Assessing Transit Rents

Katrin Tinn* Mario Milone†

October 12, 2018

Abstract

Trading frictions due to inevitable transportation costs are fundamentally different from those due to rent extraction by transit countries. We propose a theoretical and empirical methodology to disentangle these two types of costs and assess the presence and global magnitude of a hold-up problem. We construct a new measure of distance based on a global network of the most likely trade routes. While transportation costs make all countries worse off, rent extraction benefits transit countries. Further, we show that in general equilibrium, countries that are neither landlocked nor transit countries bear a large share of the cost of distortions due to rent extraction. While free trade agreements with transit countries do not appear to mitigate the problem, customs unions do.

*Imperial College Business School
†Université Paris Dauphine

1 Introduction

Geographical location is important to international trade: countries that are closer to each other tend to trade more, and being landlocked is associated with less trade (see e.g., Frankel and Romer; Rose; Overman et al.). Transportation costs that increase with distances and costs of air transport that are higher than those of sea and land transport have been invoked as partial explanations for this phenomenon.[1] Yet, trading frictions are not limited to solely technological obstacles of transportation. Adam Smith and Ronald Coase highlighted a potential hold-up problem, whereby intermediaries (e.g. ports) and perhaps transit countries have an opportunity and a strategic incentive to extract monopolistic or oligopolistic rents for letting goods pass through.[2]

Such rents to "the middlemen" are central to policy discussions on trade involving developing countries.[3] Using micro-level data of trade by Ethiopian and Nigerian firms, Atkin and Donaldson find that a substantial part of the surplus generated by trade is captured by intermediaries. Furthermore, hold ups in freight are also argued to be a substantial obstacle to trade by developed countries. This observation has prompted discussions about the adoption of new technologies that can improve supply chain management.[4]

A geographically advantageous location may provide transit countries with an opportunity to extract rents just like an advantageous position in the supply chain may enable firms to engage in rent seeking. If transit countries do extract rents, trade is affected by another layer of hold-up the magnitude of which depends on geographical locations. In particular, this hold up should affect countries that need to use a port in another country more than countries that have their own port. This differential country-level hold-up poses a potentially complex international coordination and political economy problem, which, unlike transportation technology or the reduction of intermediaries' monopolistic power, may not be easily solved with technological innovation (including innovation to supply chain management) or better competition regulation. At the same time, one

[1]Shipping a 70kg worth goods from Shanghai to London has been estimated to cost four times as much (and takes three times longer) than buying an airline ticket to a human of the same weight (see Economist 26 April 2018). See also Limão and Venables or Raballand et al. (b) for evidence that landlocked countries face higher transport costs.

[2]In contrast to the incomplete contracts literature which often focuses on the ex ante underinvestment implications of rent extraction (see Chemla and Milone, 2017), this international trade literature on the hold-up problem focuses on rent extraction rather than measuring the economic consequences of rent extraction.

[3]For example, Raballand et al. (a) explore delays in six African ports and argue that these delays serve the interests of public and private actors with market power. Relatedly Arvis et al. argue that inefficient logistics may be a more important obstacle to trade for landlocked countries than infrastructure development. See also Djankov et al. and USAID.

[4]For example, an article in The Economist 26 April 2018 argues that intermediaries involved in transfers between different means of transportation, custom clearances, insurance, and bureaucracy account for a fifth of logistics industry revenues, highlighting the promises of blockchain technology and some related initiatives in reducing these frictions.

may expect country level hold-ups to be historical problems that have been eliminated or alleviated by bilateral and multilateral trade agreements.[5]

The goal of this paper is to suggest a methodology to examine and assess the country-level hold-up problem aforementioned as well as its global impact. We start by developing a global general equilibrium model of trade that explicitly takes into account the fact that some trades need to go through a transit country due to geographical constraints. The global general equilibrium approach is essential as local trading frictions have a global impact via general equilibrium price effects. This was notably highlighted by Anderson and Van Wincoop who emphasize the importance of empirically capturing these price effects in gravity equations. We build on their framework and include the possibility that in addition to transport (and other "iceberg") trading costs, some countries can charge "transit fees" which differ from iceberg costs as they are a source of revenues for transit countries. Our model shows that there is a global deadweight loss that falls largely on the group of directly unaffected countries (like the UK, Japan, Australia, USA, or Mexico) that are in geographical locations that enable them to trade directly with most countries and are unlikely to obtain transit rents themselves. The reason is that while from the perspective of landlocked countries transport costs and hold-up frictions have a similar effect, typical transit countries benefit from the country level hold up. In contrast, losses due to transport and other iceberg costs are likely to be more evenly spread across all countries.

Our theoretical exercise further suggests that in a world where the country level hold-up problem is empirically relevant, estimating gravity equations without considering transit rents may overstate the role of transport costs and socio-economic ties when explaining why landlocked countries trade less and why neighboring countries trade more. We show that such pattern would be present also in a hypothetical world where all countries are identical apart from their location, and transport is costless. Furthermore, a cross-country structural gravity estimation approach that builds on Anderson and Van Wincoop and does not distinguish transit fees and iceberg-type trading costs leads to systematically biased estimates of global price effects, frequently called "multilateral resistance terms".

Empirically, distinguishing transit rents from transportation costs requires a good measure of distance. We propose a novel and flexible measure of distance: we construct a world-wide network of theoretically possible trade routes between all main cities that considers the location of major ports and differentiates between land and sea distances. Our algorithm then generates the most likely trade routes solely based on geography, the relative cost of sea and land transport, and potential fixed costs associated with loading and unloading goods. An advantage of that approach is that it enables us to identify the most likely transit countries based on geography alone, and it is flexible enough to

[5] See e.g., Franck and Brownstone that discusses the Silk Road and tax collection on route. Also, Hirschman discusses trade policy as a tool for global influence.

easily consider alternative relative and fixed costs, some of which we have considered in our robustness checks. An obvious benefit of using this measure compared to the traditional great-circle distance measure between the main cities is that the great-circle distance tends to minimize long trade routes, potentially resulting in an underestimation of bilateral transportation costs, which is particularly relevant for trade with landlocked countries. The great-circle distance cannot also provide information regarding the type of transportation used (land or sea)

Using 1993-2016 trade data, we show that the hold-up problem exists and is statistically and economically significant. On average trades that are likely to go though a transit country could be increased by approximately 28% were they not held up. Even though bilateral trades that are exposed to transit rents often involve a landlocked country, it is important to emphasize that the country-level hold up differs from a country's status on being landlocked. Being landlocked is a static, country-specific characteristic that is captured by (time varying) fixed effects included in our analysis. If lower trade by these countries would relate to specific characteristics of landlocked countries, we would not find significant results. In contrast, whether or not a particular trade is potentially held up is a bilateral and trade-specific problem: for example the trade between a landlocked country and its neighbor is not held up, while its trades with further away countries is. Furthermore, as land transport is not prohibitively expensive trade between two coastal countries may benefit from going through a transit country (e.g., trade between Slovenia and Germany may benefit from going through Austria) and could be held up as a result. A landlocked country itself could be a transit country that can charge rents in some bilateral trade relations (e.g., Austria in the case of trade between Slovenia and Germany). There are indeed numerous cases where landlocked countries are also transit countries.

Our estimation strategy does not aim to identify the particular method of rent extraction the transit country uses. Obvious examples of possible methods include tariffs, road tolls, and different port handling costs for good in transit and goods that are part of exports from or imports to the country of the port. Furthermore, the monopolistic/oligopolistic power of ports that intermediate large volumes of trade in transit alone enables them to extract rents: even if the port charges similar rents for all firms, both profits and the income of its employees remain within the transit country's GDP and there is still a de facto wealth transfer between the held up country and the transit country. Hence transit countries may have a limited interest in reducing the market power of ports. Relatedly, it is worth emphasizing that that the hold-up problem we identify is the differential one and would not capture the cost at ports that falls identically on goods traded by domestic firms and goods in transit.

We further consider a number of robustness checks, including differences across continents. The hold-up problem appears to be most severe in Africa and least severe in Europe, but is present in all continents. As trade between many European countries is facilitated by European Union and free trade agreements and customs unions also exists elsewhere, a natural question is whether the hold-up problem is mitigated, or perhaps eliminated, by these agreements. We find that while free trade agreements between the hold up and the transit countries do not appear to mitigate the problem, customs unions reduce the hold-up friction. Indeed, central features of a customs union are that countries charge identical import duties to each other and typically allow free trade between themselves. Nevertheless, customs unions do not appear to eliminate the country-level hold-up friction, which suggests that transit rents may indeed include more indirect features, e.g., differential costs at ports, monopolistic power of ports, road tolls etc.

After establishing the hold up and indirectly assessing transit rents, we use our model and data to simulate the world without the hold-up problem and transit rents. We find that if these rents were to be eliminated, the global gains would be around 350 billion 2017 USD per year.[6] These gains are not evenly distributed. Absent transit rents, the group of likely transit countries would lose approximately USD 350 billion, but landlocked countries would gain USD 500 billion. The group of countries that are *not* directly affected (countries such as the UK and the USA), would gain around USD 200 billion annually. We repeat this exercise considering that transit countries in customs unions charge lower transit fees when intermediating trades that involve other countries in the same customs union. The global gains and losses are qualitatively similar albeit quantitatively smaller. The latter is to be expected as customs unions include many relatively richer countries. We contrast this prediction to a simulation of the world without transit rents to one where there is a reduction of transport costs leading the exactly the same global gain. In that simulation all groups of countries gains, and importantly the gains of directly unaffected countries is much smaller. This highlights that mitigating country level hold up would be of benefit to a wide set of countries and not just landlocked countries, but would not be in the interest of transit countries. Yet, reducing this problem does not require technological innovation, and could at least theoretically be tacked by limiting the market power of transit countries and ports while compensating for the losses of transit countries.

The paper builds on, and contributes to, the gravity equations literature (see e.g., Head and Mayer (b) and Costinot and Andrés for elaborate overviews including the relationship between theoretical models of trade and empirical methodologies). As our question is about global general equilibrium effects of country level hold up and transit rents, and micro level data does not exist in standardized format at the global scale, our theoretical setting builds on Armington and Anderson and Van Wincoop where country level production is exogenous. It also provides a simple framework to highlight the main distortions generated by transit rents. Namely, even with exogenous production, transit

[6] Estimates vary if one considers different elasticities of substitution, or the beneficial effect of customs unions.

countries wealth in the presence of transit rents is endogenous. We show that global price indexes are affected by transit rents, and multilateral resistance terms associated with importing and exporting country are not symmetric, even if physical trading costs are symmetric. Furthermore, as transit rents are not observable, but enter in measured GDP, our method of identifying transit countries enables us to provide preliminary assessment of global welfare costs of country level holdup.[7]

While the estimated magnitude of welfare costs is model specific, the same qualitative predictions would also emerge in other settings. Namely, the gravity equation that our model generates has a standard form, and is well known to emerge in many international trade models that explicitly consider production choices, different forms of production between firms and firm level heterogeneity (see e.g. Krugman; Eaton and Kortum; Bernard et al.; Chaney; Arkolakis et al.; Arkolakis) In fact, welfare gains obtained by reducing trade barriers are known to be higher if one considers imperfect competition between firms (see e.g., Table 4.1 in Costinot and Andrés). Hence, the welfare gains associated with the transit rents we estimate are likely lower than those that would emerge in settings that incorporate realistic firm level effects. For example, introducing the possibility of transit rents to Melitz's setting and considering the effect of a reduction in the hold-up problem will likely lead to larger global gains due an increase in productivity via a country-level endogenous shift toward more productive firms. Such additional effects could be assessed when more micro-level data is available globally. At the same time it should be noted that unlike the estimation on welfare, our estimates of the presence of hold up and its effect on log-export do not rely on a particular model, as they are based on a gravity equation that holds more generally, as argued above. This argument also benefit from results by Feenstra (b) and Redding and Venables who show that using (time varying) exporter and importer fixed effects produces unbiased estimates of trade frictions based on gravity equations that emerge in different settings.

