Country I, while trade leaves the internal communications of Country II unaffected: individual b' is still unable to coordinate a rebellion with either of his compatriots a' or c' .

estimation of the impact of political institutions on importers and exporters of the same products in our empirical analysis reported in Section 4.

Agreeing to Trade

Let's return to our example of trade between the open society and the autocracy depicted in Figure 2. For trade to transpire between a democracy and an autocracy it must meet with the approbation of the autocrat, d , and with the approval of the citizens of the open society, each of whom has the same preferences over trade. Thus, trade will transpire for an open society and an autocracy for an exchange with narrow spillovers in the autocracy whenever:

$$\alpha > \max\{\alpha_n(\rho), \alpha_o(0)\}. \quad (5)$$

where we denote the threshold for α for an open society as $\alpha_o(0)$ to symbolize the fact that there is no threat of rebellion. By the same token, when spillovers are broad, a necessary and sufficient condition for trade to take place is:

$$\alpha > \max\{\alpha_b(\rho), \alpha_o(0)\}. \quad (6)$$

Open societies are not the only cases with thresholds for α of zero as we have already seen in Figure 3; trade with Country I still leaves the subjects of Country II unable to communicate with

one another outside the intermediation of the dictator, and so the second country would be willing to conclude any agreement with the first for which $\alpha > \alpha_{\text{no-spill}}(\rho_{II}) = 0$. Of course, Country I has a threshold of $\alpha_n(\rho_I)$, so that trade between the two autocratic countries will take place provided:

$$\alpha > \max\{\alpha_n(\rho_I), \alpha_{\text{no-spill}}(\rho_{II})\}. \quad (7)$$

More generally, for any given product k , with gains from trade parameter α_k , let's consider the potential for trade between country y with internal vulnerability ρ_y and country z whose vulnerability is ρ_z . The threshold α_k must exceed for a trade agreement to be reached is:

$$\hat{\alpha}_{yzk} := \max\{\alpha_k(\rho_y), \alpha_k(\rho_z)\}. \quad (8)$$

This framework encompasses trade amongst any potential pair of government types, open or authoritarian. The probability that countries y and z agree to trade is thus:

$$\pi_k(\hat{\alpha}_{yzk}) = \Pr\{\alpha > \hat{\alpha}_{yzk}\}. \quad (9)$$

We can now characterize the conditions under which countries are more likely to agree on trading at the extensive margin.

PROPOSITION 2 (POLITICAL INSTITUTIONS AND THE EXTENSIVE MARGINS OF TRADE) *The more stringent is the higher of the two trade thresholds, the lower the probability a dyad will trade in any given product k .*¹⁴ Formally,

$$\frac{d\pi_k}{d\hat{\alpha}_{yzk}} < 0. \quad (10)$$

2.4 Trade Volumes: The Intensive Margin

Given the linearity of our model, the two parties to the trade will exchange their entire endowments if they trade at all. But whether they trade depends on regime type. This affects the intensive margin of trade. Specifically, the reluctance of a vulnerable authoritarian regime to trade impacts its actual trade volume by way of reducing the set of agreements the regime enters into:

PROPOSITION 3 (POLITICAL INSTITUTIONS AND THE INTENSIVE MARGINS OF TRADE) *Countries with higher trade thresholds engage in less overall trade, ceteris paribus. Formally, the expected per capita level of trade of product k between countries y and z given by*

$$T_0(\hat{\alpha}_{yzk}) = (1 + \mathbb{E}_F\{\alpha | \alpha > \hat{\alpha}_{yzk}\}) \cdot \pi_p(\hat{\alpha}_{yzk})$$

¹⁴For the inequality in (10) to be every where strict we require the support of α to coincide with the nonnegative real line.

is decreasing in $\hat{\alpha}_{yzk}$. That is,

$$\frac{dT_0}{d\hat{\alpha}_{yzk}} = \frac{d\pi_p}{d\hat{\alpha}_{yzk}} - \hat{\alpha}_{yzk} f'(\hat{\alpha}_{yzk}) < 0 \quad (11)$$

Proof is in Appendix A.

We will observe this effect even if there is no direct impact of regime type on a country’s comparative advantage. While we cannot rule out direct effects from the regime on a country’s comparative advantage, see for example ?, yet even a primary resource exporter whose comparative advantage is not effected by the political vulnerability of the *de facto* government, might still refrain from trade if the regime fears spillovers:

PROPOSITION 4 (INSTITUTIONS DO NOT AFFECT POTENTIAL TRADE) *The potential level of per capita trade, $T(\alpha) = (1 + \alpha)$ depends on α .¹⁵, but not on $\hat{\alpha}_{yzk}$, so:*

$$\frac{dT}{d\hat{\alpha}_{yzk}} = 0 \quad (12)$$

Once the two parties decide to trade, the volume of trade is unaffected by the threshold for trade.

The contrast between Propositions 3 and ?? is the result of sample selection (Heckman, 1979; Tobin, 1958). This theoretical result motivates our two-stage estimation strategy described in Section 3.2.

The threat posed to vulnerable governments by opening trade to product pairing k depends on the scale of the spillovers, while the benefits of that trade depend on the scale of the resulting exchange. This results in a threshold, represented by $\hat{\alpha}_{yzk}$ in our model, below which the benefits of exchange in pairing k are insufficient to compensate the the more vulnerable of the governments of countries y and z for the added risk posed by the resulting spillovers, and above which both governments perceive sufficient gains to hazard the extra trade. Note that once trade takes place, the spillovers are insensitive to the scale of commerce. For instance, the lines of communication were just as open for use by the committees of correspondence in Colonial North America (in those days by surface mail) when the various colonies transacted a few million dollars of trade, as they were more recently (*via* the internet) to pro-democracy activists in the rainbow revolutions, *inter alia* the Ukrainian “Orange Revolution” and the Iranian “Green Revolution,” whose countries exchanged trade flows with the rest of the world measured in billions rather than millions of dollars.

¹⁵For this calculation, we exclude the autocrat from the denominator.

2.5 Political Institutions *vs* Comparative Advantage

Now consider an improvement in the *economic* fundamentals, holding fixed $\hat{\alpha}_{yzk}$. We represent this improved potential by letting the distribution F^* of potential gains from trade α^* first order stochastically dominates the distribution F for α , so that for any threshold $\hat{\alpha}_{yzk}$ we have:

$$\Pr\{\alpha^* > \hat{\alpha}_{yzk} | F^*\} > \Pr\{\alpha > \hat{\alpha}_{yzk} | F\}. \quad (13)$$

Of course, potential trade is increasing one for one in α :

$$\frac{dT}{d\alpha} = 1 \quad (14)$$

This means that an increase in the gains from trade (corresponding to α^* first order stochastically dominating the *status quo ante* distribution of terms of trade α) will lead to an increase in *both* the probability that a country trades, and the volume of trade given that trade occurs. Moreover, this will be the case for all government types.

2.6 Empirical Implications

Our analysis generates four main hypotheses. Firstly, the impact of trade promoting configurations of economic variables will be to increase trade on *both* margins as implied by expressions (14) and (15):

HYPOTHESIS 1 Trade promoting economic variables will lead to increased trade on both the extensive and intensive margins.

A second implication of the model is that political institutions will affect trade on the extensive margin through selection in a manner distinct from any direct impact they may have on potential intensive margin trade, as indicated by Proposition 2 and expressions (10) and (12):

HYPOTHESIS 2 The effect of political institutions on the extensive margin of trade will be distinct from their effect upon intensive margin trade volumes, conditional on there being any trade at all.

The second hypothesis rests on regime type affecting the threshold of trade $\hat{\alpha}_{yzk}$ by way of the regimes aversion to political spillovers. This effect comes above and beyond any direct impact the regime has on comparative advantage, which is captured in our model by a shift in α , as might arise if political instability translated into violence that damaged the infrastructure of trade.

We emphasize that while open societies will be eager to engage in trade, so too will be secure authoritarian regimes for which the ρ parameter is small. Thus the institutions that favor trade in our model will not necessarily be paragons of Periclean democracy.

HYPOTHESIS 3 The constellation of political institutions that favor trade will not coincide with a point on the continuum from democracy to autocracy.

Finally, our model predicts that the effects of political institutions will tend to vary across products, and even between exporters and importers. It may be that a vulnerable autocracy readily trades some goods, for example commodities with narrow spillovers, or with no spillovers at all, as might typify the products identified by Rauch (1999) as substitutable, while it refrains from trade in other differentiated goods with broader spillovers (see Proposition 1).

HYPOTHESIS 4 The impact of the institutional variables will be more pronounced on products with extensive spillovers, in particular, we expect to see greater effects for manufactured goods and for differentiated products.

While our stylized model is meant to be illustrative some of the key factors contributing to the potential for political institutions differently to affect the extensive and intensive margins, and to highlight the nature of the contrast between the effects of political regimes and the impact of economic factors on trade, it is not configured as a fully specified model that is ready to “take to the data,” a task to which we now turn.

3 Data and Methods

This section presents the data and the proposed methodology used for empirical analysis.

