Buyer-Seller Relationships in International Trade: Evidence from U.S. State Exports and Business-Class Travel*

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Abstract

International trade has become increasingly dependent on the transmission of complex information, often realized via face-to-face communication. This paper provides novel evidence for the importance of in-person business meetings in international trade. Interactions among trade partners are modeled as a fixed cost of trade, however their outcome generates unique value to the traded products. Differences in the relationship intensity of traded goods, in travel costs and market size across foreign countries, determine the optimal amount of interaction between trade partners. Using U.S. state level data on international business-class air travel as a measure of in-person business meetings, I find robust evidence that the demand for business-class air travel is directly related to volume and composition of exports in differentiated products. The empirical strategy exploits the intra-national geography of exports and business travelers by foreign country and time period, circumventing any spurious correlation induced by cross-country differences driving both travel and trade patterns. I also find that trade in R&D intensive manufactures and goods facing contractual frictions is most dependent on face-to-face meetings.

JEL Classification: F1, O3, R4

Keywords: state exports; air travel; fixed export cost; face-to-face communication; relationship intensity; tacit knowledge.

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1 Introduction

International trade has become increasingly dependent on the transmission of complex information. As traded goods involve a high degree of differentiation (Rauch, 1999) and production networks spread across the globe (Hummels et al., 2001), partnerships between buyers and sellers are key for successful trade transactions. In creating and maintaining business relationships, close communication between trade partners – often realized via face-to-face interactions – becomes essential.[1] In-person meetings facilitate information sharing, necessary for product innovations and for better meeting markets' expectations.[2]

The need to shed light on the importance of personal interactions for international trade has been increasingly recognized by trade economists. A direct connection between face-to-face meetings and international trade is implicit in several distinct literatures. For example, the incomplete contracts literature relies on the key assumption that inputs are specialized for the production needs of a single final good producer (Grossman and Helpman, 2002; Antras, 2003). This degree of input customization presumably requires considerable amounts of complex information exchanged within a buyer-seller link. Moreover, close communication between firms impacts international transactions even absent of customization motives. Face-to-face interactions remain one of the most effective ways for knowledge transfers, coordination and monitoring, having a direct impact on the nature and growth of tasks trade and offshoring.[3] A different rationale for the use of communication in trade is provided by the informative advertising literature.[4] Advertising delivers product information to buyers that are otherwise unaware of the varieties available in the market. Thus, consumers' willingness to buy traded goods is directly dependent on the information provided

[1] In a recent global survey of 2300 Harvard Business Review subscribers, respondents said that face-to-face meetings are key to building long-term relationships (95%), negotiating contracts (89%), meeting new clients (79%), understanding and listening to important customers (69%). Similar survey evidence is documented by Oxford Economics in a report that highlights the importance of business travel investments for firm performance.

[2] IBM Global CEO Study (2006) reports survey evidence that business partners are the second most important source of innovation for a firm after its own employees. Egan and Mody (1992) provide ample anecdotal evidence gathered from interviews with U.S. importers on the role of partnerships in trade. They report: "[collaborative relationships] are often an essential source of information about developed country markets and production technology as well as product quality and delivery standards." (p. 321) "In exchange for larger, more regular orders from buyers, suppliers collaborate with buyers' product designers. Collaboration in design and manufacturing at early stages of product development cuts costs and improves quality." (p. 326). Confirming survey evidence, Hovhannisyan and Keller (2010) provide empirical evidence that inward business travelers raise a country's rate of innovation.

[3] See for example Grossman and Rossi-Hansberg (2008), Head et al. (2008), Keller and Yeaple (2010).

[4] See for example Grossman and Shapiro (1984), and the application to international trade in Arkolakis (2009).

by the sellers at a cost.[5]

While academic research and business surveys suggest that close communication between trade partners is essential for international trade, providing empirical evidence in support of it has been difficult. Information transmission is not directly observable, and often times existing measures do not distinguish between its use for production or personal consumption purposes (e.g., telephone calls, internet). Both measurement problems are overcome when communication is realized *in person* across national borders, because in this particular case information flows leave a 'paper trail' in the form of business-class airline tickets.[6]

In this paper I employ novel U.S. state level data on international business-class air traffic to examine the importance of face-to-face meetings in international trade. The analysis is constructed following three steps. First, I provide empirical evidence that international travel enters as an input to trade across national borders. Second, I demonstrate that the direct dependence between international business travel and trade flows is robust in the face of common covariates, overcoming concerns of spurious correlation. Third, from industry level data, I estimate the face-to-face communication intensity of trade across manufacturing sectors and show the coefficients' systematic variation with measures of product complexity.

A preview of the data I will describe later in more detail reveals a direct relation between international business class travel and international trade. Figure 1 plots the volume of bilateral manufacturing exports against the number of U.S. outbound business-class travelers by state to all foreign countries. Figure 2 shows a similar graph, but now the data cut keeps the foreign destination country the same in order to display the intra-national distribution of departure locations for bilateral export shipments and business class travelers. Both pictures suggest a strong correlation between in-person business meetings and international trade. However the correlations may also be spurious if they are an artifact of systematic differences across locations in time-varying factors such as economic size, income or development level. For example, a state like New York may invest more in transportation infrastructure relative to other states, boosting both air travel and trade flows. Similarly, a rich country such as France imports more goods, of higher quality, and at the

[5] In line with this, the marketing literature explicitly addresses the importance of "relationship selling" for products that are complex, custom-made and delivered over a continuous stream of transactions (Crosby et. al, 1990).

[6] Considering the business-class air passengers as representing business people traveling for business purposes is consistent with existing evidence from the airline industry. For example, British Airways reports that "three quarters of people we carry in first class are top executives or own their own companies" (New York Times, Feb. 5, 1993).

same time provides attractive touristic destinations.

To guide the empirical strategy, I formalize an exporter's decision to undertake costly international travel for trade related purposes. To accommodate the various underlying motives for in-person meetings between trade partners (e.g., negotiate new contracts, build trust, maintain good partnerships, customize products, provide after-sale service, etc.), I impose a very general structure on trade relationships. That is: 1) in-person meetings require travel costs, which are part of the fixed cost of trade; 2) the interactions they facilitate add value to trade partnerships, which is reflected in a higher willingness to import products from familiar sellers; and 3) the amount of interaction between foreign partners is endogenously chosen by an exporter based on product and foreign markets characteristics.

Starting from this structure, I write a static heterogeneous firms model of trade with the following features. Buyers across foreign markets attach unique valuations to quality differentiated products based on two distinct quality components: one that is product specific and one that is trade pair specific. The latter captures any favorable attribute that adds specificity to an export shipment, making it particular to a bilateral trade pair.[7] Exporters can invest resources to establish partnerships with foreign buyers in order to increase the appeal of their products and boost export sales. Personal interactions among trade partners incur a fixed cost of trade, but at the same time, by creating relationship capital, enter (with different intensities) as input into products' relationship-specific appeal. Thus, personal interactions become an endogenous component and a choice variable in the firm's profit maximization problem. From this theoretical set-up, I derive an expression for the optimal demand for in-person meetings and show that, conditional on travel costs, it depends on the volume and the composition of exports in terms of relationship intensive goods.

Taking the model predictions to the data, I estimate an input demand equation to determine the responsiveness of business class air travel flows to variations in the scale and the composition of exports. If buyer-seller interactions are an input to international trade, then one should observe a match between export patterns and the demand for business class air travel. The data on international air travel and corresponding manufacturing exports is available at the U.S. state level

[7]These attributes may characterize the actual product (e.g. degree of customization, conformity with market-specific product standards), and/or the transaction and delivery service (e.g., level of trust, quality of coordination, after-sale service, technical support).

by foreign country level. The intra-national geographic detail plays an essential role for econometric identification. It allows me to exploit the within U.S. cross-state variation in exports and air travel patterns, while fully controlling for time-varying foreign market characteristics in order to remove spurious correlation induced by cross-country differences driving both travel and trade flows.

The main findings of the paper are the following. An increase in the volume of exports raises the local demand for business class air travel. Conditional on total value, the degree of product differentiation of manufacturing exports has an additional positive effect on the demand for business class air travel. Furthermore, the face-to-face communication intensity of trade across sectors, obtained from estimating the dependence of business air travel demand on industry level exports, is positively correlated with existing measures of product complexity, such as industry R&D intensities, Nunn's (2007) measure of contract intensities, and Rauch's (1999) classification of goods. This finding provides empirical confirmation to the insight that trade in complex, innovation intensive manufactures, as well as goods facing contractual frictions is most dependent on face-to-face meetings (Leamer and Storper, 2001).