Motivated by historical examples such as the silk road, the possibility that transit countries charge monopolistic rents features in a number of theoretical papers that consider trade through a chain of markets which can impose taxes and tolls (see e.g. Karni and Chakrabarti; Feinberg and Kamien; Gardner et al.; Miyagiwa). These focus on game theoretical questions of rent extraction by multiple intermediaries and do not consider general equilibrium pricing and welfare effects on which we focus here. Related research analyzes and estimates the importance of the market power of shipping industry: Hummels et al. highlight the role of markups and estimate that the gains from eliminating market power in the shipping industry in the US and Latin America would lead to noticeable gains, and particularly so Latin America. These findings are complementary to ours

[7] It should be noted that we use the "best guess" based on geography to identify transit countries, and may at times attribute transit rents to a wrong country. Such errors are likely to average out across countries, and are unlikely to bias global and country group specific estimates. However, our method or data should *not* be used as a measure of transit rents for a specific country.

as we emphasize and estimate the gains from eliminating a differential hold-up problem which generates additional costs to port level mark-ups. The benefits of eliminating both types of hold-up frictions would likely lead to gains aggregating these two effects.

Our paper also relates to the literature discussing the measurement of the distance and the possible bias generated by the commonly used great-circle distance measure. Many proposed measures aim to improve within-country distance measures, e.g., Atkin and Donaldson use Google maps data on road distances in Ethiopia and Nigeria, Head and Mayer (a) advocate district to district distances and review other related papers that highlight weaknesses using great circle distances between main cities. In specific contexts, it is also possible to use survey data on transport costs (see e.g., Raballand and Teravaninthorn). In this paper, we are less concerned about within country distances as our question is about cross country trade, and any mismeasurement within a country is likely to be a fixed characteristic that is largely captured by fixed effects. Instead, our distance measure focuses on location of ports and enables us to draw transportation networks that depend on relative costs of sea and land, which can vary over time.

Our paper also contributes to the literature on the role of trade agreements (see Maggi for a review). Our focus is somewhat different here, as we are interested in the relevance of these agreements for mitigating the hold-up problem, and hence the role of trade agreement with the transit country. Customs unions and free trade agreements have a primary and direct relevance in the context of bilateral trade beyond including bilateral agreements as a control.

2 A model of global trade with transit rents

2.1 The setting

We incorporate transit rents in a model of global trade in the spirit of Armington and Anderson and Van Wincoop. That is, each country j produces a distinct variety and its production is exogenously given and denoted with Y_j. The benefits from trade arise because the representative consumer in each country has preferences for different varieties, i.e., the representative consumer in country j solves

$$\max_{\{c_{ij}\}} U_j \equiv \left(\sum_i \beta_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \text{ s.t. } \sum_i p_{ij} c_{ij} = W_j \tag{1}$$

where $\sigma > 1$ is the elasticity of substitution, c_{ij} is the consumption of a good produced in country i in country j, and β_i is a taste parameter that captures the subjective preferences regarding country $i's$ good, p_{ij} denotes the price of a good produced in country i in country j and W_j is the nominal wealth of consumers in country j. The budget constraint equates the nominal wealth with spending of country $j's$ consumer on goods produced in each country j. As in many related papers, solving (1) leads to the following demand function

$$c_{ij} = (p_{ij})^{-\sigma} W_j \frac{(\beta_i)^{1-\sigma}}{P_j^{1-\sigma}}, \tag{2}$$

where a country specific price index is defined as

$$P_j \equiv \left(\sum_i (\beta_i p_{ij})^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \tag{3}$$

In nominal terms (in importing country prices), the export from i to j is

$$X_{ij} = p_{ij} c_{ij} = W_j \frac{(\beta_i p_{ij})^{1-\sigma}}{P_j^{1-\sigma}} \tag{4}$$

Due to physical trading costs and transit rents, consumers in different countries may pay different prices for goods produced in country i. However, goods exported to different countries are perfect substitutes at the producing country. We denote the producer price in country i with p_i. As standard, we allow for iceberg trading costs: in order to deliver c_{ij} units from i to j, country i must produce $\tau_{ij} c_{ij}$ units, where $\tau_{ij} \geq 1$. We refer to τ_{ij} as "the transportation cost", but it can include other costs associated with bilateral trade (additional controls which we later include in our empirical analysis).

Our main innovation is to allow transit rents in addition to these standard exogenous trading costs. The final price that country consumers in country j pay for country i's good is

$$\begin{aligned} p_{ij} &= \tilde{1}_{mij} \varphi_{mij} \tau_{ij} p_i + \left(1 - \tilde{1}_{mij}\right) \tau_{ij} p \\ &= \tau_{ij} p_i \left(1 + \tilde{1}_{mij} \left(\varphi_{mij} - 1\right)\right) \end{aligned} \tag{5}$$

where p_i is the producer price in country i; $\tilde{1}_{mij}$ is an indicator function, where $\tilde{1}_{mij} = 1$ if due to geography, the trade between country i and j must go though a transit country m (a country in "middle"), and is zero otherwise. The variable $\varphi_{mij} \geq 1$ measures the additional cost imposed by country m on bilateral trade between countries i and j $(i, j \neq m)$. If i and j trade directly (e.g., they are neighbors or they both have sea access and the best trade route between them is via the sea[8]) then $\tilde{1}_{mij} = 0$. To shorten the notation, we will also use

$$\tilde{\varphi}_{mij} \equiv 1 + \tilde{1}_{mij} \left(\varphi_{mij} - 1\right) \tag{6}$$

such that $p_{ij} = \tau_{ij} p_i \tilde{\varphi}_{mij}$. In the presence of iceberg cost, the market clearing condition

[8]Or via a large lake as it is the case of countries around the Caspian Sea

within each country is

$$Y_i = \sum_j \tau_{ij} c_{ij}, \tag{7}$$

i.e., production of country i's good must equal the global consumption of country i's good in real terms.

Finally, it is important to emphasize that the nominal wealth of consumers in a country depends on whether, or not, the country is a transit country. The wealth of country m that is a transit country is

$$W_m = p_m Y_m + T_m, \tag{8}$$

where T_m is the total a transit fee that country m obtains. The total transit fee is

$$T_m = \sum_j \sum_i \tilde{1}_{mij} \left(\varphi_{mij} - 1\right) \tau_{ij} p_i c_{ij}.$$

If a country j is never a transit country for any trading relations (e.g., USA), then $T_j = 0 \implies W_j = p_j Y_j$. Note that the measured wealth/nominal income (empirically measured by GDP) of a country includes any transit rents the country receives and in the case of transit countries we need to rely on the model to distinguish transit rents and local production. Finally, the global nominal wealth must equal nominal income from production in all countries and total income from transit fees charged by all countries, i.e.,

$$\sum_i W_i = \sum_i p_i Y_i + \sum_i T_i.$$

2.2 Gravity equation and multilateral resistance terms

From (5) and (6), we have $p_{ij} = \tilde{\varphi}_{mij} p_i \tau_{ij}$. Hence, using market clearing (7) and export (4), we obtain

$$\left(\beta_i p_i\right)^{1-\sigma} = \frac{p_i Y_i}{\Pi_i^{1-\sigma}}, \tag{9}$$

where

$$\Pi_i \equiv \left(\sum_j \frac{1}{\tilde{\varphi}_{mij}} W_j \frac{\left(\tilde{\varphi}_{mij} \tau_{ij}\right)^{1-\sigma}}{P_j^{1-\sigma}} \right)^{\frac{1}{1-\sigma}}, \tag{10}$$

is the multilateral resistance term associated with the exporting country. We can then use (4), (9) and (8) to obtain the following gravity equation

$$X_{ij} = \left(\tau_{ij} \tilde{\varphi}_{mij}\right)^{1-\sigma} \frac{W_j \cdot p_i Y_i}{P_j^{1-\sigma} \Pi_i^{1-\sigma}} = \left(\tau_{ij} \tilde{\varphi}_{mij}\right)^{1-\sigma} \frac{W_j \cdot \left(W_i - T_i\right)}{P_j^{1-\sigma} \Pi_i^{1-\sigma}}, \tag{11}$$

where the price index (multilateral resistance term associated with the importer)

$$P_j = \left(\sum_i (p_i Y_i) \frac{(\tilde{\varphi}_{mij}\tau_{ij})^{1-\sigma}}{\Pi_i^{1-\sigma}} \right)^{\frac{1}{1-\sigma}} = \left(\sum_i (W_i - T_i) \frac{(\tilde{\varphi}_{mij}\tau_{ij})^{1-\sigma}}{\Pi_i^{1-\sigma}} \right)^{\frac{1}{1-\sigma}} \tag{12}$$

From (11), it is clear that hold up and transit rents reduce bilateral exports via three channels. First the additional costs due to transit rents, $\tilde{\varphi}_{mij}$, reduce trade similarly to transportation costs. Second, it the exporting country i is a transit country that receives fee income ($T_i > 0$), it trades less at a given level of wealth because it produces less. Third the multilateral resistance terms are further indirectly affected by transit fees and rents anywhere else in the the world. The latter effect is also present for bilateral trades that are not held up ($\tilde{\varphi}_{mij} = 1$) or do not involve a transit country. From (10) and (12) transit rents and hold up fees imply higher price indices P_j and Π_i (and lower $P_j^{1-\sigma}\Pi_i^{1-\sigma}$). This in turn implies that trade between countries that are not directly affected, such as two non-transit neighbors, is higher.

Anderson and Van Wincoop consider trade frictions that are symmetric, i.e., $\tau_{ij} = \tau_{ji}$, which imply symmetric multilateral resistance terms, facilitating their structural estimation. In a setting with transit rents, the symmetry of trade frictions, i.e., $\tau_{ij} = \tau_{ji}$ and $\tilde{\varphi}_{mij} = \tilde{\varphi}_{mji}$, no longer implies the symmetry of the multilateral resistance terms. Hence, $P_j \neq \Pi_i$ and a symmetric approach cannot be used.

Notice also that from (11)

$$\frac{X_{ij}}{W_j W_i} = \frac{(\tau_{ij}\tilde{\varphi}_{mij})^{1-\sigma}}{P_j^{1-\sigma}\Pi_i^{1-\sigma}} \frac{(W_i - T_i)}{W_i},$$

where the left hand side is observable by data. If the correct model includes transit rents but the econometrician only considers iceberg costs, he would consider the left hand side to be $\frac{(\tau_{ij})^{1-\sigma}}{\breve{P}_j^{1-\sigma}\breve{\Pi}_i^{1-\sigma}}$, where $\breve{P}_j$ and $\breve{\Pi}_i$ are multilateral resistance terms under the incorrect model. The estimated $\breve{P}_j^{1-\sigma}\breve{\Pi}_i^{1-\sigma} = P_j^{1-\sigma}\Pi_i^{1-\sigma}\left((\tilde{\varphi}_{mij})^{1-\sigma}\frac{(W_i-T_i)}{W_i}\right)^{-1}$. Since $(\tilde{\varphi}_{mij})^{1-\sigma} < 1$ for bilateral trades that are held up and $\frac{(W_i-T_i)}{W_i} < 1$ when the exporter is a transit country, it follows that in these cases $\breve{P}_j^{1-\sigma}\breve{\Pi}_i^{1-\sigma} < P_j^{1-\sigma}\Pi_i^{1-\sigma}$. Hence, the econometrician would systematically overestimate the multilateral resistance terms for such trading pairs. Consequently, from the analysis of (11), the econometrician may attribute too much importance to the distance (less trade with far away countries, more trade with neighbors) and to cultural and common characteristics of nearby countries (see also Section 2.5).

Finally, notice that terms $\frac{W_j}{P_j^{1-\sigma}}$ and $\frac{(W_i-T_i)}{\Pi_i^{1-\sigma}}$ in (11) are country specific. As highlighted in Feenstra (b), one can obtain unbiased estimates of τ_{ij} and $\tilde{\varphi}_{mij}$ by considering logs and including exporter and importer fixed effects. Section 5 will discuss this further.