3.1 Data

Differences in production technology imply that even the typical economic factors in the gravity models of trade, such as distance and size of the economy, can have differential effects on trade flows across dissimilar products on both margins. For instance, distance might matter more for industries with high transportation costs, whereas the importance of the size of the importing country’s market will be magnified for industries with greater increasing returns to scale. Despite the indisputable heterogeneity across products, most studies of institutional effects on trade implicitly

assume homogeneous effects across products by only modeling the *total* volume of bilateral trade, aggregating across a diverse set of products, and conducting country-level analysis (e.g., Rose, 2004; Goldstein, Rivers and Tomz, 2007).

Because different countries trade different bundles of goods, we seek to minimize compositional bias by analyzing SITC 4-digit product-level trade data for all country pairs from 1962 to 2012, which are the most finely disaggregated trade data available that spans the entire time period.¹⁶ This classification, maintained by the UN, distinguishes each product based on the materials used in their production, the processing stage, market uses, and technological changes.

Including countries that have existed as sovereign states since 1961 (a number of countries have been created or disbanded over time, such as the USSR) results in a total of 131 countries whose trade flows account for more than 90% of the total trade. The list of countries is presented in Section ?? of the Web Appendix. Next, we created 449 unique SITC 4-digit product categories that are comparable across years to deal with the appearance and disappearance of product categories over time in order to reduce the bias due to the heterogeneity across products in different periods. We used the concordance table available in the United Nations Statistics Division for this task.¹⁷ We then computed the volume of trade for each product so that a dataset of 449 products for each country pair is available across each year while distinguishing between imports and exports. Since we consider all directed dyads even when there is no trade, we have a total of 389,969,970 ($131 \times 130 \times 449 \times 51$) observations for our analysis. Both the original and the aggregated SITC 4-digit datasets are made available on line through our Web Appendix. The open-source software `concordance: Product Concordance for International Trade`, for creating the concordances across different product categories, is made available through the Comprehensive R Archive Network (<http://cran.r-project.org/package=concordance>).

Gravity Variables. We include a set of “gravity” variables widely used in the literature. To control for market size, we use the log of population for both the importer and the exporter (`imp_POP`, `exp_POP`), and logged income for both the importer and the exporter (`imp_tcgdp`, `exp_tcgdp`), from Penn World Tables 7.0. We also include the dyad-level covariates: the logged distance between the

¹⁶We used the data extraction API available from the UN Comtrade Database to handle the large automatic download volume. Typically, the size of data amounts to more than 150MB for each year.

¹⁷The concordance table is available in <http://unstats.un.org/unsd/trade/conversions/HS%20Correlation%20and%20Conversion%20tables.htm>

members of the dyad (**ldist**), the log of the product of the land area of the two countries in the dyad (**lareap**), the number of landlocked countries in the dyad ($\text{landl} \in \{0, 1, 2\}$), the number of island nations in the dyad ($\text{island} \in \{0, 1, 2\}$), an indicator for a contiguous land border (**border**), another for whether both members of the dyad were territories of the same nation during the entire sample period (**comctry**), *e.g.* France and Guadeloupe, as well as indicators for a common language (**comlang**), a past colonial relationship (**colony**), and a common colonizer (**comcol**).¹⁸ In order to control for the effects of institutional membership in GATT/WTO, we include indicators for formal membership as well as non-member participants for both importers and exporters (*e.g.*, **imp_fmmember**, **exp_participant**). Furthermore, we control for whether both elements of a dyad are formal members of the WTO (**bothf**) or participants (**bothp**), and for whether only one of the countries in a dyad is a formal WTO member (**onef**), or a WTO participant (**onep**). These “gravity” variables are from Rose (2004) and Goldstein, Rivers and Tomz (2007). Finally, we include an indicator for the presence of an alliance relationship (**defense**) in order to control for security relations among trading partners (Gowa, 1989). The alliance data is from the Correlates of War Project (Gibler, 2013). Although this is not an exhaustive list, we believe that these variables capture important economic forces identified in the literature that either directly or indirectly affect bilateral trade.

Unpacking *Polity IV* As foreshadowed by the discussion in Section ??, our model predicts that an eclectic mix of democratic and secure authoritarian regimes will be open to trade, while countries with insecure authoritarian institutions will not. The *portmanteau* measure of democracy will not be monotonically related to these regime characteristics, and moreover, the weights used to aggregate the POLITY score from its component parts are somewhat arbitrary.¹⁹ Accordingly, just as we have disaggregated trade flows, we strive to do the same with our institutional data. We do not rely on a dichotomous measure (Przeworski et al., 2000) or even a single scale (Coppedge and Reinicke, 1991; Bollen, 1993; House, 2014), instead we separate the POLITY measure into its constituent components. We include as separate explanatory variables four *Polity IV* component variables. These variables possess natural orders of their own, with lower values generally corresponding to more autocratic institutions, while higher scores are earned by institutions associated with more open societies. These variables include XRCOMP (Competitiveness of Executive Recruitment),

¹⁸Notice that some of these variables, such as **comcol**, might reasonably be considered to proxy political institutions, although they are included in “economic” gravity specifications.

¹⁹See Table ?? in the Web Appendix.

XROPEN (Openness of Executive Recruitment), XCONST (Constraint on Chief Executive), and PARCOMP (Competitiveness of Political Participation).²⁰ We incorporate two other measures from the *Polity IV* data set, XRREG and DURABLE. The first of these is a three-point scale measuring the “regularity” of the current leader’s accession to power. The DURABLE variable measures the length of time the current regime has been in power.²¹ We illustrate the improvements through disaggregation of these terms, relative to the POLITY measure, in an analysis below.

3.2 The Methodology: Sparse Two-Stage Selection Model

To distinguish between the extensive and intensive margins of trade, we apply Heckman’s “Two-Stage Tobit” estimator (Heckman, 1979; Amemiya, 1984).²² The two-stage Tobit-model differs from the standard Tobit model in that it allows for differential impact of covariates in the first and second stage.

The first stage consists of a probit model of whether a given dyad trades a given good. Let $\delta_{ijtk} = 1$ if there are positive imports by country i from exporting country j in year t for SITC 4-digit product k , while otherwise $\delta_{ijtk} = 0$, with the $P \times 1$ vector of explanatory variables X_{ijtk} indexed similarly. To account for “multilateral resistance” (Anderson and Wincoop, 2003) and the panel structure of the data, we incorporate three sets of random effects: a year effect for each product, d_{tk} and importer- and exporter- effects, b_{ik} and c_{jk} . See Table ?? in the Web Appendix for a complete list of variables.

Our first stage model of the extensive margin is the probit specification

$$\Pr(\delta_{ijtk} = 1 | X_{ijtk}, b_{ik}, c_{jk}, d_{tk}) = \Phi(Z_{ijtk}^* > 0) \quad (15)$$

with

$$Z_{ijtk}^* = X_{ijtk}^\top \beta_k + b_{ik} + c_{jk} + d_{tk} - \tilde{u}_{ijtk}; \quad \tilde{u}_{ijtk} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, 1). \quad (16)$$

We include only observations with at least one year of positive trade and at least one year without

²⁰For more detail on each sub scale, see Gurr, Marshall and Jagers (2010)

²¹We do not include PARREG, the extent to which political participation is “regulated,” as it is not a monotonic scale.

²² Liu (2009) advocated Poisson regression over the Tobit, however our outcome is virtually continuous and our theory predicts heterogeneous zero-inflation, both of which would confound a Poisson model. Another alternative, the Poisson pseudo-maximum likelihood model (Silva and Tenreyro, 2006), does not differentiate between the two margins.

trade over our 51-year time frame. We do include the countries that always-trade in the next stage of our model, as there is no first-stage sample correction needed.

For the second stage, our outcome is $Y_{ijtk} = \log(1 + Y_{ijtk}^o)$, with Y_{ijtk}^o the volume of trade between importer i and exporter j in year t for SITC 4-digit product k . By construction, $Y_{ijtk}^o = 0$ implies $Y_{ijtk} = 0$. We only observe $Y_{ijtk} > 0$ when $\delta_{ijtk} = 1$, while otherwise there is no trade.

To account for this censoring bias, we include in our second-stage model all of our first-stage variables as well as the bias-correction term from the inverse Mills ratio

$$\mathbb{E}(\tilde{u}_{ijtk} | \tilde{u}_{ijtk} < X_{ijtk}^\top \beta_k + b_{ik} + c_{jk} + d_{tk}) = \frac{\phi(X_{ijtk}^\top \beta_k + b_{ik} + c_{jk} + d_{tk})}{1 - \Phi(X_{ijtk}^\top \beta_k + b_{ik} + c_{jk} + d_{tk})} \equiv m_{ijtk}. \quad (17)$$

This gives our second-stage specification

$$Y_{ijtk} = \tilde{X}_{ijtk}^\top \gamma_k + m_{ijtk} \theta_k + f_{ik} + g_{jk} + h_{tk} + \tilde{\epsilon}_{ijtk}; \quad \tilde{\epsilon}_{ijtk} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_\epsilon^2) \quad (18)$$

which is indexed the same as the first-stage.