The extent to which personal interactions affect trade patters has significant implications for several lines of work. This paper contributes to the empirical literature on trade costs, adding to an insufficiently explored area of research on information frictions. A number of empirical studies have proposed various proxies for the ease of information transfers and have used them in a gravity equation model to estimate the magnitude of information barriers to trade.[8] Of these studies, the paper most related to this one is Poole (2010), who uses country level data to estimate the impact of incoming business travelers (distinguished by residency and skill level) on the intensive and extensive margins of U.S. exports. Reinforcing Poole's (2010) finding of a direct relation between business travel and trade patterns, this study complements existing work in several respects: it formalizes the relation between in-person business meetings and export flows (making transparent the departure from gravity estimation models), it uses a novel identification strategy based on intra-national geography, and it provides industry level analysis by highlighting the systematic variation in the travel intensity of trade across manufacturing sectors according to product complexity.

The empirical results of this paper also relate to work on the distance puzzle and the border

[8] The information measures previously used are distance and common language/colonial ties (Rauch, 1999), ethnic networks (Rauch and Trindade, 2002; Herander and Saavedra, 2005), internet penetration (Freund and Weinhold, 2004), telecommunication (Fink et al., 2005; Tang, 2006), product standards (Moenius, 2004).

effects.[9] Familiarity and personal interactions have often been recognized as potential explanation for the persistent sensitivity of trade flows to geographic distance in a time of significant declines in transportation and communication costs (Grossman, 1998; Anderson and Van Wincoop, 2004; Head and Ries, 2008). Face-to-face meetings are essential not only for identifying new trading opportunities, but also for maintaining existing partnerships, especially when the delivery and use of traded goods or services has to be accompanied by the transmission of non-codifiable information from sellers to buyers (Leamer and Storper, 2001; Durandon and Storper, 2008). However, direct empirical evidence in support of these insights is scarce, a gap which this paper tries to fill.

Finally, the results of the paper are also of considerable policy interest. For one, they provide support for the goals and efforts of export promotion institutions (Volpe Martincus and Carballo, 2008). Moreover, they also bring to attention additional benefits from lowering the barriers associated with the temporary cross-border movements of people. Policy can help in this direction by reducing the cost of air travel through air services liberalization (Cristea and Hummels, 2010), and also by relaxing the restrictions imposed on temporary visits through visa programs.

The paper proceeds as follows. Section 2 provides theory and generates predictions regarding the optimal demand for in-person business meetings. Section 3 describes the data and sample construction. The econometric strategy and estimation results, including industry level analyses, are discussed in section 4. Section 5 concludes.

2 Theory

This section proposes a partial equilibrium model of trade that formalizes an exporter's decision to undertake costly travel and build ties with foreign trade partners in return for larger export sales. In-person meetings are modeled as an input to products' relationship specific appeal. The set-up follows the quality heterogeneous firms literature, except that here product differentiation relies on an input that is trade pair specific, and involves a fixed rather than per-unit cost.[10]

[9] Disdier and Head (2008) provide a meta analysis documenting the non-decreasing effects of distance on international trade. Hillberry and Hummels (2008) provide striking evidence for the geographic localization of manufacturing shipments at the zip code level. While transport costs are given as the main driving force, the need of personal contacts may provide an additional explanations.

[10] See Kugler and Verhoogen (2009) and Baldwin and Harrigan (2009) for examples of quality heterogeneous firms models of trade. Johnson (2008) and Hallak and Sivadasan (2008) do relate quality production to fixed costs, however in their models the fixed outlays do not vary by destination market. Arkolakis (2010) proposes a model with bilateral marketing costs, but such investments ensure larger exports by raising the number of foreign consumers reached

2.1 Model Set-up

There are *J+1* countries indexed by j that trade varieties from H differentiated goods indexed by h. For one country of interest (the U.S.), I distinguish agents based on their location in one of the S sub-national regions (states) indexed by s. For simplicity, I assume that the other J countries each consists of a single region, so the country index suffices to identify the region.

Preferences. A representative buyer in country j has preference for all available varieties ω, and chooses the consumption quantities $x_{sjh}(\omega)$ of each variety to maximize the utility function:

$$U_j = \prod_h (C_{jh})^{\mu_{jh}}, \qquad C_{jh} = \left(\int_{\omega \in \Omega_{jh}} q_{sjh}(\omega)^{1/\sigma} x_{sjh}(\omega)^{1-1/\sigma} d\omega \right)^{\sigma/(\sigma-1)} \tag{1}$$

where μ_{jh} is the expenditure share, with $\sum_h \mu_{jh} = 1$; Ω_{jh} is the variety set of good h available in market j; σ is the elasticity of substitution between varieties, with $\sigma > 1$; and $q_{sjh}(\omega)$ is the value attached by country j consumers to variety ω of good h produced in region s.

Demand. Consumer optimization delivers the Dixit-Stiglitz demand for variety ω:

$$x_{sjh}(\omega) = q_{sjh}(\omega)\big(\tau_{sj} p_{sh}(\omega)\big)^{-\sigma} \frac{\mu_{jh} Y_j}{P_{jh}}, \tag{2}$$

where $p_{sh}(\omega)$ is the f.o.b. product price, τ_{sj} is the "iceberg" trade cost, and Y_j is country j's total income. The CES price index is given by $P_{jh} = \int_{\omega \in \Omega_{jh}} q_{sjh}(\omega) \ \big(\tau_{sj} p_{sh}(\omega)\big)^{1-\sigma} d\omega$.

I assume that the preference weight $q_{sjh}(\omega)$ is separable into two components: $\lambda_{sh}(\omega)$, which is product specific and common across all destination markets (e.g., standard product quality), and $\lambda_{sjh}(\omega)$, which is product-market specific (e.g., product appeal).[11] That is:

$$q_{sjh}(\omega) = \lambda_{sh}(\omega)\lambda_{sjh}(\omega), \qquad \text{with} \qquad \lambda_{sh}, \lambda_{sjh} \geq 1 \tag{3}$$

This paper focuses on the bilateral quality component $\lambda_{sjh}(\omega)$, assumes it to be a deterministic demand shifter[12], and interprets it as the value added created from face-to-face communication

rather than raising sales per consumer. The set-up in Arkolakis (2010) however is isomorphic to a model of quality, thus it comes closest to the set-up in this paper.

[11]Most research on vertical differentiation examines the producer-specific component, relating it to technological factors (Flam and Helpman, 1987), endowments (Schott, 2004), input quality (Kugler and Verhoogen, 2009) or productivity (Baldwin and Harrigan, 2008).

[12]This assumption differentiates this set-up from those with demand uncertainty (e.g., Nguyen, 2009).

between trade partners. Personal interactions are explicitly modeled here as being facilitated by an intermediate service sector – the airline industry – that supplies business travel services locally for the use of the exporting firms in that region.

Technologies. Labor is the only factor of production. It is homogenous and mobile across goods in a region but immobile across regions. L_s labor units are inelastically supplied in region s.

The airline industry is perfectly competitive and operates under constant returns to scale. Technology varies across locations such that a flight service supplied in region s to destination j requires β_{sj} labor units. This reflects regional differences in infrastructure, geography or network connectivity. In equilibrium, the price of travel services for a trip of fixed length is $c_{sj} = w_s\beta_{sj}$.

Every region s has an exogenous mass M_s of entrepreneurs proportional to the economic size of the region. Each entrepreneur can potentially produce in one of the H differentiated sectors, but to do so she must first draw a labor productivity φ from a Pareto distribution $G(\varphi) = 1 - (1/\varphi)^\kappa$ with shape parameter κ.[13] If a producer in sector h from region s starts exporting to foreign market j, then a fixed market entry cost F_{sjh} must be incurred. Since the differentiated good technology involves fixed and variable costs, in equilibrium firms produce distinct varieties. Thus, the productivity level φ is used to index both firms and varieties.

Production in sector h is described by separate technologies for physical output and product attributes. The production of the physical output is given by $y(\varphi) = \varphi^a l$, where l is the amount of labor used and $a < 1$ is a parameter reflecting the rate at which productivity lowers marginal cost. This implies a marginal cost of production equal to w_s/φ^a.

A variety's quality attributes are the result of produced 'standard quality' λ_{sh}, and 'relationship-specific appeal' λ_{sjh}. Standard quality is described by the production function $\lambda_{sh}(\varphi) = \left(\delta_{sh}\varphi^{1-a}\right)^{\sigma-1}$. One can think of δ_{sh} as capturing any location or industry specific factors that affect quality production. For simplicity, I set $\delta_{sh} = 1\ \forall s, \forall h$. Given the convenient restriction on the range of parameter a values, higher productivity relates to higher standard product quality. Rewriting the expression for standard quality in price equivalent units, the quality-adjusted marginal cost of production becomes w_s/φ, which is decreasing in firm's productivity level.[14]

Relationship specific appeal is generated from personal interactions between trade partners.