2.3 Welfare

Using the budget constraint, (2) and (3) in (1) we derive the indirect utility of the representative consumer in country j as

$$U_j = \frac{W_j}{P_j}$$

In order to assess the global welfare gains and losses in units that can be interpreted, it is useful to transform this utility to a *money metric* indirect utility function constructed via the expenditure function $e(P_j, U_j) = P_j U_j$ (see Section 3.I in Mas-Colell, Whinston and Green (1995)). We adopt equivalent variation as our measure of welfare change that results from moving from the existing world to an alternative hypothetical world that consider some change in trading costs (such as elimination of transit fees), i.e., the welfare change in country j is

$$EV_j(P_j, \bar{P}_j, W_j, \bar{W}_j) = e\left(P_j, \bar{U}_j\right) - e(P_j, U_j) = P_j \bar{U}_j - P_j U_j = \frac{\bar{W}_j}{\bar{P}_j} P_j - W_j, \tag{13}$$

where P_j and W_j is the observed prices and wealth, and $\bar{P}_j$ and $\bar{W}_j$ are the prices and wealth in the alternative world. Equivalent variation reflects the monetary amount that the representative consumer in country j would be indifferent about accepting (or paying) instead of living in such alternative world. As our data is in US dollars the equivalent variation in each country is also measured in US dollars. It is then also straightforward to measure utility changes globally and within a specific group of countries (e.g., landlocked) in US dollars by the sum

$$\sum_{j \subset \{group\}} EV_j(P_j, \bar{P}_j, W_j, \bar{W}_j).$$

2.4 Monopolistic fees charged

The fees collected from different trades by different intermediates are additive and can be thus analyzed separately. Suppose that the export from country i to j needs to go through country m. The income from the transit fee that country m obtains from this trade is

$$Fee_{ij}^m = (\tilde{\varphi}_{mij} - 1)\, \tau_{ij} p_i c_{ij} = \frac{(\tilde{\varphi}_{mij} - 1)}{\tilde{\varphi}_{mij}} X_{ij},$$

where we used $p_{ij} = \varphi_{ij}^m \tau_{ij} p_i$ and export $X_{ij} \equiv p_{ij} c_{ij}$. A monopolistic transit country takes global prices and wealth levels as given, and internalizes the fact that fees affect

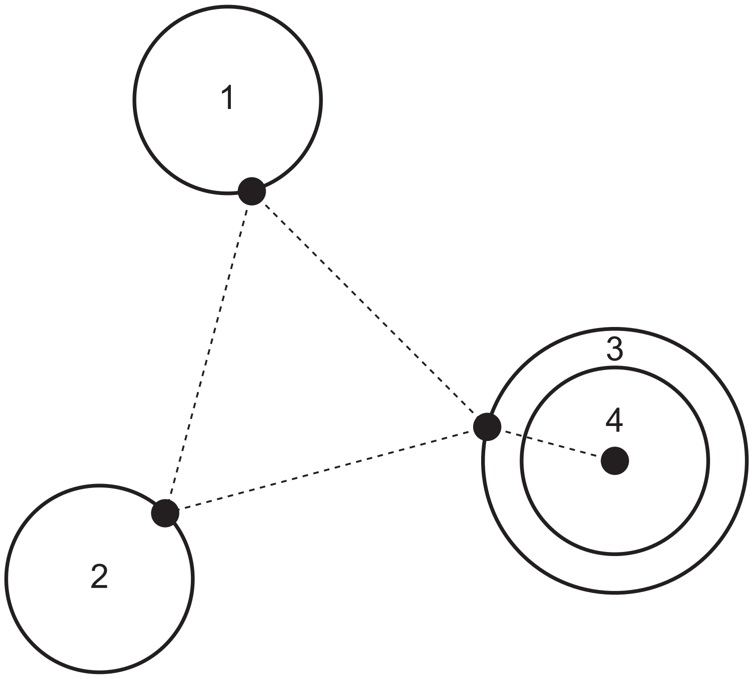

Figure 1: Topology of the four countries example.

trade flows, i.e. it chooses $\tilde{\varphi}_{mij}$ to maximize Fee_{ij}^{m} subject to export given by (11). Hence,

$$Fee_{ij}^{m} = \frac{(\tilde{\varphi}_{mij} - 1)}{\tilde{\varphi}_{mij}^{\sigma}} (\tau_{ij})^{1-\sigma} \frac{W_j \cdot (W_i - T_i)}{P_j^{1-\sigma} \Pi_i^{1-\sigma}}$$

and the optimal transit fee is

$$\tilde{\varphi}_{mij} = \frac{\sigma}{\sigma - 1}, \tag{14}$$

i.e., a monopolistic transit country charges a constant mark-up. This relationship is useful as it provides a relationship between hold up fees and the elasticity of substitution σ that is not directly observable.

One could further speculate that transit countries may have less market power, e.g., the good could take an alternative route or there is an agreement between countries that limits the transit country's limit power. Under such alternative scenarios, the transit fees could be expressed as $\tilde{\varphi}_{mij} = \chi \frac{\sigma}{\sigma-1}$, where $\chi \in [0, 1]$, where lower χ indicates less market power and a lower mark-up.

2.5 Example with four countries

To highlight the main differences between transport (and other iceberg-type) costs and transit fees consider a greatly simplified world depicted on Figure 1. Countries 1 and 2 are directly unaffected countries (islands), Country 3 is a transit country and Country 4 is a landlocked country, whose trade with Countries 1 and 2 is help-up and whose trade with Country 3 is not held-up. The circles mark the centers of economic activity in each country, and the dotted lines represent shortest transport routes. Furthermore, trade between Countries 1,2,3 takes place via sea transport, while in order to trade with any other country, goods from Country 4 must use road transportation to reach the main city/port in Country 3. For the sake of clarity, assume that all countries $j = \{1, 2, 3, 4\}$ are equally productive, i.e., $Y_j = Y$ for all j, and goods from all countries are equally valued $\beta_j = 1$. We normalize the price of the good produced in Country 1, $p_1 = 1$, and assume that the elasticity of substitution is $\sigma = 5$.

As a benchmark, assume a frictionless world where Country 3 does not charge transit rents and both land and sea transport is costless. Since all countries are identical under this benchmark economy, it follows from (1), (2), (3), and (4) that prices and price indexes are the same in all countries, $p_j = 1$ and $P_j = 4^{\frac{1}{1-\sigma}} = \frac{\sqrt{2}}{2}$, and the nominal income in all countries is the same, $W_j = p_j Y = Y$ for all j. Furthermore, the representative consumer in each country consumes domestic and foreign goods from each other country in equal proportions, i.e., $c_{ij} = \frac{Y}{4}$ for all $i, j = \{1, 2, 3, 4\}$ and $\frac{import}{GDP} = \frac{W_j - p_j c_{jj}}{W_j} = 75\%$. Weighting all countries equally, the global indirect utility is $U_w^B = \sum_j \frac{W_j^B}{P_j^B} = \frac{8Y}{\sqrt{2}}$.

We then compare three stylized cases of different frictions, such that the global utility under all these cases, i.e., $U_w = \sum_j \frac{W_j}{P_j}$ is constant. We consider frictions lead to a global utility loss $U_w/U_w^B - 1 = -1.3\%$.

Case I is the world where transport is costless, and Country 3 charges monopolistic transit rents whenever Countries 1 or 2 trade with Country 4. From (14) Country 3 charges the same the same rents $\varphi = \frac{\sigma}{\sigma-1} = 1.25$ from all trades that pass through. Case II is the world where there the sea transport remains costless and there are no transit rents, but land transport is subject to an iceberg cost τ_L. This implies that trade with Country 4 is costly, i.e., $\tau_{i4} = \tau_{4i} = \tau_L > 1$ for $i = \{1, 2, 3\}$, and the trade between 1-2-3 is costless. We use $\tau_L = 1.0375$ to keep the global utility loss constant. Case III considers the same costs for land and sea transport, and no transit rents, i.e., there is an iceberg cost $\tau_{i4} = \tau_{4i} = \tau^2 > 1$ for trade between 4 and $i = \{1, 2\}$, and an iceberg cost cost is τ for all other bilateral trades. This last case corresponds to a world where transport costs can be well captured by the great circle distance. We use $\tau = 1.013$ to keep the global utility loss constant.

Table 1 presents percentage utility gains and losses ($\%\Delta\ U$), and percentage changes in wealth ($\%\Delta\ W$), price indexes ($\%\Delta$ in P) and producer prices ($\%\Delta\ p$) relative to the frictionless benchmark. It also reports the import/GDP ratio $\frac{imp_j}{W_j} \equiv \frac{W_j - p_j c_{jj}}{W_j}$.

Table 1 highlights that while different transportation costs reduce utilities in all countries, the utility losses are spread across different countries. While landlocked countries are affected more, all other countries have lower utility as well due to price effects (the

	Country 4 Landlocked	Country 3 Transit	Country 1&2 Other
$\%\Delta U$	-11.7	+15.6	-4.5
$\%\Delta W$	-3.7	+15.5	na
$\%\Delta P$	+9.0	-0.1	+4.5
$\%\Delta p$	-3.8	+4.2	na
$\%\frac{imp}{W}$	57	76	70

(a) I Transit rents

	Country 4 Landlocked	Country 3 Transit	Country 1&2 Other
$\%\Delta U$	-3.6	-0.5	-0.5
$\%\Delta W$	-1.4	na	na
$\%\Delta P$	+0.6	+0.6	+2.3
$\%\Delta p$	-1.4	na	na
$\%\frac{imp}{W}$	71	74	74

(b) II: Costly land transport

	Country 4 Landlocked	Country 3 Transit	Country 1&2 Other
$\%\Delta U$	-1.6	-0.9	-1.3
$\%\Delta W$	-0.03	-0.04	na
$\%\Delta P$	+1.6	+1.0	+1.3
$\%\Delta p$	-0.03	-0.04	na
$\%\frac{imp}{W}$	73	74	74

(c) III: Costly land and sea transport

Table 1: Changes in Utility, price indices and production prices

producer prices fall and the price indexes that affect the consumption basket increase). These effects are well known and can partially explain the observed lower trade by landlocked countries and as well as somewhat less trade by all countries (i.e., import to GDP ratios are lower than in frictionless world as the consumption baskets are tilted towards the consumption of domestic goods). As it is to be expected, the losses of a landlocked country are relatively bigger when land transport is noticeably more expensive that sea transport.

Transit rents have a very different impact on the distribution of losses across countries. These rents benefit transit countries, and noticeable losses are incurred not just by the landlocked country 4, but also by the seemingly less affected "islands" 1 and 2. While the specific values are specific to the example, the fact that a large part of losses falls on such countries is a general pattern. There is a global deadweight loss, and the transit country 3 gains, which means that the combined welfare losses of Countries 1, 2, and 3 must be greater than the global loss. Furthermore, notice that the transit country 3 gains via three channels: first, it gets an additional income from rents; second, as it is not held up itself, it can buy goods from all other countries more cheaply (its price index falls); third, it sells its own production at a higher price everywhere. It also uses its extra wealth to tilt its consumption towards foreign goods (its import/GDP ratio is higher than in the frictionless benchmark). This explains why "islands" 1 and 2 must bear a substantial part of utility losses in general equilibrium: not only it is expensive for them to buy goods produced in Country 4, but also Country 3's goods are more expensive relative to their own production (numeraire). All this increases the price of the consumption basket in Countries 1 and 2 and sub-optimally tilts consumption towards their own good. As expected, transit rents have a similar negative price effect on the landlocked country and the relative price of its own production is lower. Consequently, its consumption basket is even more heavily tilted towards own good.

Table 2 further reports the percentage changes of quantities consumed demand (i.e., Hicksian demand) compared to the benchmark under these three scenarios. The columns reflect the compositions of consumption baskets in a given country. The rows reflect the origin of the goods consumed.