A Sparse Model. We are conducting a fine-grained analysis not just in terms of data but in terms of model specification. After including main effects in gravity variables, disaggregated *Polity IV* component variables, interactions, and allowing for time-varying effects, we are left with hundreds of possible explanators. In order to estimate and select from this subset, we turn to recent advances in machine learning developed for fitting high-dimensional linear models (Ratkovic and Tingley, 2017). We turn to this variable selection technology in order to estimate parsimonious models and select the most relevant explanators.

The statistical method implements a method for “sparse modeling,” a type of modeling where the researcher confronts a large number of explanators and wants to estimate a model that explains the data well in terms of some small subset of the variables. Across the different products and model specifications, we estimate over 90,000 coefficients that correspond with political or economic covariates. If we fit a standard model via maximum-likelihood and selected using a p -values threshold 0.05, we would expect over 4,500 false positives!

Instead, our Bayesian model incorporates a prior with two characteristics. First, we assume that some small subset of the variables are relevant and the rest are irrelevant in explaining the outcome. Second, we assume that there are some in-truth large effects, captured by the prior flattening out beyond zero. Our notions of “small subset” and “large effects” is estimated endogenously from the model, so the researcher does not need to specify, say, ten total non-zero effects. In effect, the

model has been found to be both powerful in identifying true effects and reliable in uncovering few in-truth-zero effects (see Ratkovic and Tingley, 2017, for extensive simulation evidence and applications.). We include a description of the model specification in Appendix B, but highlight that we have described the intuition of its major assumptions directly above.

4 Empirical Findings

We fit several models, and summarize our results using heat maps, which we briefly introduce in Section ???. Our basic specification (Model 1), which we present in Section 4.1, includes a set of 22 standard “gravity” variables described in Section 3.1, which we refer to as the “economic variables.” Incorporating the six *Polity IV* measures, interacted with exporter and importer dummy variables, leaves us with 12 additional variables. In Section 4.2 we go on to use Bayes Factors to probe the plausibility of including the institutional variables, either separately or aggregated as the POLITY scale. In Section 4.3 we extend our basic model to include interactions between the regime type variables for importers and exporters (Model 2) to examine whether bilateral trade is affected by complementarities among participants’ political institutions.

4.1 Reading the Heat Maps

As we have seen in Section 3.1, we have a massive amount of data: for our basic model we estimate the extensive and intensive margins of trade separately for each of the 449 SITC 4-digit products. Consequently, we have a vastitude of coefficient values and corresponding credible intervals ($13,470 = 449 \times (18 + 12)$) to report for each margin. To manage the presentation of so many coefficients data we use a “heat map”, as has become common practice in genomic studies (???) which provides an efficient display of the effects across a large number covariates and products.

The products are arrayed by SITC 4-digit code, with industry groupings on the vertical axis and explanatory variables on the horizontal axis. Coefficients for which at least 95% of the posterior mass falls below zero are represented by narrow blue bands. Similarly, coefficients with 95% posterior mass above zero are colored red. The greater the median of the posterior density, the darker the share of color. To illustrate, we first present Figure 4 and Figure 5 that zoom in on a particular column and a specific row, respectively.

Figure 4 portrays our estimated coefficients for the log of distance, the key element of the gravity model, in our model of the extensive margin. The industries are sorted by their SITC

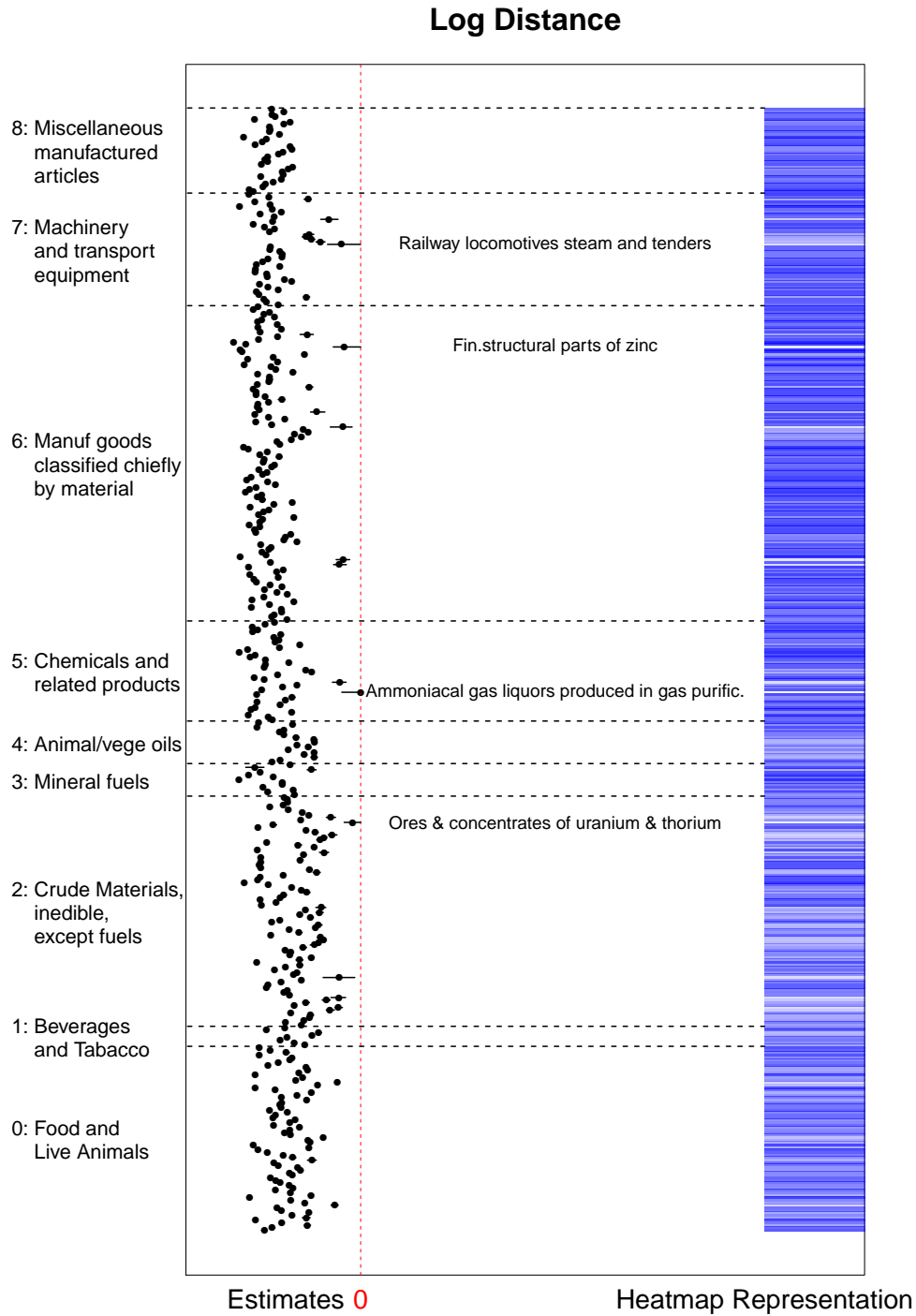


Figure 4: **Effects of Distance on the Extensive Margin of Trade:** This figure presents the heterogeneous effects of distance (logged) on the extensive margin. We label the four industries with the smallest effects of distance on trade. The left side of the panel shows the posterior medians (black circles) with 95% credible intervals. The right-hand side is the heat map representation, which corresponds to the first column in Figure 6.

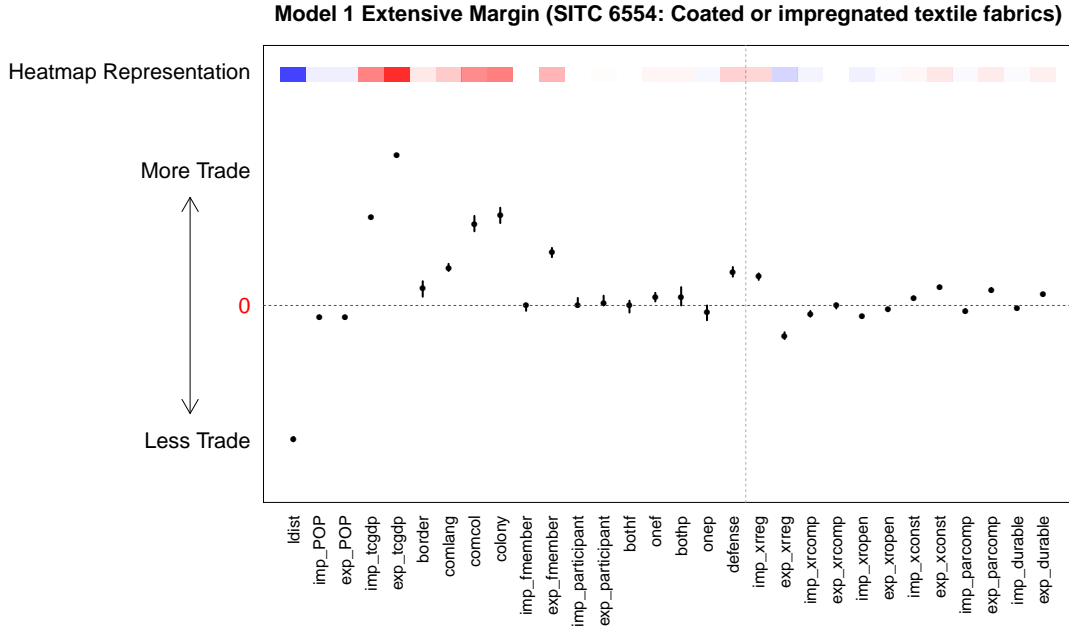


Figure 5: **Effects of Gravity and Polity Variables on Product-Level Trade:** This figure shows the effects of each explanatory variable on the extensive margin of trade for a product in the textile industry (SITC 6554). The heat map representation at the top corresponds to a row in Figure 6.