[13] To guarantee a finite mean for the distribution of firm revenues, the following must hold: $\kappa > max\left(1, \frac{\sigma-1}{1-\theta_h}\right)$.

[14] These quality production features follow recent studies (Kugler-Verhoogen, 2008; Baldwin-Harrigan, 2008).

Face-to-face meetings (by generating relationship capital such as trust, reciprocal commitment, information sharing), can improve a trade transaction and add value to the exported varieties. These benefits are partnership-specific.[15] The technology to transform business meetings into relationship-specific product appeal is assumed to take the form:

$$\lambda_{sjh}(\varphi) = \left[i_{sjh}(\varphi)\right]^{\theta_h}, \qquad \theta_h \in [0,1) \tag{4}$$

where $i_{sjh}(\varphi)$ denotes the interaction within a buyer-seller link obtained through costly travels, and θ_h is a parameter that captures the importance of in-person meetings for trade in sector h. A large value of θ_h implies high returns to relationship investments because it indicates a high scope for transaction improvements and/or a high willingness of buyers to trade with familiar suppliers. Setting θ_h to be less than one ensures a well-behaved optimization problem.

Firm profits. A firm with productivity φ in sector h and region s that exports to j earns:

$$\pi_{sjh}(p_{sh}, i_{sjh}, \varphi) = \left[p_{sh}(\varphi) - w_s\varphi^{-a}\right]x_{sjh}(\varphi, i_{sjh}) - c_{sh}i_{sjh}(\varphi) - F_{sjh} \tag{5}$$

where in equilibrium x_{sjh} is given by (2), and takes as arguments $\lambda_{sh}(\varphi)$ and $\lambda_{sjh}(\varphi)$ (by eq. (3)).[16]

A couple of points should be noted. First, the business travel costs $c_{sj}i_{sjh}(\varphi)$ measures the investment in relationship capital a firm is willing to make in order to increase buyers' valuation for its products via λ_{sjh}. The fixed nature of the costs implies that once in-person meetings are carried out, the resulting benefits can be costlessly embeded in each unit sold. The assumption that a product's relationship-specific appeal does not require per unit costs keeps the model centered on the fixed cost nature of business travels. Second, trade costs differ across markets because of the two-part fixed cost (c_{sj}, F_{sjh}) and the variable shipping cost (τ_{sj}).

2.2 Firm's Problem

Differentiated good producers must first decide which markets to enter. Then, in each selected market, they must choose how much interaction i_{sjh} to have with foreign trade partners and the

[15] Firm surveys highlight various explanations for why face-to-face communication benefits business transactions. My intention here is to accommodate these channels rather than try to distinguish between them.

[16] Here, I have implicitly assumed that business trips incurred at travel cost c generate personal interaction i at a rate normalized to one. Therefore, choosing the amount of interaction i is equivalent to deciding the number of business trips/meetings.

price to charge for their exported varieties. With no uncertainty in the model, the decisions about the product price and interaction level are assumed to be simultaneous. The first order conditions from the firm's profit maximization problem leads to:

$$p^*_{sjh}(\varphi) = \frac{\sigma}{\sigma - 1} w_s \varphi^{-a} \tag{6}$$

$$i^*_{sjh}(\varphi) = \left(\frac{\theta_h}{\sigma c_{sj}} \varphi^{\sigma-1} B_{sjh} \right)^{\frac{1}{1-\theta_h}}, \qquad B_{sjh} \equiv \left(\tau_{sj} \frac{\sigma}{\sigma - 1} w_s \right)^{1-\sigma} \frac{\mu_{jh} Y_j}{P_{jh}} \tag{7}$$

$$r^*_{sjh}(\varphi) = p_{sjh}(\varphi) x_{sjh}(\varphi) = \left[\left(\frac{\theta_h}{\sigma c_{sj}} \right)^{\theta_h} \varphi^{\sigma-1} B_{sjh} \right]^{\frac{1}{1-\theta_h}} \tag{8}$$

$$\pi^*_{sjh}(\varphi) = \left(\frac{1-\theta_h}{\sigma} \right) r^*_{sjh}(\varphi) - F_{sjh} \tag{9}$$

B_{sjh} captures the import demand level in market j for products in region s; $r^*_{sjh}(\varphi)$ and $\pi^*_{sjh}(\varphi)$ denote the optimal revenues and profits for a firm with productivity φ. Equation (6) shows that the export price follows the monopoly pricing rule; i.e., constant mark-up over marginal cost. Since travel costs are fixed rather than per-unit costs, their level has no effect on prices.

Conditional on the CES price index, equation (7) leads to the following proposition.

Proposition 1 *The optimal interaction level between an exporter and foreign buyer is positively related to the productivity of the firm (φ), the size of the destination market ($\mu_{jh} Y_j$) and the relationship intensity of the differentiated good sector (θ_h); it is negatively related to the "iceberg" trade cost (τ_{sj}), and the elasticity of substitution between varieties (σ).*[17]

Proof: See Appendix A.1.

The intuition behind Proposition 1 goes as follows. Traveling to foreign markets to meet trade partners is costly; however its fixed cost nature allows exporters to take advantage of the capital built from personal interactions, and use it costlessly to enhance the valuation of each unit shipped to that market. This leads to higher export profits from larger sales per buyer. As a result, countries with large market potential, either because of economic size (large $\mu_{jh} Y_j$), geographical proximity (low τ_{sj}) or reduced competition (low σ), provide scope for relationship-specific investments. In fact, the market potential of a foreign destination acts as an income shifter in the demand for in-person business meetings, affecting the level of buyer-seller interactions at any travel cost c_{sj}.

[17] The effect of the elasticity of substitution on the level of information transmission requires that the quality-adjusted delivery prices are no less than unity.

The importance of the trade relationship intensity parameter θ_h becomes transparent in equation (7). When θ_h is equal to zero, the incentives for market-specific product differentiation disappear due to identical product valuations across world markets (i.e., $\lambda_{sj} = 1$). As a result, the optimal amount of interaction within a trade pair becomes zero as well. This particular case corresponds to the quality heterogeneous firms model of trade with identical CES preferences, and provides a natural alternative to the relationship-driven product differentiation hypothesis.

Dividing equation (7) by (8), it follows that for each exporting firm the share of traveling costs in variable profits is equal to the sector level relationship intensity. Re-arranging, this becomes:

$$c_{sh} i^*_{sjh}(\varphi) = \theta_h \frac{r^*_{sjh}(\varphi)}{\sigma} \tag{10}$$

Equation (10) depends only on observables and provides a key testable implication of the model. If θ_h is zero, then export revenues should not be related to the level of in-person business meetings.

2.3 Partial Equilibrium

To describe trade at the regional level, I proceed by solving for the selection of firms into export markets, which pins down the number of exporters and aggregate bilateral trade within a sector. I take as exogenous the import country equilibrium variables; i.e., the CES price index P_{jh} and income Y_j.[18]

Market entry. Not all firms in a region s and sector h can generate sufficient profits to cover the fixed costs of entering market j. Since firm revenue and profits are increasing in productivity, then there is a cut-off value $\overline{\varphi}_{sjh}$ such that $\pi^*_{sjh}(\overline{\varphi}_{sjh}) = 0$. Using equation (9), it follows:

$$\overline{\varphi}_{sjh} = \alpha_1 \Big[B_{sjh} (c_{sj})^{-\theta_h} (F_{sjh})^{-1+\theta_h} \Big]^{1/(1-\sigma)} \tag{11}$$

with $\alpha_1 = \big[(1-\theta_h)^{1-\theta_h}(\theta_h)^{\theta_h}/\sigma\big]^{1/(1-\sigma)}$ a constant. All firms in sector h and region s with productivity above this threshold find it profitable to export to market j.