Table 2 shows that while trading frictions generally lead to sub-optimally high consumption of domestic goods, the patterns of trade between countries are quite different. In particular, transit rents encourage more consumption of neighboring country's goods and thus trading between neighboring countries. Note that under scenario I, countries 1 and 2 trade noticeably more with each other, and also landlocked countries trade noticeably more with the transit country. Such neighboring trade patterns are not by far as striking when we consider different types of transport costs only.

Consider an econometrician who observes data generated in a world with transit frictions (case I), but considers an empirical setting based on iceberg costs and the great

	Country 4 Landlocked	Country 3 Transit	Country 1&2 Other
Domestic	+64.7	+13.1	+20.1
Import from landlocked	na	+39.6	-55.5
Import from transit	+10.5	na	-2.1
Import from other	-55.5	+15.1	+20.1

(a) I Transit rents

	Country 4 Landlocked	Country 3 Transit	Country 1&2 Other
Domestic	+16	+2.2	+2.2
Import from landlocked	na	-8.8	-8.8
Import from transit	-10	na	+2.2
Import from other	-10	+2.2	+2.2

(b) II: Costly land transport

	Country 4 Landlocked	Country 3 Transit	Country 1&2 Other
Domestic	+6.7	+5.1	+5.2
Import from landlocked	na	-2.4	-1.5
Import from transit	-0.3	na	-7.4
Import from other	-6.4	-2.5	-1.3

(c) III: Costly land and sea transport

Table 2: Percentage changes in consumption demands

circle distance (case III). The econometrician will likely conclude that the noticeably higher trade between neighboring countries must be due to unobservable common tastes, which we assumed not to be the case here. Furthermore, the econometrician is also likely to attribute greater wealth in the transit country and lower wealth in the landlocked country to be due to differences in productivity, which we also assumed not to be the case. While common tastes and productivity differences are likely to be present in the real world data, this example illustrates that the estimates of these effects may be biased and overestimated when one ignoring transit rents.

3 Global Trade Network

An important contribution of our paper is to provide an accurate distance measure between trading countries. Gravity equations are typically estimated using the great-circle distance which provides at best a crude approximation of how far apart countries are from each other, underestimates long trading distances and does not provide any information about the type of trade route used. To properly investigate the holdup problem, one needs to be able to carefully analyze trade paths between any trading countries, and determine which are the most likely transit countries. Moreover, disentangling the hold-up friction from transport costs needs a better understanding of the trade path in terms of land or sea transportation.

Using a worldwide network of trade routes, we are able to overcome the shortcomings of the great-circle distance, arguably providing much more accurate estimations of the real trade distances. We generate valuable information as we can distinguish land and sea transportation as well as determine the most likely transit countries. The trade routes network is constructed as follows. We first create a network of all shipping lanes using data from the Oak Ridge National Laboratory.[9] With port information from the World Port Source website[10], we connect the shipping lanes to all ports with container liner services.[11] We then add all the countries' main cities[12] to their countries' respective ports and to the main cities of the neighbors countries using great circle distance.[13] This procedure returns a complete worldwide graph of all land routes and shipping lanes between all countries.[14]

Using this graph, any trade route between any two countries can be approximated. The simplest way to do so is to find the shortest route between any two countries main

[9]See `http://oceanids.geoiq.grida.no/overlays/25`.

[10]See `http://www.worldportsource.com/`. World Port Source provides the location of ports worldwide as well as their uses and sizes.

[11]If a country does not have any port with container liner service, we use its biggest ports.

[12]The main cities are provided by CEPII, and extended for over 20 countries.

[13]It is possible to create a graph with all real land routes, but it adds a lot of complexity and does not substantially increase accuracy. We aim for simplicity while accurately capturing trade routes.

[14]Land routes (road and rail networks) being approximated by great-circle distances between neighbors.

cities. Doing so has several shortcomings, as realistic trade routes are not the ones with the shortest path. One needs to account for the facts that transportation costs differ between land and sea, and that it would be too costly to load and unload goods at several ports along the way. We obtain realistic trade routes by taking these two constraints into account. Instead of looking for the shortest paths in terms of distance, we look for the cheapest paths and assign differentiated costs between land routes and shipping lanes, as well as fixed cost for any loading/unloading of goods in ports. Land transportation must be expensive enough for long trading routes to be relying on shipping lanes while shorter trading routes are more likely to be using truck or rail shipments, as in Europe. In our main specification, we assume that land routes are 7 times more costly than shipping lanes.[15] These calibrations seem to be consistent with real estimations of transportation costs. According to the U.S. Department of Energy and the U.S Department of Transportation [16] , U.S domestic shipping is estimated to be roughly between 7 to 12 times more energy efficient than trucks. To be confident that our methodology provides sensible trade routes, every single trade path pattern has been checked to start with road transportation followed by possible shipping, and ending by road. Figure 2 and 3 illustrate the predicted trade routes between the United Kingdom and the Central African Republic, Angola and India, France and Hungary as well as Slovenia and Germany.

Given the predicted trade paths transit countries between any two trade partners can be determined by analyzing countries through which each trade path passes. In our subsequent analysis of the impact of transit rents on welfare, we seek to differentiate transit countries and countries that are held up. However, depending on the trade partners considers, some countries may sometimes be transit countries or held up countries. Figure 4 presents the map of transit countries as identified by the global network of trades – countries in gray and black. In our welfare analysis we use the following methodology to define a clear non-overlapping set of transit and held up countries. From all the possible trade routes resulting from the global network, we classify as transit countries those that are more often transit than held up countries. These countries are the ones in black on the map.

[ADD ROAD COST REFERENCES IN THE BIBLIOGRAPHY]

4 Data and empirical strategy

We construct an extensive dataset of international trade. Trade statistics come from the IMF DOTS database[17] with values expressed in millions of constant 1982-1983 US dol-

[15] We have considered other cost differentials and the results are robust to variations of this parameter.

[16] See U.S. Department of Energy, *Transportation Energy Data Book*, 2008. and U.S. Department of Transportation, *National Transportation Statistics*, 2009.

[17] IMF Direction of Trade Statistics database.

(a) United Kingdom – Central African Republic

(b) Angola – India

Figure 2: Predicted trade routes for long distances.

(a) France – Hungary

(b) Slovenia – Germany

Figure 3: Predicted trade routes for short distances.

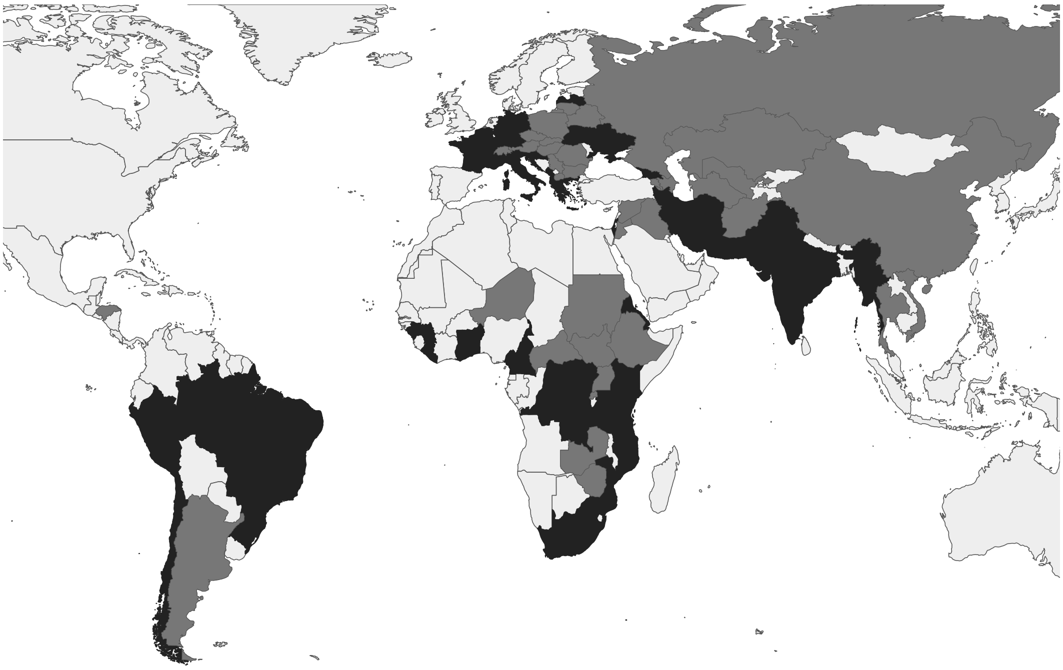

Figure 4: Transit Countries

lars. We symmetrize trading amounts by averaging imports and exports for each country pair. If only one partner country reports the value of exports (imports), it is considered as being the value of imports (exports) for the other country. This procedure ensures the use of all available trade information, mitigates reporting errors, and minimizes the issue of missing data. We extend the trade statistics to include country pairs information. Main geographic information as well as languages and colonies are from the CEPII[18] and manually extended to include all countries in our dataset. WTO memberships and regional trade aggreements are from the WTO.[19] They include all bilateral and multilateral trade agreements as well as customs unions. Currency unions are taken from various sources[20], and GSP (General Scheme of Preferences) information is from Andrew Rose[21] dataset and updated for later years. All control variables are described in appendix A. To have a large and consistent number of countries, notably countries from easter Europe, our final dataset spans from 1993 to 2014 and includes trades between up to 200 countries.[22] Because our dataset covers substantially more landlocked countries from 1993, most of our analysis is based on the 1993-2016 time period.

Our empirical strategy is twofold. First we aim to provide empirical evidence of the existence of transit rents and their impact on trade. Second we wish to estimate the

[18]Centre d'Etudes Prospectives et d'Informations Internationales.

[19]See `https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm` for WTO memberships and `http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx` for regional trade agreements.

[20]See `https://en.wikipedia.org/wiki/Customs_union`

[21]See `http://faculty.haas.berkeley.edu/arose/`

[22]We have tested for the presence of the holdup problem in earliest period from 1950 to 1993 – available on demand – and we have found similar effects.

economic significance and the welfare losses associated.

In order to test for the existence of the holdup problem, we use a regression approach and estimate the logarithmic form of the gravity equation (11).

$$\ln X_{ij} = (1-\sigma)\left(\ln \tilde{\varphi}_{mij} + \ln \tau_{ij}\right) + \ln\left(\frac{W_j}{P_j^{1-\sigma}}\right) + \ln\left(\frac{W_i - T_i}{\Pi_i^{1-\sigma}}\right) \tag{15}$$

Notice that the last two terms are colinear to importer and exporter fixed effects respectively. This implies that we can use Feenstra (a) approach to obtain unbiased estimates of the coefficients of interest by using time-varying importers and exporters fixed effects.[23] The fixed effects also control for any other country specific characteristics, such as productivity, status of being a landlocked or coastal country, quality of roads, infrastructure of road, etc.