4-digit codes, with one-digit industry groups on the y-axis. On the left-hand side of the panel, each dot represents the median of the posterior density for each product, while the lines present 95% credible intervals—in many cases these are so narrow with the large number of observations that they appear to coincide with the dots representing the medians. On the right-hand side, we color code each coefficient (the heat map representation).

This figure shows that the effect of distance varies by product, though it generally reduces the likelihood of trade. Consistent with the gravity model of trade, we never find that distance encourages trade flows, indicated by the lack of red stripes. However, we find that distance does not matter for some industries. Consider the coefficient for “Railway locomotives with steam tenders” (SITC 7912) that appears among the results for the “Machinery and transport equipment” industry (SITC 7). The plot of the posterior indicates that the 95% credible interval for this coefficient barely excludes zero, and the corresponding band of the heat map takes on a lighter shade. This is likewise the case for “Finished structural parts of zinc” (SITC 6863) and for “Ores and concentrates of uranium and thorium” (SITC 0721). The median of the “Ammoniacal gas liquors produced in gas purification” (SITC 5213) coefficient actually coincides with 0, and the corresponding color band is white.

Figure 5 zooms in on a row of the subsequent heat map representations. It presents extensive margin coefficients for “Coated or impregnated textile fabrics” (SITC 6554). The 95% credible interval for the exporter GDP coefficient corresponding to this product lies far above zero, represented by a dark red band of color, while the posterior mode of the distance coefficient is well below zero, represented by a dark blue streak in the corresponding line of the heat map. The posterior density of the XRREG coefficient for importers is relatively small and positive, thus it is represented on the heat map as a faded pink stripe.

4.2 Our Basic Specification: Model 1

Let’s now turn to the results for our basic specification; Model 1. Figures 6 and 7 display heat maps of the coefficients for the extensive and intensive margins of trade, respectively, for all covariates and all products. We depict the coefficients for the standard “gravity” variables in the left-hand panel and the regime characteristic coefficients in the right-hand panel. Model 1 uncovers several key regularities.

4.2.1 The Gravity Variables

First, the standard gravity variables have their expected coefficients, and consistently with Hypothesis 2, the signs on the extensive and intensive margins of trade tend to be the same.

Consulting the left-hand panel of Figure 6 we see that, across products, the standard gravity variables have their expected effects. Distance impedes the extensive margin of trade, while increased income (GDP) in either the exporting or the importing country is associated with a greater likelihood that two countries trade in a given product. We find that higher GDP for the exporting country is associated with an even higher likelihood of trade in chemical and manufactured industries indicated by the darker lines in the top part of the fifth column. We also find, consistent with the literature on trade, that sharing a border or a common language, or being linked by a defensive alliance or by having once been part of the same colonial empire each increases the likelihood that two countries will engage in trade. On the intensive margin, displayed in Figure 7, we see that similarly to the extensive margin, incomes for both the exporter and the importer are strongly trade promoting, as is being part of the same defensive alliance, while distance impedes trade. The effect of sharing either a common language or a border, and the impact of sharing the same former colonial power fades relative to the extensive margin. The sporadically negative coefficients

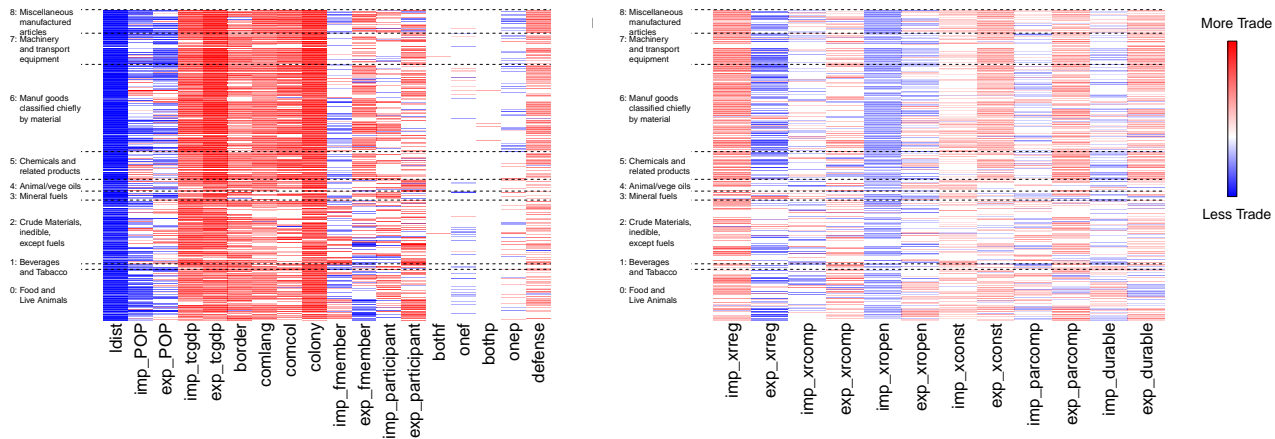


Figure 6: **Extensive Margin (Model 1)**: This figure presents our coefficient estimates and corresponding credible intervals for all variables included in Model 1 on the extensive margin. The left panel contains the results for conventional gravity variables, and the right panel depicts the coefficients for POLITY component variables. Red (blue) color represents positive (negative) correlation between a given explanatory variable on the x-axis and the occurrence of trade of a particular SITC 4-digit product. Darker shade represents a greater degree of correlation. White color is used when there is no statistically significant relationship. We will use heat map representations in the subsequent figures similarly in order to make the comparison across products (along vertical direction) and explanatory variables (along horizontal direction) easier.

of our population measures on the extensive margin, and to a lesser extent on the intensive margin, represented by the blue bands, indicate that most traded goods have positive elasticities with respect to *per capita* income—most but not all, on both the extensive and intensive margins we encounter the occasional positive coefficient for the log of population.

While the gravity variables tend to have larger effects on the extensive margin, the impact on the intensive margin for each of distance, income and a former colonial relationship is still of the *same* sign as for the extensive margin (Hypothesis 2). Note that only the GATT/WTO membership variables appear to change in sign when we move from the extensive to the intensive margin consistent with the recent findings from Dutt, Mihov and Van Zandt (2013).

4.2.2 Trade Promoting Institutions

Our second main finding is that several of our institutional variables appear to affect the extensive margin, see the results reported in the right-hand panel of Figure 6. Consistently with Hypothesis ??, we find that while the coefficients estimates for some of the polity variables, XCONST, and PARCOMP, are consistent with democracy promoting trade, other components of democracy emerge as trade inhibiting: our estimates indicate that XROPEN reduces imports while the XRREG measure

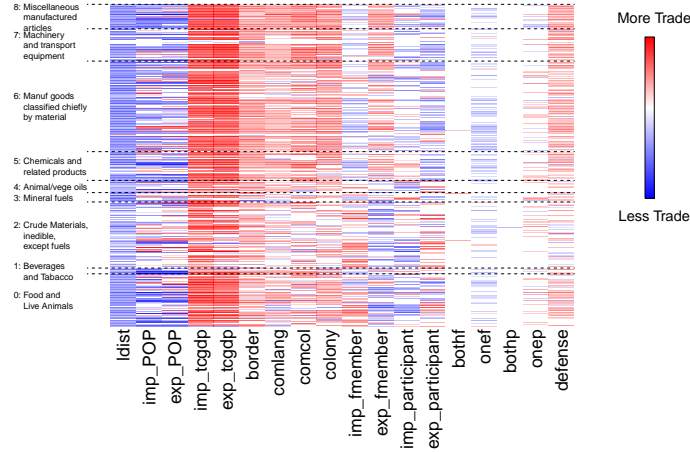


Figure 7: **Intensive Margin (Model 1 – Gravity Variables)**: This figure summarizes the estimated effects of “gravity” variables on the intensive margin of trade. Consistent with Hypothesis 2, a comparison between this figure and the left panel of Figure 6 shows that gravity variables have similar effects on the extensive and intensive margins of trade.

is associated with a reduced probability of exporting a given product. Moreover, another variable, DURABLE, emerges as trade promoting, even though it makes no contribution to the POLITY scale whatsoever. We do note that DURABLE is at least tangentially, related to the vulnerability of a regime.²³

4.2.3 Heterogeneous Effects

A third finding is in line with Hypothesis ??: the effects we identify vary across products, and between imports and exports. Again turning to Figure 6, notice that while XRREG inhibits extensive margin exports for most products, it is simultaneously associated with a greater extensive margin imports, whereas XROPEN markedly reduces extensive margin imports, though it has but a small impact on extensive margin exports.