Aggregate Exports. Given the exogenous mass of potential entrants in each source region and the assumption of Pareto distributed productivities, one can use the threshold productivity

[18] Given the empirical focus on the intra-national geography of U.S. exports and international air travel flows, foreign production and third country trade are deliberately left in the background for expositional simplicity.

level $\overline{\varphi}_{sjh}$ to directly solve for the industry export level, X_{sjh}, and the equilibrium number of firms, N_{sjh}, as functions of the trade cost variables, the CES price index and income in market j. Sector level exports are obtained by summing firm export revenues across all active firms: $X_{sjh} = M_s \int_{\overline{\varphi}_{ijh}} r_{sjh}(\varphi) dG(\varphi)$. Solving for it leads to:

$$X_{sjh} = \alpha_2 M_s \left(\frac{\mu_{jh} Y_j}{P_{jh}}\right)^{\frac{\kappa}{\sigma-1}} (\tau_{sj} w_s)^{-\kappa} \left(\frac{F_{sjh}}{c_{sj}}\right)^{\frac{\theta_h \kappa}{\sigma-1}} (F_{sjh})^{1-\frac{\kappa}{\sigma-1}} \tag{12}$$

with $\alpha_2 = \left[\left(\frac{1-\theta_h}{\sigma}\right)^{\frac{\kappa(1-\theta_h)}{\sigma-1}} \left(\frac{\theta_h}{\sigma}\right)^{\frac{\theta_h \kappa}{\sigma-1}\theta_h} \left(\frac{\sigma}{\sigma-1}\right)^{-\kappa} \frac{\kappa\sigma}{\kappa(1-\theta_h)-\sigma+1} \right]$ a constant.

Number of exporters. The number of exporters is equal to the mass of firms that earn non-negative profits: $N_{sjh} = M_s \int_{\overline{\varphi}_{sjh}} dG(\varphi) = M_s \big(1 - G(\overline{\varphi}_{ijh})\big)$. After substituting for the productivity threshold using equation (11) and solving for N_{sjh}, it is straightforward to verify that the following holds:

$$N_{sjh} = \left(\frac{\kappa(1-\theta_h) - \sigma + 1}{\kappa\sigma}\right) \frac{X_{sjh}}{F_{sjh}} \tag{13}$$

This shows that aggregate fixed costs, $N_{sjh} F_{sjh}$, represent a constant fraction of bilateral exports.

2.4 Testable Implications

Equation (10) suggests a strategy to empirically examine whether business travel enters as an endogenous input to trade in complex manufactures. It consists of estimating the derived demands for in-person meetings between trade partners. To match the level of aggregation in the data (i.e., U.S. region by foreign country), the firm level predictions for the optimal interaction within a buyer-seller link must be aggregated across exporters within a sector and then across sectors within a trade pair. Integrating equation (10) across firms, the demand for business meetings at sector level I_{sjh} is given by:

$$I_{sjh} = M_s \int_{\overline{\varphi}_{ijh}} i^*_{sjh}(\varphi) dG(\varphi) = \frac{\theta_h}{\sigma c_{sj}} X_{sjh} \tag{14}$$

where X_{sjh} represents total exports from region s to destination j in sector h given by equation (12). These sector level demands are then aggregated across all the differentiated goods traded within a region - country pair. Factoring out bilateral exports X_{sj}, I decompose the effect of trade on the aggregate level of business meetings I_{sj} into a scale and a composition effect:

$$I_{sj} \equiv \sum_h I_{sjh} = \frac{X_{sj}}{\sigma c_{sj}}\big(\sum_h \theta_h z_{sjh}\big), \qquad X_{sj} \equiv \sum_h X_{sjh}, \qquad z_{sjh} \equiv \frac{X_{sjh}}{X_{sj}} \tag{15}$$

This expression can now be easily mapped into the available data and provides the main empirical prediction of the model. It identifies the key factors that determine the aggregate demand for in-person meetings incurred for trade-related purposes: conditional on the unit travel cost c_{sj}, both the scale (X_{sj}) and the composition of exports ($\sum_h \theta_h z_{sjh}$) in terms of relationship intensive products have direct effects on the level of business meetings. Equation (15) shows in fact that the firm level predictions regarding the optimal level of buyer-seller interactions (i.e., equation (10)) are preserved in the aggregate. The positive relation between export composition and business travel demands can then be used as an empirical test for the proposed model. Had it been the case that the relationship capital generated from interactions among trade partners is not a valuable input to trade, i.e., $\theta_h = 0 \; \forall h$, then export composition should have no effect on observed air travel flows.

To understand the driving forces behind the export composition term, it can be written as:

$$\sum_h \theta_h z_{sjh} = H cov(\theta_h, z_{sjh}) + \overline{\theta} \tag{16}$$

where H is the total number of sectors and $\overline{\theta}$ is the average trade relationship intensity of all sectors. The main source of variation in the export composition term is then given by the proportion of trade that takes place in industries that are dependent on intensive communication – i.e., the covariance between θ_h and sector h export share, z_{sjh}. This implies that business meetings must be more frequent between regions that trade a higher fraction of differentiated goods.

2.5 Discussion

Before going to the data, it is informative to consider the specificity of the derived theoretical predictions. That is, one would like to know if an alternative framework could similarly relate the scale and composition of exports to the volume of business travel in the aggregate. In particular, it could be the case that even though firms incur fixed export costs in the form of travels to export markets, the established buyer-seller networks do not translate into increased valuation for the traded goods (i.e., $\lambda_{sjh} = 1\,\forall h$). This would correspond to a heterogeneous firms model of trade as in Chaney (2008), but where the fixed cost of exporting (F_{sjh}) involves an exogenous amount of interaction among trade partners ($\bar{i}_{jh}$) that is imposed on all firms in a sector. Formally, this alternative set-up implies making the following assumptions:

$$\theta_h = 0 \qquad \text{and} \qquad F_{sjh} = c_{sj}\bar{i}_{jh}, \quad \forall h \tag{17}$$

By setting θ_h equal to zero, firms are now deprived of any gains generated by improved trade relationships, and so in equilibrium choose not to additional spend resources on buyer-seller interactions (i.e., $i^*_{sjh} = 0\,\forall h$). A key difference now is that the export revenues of infra-marginal firms are independent of the level of interaction among trade partners (unlike equation (8)). It is only the number of exporters (N_{sjh}) that responds endogenously to the fixed cost level $c_{sj}\bar{i}_{jh}$. To see this, combine the assumptions given by (17) with equation (13) to get:

$$I_{sjh} \equiv N_{sjh}\bar{i}_{jh} = A\frac{X_{sjh}}{c_{sj}}, \qquad A \equiv \frac{\kappa - \sigma + 1}{\kappa\sigma} < 1/\sigma \tag{18}$$

Equation (18) shows that while a significant effect of export volumes on business meetings is consistent with travel costs representing fixed export market entry costs, it does not identify the nature of these costs – exogenous or endogenous to the firm. Another insight is that now the industry parameter A must be directly controlled for in the empirical exercises to ensure that the effect of exports composition on the aggregate demand for face-to-face meetings is not the artifact of the firm extensive margin. Since the industry level parameter A combines features about market structure and degree of competition, I do so by relying on available measures of industry concentration, in particular the Herfindahl -Hirschman Index (HHI), which is inversely related to the industry structure parameter A (see the Theory Appendix A.2 for a formal derivation). Intuitively, when a sector is characterized by a large A parameter – either because of a large variance in firm productivities (i.e., low κ) or because of a high degree of substitution across products (i.e., large σ) – then there is a large dispersion in firm revenues and more of the industry's output is concentrated among a few big firms, resulting in a large industrial concentration level. Thus, in the empirical analysis I control for the average industrial structure parameter A using the (trade share) weighted average concentration index, which is constructed in the same way as the export composition term from data on industry Herfindahl -Hirschman Index (HHI):[19]

$$HHI_{sj} = \sum_h HHI_h z_{sjh}, \qquad z_{sjh} = X_{sjh}/X_{sj} \tag{19}$$

The effect of HHI_{sj} on aggregate business meetings I_{sj} depends on the covariance across sectors between concentration HHI_h and export shares z_{sjh}. When a larger fraction of exports falls in sectors with high elasticity of substitution and/or high variance in firm productivities (both of which imply a low A), or in sectors with high fixed export costs, then the average concentration of exporting industries has a negative impact on the total volume of business meetings.[20]

3 Data Sources and Variable Construction

In testing the hypothesis that in-person business meetings are directly related to trade in complex manufactures, a key consideration in the choice of data is the ability to clearly identify the link between exports and business travel from spurious correlation. This paper employs data at the U.S. state level and exploits a novel source of exogenous variation: intra-national geography. By comparing the spatial distribution of exports and business travel within the U.S. by foreign country, I rely entirely on cross-state variation to identify the effects.

As a direct measure of in-person buyer-seller meetings, I use data on international business-class air travel from the Databank 1B (DB1B) Passenger Origin-Destination Survey, provided by the U.S. Department of Transportation. The DB1B database is a quarterly 10% sample of domestic and international airline tickets. Each sampled ticket contains information on the full flight itinerary at airport detail, the number of passengers traveling, the airfare paid, distance traveled, and a set of characteristics specific to each flight segment, class type being among them. I remove from the dataset all domestic itineraries, and distinguish the remaining international tickets based on class type (economy, business) and direction of travel (inbound, outbound).[21] For the most part,

[19] The Herfindahl-Hirschman Index depends not only on the parameter A, but also on the fixed cost of selling in the domestic market (see Appendix A.2.). So, sectors with identical industry structure parameter A may have different HHI when fixed costs vary across sectors.This has implications for the empirics, since it suggests that the variation in the weighted average HHI may reflect differences in A, or differences in fixed costs across sectors, or both.