Following the existing literature (e.g. Anderson and Van Wincoop, we model the transport costs τ_{ij} as being a log-linear function of the distance between countries i and j.

$$\tau_{ij} = d_{ij}^{\rho} \tag{16}$$

Where d_{ij} is the distance between countries i and j. To capture other iceberg costs, we include standard bilateral controls, described in appendix A. The transit rent $\tilde{\varphi}_{mij}$ is defined as in section 2.1. We start by considering the same transit rent ($\tilde{\varphi}_{mij} = \varphi$). In section 5.3, we consider several transit rents depending on the existence of trade agreements. Plugging the functional forms of equations 16 into equation 15, and allowing for additional factors, the empirical model becomes

$$\ln X_{ij} = a_1 \tilde{1}_{mij} + a_2 \ln d_{ij} + b_j \delta_j + b_i \delta_i + \sum_k b_k \mathbb{1}_{\alpha_k=1} + \varepsilon_{ij} \tag{17}$$

Where α_k is a set of bilateral dummy variables corresponding to additional controls such as trade agreements or common currency. δ_i is an indicator variable that is unity if country i exports, δ_j is an indicator variable that is unity if country j imports, and $a_1 = (1-\sigma)\ln\varphi$. Given an elasticity of substitution σ, one can find the tariff-equivalent cost generated by the transit rents as

$$\varphi = e^{\frac{a_1}{1-\sigma}} \tag{18}$$

This regression approach allows us to show the effect of the transit rents on trade and to document the economic significance of the holdup problem. It stays silent, however, on any welfare implications. To understand further the distortionary effects of the holdup problem, one needs to study the general equilibrium consequences of transit rents on global welfare through their effect of prices. To do so, we proceed in two steps. The

[23] With approximately 200 countries over 25 years, that amounts to over 5,000 fixed effects.

first step aims at calibrating the model's parameters in order to subsequently perform welfare analysis. Calibrating the model means finding the unobservable production Y_i (GDP excluding transit rents) of each country and the set of prices. We first estimate the transportation costs and transit rents using the regression results and the global network of trade routes. From the regression's coefficients, we back out the parameters φ and τ_{ij} using the functional forms described previously. With the information provided by the global network of trade route, one can then estimate the transit rents extracted by the most likely transit countries, which in turns make it possible to find the nominal productions p_iY_i using equation 8. We then solve for the prices $(\beta_i p_i)^{1-\sigma}$ and price indices P_i by solving the system of equations 9, 10 and 12 to find the set of prices. We finally recover the production Y_i of each country using prices and nominal productions. The nominal production is the fixed point of our subsequent welfare analyzes.

The first analysis we perform is to find prices and wealth in a world where the holdup friction and transit rents are not present. Doing so requires solving the same system if equations 9, 10 and 12, with fixed productions. This allows the determination of prices and wealth that are consistent with the production and trade frictions as estimated in the calibration. The second exercise is an experiment in which we compare the impact of transit rent as opposed to traditional transportation – 'iceberg' – costs.

5 Results

5.1 Existence of transit rents

Table 3 presents evidence of the existence and economic significance of the hold-up problem on trade. We use the 1993-2016 period as it exhibits substantially more data for countries that are most likely to be held up, such as landlocked countries. The results hold for each year of the sample as shown in tables 11, 12 and 13 in the appendix, where we perform the same analysis on a yearly frequency. Every test include time, country, and time-varying fixed effect to capture the effect of the multilateral price pressures (see Feenstra (a)) and all standard errors are clustered at the country pair level.

The first two columns of table 3 use the great-circle distance while the last three make use of our new distance measure based on the global trade network. As described in the econometric model, the dependent variable is the natural logarithm of the dollar amount of traded good between two partners. In all the paper's tests, we use exports, but as the data is symmetric, similar results can be seen when using imports instead. The 'hold up' independent variable is a dummy at one if the trade between the country pair is passing through a transit country. When using the network based distance, we are able to include control for the percentage of the trade route that is achieved on land as opposed to sea. All regressions include the control variables described in the

	Log(Trade)				
	Great-Circle Distance		Network Distance		
	(1)	(2)	(3)	(4)	(5)
Holdup		-0.940^{***}	-0.825^{***}	-0.807^{***}	-0.836^{***}
		(0.062)	(0.063)	(0.068)	(0.069)
Log(Distance)	-1.581^{***}	-1.550^{***}			
	(0.022)	(0.021)			
Log(Distance)			-1.414^{***}	-1.352^{***}	-1.463^{***}
			(0.022)	(0.023)	(0.025)
Land (%)			-0.154	-0.157	-0.151
			(0.179)	(0.180)	(0.198)
FTA	0.686^{***}	0.644^{***}	0.733^{***}	0.710^{***}	0.730^{***}
	(0.040)	(0.039)	(0.041)	(0.049)	(0.044)
WTO	0.852^{***}	0.816^{***}	0.758^{***}	0.648^{***}	0.856^{***}
	(0.067)	(0.065)	(0.067)	(0.068)	(0.095)
Timespan	1993–2016	1993–2016	1993–2016	1993–2004	2005–2016
Time FE	Y	Y	Y	Y	Y
Countries FE	Y	Y	Y	Y	Y
Time varying FE	Y	Y	Y	Y	Y
Observations	522,066	522,066	522,066	222,602	299,464
Adjusted R^2	0.725	0.726	0.722	0.716	0.726
Note:	*p<0.1; **p<0.05; ***p<0.01				

Table 3: Holdup Effect

appendix A, but for the sake of clarity, only the coefficients regarding the presence of a bilateral trade agreement (foreign trade agreement or customs unions, variable 'FTA') and whether both countries trading belong to the World Trade Organization ('WTO') are reported. The first column serves as a control by excluding our variable of interest, the holdup dummy. The allows to observes that the coefficients of all the control variables are in line with the existing literature. For instance, the distance has a negative impact due to transportation costs, and bilateral agreements and being part of the WTO has a positive impact. We then add the holdup dummy (in column 2) and find that the presence of a transit country on the trade path indeed significantly affect trade. The third column makes use of our new distance measure to control more finely for realistic trade distances. It is important to note that the test performed in column 2 would not be possible without the construction of a global network of trade as the holdup dummy is created using that network. We observe that using more realistic distance estimations reduces the measured impact of the presence of transit countries. Indeed, when one uses the great-circle distance, the transportation costs are over-estimated because the great-circle distance underestimates long trading distances. Consequently, part of the effect of the holdup friction is wrongly captured by the distance measure. The overestimation of the transportation cost by the great-circle distance can be observed by looking at the difference between the second and the third column. Interestingly, it seems that the percentage of land on the trade route does not seem to significantly impact trade. That shows that an intuitive explanation as to the reason why landlocked countries trade less cannot simply be that they are far from the sea. The last two columns runs the same test as in column 3, but on sub-samples. Column 4 focuses on the 1993-2004 subperiod and column 5 on 2005-2016. Both show that the holdup effect is consistent over time, a result generalized in our yearly estimation performed in the appendix. In terms of economic importance, the coefficient of the holdup dummy in column 3 (-0.825) tells us that on average, trade could be increased by approximately 28% for the hold up trades if they did not go through a transit country.[24]

An important concern is that being held-up affects not only the amount of trade, but also the probability of initiating trade between two countries, resulting in a possible selection bias. To address this concern, we run a two stages Heckman procedure consisting of a first stage probit estimation using the same explanatory variables as the initial gravity specification. The second stage omits the common language dummy, shown by Helpman et al. to satisfy the exclusion restrictions. Due to computational costs, the first stage probit does not include time-varying country fixed effects, but only time and country fixed effects. Table 4 presents the same tests as table 3 with the heckman procedure, using our network based distance measure only. The first two columns are respectively the first and second stages on the full 1993-2016 sample, and the last two columns provide

[24]The percentage increase in trade if the holdup dummy goes from 1 to 0 is approximately $e^(0.825) - 1$.

the subperiods results. We find that while the selection bias is an issue as shown by the significant coefficient on the inverse Mill's ratio, our result are not significantly modified by correcting for the presence of zero-trades.

	Does Trade (1) / Log(Trade) (2,3,4)			
	Full Sample		Sub-periods	
	(1)	(2)	(3)	(4)
Holdup (HU)	-0.160^{***}	-0.866^{***}	-0.842^{***}	-0.877^{***}
	(0.009)	(0.064)	(0.069)	(0.070)
Log(Distance)	-0.495^{***}	-1.507^{***}	-1.427^{***}	-1.569^{***}
	(0.003)	(0.026)	(0.026)	(0.028)
Land (%)	0.044^{*}	-0.122	-0.142	-0.106
	(0.026)	(0.179)	(0.181)	(0.197)
FTA	0.396^{***}	0.802^{***}	0.758^{***}	0.810^{***}
	(0.009)	(0.042)	(0.051)	(0.045)
WTO	0.149^{***}	0.693^{***}	0.592^{***}	0.796^{***}
	(0.006)	(0.067)	(0.069)	(0.095)
Inverse Mill's ratio		0.476^{***}	0.357^{***}	0.547^{***}
		(0.058)	(0.056)	(0.066)
Timespan	1993–2016	1993–2016	1993–2004	2005–2016
Time FE	Y	Y	Y	Y
Countries FE	Y	Y	Y	Y
Time varying FE	N	Y	Y	Y
Observations	1,434,720	522,066	222,602	299,464
Adjusted R^2		0.721	0.715	0.724
Note:	*p<0.1; **p<0.05; ***p<0.01			

Table 4: Holdup Effect - Heckman Correction

5.2 Global welfare implications

The above regression approach provides evidence of the existence and economic significance of the hold-up problem. However it does not help understand the welfare implication of the existence of transit rents. The global trade model developed in earlier sections enables us (i) to interpret more accurately the results of the previous regressions and (ii) to perform welfare analyses.

As explained earlier, the variable $\tilde{\varphi}_{mij}$ in the model represents the transit fees and $\varphi - 1$

is the average tariff-equivalent cost of a trade being held up. This tariff-equivalent barrier cost can easily be retrieved from the previous regression coefficient using equation 18. However one needs to know the elasticity of substitution σ in order to find it. Section 2.4 provide a useful relationship between the elasticity of substitution and the transit fees that would be strategically changed by transit countries were they in a monopolistic position to do so. Combining equations 18 and 14, one can find the elasticity of substitution that is consistent with previous results if one consider that transit countries charge monopolistic fees. The elasticity of substitution considering our previous results is approximately $\sigma \approx 5$. This is in line with the elasticity of substitution considered in earlier studies such as in Anderson and Van Wincoop. With $\sigma = 5$, the tariff-equivalent cost of being holdup is approximately 23%, that is, on average, transit countries charge 23 cents for every dollar worth of goods passing through. More than providing a finer interpretation of our previous results, the global trade model developed above allows us to perform welfare analyses. By calibrating the model's parameters consistent with the observed trade patterns, wealth and geographical constraint, we are able to analyze the general equilibrium consequences of the transit rents, and how the welfare would be modified were they not present. These calibrations are performed at a yearly frequency, and to observe a relatively stable number of countries over time, we are constraint by the availability of trade and GDP data. Therefore, we perform our welfare analises on the 2004-2016 period.

We perform two separate exercises. The first one is to estimate the global loss in utility due to the presence of the hold-up friction. The second is to analyse how this friction differs from transportation costs. For each exercise, we group the countries depending on wether they are landlocked countries or transit countries[25] The 'other' countries are the ones that are supposedly not affected by the holdup problem. Nonetheless, through the general equilibrium on prices, they are indirectly affected. We use three different measures to understand the impact of the transit rents. First, we compute the change in welfare between a world where the holdup problem is present and a world where it is not. As explained in section 2.3, we use the equivalent variation to capture a change in welfare. The equivalent variation represents the monetary (dollar) equivalent that a given consumer looses due to the presence of transit rents. We report that wealth measure as a percentage of observed wealth. Second, we directly compare the loss in wealth in between the two worlds, over the full period 2004-2016 and also the yearly average. Finally, we measure the change in trade amount by computing the percentage change difference in the import to GDP ratio between the two worlds. Table 5 presents the results of the impact of transit rents on global welfare.

We find that the presence of transit rent reduces global welfare by approximately

[25] As explaine above transit countries as classified as such when they are more often transit countries than holdup countries.

	All countries	Landlocked	Transit	Others
% Utility change	-0.15	-7.26	0.72	-0.12
Total Loss	-4521.75	-6503.24	4748.08	-2766.59
Yearly Loss	-347.83	-500.25	365.24	-212.81
% change in $\frac{Import}{GDP}$	-0.41	-7.56	0.21	-0.28

Losses are expressed in 2017 Billion USD

Table 5: General equilibrium effect of the holdup problem.