Several political variables affecting the extensive margin; XCONST, PARCOMP, and DURABLE are focused on manufacturing exports, but not on imports, nor on primary products. This is what we might expect if information spillovers were more extensive for differentiated manufacturing products and the extensive networks of personal contacts their marketing entails (Rauch, 1999), see our earlier discussion in Section 2.3.

²³*Ceteris Paribus* we expect long lived regimes to be less vulnerable to overthrow, if only because the more fragile governments don’t last very long.

4.2.4 Political Institutions and the Intensive Margin

Next we turn to the intensive margin of trade, where our estimates appearing in the left-hand panel of Figure ?? control for the bias induced by the fact that the intensive margin is contingent on the extensive margin of trade. Here we encounter a fourth finding, consistent with our Hypothesis 1: conditional on a pair of countries trading at all, the export promoting extensive margin effects of DURABLE and PARCOMP, along with the export inhibiting effects of XRREG, are reversed on the intensive margin. Our estimates indicate that DURABLE and PARCOMP are export inhibiting, while XRREG is weakly export promoting. Likewise, and despite their export promoting effects on the extensive margin, XCONST, and XROPEN exert exiguous effects on the intensive margin. The one exception to the tendency of our political variables to operate in distinct ways on both margins is the import promoting effect of XRREG, which we encounter, with the exception of a few industries, on both the intensive and extensive margins of trade.²⁴

Recall from our discussion in Section 2.5, in the context of our model and contingent on a dyad trading at all, the extensive margin trade effects of our variables operate through their direct effect on economic comparative advantage, represented by α , whereas for our political institutional variables, there is a second effect at work on the intensive margin that hinges on the threshold $\hat{\alpha}_{yzk}$ for trade. This contrasts with the effect of our gravity variables, which are hypothesized to operate only by way of α , and so are predicted by Hypothesis 1 to impact both margins of trade in the same direction.

In the next section we will subject the selection model to a more encompassing evaluation. However, as a quick robustness check of the importance of first stage selection for our intensive margin parameter estimates, compare the left and right hand panels of Figure ?. The left-hand panel incorporates the inverse Mills ratio to correct for estimation bias, while the righthand side panel does not. While all of the second stage coefficients are tepid compared with those pertaining to the extensive margin, the estimated signs for XRREG, PARCOMP, and DURABLE are dramatically distinct when we omit the Heckman's bias correction term.

Now let's turn our attention to a more comprehensive evaluation of the overall impact of political

²⁴It is of course possible that low values of XRREG which we associate with kleptocratic regimes such as the Central African Empire of Jean-Bédél Bokassa distort a country's comparative advantage even as they promote cross border trade by driving producers eschew locating inside the country fear of having their facilities seized, forcing the country to import more than it would have.

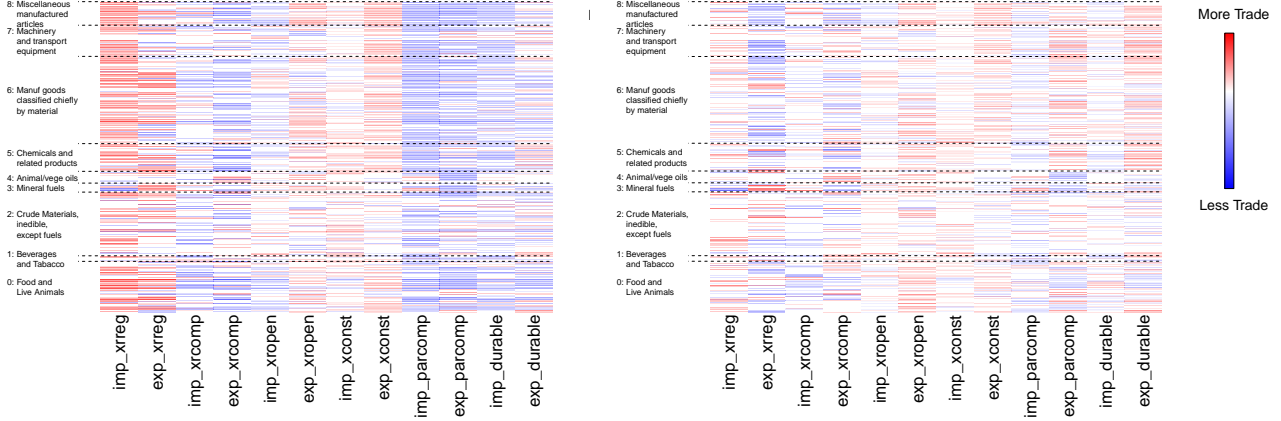


Figure 8: **Intensive Margin (Model 1 – Polity Variables)**: The left panel summarizes the estimated effects of *Polity IV* variables on the intensive margin of trade with the proposed bias correction. We compare this against the right panel which summarizes the estimated effects with no correction of the selection effect. The difference between the two figures provides strong evidence for the importance of selection effects in the extensive margin.

institutions on trade flows.

4.3 Do Institutions Belong in our Specification?

Proposition 1 predicts that political considerations are particularly important in choosing trading partners. To examine empirically whether political institutions matter more for extensive margins than for intensive margins, we compare the Bayesian posterior density for each product k from a model that incorporates both gravity and *Polity IV* variables (\mathcal{M}_k^P) against a model that includes only gravity variables (\mathcal{M}_k^G). Applying the widely used procedure of Kass and Raftery (1995), we calculate the Bayes factor (BF) which tells us about how strongly the data favor the model incorporating the *Polity IV* variables compared with the model using the gravity variables by themselves:

$$\text{BF}_k^{PG} = \frac{\Pr(\mathbf{D}_k | \mathcal{M}_k^P)}{\Pr(\mathbf{D}_k | \mathcal{M}_k^G)} \quad (19)$$

where $\mathbf{D}_k = \{Y_k, X_k\}$ denotes the observed data for product k . Appendix C provides more extensive computational details. Working with logged values of the Bayes factor, a positive difference implies that the model with *Polity IV* variable is preferred, while $\log(\text{BF}_k^{PG})$ greater than 2 is sometimes taken to imply “decisive” evidence in favor of \mathcal{M}_k^P (Jeffreys, 1998; Kass and Raftery, 1995).

The first panel of Figure 8 shows the distribution of Bayes factors for Model 1 against a model

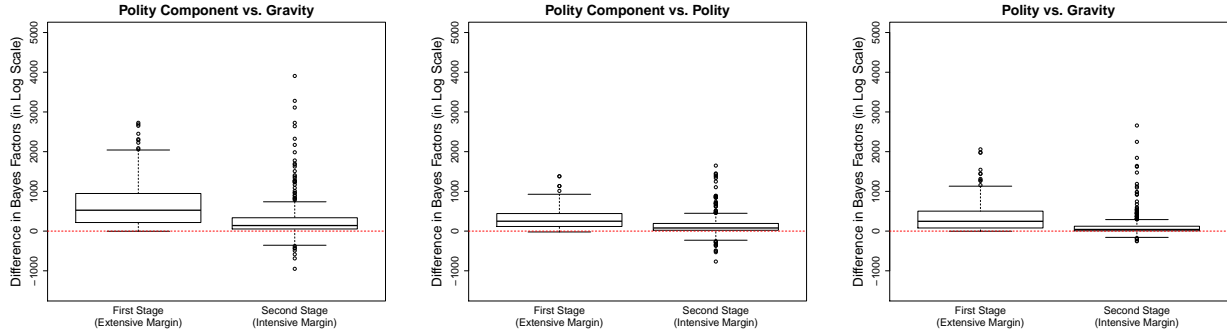


Figure 9: **Institutional Variables Matter for Extensive Margins:** The box-and-whisker plots in each panel shows the distribution of BF_k based on the comparison of two competing models on extensive (left) and intensive (right) margins of trade across each product k . Specifically, it compares Bayes factors across three models: A) Model with gravity and *Polity IV* component variables, B) Model with only gravity variables, and C) Model with gravity and the single POLITY variable ranging from -10 to 10. Bayes factors are given by expression (20). The three panels correspond to the comparison between models (1) A vs. B, (2) A vs. C, and (3) C vs. B, respectively. We find that models with *Polity IV* component variables are most preferred on the extensive margins, and less so on the intensive margins. That is, political institutions exert a significant influence over the decision to trade at all, but given there is trade, the level of trade is primarily governed by economic factors.

that only includes economic gravity variables across each product k . The left-hand box and whisker plot of the first panel confirms the importance of *Polity IV* variables for predicting the extensive margin of trade: including the *Polity IV* variables in addition to conventional gravity variable leads to an improved Bayes factor for every single product in our dataset. Furthermore, the median Bayes factor is around 500 in log-scale, which provides strong evidence in favor of our finding. The right-hand results in the first panel, which relate to the intensive margin, are less overwhelming—in some products, the improved fit to the data is not sufficient to justify the addition of so many parameters, though for the majority of industries it does.