[20] See the online appendix for a more detailed discussion on the relation between fixed costs, export shares and industry concentration.

[21] Since the ticket class is reported for each flight segment of an itinerary, I define as business class any ticket that

I restrict attention to U.S. outbound air travel flows (to be consistent with the direction of trade flows) but use inbound flows for robustness checks. I collapse the original ticket level data by class type and direction of travel to obtain measures of the total number of travelers, average airfare and average flight distance at the state-country-year level.[22] The details on the sample construction are relegated to the Data Appendix.

One limitation of the DB1B air travel dataset is the sample coverage. The air carriers that report ticket level information to the US Department of Transportation (DOT) are domestic airlines and foreign carriers with granted antitrust immunity. As a result, the constructed bilateral air travel flows are measured with error and the likelihood of under-representation is not uniform across bilateral pairs, being potentially greater for dense aviation routes involving large US gateways. While the origin and destination fixed effects employed in the empirical exercises account for a significant part of this miss-measurement, I will directly address this sampling limitation in the robustness exercises.[23]

The state level export data by destination country is provided by the US Census Bureau. In the Origin of Movement series (OM), exports are reported based on the state where the export journey begins, which for manufactured goods represents "the closest approximation to state of production origin".[24] For this reason I restrict attention only to manufacturing exports, which are classified by three-digit NAICS codes into 21 industrial sectors.

A key variable for the model's prediction is the composition of trade in terms of relationship intensive goods. To construct this measure, I take Rauch's (1999) "liberal" classification of goods and map it into 3-digit NAICS sectors using a concordance available at NBER and provided by Feenstra and Lipsey. I calculate (by simple counting) the fraction of differentiated goods in each 3-digit NAICS sector, and use this value as a proxy for θ_h – the sector level relationship intensity of trade. Then, I compute the degree of differentiation of manufacturing exports using the index: $\sum_h \theta_h X_{sjht}/X_{sjt}$ from equation (15), with h representing a 3-digit NAICS sector.

In the original datasets, both travel and trade flows are observed at US state level; however,

has a distance-weighted average share of business or first class segments greater than one half.

[22]The fare and distance averages are computed using passenger-weights.

[23]For a subset of city-pair international aviation routes, I compare the air travel flows from the DB1B dataset with those constructed from a representative firm level dataset (T100 Market dataset provided by the U.S. DOT). I find evidence that the mis-measurement in the DB1B sample is much reduced after controlling for origin and destination fixed effects. See the online data appendix for details.

[24]www.wisertrade.org. Cassey (2006) also describes the OM state exports data and its limitations.

states are geopolitical units that are delimited independently of the more dynamic aviation network. To account for the fact that large U.S. gateway airports might serve out-of-state passengers as well, I cluster the contiguous US states into 17 regions based on their proximity to the nearest large hub or gateway airport. Table A1 in the Appendix provides the allocation of states to regions. Exports and air passenger flows are first aggregated at region by destination country level, and then merged into a single dataset.[25] The resulting sample is an unbalanced panel covering 93 foreign countries (Appendix Table A3) over the period 1998-2003.[26] Table 1 Panel A reports the sample summary statistics.

The empirical exercises use several control variables available at the state level from the following sources. Data on foreign-born population by state by origin of birth is provided in the 2000 Decennial US Census. Gross state product (GSP) and employment in foreign affiliates by country of ultimate beneficiary owner are taken from the Bureau of Economic Analysis. Country GDP data is taken from the World Development Indicators. Finally, data on Herfindahl-Hirschman Index (HHI) based on shipment values of the 50 largest firms within each 3-digit NAICS sector is available from the 2002 Economic Census.[27]

Given the importance of the intra-national geographical dimension of the data, it is useful to examine the cross-state variation in trade patterns and understand the extent to which U.S. regions differ in the scale and specialization of manufacturing exports. Panel B of Table 1 reports the variance decomposition of the regional manufacturing exports into source, destination and time specific effects. Most of the variation in exports comes from differences across importing countries, which is not that surprising. Everything that causes variation in U.S. exports to, for example, China versus Costa Rica - including economic size, development level, comparative advantage or trade barriers - is captured in the destination country effect. What is interesting however is the fact that the residual variation in exports, which includes the value attributed to a high quality transaction (as modeled in the theory), is similar in magnitude to the variation in regional exports

[25] A significant number of bilateral pairs are dropped while creating the estimation sample; however they correspond to very small trade flows (see Appendix Table A2). The resulting dataset accounts for 99% of total US manufacturing exports.

[26] The sample period includes 9/11, a shock to which both the aviation and trade flows have reacted heavily and differentially across countries. However, the country-time fixed effects included in the empirics reduce the potential for spurious correlation generated by the 9/11 shock.

[27] Similar to the export composition index, I construct the average concentration index of trade as: $\sum_h HHI_h(X_{sjh}/X_{sj})$, where h denotes a 3-digit NAICS sectors.

arising from comparing, for example, New York and California to Rhode Island and North Dakota. Put differently, the residual variation in exports is comparable to the variation in manufacturing exports caused by such differences as size, factor endowments or average productivity. The empirical exercises from the next section will reveal if the residual variation in state exports is systematically related to business travel flows.

Further, I examine whether U.S. states differ in their specialization in manufacturing exports (the main source of variation in the composition of exports across regions). For this, I compute the measure: $\frac{X^h_{region}}{X^h} \Big/ \frac{GDP_{region}}{GDP}$, which represents a region's export share in total industry exports normalized by the region's size share in U.S. GDP. This index captures the degree of concentration of industry exports across U.S. regions. If within each sector, exports are distributed across regions in proportion to the regions size (i.e., index is one), then this implies the absence of any specialization patterns across US regions. Panel C of Table 1 reports the summary statistics of the normalized region level export shares across industries. The significant dispersion in the concentration index (e.g., coefficient of variation is 0.98) is indicative of a strong cross-regional specialization in manufacturing exports.

4 Empirical Analysis

The empirical analysis of this section proceeds in three steps. First, I provide empirical evidence that international travel is an input to trade across national borders. Second, I establish that the direct relation between international business travel and trade flows is robust across specifications, i.e., not driven by common covariates, sample construction or a particular subset of import countries. Third, I estimate the face-to-face communication intensity of trade across manufacturing sectors and show that the estimates vary systematically with external measures of product complexity.

4.1 Model Specification and Baseline Results

Taking logs of the aggregate demand for business meetings given by equation (15), and adding time subscripts consistent with the panel nature of the data, one obtains the following regression:

$$lnI_{sjt} = \beta_1 lnc_{sjt} + \beta_2 lnX_{sjt} + \beta_3 ln\Big(\sum_h \theta_h z_{sjht}\Big) + \epsilon_{sjt} \quad (20)$$

where s, j, and t index U.S. regions, foreign destination countries and years, respectively. I_{sjt} is measured by the number of outbound business-class air passengers traveling from region s to country j, c_{sjt} is measured by the average business class airfare, X_{sjt} is the total manufacturing exports, and the export composition term $\sum_h \theta_h z_{sjht}$ is proxied by the average share of differentiated manufactures in total exports.

Given the hypothesis that business travel is an input to trade in complex manufactures, the theory predicts that controlling for unit information costs, the volume and composition of exports should have a positive and significant effect on the demand for business-class air travel: i.e., $\beta_2 > 0$ and $\beta_3 > 0$. Intuitively, if in-person business meetings are necessary in international transactions, then one should observe a match between regions' specialization in relationship intensive goods and their demand for international business travel. Under the alternative hypothesis when $\theta_h = 0 \ \forall h$ (which corresponds to the case where international trade is not mediated by face-to-face meetings or when such travel costs are exogenous across categories of goods), the composition of exports should not be related in a systematic way to observed business-class air travel flows, i.e., $\beta_3 = 0$.

One challenge in performing these hypotheses tests is to ensure that the estimates reflect the true relation between air passenger traffic and international trade, and not some spurious correlation driven by cross-country differences. To make this clear, take as an example population size and per capita income level: these two variables are frequently used in gravity equation models of trade, but at the same time they are considered key determinants of air passenger traffic in empirical industrial organization studies.[28] Undoubtedly, the set of variables that affect both air travel and trade flows in the aggregate is extensive, including factors like geography, quality of infrastructure, development level or patterns of industrial specialization. To eliminate any sources of spurious correlation or endogeneity coming from cross-country differences, I include in the regression model importer-year fixed effects.[29] Similarly, I use region dummies to account for any systematic differences across export regions, and add the region GDP level to control for source-specific trends.