0.15%. While this estimate might seem relatively small, the total loss over the 2004-2016 period amount to more than USD 4,500 billion, approximately USD 350 billion per year. More interestingly is the distribution of the welfare change among country groups. As expected, landlocked countries suffer the most by being heldup the most often, and the transit countries gain from their ability to extract transit rents. That represents a fundamental difference between the holdup costs and the transportation costs as will be seen shortly. Interestingly, the loss suffered by the landlocked countries is greater than the gain of transit countries. Due to the general equilibrium impact of prices, other countries, that might at first sight appear indifferent to the existence of this problem, are indeed affected. We estimate that these other countries, such as the United States or the United Kingdoms, suffer a welfare loss of approximately 0.12%. The welfare loss over the all sample for these countries amount to more than USD 2,500 billion (a little more than USD 200 billion per year), which is a non-negligable impact. The main take-away of this exercise is that countries that are not directly held up or transit countries are still affected by this friction through the general equilibrium impact on prices.[26]

The next natural question is to see how this problem compares to well known trade frictions such as transportation costs. To do so, we analyse how the different groups of countries would be affected if transportation cost increased in a way that would result in the same welfare loss. Specifically, we remove any hold-up friction and transit rents, and we adjust the model's transportation costs such that the global welfare loss due to increased transportation costs is equal to the welfare loss resulting from the presence of transit rents. The results of that exercise are shown in table 6.

The main difference is the distribution of gains and losses across the groups of countries. Unlike transit rents which represent a wealth transfer between holdup and transit countries, transportation costs are iceberg costs and are a wealth loss for all countries. Therefore an increase in transportation costs negatively impacts welfare for all country groups. As our estimate show landlocked countries are still more affected than transit countries because they are facing on average longer trading distances. But because there

[26]Note that by featuring exogenous production, our model cannot capture the endogenous impact that lower transit rent may have on the production decision of held up countries. However, if anything, the welfare implications would be stronger if one allows such endogenous behavior, as the presence of transit rents most likely lowers incentives for higher production.

	All countries	Landlocked	Transit	Others
% Utility change	-0.15	-0.49	-0.22	-0.12
Total Loss	-4521.75	-441.15	-1429.62	-2650.98
Yearly Loss	-347.83	-33.93	-109.97	-203.92
% change in $\frac{Import}{GDP}$	-0.10	-7.10	0.62	-0.02

Losses are expressed in 2017 Billion USD
[1] Transportation costs are adjusted such that a world without the holdup friction would generate an equivalent change in utility.

Table 6: General equilibrium effect for an equivalent change[1] in transportation costs.

are no wealth transfer, both landlocked and transit countries are affected by transportation in the same magnitude. The impact of an increase in transportation costs for the other countries is particularly striking, as they seem to be affected as much, if not less, than by the presence of transit rents. This result speaks to the relevance of transit rents for these countries. While they are affected by transportation costs, and might therefore be incentivized to invest in infrastructure and technology to reduce these, our analyses shows that the existence of transit rents is as important for these countries. However, as they might not internalize the indirect impact that the hold-up problem generates on prices and their welfare, the incitation to mitigate this problem might be reduced.

5.3 Role of FTAs and customs unions

One concern about the previous exercise is that the transit rents have been globally estimated to be equal for every trade that are held up. However, the ability of the transit countries to extract transit rents might differ depending on the origin and destination of the goods transiting. For instance, one may rightly expect trade agreements between held up and transit countries to affect the rent extraction abilities of the transit countries. This section analyzes the impact of the two main agreement, trade agreements and customs unions.

We construct dummy variables to indicate wether there exists a free trade agreement between the holdup and the transit country for every held up trades for each year – as agreements are time varying – , or if both countries belong to the same customs union. When there are several transit countries on the trade path, we set the summies at one if at least one of the transit country on the path has an active agreement with the holdup country. The European Union is of particular interest because it is features both a multilateral free trade agreement along with a customs union. Furthermore, the European Union allows free movement of good, capital and citizens within the block, and one might wonder if it has the ability to mitigate the holdup problem above and beyond FTA and customs unions. We add a European Union dummy set at one if both holdup and transit countries are part of the E.U. and investigate if the E.U. provide any benefits in mitigating the problem. In order to have enough data and to avoid problems related to the expansion of the E.U. block, we run the tests using the 2004–2016 time period. Table 7 presents the results.

Columns 3 and 4 clearly illustrate the differential effect of FTAs and custom unions on the hold-up problem. It shows that the existence of a trade agreement between the holdup and the transit country does not seem to mitigate the problem. However, if both countries belong to the same customs union, the problem seems to clearly be reduced. This is in line with the fact that one way for transit countries to extract rent is to charge higher tariffs for holdup countries. However, if both countries belong to the same customs union, this possibility is reduced if not removed. The fact that customs union does not seem to completely eliminate the problem illustrate that transit countries may have other way to extract rent, such as highwy tolls or others. In fact this result not only shows that customs union mitigate the problem, but it also reinforce the belief that transit countries engage in a rent extraction activity. Column 4 shows, unsurprisingly perhaps, that the problem is also reduced when the hold up and transit countries are part of the European Union. As column 5 and 6 show, and in line with the previous result, it seems that the positive impact of the European Union on the holdup problem is due to the existence of the European customs union and not from the free trade agreement. In addition it does not seem that the European Union is better able to mitigate the holdup problem than the presence of customs union. This suggests that fr this particular problem, the European Union does not provide superior cooperation mechanisms than the one provided by the customs unions.

We then perform the same welfare analysis as before while taking into account the mitigating effect of customs unions. The impact of transit rents is shown in table 8 and the results with an increase in transportation costs are shown in table 9

The mitigating effect of customs unions does not modify the magnitude of the results albeit exhibiting smaller welfare losses. Interestingly, while the existence of customs unions reduces the average yearly loss by USD 70 billion (from 350 to 280) the loss for countries that are neither landlocked or transit countris is reduced only by less than USD 15 billion (from 200 to 185). Consistent with the previous welfare results, these other countries are more affected by the holdup problem than by an increase in transportation costs that would result in an equivalent global welfare loss.

5.4 Further discussion and robustness

In this section, we perform two additional tests for robustness purposes. The first one is to consider the possibility that both trade partners are being hold up by different transit countries. The hold up dummy used in the regression analyses is set at one when at least

	Log(Trade)					
	Base	FTA	CU	European Union		
	(1)	(2)	(3)	(4)	(5)	(6)
Holdup (HU)	−0.840***	−0.885***	−0.974***	−0.882***	−0.977***	−0.915***
	(0.068)	(0.077)	(0.074)	(0.068)	(0.074)	(0.077)
HU X FTA		0.083				0.064
		(0.083)				(0.082)
HU X CU			0.392***		0.344***	
			(0.088)		(0.097)	
HU X E.U.				0.311***	0.145	0.303***
				(0.117)	(0.127)	(0.116)
Log(Distance)	−1.458***	−1.458***	−1.457***	−1.458***	−1.458***	−1.458***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Land (%)	−0.157	−0.165	−0.240	−0.186	−0.243	−0.192
	(0.197)	(0.197)	(0.196)	(0.197)	(0.196)	(0.197)
FTA	0.740***	0.740***	0.739***	0.738***	0.738***	0.738***
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
WTO	0.840***	0.840***	0.841***	0.844***	0.843***	0.844***
	(0.093)	(0.093)	(0.093)	(0.093)	(0.093)	(0.093)
Timespan	2004–2016	2004–2016	2004–2016	2004–2016	2004–2016	2004–2016
Time FE	Y	Y	Y	Y	Y	Y
Countries FE	Y	Y	Y	Y	Y	Y
Time varying FE	Y	Y	Y	Y	Y	Y
Observations	321,720	321,720	321,720	321,720	321,720	321,720
Adjusted R^2	0.726	0.726	0.726	0.726	0.726	0.726

Note: *p<0.1; **p<0.05; ***p<0.01
'HU X FTA' ('HU X CU') is a dummy variable equal to 1 if a Free Trade Agreement (Customs Union) is active between the heldup and the transit country. 'HU X E.U.' is a dummy equal to 1 if both heldup and transit countries belong to the European Union. Switzerland, Norway, Iceland and Liechtenstein are considered part of the E.U. in this analysis.

Table 7: Holdup Effect - Regional Trade Agreements

	All countries	Landlocked	Transit	Others
% Utility change	-0.12	-6.28	0.66	-0.11
Total Loss	-3660.05	-5643.21	4396.43	-2413.27
Yearly Loss	-281.54	-434.09	338.19	-185.64
% change in $\frac{Import}{GDP}$	-0.36	-6.63	0.17	-0.25

Losses are expressed in 2017 Billion USD

Table 8: General equilibrium effect of the holdup problem accounting for Customs Unions.

	All countries	Landlocked	Transit	Others
% Utility change	-0.12	-0.40	-0.17	-0.10
Total Loss	-3660.05	-360.68	-1157.60	-2141.77
Yearly Loss	-281.54	-27.74	-89.05	-164.75
% change in $\frac{Import}{GDP}$	-0.11	-6.27	0.50	-0.04

Losses are expressed in 2017 Billion USD

[1] Transportation costs are adjusted such that a world without the holdup friction would generate an equivalent change in utility.

Table 9: General equilibrium effect accounting for Customs Unions, for an equivalent change[1] in transportation costs.

one of the trading partner is being held up. However, it is possible that both partners are independently begin held up by two different transit countries. We show here that this possibility does not seem to affect the main result. The second test looks at the robustness of the holdup problem for different regions of the world. This robustness test is necessary to see if the global holdup problem identified in the previous sections is drivne by a particular region. Table 10 presents these two robustness tests.

Column 2 shows that the fact that the trade path is double hold up does not affect the results. It also seems to suggest that trades that are double heldup do not seem to significantly suffer more than trade that are heldup by only one transit country. Column 3 provides evidence that the hold-up problem seems to be present and significant in all four continent in the world where there are hold up countries. However, it shows that the problem is more accute in Africa than in Europe for instance. One of the reason why the problem is mitigated in Europe is most likely due to the existence of the European Union and the presence of the European customs unions that, as has been shown above, mitigates the problem.

The appendix provides further robustness checks. Tables 11,12 and 13 provide yearly regressions of the main test on the existence of the holdup problem, and exhibit very stable coefficients of the holdup dummy over time. Tables 14, 15 and 16 are the same tests including the heckman two stage procedure. Again, the results are stable and consistent with previous estimates. Finally, table 17 provide the robutness test presented in this section with the heckman procedure. The result are in all accounts similar to the

	Log(Trade)		
	(1)	(2)	(3)
Holdup (HU)	-0.825^{***}	-0.839^{***}	
	(0.063)	(0.071)	
Double Holdup		-0.038	
		(0.074)	
HU Africa			-0.976^{***}
			(0.137)
HU Asia			-0.656^{***}
			(0.143)
HU Europe			-0.345^{***}
			(0.114)
HU America			-1.167^{***}
			(0.260)
Log(Sea+Land Distance)	-1.414^{***}	-1.415^{***}	-1.413^{***}
	(0.022)	(0.023)	(0.023)
Share of Land in distance	-0.154	-0.163	-0.221
	(0.179)	(0.180)	(0.188)
FTA	0.733^{***}	0.732^{***}	0.725^{***}
	(0.041)	(0.041)	(0.041)
WTO	0.758^{***}	0.759^{***}	0.770^{***}
	(0.067)	(0.067)	(0.068)
Timespan	1993–2016	1993–2016	1993–2016
Time FE	Y	Y	Y
Countries FE	Y	Y	Y
Time varying FE	Y	Y	Y
Observations	522,066	522,066	522,066
Adjusted R^2	0.722	0.722	0.721
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 10: Holdup Effect - Robustness

ones in table 10.