Next, we consider whether the data support shattering POLITY into its components rather than simply including this aggregate measure. We have just seen that the model including the *Polity IV* components produces a vastly better fit on the extensive margin, and in most cases it can also justify the extra parameters it entails on the intensive margin. The central panel of Figure 8 compares the model with the gravity variables and the *Polity IV* components with the model that retains the gravity variables, but supplants the six *Polity IV* components with the single POLITY index that runs from -10 for extreme authoritarian governments, to 10 for democracies. Consulting the box and whisker plots we find that the data support shattering POLITY into its *Polity IV* components

in the extensive margin specification (on the left of the central panel), albeit by a less overwhelming margin than our rejection of the model with no institutional variables at all, while on the intensive margin we see little systematic difference between the “shattered” and “unshattered” institutional measures.

For the sake of completeness, the panel on the right-hand side of Figure 8 evaluates the gravity variables-only model against the model whose only institutional measure is the POLITY scale itself. Again, although less overwhelmingly than for our full complement of *Polity IV* components, the results indicate that on the extensive margin even the model whose only institutional measure is the POLITY scale is preferred to the model that only incorporates the gravity variables, while the preference for including POLITY on the extensive margin varies across industries. Of course, the results from the other two panels already show that the shattered *Polity IV* components fit better than simply incorporating the POLITY scale, the relative parsimony of the latter specification notwithstanding.²⁵

While spillovers will be idiosyncratic to each product, Rauch (1999) argues that personal contacts are more important to cross-border trade in some products than in others, and presents evidence that personal connections are more important for trade in differentiated products than they are for trade in goods belonging to his other two categories; products with a reference price, and those traded on a common exchange. Our notion of network spillovers developed in Section 2 is more or less synonymous with systems of interpersonal connections. Thus, following Rauch (1999), we would expect to see a greater impact of political institutions on trade in products with extensive network spillovers, and to the extent that personal networks tend to be densest in differentiated products, and less dense in reference priced products and for those traded on exchanges. Consequently, we would also expect to encounter a greater impact of political institutions on trade in differentiated products than on those that are reference priced or exchange traded. To assess this, we calculate Bayes Factors for the subset of our data that pertain to SITC 4 products categorized by Rauch into each of the three categories, in each case comparing model \mathcal{M}_k^P with model \mathcal{M}_k^G . Our results are summarized by the box and whisker plots appearing in Figure ???. The left-hand panel displays plots for the Bayes Factors pertaining to extensive margin trade in each of Rauch’s categories. Consistently with our prediction that greater spillovers will result in a greater estimated impact

²⁵We find similar results for Models 2 and 3 with regard to Bayes Factors, so we place these figures in the Web Appendix.

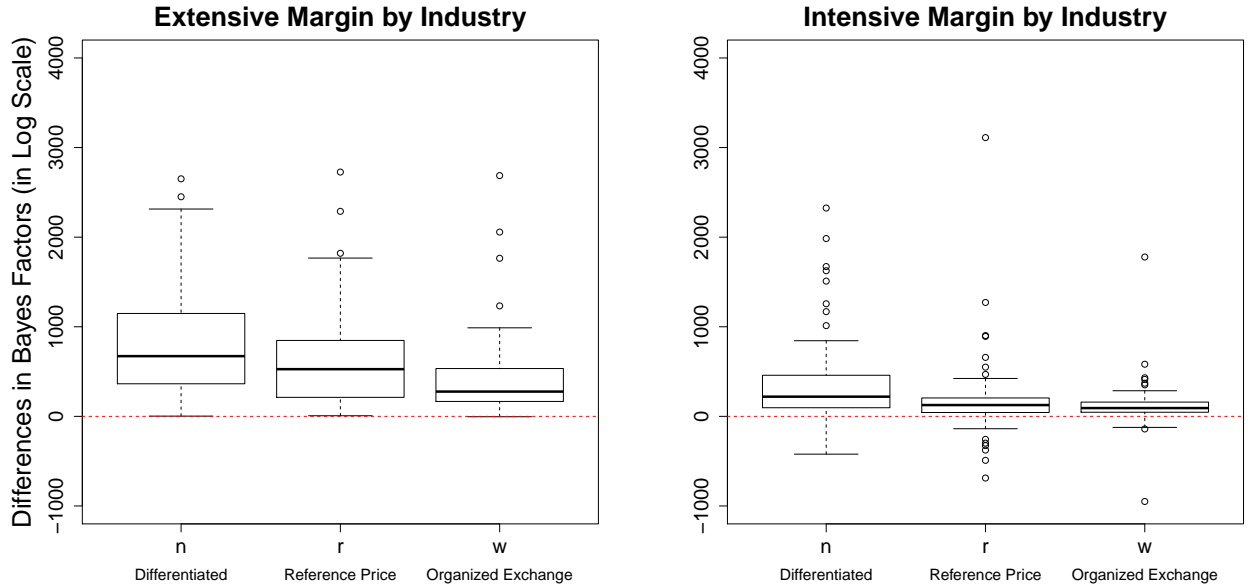


Figure 10: **Broad vs. Narrow Spillovers:** This figure compares the importance of political institutions on the two margins of trade across products. We make the comparison of the two models with vs. without *Polity IV* component variables (corresponding to the first panel of Figure 8). Following Rauch (1999), we categorize each product into three groups based on the degree of potential network effects: (1) Differentiated products (n), (2) Products with reference prices (r), and (3) Homogeneous products sold in organized exchange (w). Consistent with Proposition 1, we find a clear ordering of the magnitude of selection effect. Specifically, the importance of political institutions is more pronounced for products with broader spillovers.

of political institutions on extensive margin trade, the leftmost plot pertaining to differentiated products shows the greatest preference for incorporating polity variables into the model. While the reference priced and exchange traded products result in smaller Bayes Factors, our estimates reveal a positive Bayes Factor across all industries on the extensive margin. Turning to the intensive margin, the results are more mixed, with only a fraction, albeit a majority, of industries in each group exhibiting Bayes Factors favoring the inclusion of our polity variables.

The analysis of this section provides strong support for the use of the full cluster of *Polity IV* variables to explain extensive margin trade, and for our model’s implication that the institutional effects on the extensive margin of cross border trade are mediated by networks of personal contacts, as partially measured by Rauch’s taxonomy of products into differentiated products for which personal interconnection is important for trade, and reference priced and exchange traded products, for which it is less central. In contrast, our analysis in this section provides but lukewarm support for the impact of political variables on the intensive margin of trade.

4.4 Interactions among the *Polity IV* Variables: Model 2

Scholars of international political economy have emphasized that political institutions of country pairs *mutually* affect international cooperation (e.g., Dixon, 1994; de Mesquita et al., 1999; Mansfield, Milner and Rosendorff, 2000, 2002). In particular, Mansfield, Milner and Rosendorff (2000) theorize that exporters’ and importers’ legislative control over the head of state interact, with dyads that impose greater constraints on their executives tending to trade more with each other.²⁶ To explore the possibility that political variables interact in a meaningful way, we expand our basic model by including interactions between the importer’s and the exporter’s *Polity IV* component variables for each product category. Specifically, we work with interaction terms that are constructed to be uncorrelated with their main effects, allowing us more effectively to distinguish main effects from interactive effects (Ratkovic and Tingley, 2017). Doing so reduces the collinearity between interactive and main effects, such that if there are interaction effects among our variables we will find them.

We find little evidence for interaction effects, indicated by the white columns corresponding to the interaction terms in the two right-hand side graphs of Figure ???. Of the twenty interaction effects in the extensive margin, only three show the least hint of a stable effect across product classes: we find a possible trade promoting interaction between importers’ XRCOMP and exporters’ PARCOMP, though the estimated effect is small and it appears to be concentrated among manufactured goods. We also find sporadic trade promoting effects for the interaction between the importer’s value of XRCOMP and the level of XCONST for the exporter, and the interaction of importer XRREG and exporter XROPEN. The bulk of the impact of institutions appears to come from main, and not interactive, effects.

We check the robustness of the Bayes factors. As shown in the left panel of Figure ??, we continue to observe that, for the extensive margin, including the *Polity IV* variables improve the fit of our model for every product in our dataset, whereas we encounter languid results on the intensive margin, with negative Bayes factors for many, albeit a minority, of products. As expected by the

²⁶Note that Mansfield, Milner and Rosendorff (2000) do not directly test their hypothesis by interacting XCONST values of importers and exporters, which they recognize as “directly related to” their central argument. Instead, they create a dummy variable for democratic pairs if both countries’ POLITY scores are greater than 6. See p. 313 for their discussion.