Re-labeling the variables in terms of the corresponding observables, and adding the matrix Z of bilateral controls, region and foreign country-year fixed effects (α_s and α_{jt} respectively), the

[28]See for example Brueckner (2003) and Whalen (2007) among others.

[29]Since the exporting regions are within the same country, the fixed effects also absorb any time varying bilateral factors specific to the US-country j trade pair (e.g., exchange rates, bilateral agreements, cultural or historical ties).

baseline regression model becomes:

$$lnTrav_{sjt} = \beta_1 lnFare_{sjh} + \beta_2 lnX_{sjt} + \beta_3 lnComp_{sjt} + \beta_4 lnGDP_{st} + Z\beta + \alpha_s + \alpha_{jt} + \epsilon_{sjt} \quad (21)$$

The model identification relies on two sources of variation: one coming from the intra-national location of U.S. manufacturing firms that export to destination j at time t (i.e., variation in *export volumes* across origin s for a given (j,t) pair), and the other coming from differences in the specialization of US states in terms of complex, relationship-intensive manufactures (i.e., variation in *export composition* across origin s for a given (j,t) pair).

Table 2 reports the estimates from the baseline model given by equation (21). The first column includes the OLS results. Since the regression model is a demand equation, airfares are endogenous to air travel flows. Column 2, and all the following estimations in this paper, instrument for air fares using the interaction between average flight distance and oil prices. Looking at the coefficients of interest, the volume and composition of manufacturing exports have positive and significant effects on the number of business travelers, confirming the prediction that the strength of buyer-seller interactions across trade partners depends on the value and complexity of exported products. The results reported in column 2 suggest that a one percent increase in total exports raises the demand for business -class air travel by 0.24 percent. An increase in export composition as measured by the average share of differentiated goods in trade further raises the demand for business class air travel by 0.16 percent.

While extensive in coverage, the structure of origin and destination-time fixed effects does not account for all potential sources of spurious correlation. In particular, it does not control for omitted variables that have state s by destination j variation, of which ethnic networks are the main candidate. Rauch and Trindade (2002) provide evidence that ethnic networks facilitate international trade, with larger effects for trade in differentiated goods. It is reasonable to think that ethnic networks also determine the volume of international air travel services demanded for consumption purposes. To account for this, I add the size of foreign-born population in U.S. region s that originates from country j to the baseline regression. The results are reported in the third column of Table 2. Controlling for the strength of ethnic networks reduces the effect of the volume and composition of exports, but the coefficients remain positive and highly significant.[30]

Finally, column 4 of Table 2 includes the average Herfindahl-Hirschman index (HHI) across exporting sectors as a control for the alternative, extensive margin channel linking business travel and international trade. Consistent with expectations, industrial concentration has a significant and negative impact on the number of business-class air travelers conditional on total exports. More importantly, the positive effect of export composition on the number of travelers survives the inclusion of HHI. In what follows, I will refer to this specification as the preferred regression model.

Overall, the results reported in Table 2 support the proposed theory framework, providing empirical evidence for the hypothesis that in-person meetings are a valuable input in international trade. Conditional on travel costs, exporters that produce complex manufactures and face large foreign demands invest more in establishing networks and close relationships with foreign partners.

One might be concerned that the export variables are endogenous in the baseline specification, either because of direct correlations with the residuals in the business-class air travel demand equation, or because of reverse causality.[31] However, it is important to emphasize that the data employed and the econometric specification are instrumental in effectively reducing the incidence of endogeneity. The significant exogenous variation in industrial specialization and agglomeration patterns across the U.S. states induces (at least to some degree) orthogonality in the volume and composition of exports.[32] In addition, the extensive set of control variables already included, as well as the fixed effects, directly account for the most relevant sources of endogeneity: for example, economic size, development level, quality and growth rate of infrastructure, shocks to average income or productivity levels, location and access to world markets, just to name a few.[33] Therefore, if there still are factors that make the volume and composition of exports correlated with the regression residuals, then in theory they must have source s by country j variation and

[30] In unreported results available upon request, I have experimented with other measures of ethnic and social networks, such as the interaction between the size of foreign-born population in region s originating from country j and linguistic or religious distance between the U.S. and country j. Data on cultural distance is available from Gordon and Xiang(2010). Results are very similar with those reported in column 3 of table 2.

[31] Reverse causality occurs whenever the regression residuals include factors that are orthogonal to export flows but systematically shift the air travel demand; these shifts in business-class air travel in turn induce changes in export flows, leading to endogeneity. Reverse causality is directly suggested by the theory, since exports are a direct function of in-person meetings. Thus, exogenous factors that shift the air travel demand, implicitly affect exports as well.

[32] The location of economic activity across the U.S. is decided to a large degree independently of the more flexible and more dynamic air traffic network. Factor endowments, geography, historical events that trigger industrial clustering and specialization, all are motives that support this orthogonality assertion.

[33] Other sources of endogeneity that are controlled by the destination-country fixed effects are: exchange rate shocks, price of substitutes to air travel (e.g. phone call rates, internet), bilateral country-level policy factors.

be uncorrelated with the other bilateral controls, i.e., air transport costs and ethnic networks.

4.2 Additional Covariates and Sensitivity Analyses

In what follows, I directly control for such bilateral covariates to eliminate any remaining endogeneity in the model.[34] I proceed by accounting first for omitted variables that are correlated with both travel and trade flows. Then, I account for variables that are only correlated with air travel flows, but need to be explicitly pinned down so that their systematic variation is separated from the residual variation in business-class travel to eliminate the reverse causality effect.

There are two additional channels that generate contacts across international markets and could be responsible for simultaneously increasing travel and trade: horizontal FDI inflows and international leisure travel. Suppose for example that the affiliates of foreign owned multinational firms locate next to U.S. exporters and that the demand for business air travel comes exclusively from foreign affiliate executives. Since horizontal FDI plants produce mainly for the domestic market, the correlation between business air travel and exports could simply be an artifact of the co-location of exports and inbound FDI across U.S. regions. In a similar manner, suppose that a fraction of the observed business-class air traffic comes from personal consumption of high-end travel services. Many US trade partners also provide attractive tourism destinations. If high-income consumers predominantly live in export oriented industrial regions, then the estimated relation between exports and business class air travel could be the result of omitted leisure travel. Therefore, I augment the baseline regression model using the size of inbound multinational networks, as measured by total employment in foreign owned affiliates across US regions, and the volume of international tourism services, as measured by the economy-class air travel. The results are reported in the first two columns of Table 3, with no qualitative change to the main model predictions.[35]

Next, I explicitly consider factors that directly affect the number of business-class air travelers flying for business purposes and that, if omitted from the air travel demand model could bias the

[34] The standard solution to endogeneity problems is instrumental variables. But since the variation in manufacturing exports is much reduced after accounting for origin region and destination country-time fixed effects, it becomes difficult to find valid exogenous instruments for exports without running into the problem of weak instruments.

[35] In column 1 of Table 3, the magnitudes of the coefficients change a lot, presumably due to the severely reduced sample size. The only countries with publicly available state level data on affiliate employment are: Australia, Canada, France, Germany, Japan, Netherlands, United Kingdom and Switzerland. Canada is omitted due to proximity to the US. Also, in column 2 of Table 3, foreign-born population was dropped from the regression due to multicollinearity issues. Because of that, as well as due to the common aviation industry shocks that affect both categories of air travel flows, the coefficient on the economy-class variables is larger in magnitude than most explanatory variables.

results via reverse causality effects. For example, consider the degree of airline competition on a given international aviation route, or the quality of travel services on that route (e.g. frequency of flights, network connectivity, etc). Such factors affect the demand for business-class air travel and indirectly influence the export decision of face-to-face communication intensive sectors, inducing an upward bias in the estimated trade coefficients. To control for such reverse causality effects, I include in the baseline model additional travel-related variables intended to pin down any remaining systematic shifts in the demand for business-class air travel realized in the scope of trade meetings. The first variable that I consider is an indicator for the availability of direct flights connecting a US region and foreign destination country. The third column of Table 3 reports the results. Compared to the preferred baseline specification (Table 2 column 4), the coefficients of interest are slightly smaller – consistent with the reverse-causality hypothesis – but remain positive and highly significant. This is true even when interacting the direct flight indicator with exporting region-year dummy variables. This specification, reported in column 4, is intended to capture any dynamics in the introduction of direct flight services and also any time-varying region specific factors. Further, to account for differences in competition and market structure across international aviation route, I interact an indicator for selected US regions that host major international gateway airports with destination country dummies.[36] The estimates are reported in column 5 of Table 3. The coefficient for the composition of exports decreases in magnitude and is only weakly significant, consistent with the observation that the US regions that host international gateway airports are also responsible for most of the production in differentiated manufactures. Finally, for the subsample of U.S. region-foreign country pairs that are served by direct flights, the U.S. Department of Transportation provides additional data on the number of departures operated annually on each of those aviation routes. Using flight frequency as a proxy for the quality of bilateral air travel services, Column 6 reports the results from including the number of departures in the baseline regression, while column 7 accounts for the interaction between flight frequency and region-year dummies.