6 Conclusion

This paper provides a theoretical and empirical analysis of the trading costs created by the presence of transit countries in trading relationships. Because transit countries are in a unique position to extract rent from goods passing through, it negatively affects trades from and to holdup countries. Our theoretical analysis shows that such costs are fundamentally different from transportation costs as they represent a wealth transfe between holdup and transit countries. Through its general equilibrium effect on prices, countries that are not directly held up are still affected by this holdup problem and bear a large share of the cost of the distortions created by this friction. By creating a global network of trade routes, we are able to accurately estimate trade distances and identify the most likely transit countries. This allows us to estimate that on average, these countries suffer from a yearly loss of more than USD 200 billion. Our empirical analyses show that the hold-up problem is partly mitigated when the held up and transit countries belong to the same customs union as it limits the ability of the transit countries to apply differential tariffs, arguably one of the main way for them to extract rents. We do not find evidence that free trade agreements exhibit the same mitigating effect. While helping, the presence of customs union does not seem to drastically reduce the global welfare implications of the friction. We also provide evidence that the holdup friction is no less important for countries that are not directly held up than is the presence of transportation costs. While this paper stays relatively silent on the ways in which transit countries can extract rents, apart from the use of tariff as our results on customs unions suggest, further research is needed to unerstand this complex problem in depth. While transport costs can be reduced through the use of infrastructure development and technology, the hold-up problem is more difficult to mitigate as it represents a complex international and political economy problem.

References

James E. Anderson and Eric Van Wincoop. Gravity with gravitas: A solution to the border puzzle. 93(1):170–192. ISSN 00028282. doi: 10.1257/000282803321455214.

Costas Arkolakis. Market Penetration Costs and the New Consumers Margin in International Trade. 118(6):1151–1199. ISSN 0022-3808. doi: 10.1086/657949. URL https://www.jstor.org/stable/10.1086/657949.

Costas Arkolakis, Svetlana Demidova, Peter J. Klenow, and Andres Rodriguez-Clare. Endogenous Variety and the Gains from Trade. 98(2):444–450. ISSN 0002-8282. doi: 10.1257/aer.98.2.444. URL https://www.aeaweb.org/articles?id=10.1257/aer.98.2.444.

Paul S. Armington. A Theory of Demand for Products Distinguished by Place of Production. 16(1):159–178. ISSN 0020-8027. doi: 10.2307/3866403. URL https://www.jstor.org/stable/3866403.

Jean Francois Arvis, Gael Raballand, and Jean-Francois Marteau. The Cost of Being Landlocked: Logistics Costs And Supply Chain Reliability. URL http://papers.ssrn.com/sol3/papers.cfm?abstract_id=995079%5Cnhttp://elibrary.worldbank.org/content/book/9780821384084.

David Atkin and Dave Donaldson. Who's Getting Globalized? The Size and Implications of Intra-national Trade Costs. URL http://www.nber.org/papers/w21439.

Andrew B. Bernard, Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum. Plants and Productivity in International Trade. 93(4):1268–1290. ISSN 0002-8282. doi: 10.1257/000282803769206296. URL https://www.aeaweb.org/articles?id=10.1257/000282803769206296.

Thomas Chaney. Distorted Gravity: The Intensive and Extensive Margins of International Trade. 98(4):1707–1721. ISSN 0002-8282. doi: 10.1257/aer.98.4.1707. URL https://www.aeaweb.org/articles?id=10.1257/aer.98.4.1707.

R.H. Coase. The Nature of the Firm. 4(16):386–405. ISSN 0521311403. doi: 10.2307/2626876. URL http://onlinelibrary.wiley.com/doi/10.1111/j.1468-0335.1937.tb00002.x/full.

Arnaud Costinot and Rodríguez-Clare Andrés. Trade Theory with Numbers: Quantifying the Consequences of Globalization. In Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, editors, *Handbook of International Economics*, volume 4, pages 197–261. Elsevier. URL https://econpapers.repec.org/bookchap/eeeintchp/4-197.htm.

Simeon Djankov, Caroline Freund, and Cong S Pham. Trading on Time. 92(1): 166–173. ISSN 0034-6535. doi: 10.1162/rest.2009.11498. URL https://www.mitpressjournals.org/doi/10.1162/rest.2009.11498.

Jonathan Eaton and Samuel Kortum. Technology, Geography, and Trade. 70(5):1741–1779. ISSN 1468-0262. doi: 10.1111/1468-0262.00352.

Robert C. Feenstra. Border Effects and the Gravity Equation: Consistent Methods for Estimation. 49(5):491–506, a. ISSN 00369292. doi: 10.1111/1467-9485.00244. URL http://dx.doi.org/10.1111/1467-9485.00244.

Robert C. Feenstra. *Advanced International Trade: Theory and Evidence*. Princeton University Press, b.

Yossi Feinberg and Morton I. Kamien. Highway robbery: Complementary monopoly and the hold-up problem. 19(10):1603–1621. doi: 10.1016/S0167-7187(00)00069-2.

Irene M. Franck and David M. Brownstone. *The Silk Road: A History*. Facts On File Inc. ISBN 978-0-948894-19-0.

Jeffrey A. Frankel and David Romer. Does trade cause growth? 89(3):379–399. ISSN 00028282. doi: 10.1257/aer.89.3.379.

Roy Gardner, Noel Gaston, Robert T. Masson, David Donaldson, and Avner Greif. Tolling the Rhine in 1254: Complementary monopoly revisited.

Keith Head and Thierry Mayer. Illusory border effects. In Steven Brakamn and Peter van Bergeijk, editors, *The Gravity Model in International Trade: Advances and Applications*. Cambridge University Press, a. doi: 10.1017/CBO9780511762109.006. URL /core/books/the-gravity-model-in-international-trade/illusory-border-effects/498F4B689FE13A2380467927E2F0761F.

Keith Head and Thierry Mayer. Gravity Equations: Workhorse,Toolkit, and Cookbook. In Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, editors, *Handbook of International Economics*, volume 4 of *Handbook of International Economics*, pages 131–195. Elsevier, b. doi: 10.1016/B978-0-444-54314-1.00003-3. URL http://www.sciencedirect.com/science/article/pii/B9780444543141000033.

Elhanan Helpman, Marc Melitz, and Yona Rubinstein. Estimating Trade Flows: Trading Partners and Trading Volumes. 123(2):441–487. ISSN 0033-5533. doi: 10.1162/qjec.2008.123.2.441.

Albert O. Hirschman. *National Power and the Structure of Foreign Trade*. University of California Press.

David Hummels, Volodymyr Lugovskyy, and Alexandre Skiba. The trade reducing effects of market power in international shipping. 89(1):84–97. ISSN 03043878. doi: 10.1016/j.jdeveco.2008.05.001.

Edi Karni and Subir K. Chakrabarti. Political structure, taxes and trade. 64(2):241–258.

Paul Krugman. Scale economies, product differentiation, and the pattern of trade. 70 (5):950–959. ISSN 00028282. doi: 10.2307/1805774.

Nuno Limão and Anthony J. Venables. Infrastructure, Geographical Disadvantage, Transport Costs, and Trade. 15(3):451–479. ISSN 0258-6770. URL https://www.jstor.org/stable/3990110.

Giovanni Maggi. Chapter 6 - International Trade Agreements. In Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, editors, *Handbook of International Economics*, volume 4 of *Handbook of International Economics*, pages 317–390. Elsevier. doi: 10.1016/B978-0-444-54314-1.00006-9. URL http://www.sciencedirect.com/science/article/pii/B9780444543141000069.

Marc J. Melitz. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. 71(6):1695–1725. ISSN 0012-9682. URL https://www.jstor.org/stable/1555536.

Kaz Miyagiwa. The Silk Road: Tax competition among nation states. URL https://ideas.repec.org/p/hit/ccesdp/18.html.

Henry G. Overman, Stephen Redding, and Anthony J. Venables. The Economic Geography of Trade, Production, and Income: A Survey of Empirics. In E. Kwan Choi and James Harrigan, editors, *Handbook of International Trade*, pages 350–387. Wiley-Blackwell. ISBN 978-0-470-75646-1. doi: 10.1002/9780470756461.ch12. URL https://onlinelibrary.wiley.com/doi/abs/10.1002/9780470756461.ch12.

Gael Raballand, Salim Refas, Monica Beuran, and Gozde Isik. Why Cargo Dwell Time Matters in Trade. 81, a. URL https://openknowledge.worldbank.org/handle/10986/10039.

Gael J. R. F. Raballand and Supee Teravaninthorn. Transport prices and costs in Africa : A review of the international corridors. URL http://documents.worldbank.org/curated/en/278561468201609212/Transport-prices-and-costs-in-Africa-a-review-of-the-international-corridors.

Gaël Raballand, Antoine Kunth, and Richard Auty. Central Asia's transport cost burden and its impact on trade. 29(1):6–31, b. ISSN 0939-3625. doi: 10.1016/j.

ecosys.2005.02.004. URL http://www.sciencedirect.com/science/article/pii/S093936250500021X.

Stephen Redding and Anthony J. Venables. Economic geography and international inequality. 62(1):53–82. ISSN 0022-1996. doi: 10.1016/j.jinteco.2003.07.001. URL http://www.sciencedirect.com/science/article/pii/S0022199603000965.

Andrew K. Rose. Do WTO members have more liberal trade policy? 63(2):209–235. ISSN 0022-1996. doi: 10.1016/S0022-1996(03)00071-0.

Adam Smith. *An Inquiry into the Nature and Causes of the Wealth of Nations*. Reprint, Liberty Classics, 1979.

USAID. The Broad Economic Impact of Port Inefficiency: A Comparative Study of Two Ports.

Appendix

A Data and control variables

All regression include the following country-pair specific control variables.

-

- Common Language: Dummy at 1 if both countries use the same language.

- Common Colonizer: Dummy at 1 if both countries were or are colonized by the same colonizer.

- Colonies: Dummy at 1 if the exporter is a colony of the importer at time t or vice-versa.

- Ever Colonized: Dummy at 1 if the exporter or the importer were ever colonized.

- Common Currency: Dummy at 1 if both countries use the same currency at time t.

- FTA: Dummy at 1 if there is a bilateral trade agreement between both countries at time t or if both countries are part of a multilateral trade agreement at time t.

- WTO: Dummy at 1 of both countries belong to the World Trade Organization at time t.

- One WTO: Dummy at 1 if only one country belongs to the World Trade Organization.

- GSP: Dummy at 1 if the exporter belongs to the list of the importer's Generalized Schemes of Preferences at time t or vice-versa.

- Number of islands: Number of islands in the pair of countries (0, 1 or 2).

B Additional Tables

	Log(Trade)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Holdup (HU)	−0.901***	−0.733***	−0.817***	−0.965***	−0.819***	−0.789***	−0.752***	−0.789***
	(0.106)	(0.100)	(0.101)	(0.099)	(0.090)	(0.087)	(0.088)	(0.089)
Log(Sea+Land Distance)	−1.289***	−1.314***	−1.345***	−1.350***	−1.343***	−1.312***	−1.330***	−1.367***
	(0.032)	(0.029)	(0.029)	(0.029)	(0.029)	(0.027)	(0.027)	(0.029)
Share of Land in distance	0.285	−0.109	0.111	0.205	−0.099	−0.209	−0.448*	−0.260
	(0.237)	(0.218)	(0.221)	(0.220)	(0.215)	(0.224)	(0.234)	(0.217)
FTA	0.392***	0.519***	0.422***	0.454***	0.481***	0.590***	0.599***	0.802***
	(0.085)	(0.078)	(0.075)	(0.072)	(0.068)	(0.064)	(0.066)	(0.065)
WTO	0.893***	0.821***	0.790***	0.749***	0.573***	0.454***	0.340***	0.321***
	(0.101)	(0.104)	(0.106)	(0.107)	(0.105)	(0.105)	(0.109)	(0.112)
Timespan	1993	1994	1995	1996	1997	1998	1999	2000
Time FE	N	N	N	N	N	N	N	N
Countries FE	Y	Y	Y	Y	Y	Y	Y	Y
Time varying FE	N	N	N	N	N	N	N	N
Observations	14,332	15,214	15,877	16,501	17,454	17,973	18,740	20,500
Adjusted R^2	0.704	0.708	0.710	0.705	0.711	0.719	0.719	0.711
Note:	*p<0.1; **p<0.05; ***p<0.01							