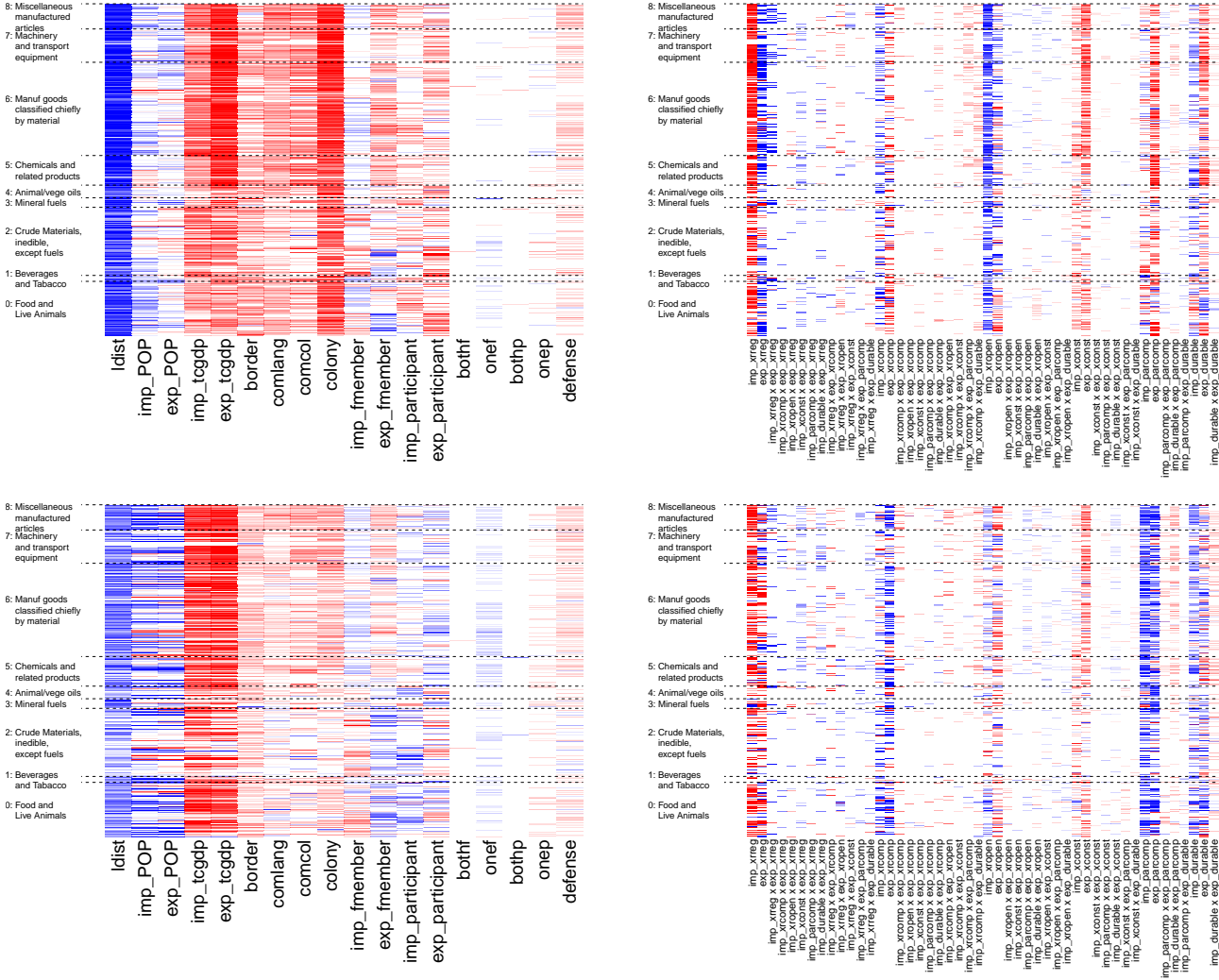


Figure 11: **Extensive (Top) and Intensive (Bottom) Margins from Model 2:** This figure summarizes the estimated effects of gravity variable (left panel) and *Polity IV* component variables (right panel) in the extensive (top row) and the intensive margin (bottom row). The consistency of gravity variables’ effects can be by comparing the two figures in the left-hand side (Hypothesis 2). In contrast, the right-hand side figures show stark differences between the two margins (Hypothesis 1). We find little evidence for interaction effects among *Polity IV* variables. This can be seen from the dominance of the white space.

lack of interaction effects, the right panel shows that including the full interaction terms often do not improve the fit in both margins.

We provide further robustness checks in Section ?? of the Web Appendix by allowing the effects vary dynamically over time. While our results for the main effects of our variables from Section 4.1 are robust to the inclusion of interaction effects, we find that the interaction effects themselves do not contribute much explanatory power to our model, our analysis of the Bayes Factors indicates

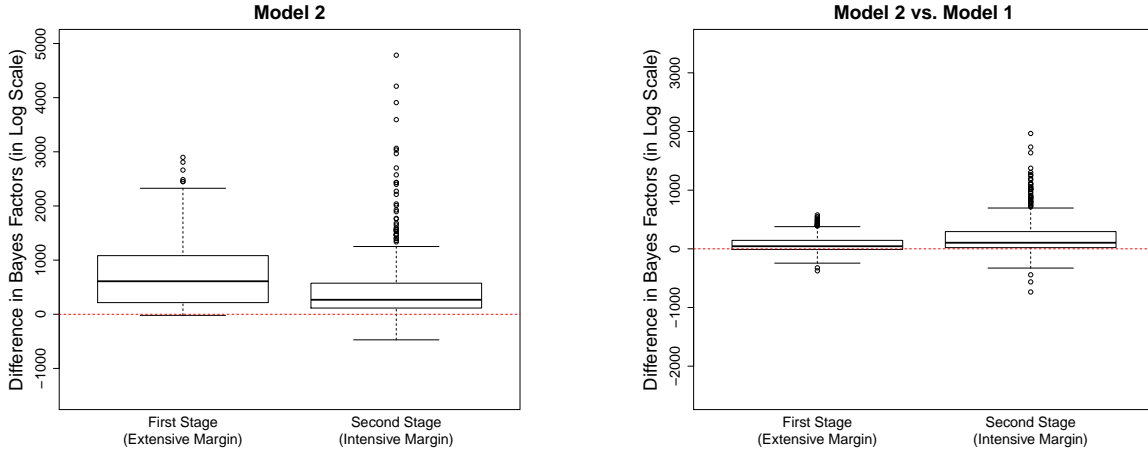


Figure 12: **Institutional Variables Matter for Extensive Margins:** The left figure compares the importance of including the *Polity IV* component variables in explaining extensive and intensive margins of trade in Model 2. The baseline model is the model with only gravity variables. It confirms the importance of political institutions on the extensive margin. The right figure compares Model 2 against Model 1. It shows that adding additional interaction terms does little to improve the fit.

that little is lost by omitting the interaction effects in the interests of parsimony.

Taken together, the findings in this section demonstrate that political institutions affect bilateral trade differently on the extensive and intensive margins. This is in stark contrast to economic variables that tend to have similar effects on both margins consistent with various gravity models of trade (Arkolakis, Costinot and Rodríguez-Clare, 2012). We also find that political institutions are particularly important in explaining the choice of trading partners (the extensive margin) whereas economic factors have consistent explanatory power in predicting the overall trade volumes *conditional on* trade (the intensive margin). Our findings are robust to inclusion of interactions between political institutions of importing and exporting countries.

5 Concluding Remarks

The extensive development of models of international trade in economics has taken place largely in the absence of analysis of the effects of political institutions. Yet, as a vast literature in political economy points out, any response to the question of international trade must be predicated on an understanding of the interaction between politics, institutions, and trade (Grossman and Helpman, 1994; Mansfield, Milner and Rosendorff, 2000; Gowa and Hicks, 2013; Nunn and Treffer, 2014). At the same time, the literature on the effects of political institutions on international trade has under emphasized the importance of distinguishing between the extensive and intensive margins of trade

both theoretically and empirically, and has largely focused its attention on the intensive margin. This paper seeks to rectify both of these oversights.

We make several contributions. First, we develop a model of political networks that explicitly distinguishes the effects of political institutions on the extensive and intensive margins of trade. Our model focuses on the tendency for trade to facilitate communication amongst the people involved in producing and marketing products across borders. For democracies and consolidated authoritarian regimes this poses no or little threat, but for vulnerable autocracies this communication can spill over into the political realm by allowing regime opponents better to coordinate their activities. This leads vulnerable regimes to block trade on the extensive margin for products with high network spillovers relative to the potential gains from trade that they offer. These spillovers appear to be greatest in differentiated products and for manufactured goods. Second, we employ an estimation strategy that simultaneously deals with the selection issue and the substantial collinearity that emerges from analyzing various features of political institutions. Our estimator, based on the recent development of machine learning techniques in variable selection methods (Ratkovic and Tingley, 2017), enables us to identify systemic patterns of international trade. Finally, we collect massive amount of product-level trade data while ensuring the compatibility across products over a half century. We then combined the trade flows data with a large number of observable country and dyad level covariates that have been identified as important determinants of bilateral trade. To the best of our knowledge, the size, scope, and level of disaggregation in our dataset expands the empirical frontier for the political economy of trade literature.