Overall, the augmented regressions estimated in Table 3 mitigate the endogeneity problem of exports by extracting systematic variation from the residual business class air travel demands, but do not overturn the expected sign and significance of the variables of interest. However, one

[36]The regions considered major international gateways are those corresponding to the following states: California, New York, New Jersey, Illinois, Florida and Georgia. On average, these regions account for half of the entries and exits into the US by air.

should be cautious here in inferring any causality from these results. Rather, the analysis should be taken as evidence for a strong correlation between business class air travel and trade flows that is larger for complex manufactures.

Next, I perform several robustness exercises to address any mis-measurement in the business-class air travel variable and also to verify the stability of estimates across subsamples. In the data section, I describe the under-representation problem in the constructed business class air travel flows. If the fraction of bilateral air traffic that is omitted during the data sampling process is not captured by the control variables or by the regression fixed effects, then this could lead to biased estimates. However, if this percentage share of omitted air traffic does not differ by ticket class type (say because of similar load factors across the air carriers in a market), then the ratio of business to economy class travel should completely remove any bilateral-specific mis-measurement in the data. So, I re-estimate the baseline model using the demand for business relative to economy class travel as the dependent variable, and report the results in column 1 of Table 4. Even though the coefficients change in their interpretation, as they now capture variables' effects on the relative demand for business class air travel, the results confirm previous findings that the scale and composition of exports have a significant and positive impact on business-class air travel.

The remaining columns of Table 4 examine the stability of the coefficients of interest on various sub-samples. The coefficients in column 2 are obtained after eliminating all the bilateral pairs involving Canada or Mexico due to their proximity to the US. However, there is little change in the coefficients of interest. Columns 3 and 4 report the estimates from the subsample of high and low income countries respectively, and provide evidence that the results are not driven by a subset of U.S. trade partners.[37] Finally, in the last two columns of Table 4 I re-estimate the preferred model on the sample of inbound business-class travelers and a combined sample of inbound and outbound travelers respectively, and show that the main results are not particular to the directional travel.[38] Overall, the results from the robustness exercises reported in Table 4 are consistent with the theoretical predictions and strengthen the findings from the baseline regression model.

[37] Countries with per-capita GDP above the sample median are considered high income, and the rest low income.

[38] In the combined sample, the number of business class passengers is computed as the sum of inbound and outbound travelers, while the airfare is computed as simple average between inbound and outbound airfares.

4.3 Face-to-face Communication Intensity of Trade across Sectors

In this subsection, I investigate in which manufacturing sectors trade is more dependent on buyer-seller interactions via face-to-face communication. To do that, I exploit the level of disaggregation in the US export data (21 manufacturing sectors) and estimate the responsiveness of business class air travel flows to industry level exports. Using the baseline specification given by equation (21), I allow the sector level export shares to take different slope coefficients:[39]

$$lnTrav_{sjt} = \beta_1 lnFare_{sjh} + \beta_2 lnX_{sjt} + \sum_h \delta_h lnz_{sjht} + \beta_4 lnGDP_{st} + Z\beta + \alpha_s + \alpha_{jt} + \epsilon_{sjt} \quad (22)$$

where z_{sjht} denotes the export share of sector h in total manufacturing exports from region s to destination country j. The coefficients δ_h proxy for the relationship intensity of exports in the H manufacturing sectors. Their identification relies on the observed patterns of specialization across US state exports. More precisely, the sector specific slope coefficients are identified from variation across US regions in the share of sector h in total manufacturing exports shipped to a given destination j. It is useful to note that including all sector export shares in the same regression reduces the potential for spurious correlation induced by the co-location of industries with different face-to-face communication intensities. However, this also has a drawback in terms of dealing with industry level export shares that are zero or missing. Since a missing value in one sector compromises the use of the entire vector of trade shares corresponding to a bilateral data point, I remove the region-country pairs that have positive trade in fewer than 75 percent of sectors; and for the remaining pairs I replace the missing values for the sector export shares z_{sjht}, with corresponding average values computed over all regions that export in that same sector, year and destination market, i.e. $\left(\sum_s lnz_{sjht}\right)/S$.[40] Given the use of country-year fixed effects in the regression, this econometric imputation should induce no bias on the estimates.

Table 5 reports the results. Looking across the sector level coefficients that are positive and significant, this confirms the insight that complex manufactures are the goods whose exports primarily rely on personal interactions between trade partners (Leamer and Storper, 2001). The most

[39] Had I observed industry level expenditures on international business travel by destination market, the empirical strategy would have required estimating the baseline regression model separately for each sector.

[40] By removing the region-country pairs that trade in fewer than 75 percent of sectors, I lose about 25 percent of the initial sample. I have experimented with lower cutoff values, and the results do not change qualitatively.

relationship intensive sectors are Machinery, Computer & Electronic Products and Miscellaneous Manufactures. To verify the robustness of the estimates, I compare the obtained relationship intensities of US exports with external measures of product complexity, such as R&D expenditure shares (reported by NSF), contract intensities computed by Nunn (2007), and Rauch's (1999) goods classification. All the indicators are adjusted by simple average to conform with the available 3-digit NAICS disaggregation level. Table 6 reports the correlation coefficients between the information intensity estimates and the selected measures of product complexity. All the coefficients have the expected sign and are generally significant. The information intensity estimates get the best match with the R&D intensity of manufacturing sectors, but they also align well with the two other indicators. This finding suggests that exports of sophisticated manufactures, which require strategic inputs of unverifiable quality and whose sales require intensive search and matching, are the type of goods that are most dependent on face-to-face interactions. This gives further support to the hypothesis that business meetings are an input to trade in complex manufactures, and that they are essential for transferring non-codifiable knowledge.[41]

5 Conclusions

This paper examines the importance of in-person meetings as an input to trade in complex manufactures by formalizing an exporter's decision to undertake costly travel and meet with trade parters in foreign markets in exchange for higher export sales. Buyer-seller interactions are modeled as a fixed cost of trade and as a valuable input into the quality of a trade transaction, being endogenously decided by heterogeneous firms. Differences in goods dependence on face-to-face communication, in travel costs and foreign market potentials determine the optimal interaction level within a buyer-seller relationship. These predictions are strongly supported by US state level data on business class air travel and manufacturing exports over the period 1998-2003. From industry analysis, I also find that the estimated relationship intensities of trade are correlated with other measures of product complexity such as R&D shares, Nunn's contract intensity measure or Rauch's differentiation index. The empirical findings complement existing work on information barriers to trade and extend our understanding of the importance of face-to-face meetings in international trade. The

[41] This insight is encountered in regional economics (Gaspar and Glaeser, 1998) and information spillovers literatures (Jaffe et al., 1993; Audresch and Stephen, 1996).

results are also relevant for theories of outsourcing and task trade, which place an increasing role on complex information transfers and relationship-specific transactions.

Several implications emerge from this study. If information transferred via face-to-face meetings is an important input to trade in complex manufactures, then presumably the geographic concentration of international trade should be higher in such industries. Similarly, if intermediate goods are more likely to be accompanied by the delivery of tacit knowledge relative to final goods, then agglomeration forces should be stronger for trade in intermediates. All these suggest the potential to develop sharper links between information transmitted via personal interactions and the geography of trade.

Moreover, this study opens up important policy questions about existing restrictions imposed on international air travel. In light of this paper's evidence that business air travel can boost international trade, it becomes more important to understand the factors that inhibit air passenger traffic. For example, how restrictive are the international aviation market regulations and what is the impact of recent liberalization efforts? How large is the impact of visa programs on the demand for business travel? Such issues require close consideration and are left for future work.