Table 11: Holdup Effect per Year

	Log(Trade)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Holdup (HU)	−0.695***	−0.739***	−0.809***	−0.878***	−0.770***	−0.804***	−0.751***	−0.793***
	(0.091)	(0.086)	(0.089)	(0.088)	(0.090)	(0.089)	(0.088)	(0.090)
Log(Sea+Land Distance)	−1.398***	−1.393***	−1.365***	−1.379***	−1.378***	−1.403***	−1.401***	−1.422***
	(0.030)	(0.029)	(0.029)	(0.030)	(0.029)	(0.029)	(0.030)	(0.030)
Share of Land in distance	−0.304	−0.301	−0.153	−0.245	−0.103	−0.119	−0.140	−0.055
	(0.225)	(0.227)	(0.232)	(0.240)	(0.217)	(0.229)	(0.236)	(0.239)
FTA	0.820***	0.831***	0.903***	0.905***	0.873***	0.921***	0.940***	1.006***
	(0.065)	(0.063)	(0.064)	(0.063)	(0.063)	(0.062)	(0.062)	(0.062)
WTO	0.625***	0.654***	0.751***	0.636***	0.976***	0.858***	0.838***	0.795***
	(0.129)	(0.132)	(0.131)	(0.133)	(0.129)	(0.124)	(0.128)	(0.130)
Timespan	2001	2002	2003	2004	2005	2006	2007	2008
Time FE	N	N	N	N	N	N	N	N
Countries FE	Y	Y	Y	Y	Y	Y	Y	Y
Time varying FE	N	N	N	N	N	N	N	N
Observations	20,783	21,143	21,829	22,256	22,728	23,415	23,874	24,502
Adjusted R^2	0.716	0.715	0.722	0.726	0.726	0.728	0.726	0.724
Note:	*p<0.1; **p<0.05; ***p<0.01							

Table 12: Holdup Effect per Year

	Log(Trade)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Holdup (HU)	-0.834^{***}	-0.825^{***}	-0.800^{***}	-0.901^{***}	-0.838^{***}	-0.932^{***}	-0.866^{***}	-0.877^{***}
	(0.086)	(0.086)	(0.085)	(0.088)	(0.089)	(0.086)	(0.088)	(0.086)
Log(Sea+Land Distance)	-1.470^{***}	-1.495^{***}	-1.503^{***}	-1.474^{***}	-1.497^{***}	-1.514^{***}	-1.468^{***}	-1.484^{***}
	(0.029)	(0.029)	(0.029)	(0.029)	(0.030)	(0.029)	(0.029)	(0.028)
Share of Land in distance	0.046	-0.124	-0.088	-0.080	-0.222	-0.059	-0.260	-0.571^{**}
	(0.230)	(0.231)	(0.229)	(0.227)	(0.229)	(0.231)	(0.234)	(0.230)
FTA	0.607^{***}	0.610^{***}	0.626^{***}	0.734^{***}	0.718^{***}	0.656^{***}	0.689^{***}	0.642^{***}
	(0.058)	(0.056)	(0.056)	(0.053)	(0.053)	(0.050)	(0.050)	(0.049)
WTO	0.838^{***}	0.915^{***}	0.740^{***}	0.732^{***}	0.851^{***}	0.901^{***}	0.813^{***}	1.038^{***}
	(0.122)	(0.122)	(0.127)	(0.142)	(0.146)	(0.145)	(0.154)	(0.145)
Timespan	2009	2010	2011	2012	2013	2014	2015	2016
Time FE	N	N	N	N	N	N	N	N
Countries FE	Y	Y	Y	Y	Y	Y	Y	Y
Time varying FE	N	N	N	N	N	N	N	N
Observations	24,553	24,966	25,376	25,488	25,735	25,987	26,205	26,635
Adjusted R^2	0.728	0.730	0.726	0.726	0.724	0.726	0.722	0.725
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$							

Table 13: Holdup Effect per Year

	Log(Trade)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Holdup (HU)	-0.936^{***}	-0.772^{***}	-0.846^{***}	-0.994^{***}	-0.854^{***}	-0.813^{***}	-0.777^{***}	-0.828^{***}
	(0.106)	(0.101)	(0.102)	(0.099)	(0.091)	(0.088)	(0.088)	(0.090)
Log(Sea+Land Distance)	-1.347^{***}	-1.378^{***}	-1.411^{***}	-1.406^{***}	-1.408^{***}	-1.362^{***}	-1.375^{***}	-1.460^{***}
	(0.035)	(0.031)	(0.031)	(0.031)	(0.032)	(0.029)	(0.029)	(0.032)
Share of Land in distance	0.299	-0.098	0.110	0.210	-0.092	-0.206	-0.440^{*}	-0.247
	(0.236)	(0.218)	(0.222)	(0.221)	(0.216)	(0.225)	(0.234)	(0.218)
FTA	0.394^{***}	0.539^{***}	0.451^{***}	0.476^{***}	0.491^{***}	0.645^{***}	0.666^{***}	0.859^{***}
	(0.088)	(0.080)	(0.077)	(0.073)	(0.069)	(0.066)	(0.067)	(0.066)
WTO	0.891^{***}	0.792^{***}	0.772^{***}	0.724^{***}	0.554^{***}	0.432^{***}	0.325^{***}	0.240^{**}
	(0.102)	(0.104)	(0.106)	(0.107)	(0.106)	(0.105)	(0.109)	(0.112)
Inverse Mill's ratio	0.224^{***}	0.255^{***}	0.288^{***}	0.231^{***}	0.293^{***}	0.249^{***}	0.206^{***}	0.477^{***}
	(0.075)	(0.073)	(0.073)	(0.073)	(0.077)	(0.077)	(0.070)	(0.075)
Timespan	1993	1994	1995	1996	1997	1998	1999	2000
Time FE	N	N	N	N	N	N	N	N
Countries FE	Y	Y	Y	Y	Y	Y	Y	Y
Time varying FE	N	N	N	N	N	N	N	N
Observations	14,332	15,214	15,877	16,501	17,454	17,973	18,740	20,500
Adjusted R^2	0.703	0.706	0.709	0.704	0.710	0.717	0.717	0.710
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$							

Table 14: Holdup Effect per Year - Heckman Correction

	Log(Trade)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Holdup (HU)	-0.735^{***}	-0.792^{***}	-0.842^{***}	-0.901^{***}	-0.794^{***}	-0.827^{***}	-0.768^{***}	-0.825^{***}
	(0.092)	(0.087)	(0.090)	(0.089)	(0.091)	(0.090)	(0.089)	(0.090)
Log(Sea+Land Distance)	-1.495^{***}	-1.488^{***}	-1.477^{***}	-1.475^{***}	-1.471^{***}	-1.499^{***}	-1.498^{***}	-1.530^{***}
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)
Share of Land in distance	-0.296	-0.298	-0.131	-0.205	-0.056	-0.058	-0.105	-0.030
	(0.226)	(0.227)	(0.232)	(0.239)	(0.217)	(0.229)	(0.235)	(0.238)
FTA	0.877^{***}	0.884^{***}	1.030^{***}	1.019^{***}	0.988^{***}	1.016^{***}	1.042^{***}	1.109^{***}
	(0.066)	(0.064)	(0.065)	(0.064)	(0.064)	(0.063)	(0.063)	(0.063)
WTO	0.530^{***}	0.540^{***}	0.682^{***}	0.568^{***}	0.914^{***}	0.813^{***}	0.793^{***}	0.755^{***}
	(0.128)	(0.131)	(0.131)	(0.132)	(0.128)	(0.124)	(0.127)	(0.129)
Inverse Mill's ratio	0.538^{***}	0.538^{***}	0.587^{***}	0.508^{***}	0.467^{***}	0.501^{***}	0.501^{***}	0.581^{***}
	(0.075)	(0.074)	(0.079)	(0.080)	(0.078)	(0.081)	(0.081)	(0.082)
Timespan	2001	2002	2003	2004	2005	2006	2007	2008
Time FE	N	N	N	N	N	N	N	N
Countries FE	Y	Y	Y	Y	Y	Y	Y	Y
Time varying FE	N	N	N	N	N	N	N	N
Observations	20,783	21,143	21,829	22,256	22,728	23,415	23,874	24,502
Adjusted R^2	0.715	0.715	0.721	0.725	0.725	0.727	0.725	0.723
Note:	$^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$							

Table 15: Holdup Effect per Year - Heckman Correction

	Log(Trade)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Holdup (HU)	-0.878^{***}	-0.867^{***}	-0.840^{***}	-0.944^{***}	-0.894^{***}	-0.988^{***}	-0.927^{***}	-0.942^{***}
	(0.087)	(0.087)	(0.085)	(0.089)	(0.090)	(0.087)	(0.090)	(0.087)
Log(Sea+Land Distance)	-1.590^{***}	-1.615^{***}	-1.608^{***}	-1.588^{***}	-1.624^{***}	-1.620^{***}	-1.594^{***}	-1.599^{***}
	(0.032)	(0.032)	(0.032)	(0.031)	(0.032)	(0.032)	(0.031)	(0.030)
Share of Land in distance	0.091	-0.087	-0.065	-0.010	-0.161	-0.015	-0.242	-0.518^{**}
	(0.229)	(0.229)	(0.228)	(0.227)	(0.228)	(0.232)	(0.235)	(0.230)
FTA	0.694^{***}	0.684^{***}	0.692^{***}	0.810^{***}	0.786^{***}	0.731^{***}	0.775^{***}	0.711^{***}
	(0.059)	(0.056)	(0.056)	(0.054)	(0.053)	(0.051)	(0.050)	(0.050)
WTO	0.803^{***}	0.883^{***}	0.722^{***}	0.689^{***}	0.784^{***}	0.829^{***}	0.699^{***}	0.929^{***}
	(0.121)	(0.122)	(0.127)	(0.142)	(0.145)	(0.145)	(0.154)	(0.144)
Inverse Mill's ratio	0.634^{***}	0.629^{***}	0.539^{***}	0.597^{***}	0.684^{***}	0.590^{***}	0.732^{***}	0.672^{***}
	(0.084)	(0.083)	(0.084)	(0.086)	(0.085)	(0.084)	(0.084)	(0.083)
Timespan	2009	2010	2011	2012	2013	2014	2015	2016
Time FE	N	N	N	N	N	N	N	N
Countries FE	Y	Y	Y	Y	Y	Y	Y	Y
Time varying FE	N	N	N	N	N	N	N	N
Observations	24,553	24,966	25,376	25,488	25,735	25,987	26,205	26,635
Adjusted R^2	0.727	0.729	0.725	0.725	0.723	0.725	0.721	0.725
Note:	$^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$							

Table 16: Holdup Effect per Year - Heckman Correction

	Log(Trade)		
	(1)	(2)	(3)
Holdup (HU)	-0.866^{***}	-0.891^{***}	
	(0.064)	(0.073)	
Double Holdup		-0.071	
		(0.075)	
HU Africa			-1.124^{***}
			(0.135)
HU Asia			-0.683^{***}
			(0.141)
HU Europe			-0.324^{***}
			(0.117)
HU America			-1.218^{***}
			(0.263)
Log(Sea+Land Distance)	-1.507^{***}	-1.509^{***}	-1.511^{***}
	(0.026)	(0.026)	(0.026)
Share of Land in distance	-0.122	-0.139	-0.188
	(0.179)	(0.180)	(0.190)
FTA	0.802^{***}	0.801^{***}	0.791^{***}
	(0.042)	(0.042)	(0.042)
WTO	0.693^{***}	0.694^{***}	0.702^{***}
	(0.067)	(0.067)	(0.068)
Inverse Mill's ratio	0.476^{***}	0.477^{***}	0.514^{***}
	(0.058)	(0.058)	(0.058)
Timespan	1993–2016	1993–2016	1993–2016
Time FE	Y	Y	Y
Countries FE	Y	Y	Y
Time varying FE	Y	Y	Y
Observations	522,066	522,066	522,066
Adjusted R^2	0.721	0.721	0.720
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 17: Holdup Effect - Robustness - Heckman Correction