Consistently with Hypothesis 1 our estimates show that the impact of political variables not only differs between the intensive and extensive margins, but that their effects fall primarily on the extensive margin. In contrast with the political variables, but in keeping with the predictions of Hypothesis 2 we find that the signs for the estimated coefficients of the standard gravity variables on the extensive and intensive margins of trade tend to be the same. As predicted by Hypothesis ?? we find that the impact of political institutions varies across industries, with their largest effects being manifest among the products classified by Rauch (1999) as differentiated, and among manufactures, products for which we expect the political spillovers resulting from personal contacts to be more important, thereby making vulnerable authoritarian regimes more reluctant to trade. In line with Hypothesis ??, the profile that emerges from our empirical analysis of a regime that promotes

extensive margin trade does not coincide with democracy. While some *Polity IV* components of democracy, PARCOMP and XCONST promote extensive margin trade, while others, XRREG and XROPEN have the opposite effect. Another variable, DURABLE, which does not even form a part of the POLITY composite, promotes exports on the extensive margin.

We find that the importance of political institutions for the extensive margin of trade are robust to including interaction effects, and that they persist across the various subperiods of our analysis.

Still to do: a speculative sentence or two about future directions

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Appendix

A Proof of Proposition 3

Starting with the definition of $T_0(\hat{\alpha}_{yzk})$ and differentiating we have:

$$\frac{dT_0}{d\hat{\alpha}_{yzk}} = \frac{d\pi_p}{d\hat{\alpha}_{yzk}} + \frac{d}{d\hat{\alpha}_{yzk}} (\pi_p(\hat{\alpha}_{yzk}) \mathbb{E}_F\{\alpha | \alpha > \hat{\alpha}_{yzk}\}) \quad (20)$$

By Proposition 2 we know that $\frac{d\pi_p}{d\hat{\alpha}_{yzk}} < 0$. Next recall that:

$$\mathbb{E}_F\{\alpha | \alpha > \hat{\alpha}_{yzk}\} = \frac{\int_{\hat{\alpha}_{yzk}}^{\infty} \alpha f(\alpha) d\alpha}{\pi_p(\hat{\alpha}_{yzk})}$$

so that:

$$\pi_p(\hat{\alpha}_{yzk}) \mathbb{E}_F\{\alpha | \alpha > \hat{\alpha}_{yzk}\} = \int_{\hat{\alpha}_{yzk}}^{\infty} \alpha f(\alpha) d\alpha$$

differentiating this term, we have by Leibniz's rule:

$$\frac{d}{d\hat{\alpha}_{yzk}} (\pi_p(\hat{\alpha}_{yzk}) \mathbb{E}_F\{\alpha | \alpha > \hat{\alpha}_{yzk}\}) = \frac{d}{d\hat{\alpha}_{yzk}} \int_{\hat{\alpha}_{yzk}}^{\infty} \alpha f(\alpha) d\alpha = -\hat{\alpha}_{yzk} f(\hat{\alpha}_{yzk}) < 0$$

substituting this expression into (21) leaves us with (13). □

B Modeling Details

For the first stage, we follow the standard latent representation of a probit model as

$$Y_{ijt}^* | \beta_k, b_{ik}, c_{jk}, d_{tk}, S_{ijk} = 1 \sim \mathcal{N}(X_{ijt}^\top \beta_k + b_{ik} + c_{jk} + d_{tk}, 1) \quad (21)$$

$$\beta_{k\ell} | \lambda_{1k} \stackrel{\text{i.i.d.}}{\sim} \text{Exp}(\lambda_{1k}) \quad (22)$$

$$\lambda_{1k}^2 \stackrel{\text{i.i.d.}}{\sim} \Gamma(\sqrt{N_{1k}}, 1) \quad (23)$$

$$b_{ik} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_{bk}^2); c_{jk} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_{ck}^2); d_{tk} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_{dk}^2) \quad (24)$$

$$\sigma_{bk}^2 \propto 1/\sigma_{bk}^2; \sigma_{ck}^2 \propto 1/\sigma_{ck}^2; \sigma_{dk}^2 \propto 1/\sigma_{dk}^2 \quad (25)$$

which is the Bayesian representation of a LASSO model (Tibshirani, 1996).

The normal likelihood is not conjugate with the double exponential prior. To restore conjugacy, we augment the data again representing the double exponential as a scale mixture of normals with an exponential mixing density (Park and Casella, 2008). We parameterize the conditional prior on

λ_{1k}^2 in terms of the sample size N in order to guarantee that the posterior mode takes on a value zero with positive probability in the limit. The parameters b_{ik} , c_{jk} , and d_{tk} are random effects, each with a Jeffreys' prior over the scale parameter.

We calculate the sparse estimate as

$$\beta_{kp}^{sparse} = \beta_{kp} \mathbf{1} \left(\left| \sum_{i,j,t} (Y_{ijtk}^* - \sum_{p' \neq p} X_{ijtkp'} \beta_{kp'}) X_{ijtk} \right| > \lambda_{1k} (N_{1k} - 1)^{1/4} \right) \quad (26)$$

See Ratkovic and Tingley (2017) for details.

For the outcome model, we use all observed positive trade flows, including those for directed dyads that trade in all of the years, and so were omitted from the first stage of our estimation. We construct the selection correction variable in terms of our first-stage parameters, which allow us to calculate Y_{ijtk}^* even for observations pertaining to directed dyads that were not used in the estimation of the first stage model. Denote the inverse-mills ratio $m_{ijtk} = \phi(Y_{ijtk}^*) / (1 - \Phi(Y_{ijtk}^*))$, with $\phi(\cdot)$ and $\Phi(\cdot)$ the density and distribution functions of a standard normal variable, respectively.

Denote as $N_{2k} = \sum_{i,j,t} \mathbf{1}(Y_{ijtk} > 0)$ the number of observations with non-zero trade. We model the level of trade for these observations as a linear regression in terms of parameters γ_k with element p denoted γ_{kp} . To account for the selection bias, we include an additional covariate m_{ijtk} and associated parameter θ_k .

$$Y_{ijtk} | \gamma_k, f_{ik}, g_{jk}, h_{tk}, Y_{ijtk} > 0, m_{ijtk} \sim \mathcal{N}(X_{ijtk}^\top \gamma_k + f_{ik} + g_{jk} + h_{tk} + m_{ijtk} \theta_k, \sigma_k^2) \quad (27)$$

$$\Pr(\theta_k) \propto 1 \quad (28)$$

$$\gamma_{kp} | \lambda_{2k}, \sigma_k \stackrel{\text{i.i.d.}}{\sim} \text{Exp} \left(\frac{\lambda_{2k}}{\sigma_k} \right) \quad (29)$$

$$\lambda_{2k}^2 \stackrel{\text{i.i.d.}}{\sim} \Gamma \left(\sqrt{N_{2k}}, 1 \right) \quad (30)$$

$$\sigma_k^2 \propto 1/\sigma_k^2 \quad (31)$$

$$f_{ik} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_{fk}^2); g_{jk} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_{gk}^2); h_{tk} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_{hk}^2) \quad (32)$$

$$\sigma_{fk}^2 \propto 1/\sigma_{fk}^2; \sigma_{gk}^2 \propto 1/\sigma_{gk}^2; \sigma_{hk}^2 \propto 1/\sigma_{hk}^2 \quad (33)$$

The model is nearly identical to the one above, except we now must model an unknown variance, σ_k^2 . We place a Jeffreys' prior over θ_k , the parameter associated with the correction term m_{ijtk} . We again generate a sparse estimate as:

$$\gamma_{kp}^{sparse|\cdot} = \gamma_{kp} \mathbf{1} \left(\left| \sum_{i,j,t} (Y_{ijtk} - \sum_{p' \neq p} X_{ijtkp'} \gamma_{kp'}) X_{ijtk} \right| > \lambda_{2k} \sigma_k^{sparse} \right) \quad (34)$$

The Gibbs sampler was run for 8,000 iterations. The first 4,000 were discarded, and every 20th sample from the remaining 4,000 were saved. We analyze these 200 saved posterior draws.

C Bayes Factor Calculation

We calculate the Bayes factor (BF) as follows:

$$\text{BF}_k^{PG} = \frac{\Pr(\mathbf{D}_k | \mathcal{M}_k^P)}{\Pr(\mathbf{D}_k | \mathcal{M}_k^G)} = \frac{\int \Pr(\mathbf{D}_k | \theta_P, \mathcal{M}_k^P) f(\theta_P | \mathcal{M}_k^P) d\theta_P}{\int \Pr(\mathbf{D}_k | \theta_G, \mathcal{M}_k^G) f(\theta_G | \mathcal{M}_k^G) d\theta_G} \quad (35)$$

where $\mathbf{D}_k = \{Y_k, X_k\}$ denotes the observed data for product k , and θ_ℓ is the set of parameters in model \mathcal{M}^ℓ where $\ell \in \{G, P\}$. Following Kass and Raftery (1995), we compute $\Pr(\mathbf{D}_k | \mathcal{M}_k^\ell)$ for Model \mathcal{M}^ℓ based on the harmonic mean of the likelihood values given by a m^{th} sample from a posterior density as:

$$\Pr(\mathbf{D}_k | \mathcal{M}_k^\ell) = \left\{ \frac{1}{M} \sum_{m=1}^M \Pr(\mathbf{D}_k | \theta_\ell^{(m)})^{-1} \right\}^{-1}. \quad (36)$$