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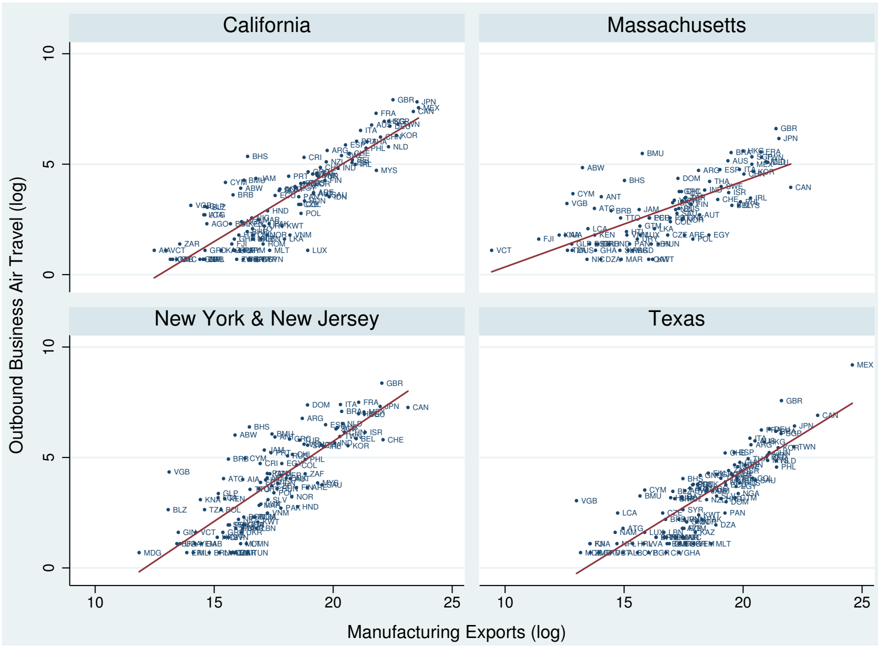
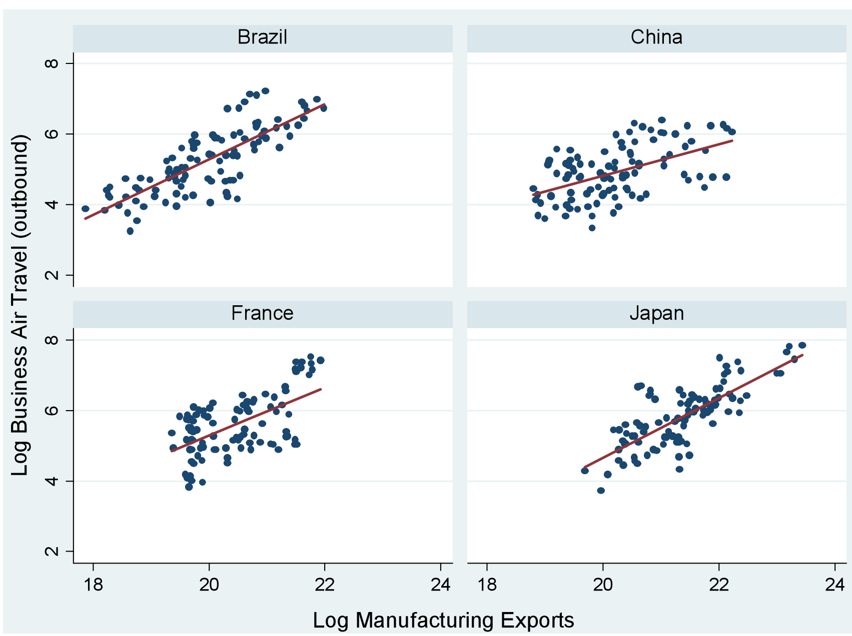
Figure 1: U.S. State Exports and International Business Air Travel (year 2000)



Data Sources: US Census for state exports; Department of Transportation for the air passengers

Figure 2: Intra-national Distribution of Exports and Outbound Business Air Travel by Destination Country



Data Sources: US Census for state exports; Department of Transportation for the air passengers

Table 1: Summary Statistics

Panel A - Variables in the Model

	No. obs.	Mean	Std. Dev.
Trade variables (from outbound sample)			
Total Exports (log)	7847	17.909	2.228
Composition Exports (log)	7847	-0.290	0.239
Herfindahl Index (log)	7847	5.117	0.436
Region GDP (log)	7847	13.149	0.521
Region GDP/capita (log)	7847	-3.393	0.103
Destination GDP (log)	7621	25.004	1.859
Destination GDP/capita (log)	7621	8.262	1.442
Foreign-born population (log)	7847	8.363	1.651
FDI employment (log)	779	8.917	1.171
Travel variables (US outbound)			
Business Travelers (log)	7847	3.064	1.802
Business Airfare (log)	7847	6.465	1.233
Economy Travelers (log)	7842	5.709	1.745
Economy Airfare (log)	7842	5.538	0.595
Business/Econ. Travel (log)	7842	-2.643	1.092
Ticket_dist * price_oil (log)	7847	12.653	0.659
Travel variables (US inbound)			
Business Travelers (log)	7531	2.829	1.801
Business Airfare (log)	7531	6.748	0.915
Economy Travelers (log)	7506	5.302	1.739
Economy Airfare (log)	7506	5.452	0.663
Business/Econ. Travel (log)	7506	-2.464	1.032
Ticket_dist * price_oil (log)	7531	12.765	0.632
Other			
Direct	7847	0.395	0.489
Departures (iff direct==1)	3098	4.775	3.195
Change variables			
Δ Log Business Travel (t, t-2)	4924	-0.211	0.602
Δ Log Airfares (t, t-2)	4924	-0.004	1.169
Δ Log Exports (t, t-2)	4924	0.049	0.584
Δ Log Export Composition (t, t-2)	4924	-0.007	0.161
Δ Log GDP orig. region (t, t-1)	4924	0.048	0.033
Δ Log GDP dest. country (t, t-1)	4783	0.072	0.187

Panel B - ANOVA Regional Manufacturing Exports

	Partial SS	Df	% explained
Origin region	4923.787	16	0.126
Destination country	29818.64	92	0.766
Year	29.5329	5	0.001
Residual	5884.722	7733	0.151

Panel C - Specialization across US states

	No. obs.	Mean	Std. Dev.
State shares in sector level US exports (normalized)	2142	0.971	0.933

Notes: Total exports includes only manufacturing exports. Export composition is calculated as the total share of trade in differentiated manufactures. Data on foreign born population is available only for year 2000. Data on foreign affiliate employment by state by ultimate beneficiary owner is available only for: Australia, Canada, France, Germany, Japan, Netherlands, Switzerland and UK. State export shares within 3-digit NAICS sectors are computed as $\frac{X^k_{state}}{X^k} / \frac{GSP_{state}}{GDP_{US}}$, where X denotes exports and k sector.

Table 2: Derived Demand for Business Travel (Baseline Specification)

	Dependent variable: Business Travel (log)			
	1 - OLS	**2 - IV**	**3 - IV**	**4-IV**
(Endogenous var.)		***(airfare)***	***(airfare)***	***(airfare)***
Airfare (log)	-0.033**	-0.140**	-0.084**	-0.083**
	(0.010)	(0.014)	(0.012)	(0.012)
Total Exports (log)	0.237**	0.240**	0.169**	0.182**
	(0.011)	(0.011)	(0.010)	(0.011)
Export Composition (log)	0.153**	0.164**	0.113**	0.125**
	(0.042)	(0.043)	(0.040)	(0.040)
GDP origin region (log)	0.566	0.678+	0.645+	0.633+
	(0.517)	(0.387)	(0.366)	(0.364)
Foreign-Born Pop. (log)			0.276**	0.274**
			(0.013)	(0.013)
Herfindahl Index (log)				-0.165**
				(0.023)
Country-year fixed effects	yes	yes	yes	yes
Region fixed effects	yes	yes	yes	yes
Region-year fixed effects	no	no	no	no
Observations	7847	7842	7842	7842
R-squared	0.605	0.595	0.637	0.640
First Stage (Dependent Variable: Log Airfare)				
Distance*Oil Price (log)		2.733**	2.811**	2.812**
		(0.053)	(0.054)	(0.054)
Total Exports (log)		0.215**	0.185**	0.191**
		(0.011)	(0.010)	(0.011)
Export Composition (log)		0.050	0.026	0.032
		(0.044)	(0.043)	(0.043)
GDP origin region (log)		0.571	0.570	0.565
		(0.377)	(0.373)	(0.373)
Foreign-Born Pop. (log)			0.138**	0.138**
			(0.012)	(0.012)
Herfindahl Index (log)				-0.077**
				(0.022)
First stage statistics				
Partial R2, 1st stage	n.a.	0.53	0.54	0.54
Partial F, 1st stage	n.a.	2645.34	2689.83	2691.09

$^{**}p < 0.01$; $^{*}p < 0.05$; $^{+}p < 0.1$ Robust standard errors are reported in parentheses.

Notes: The table contains the estimates of the baseline model given by equation (19) in the text.

Table 3: Derived Demand for Business Travel – Additional Covariates

	Dependent variable: Business Travel (log)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Airfare	-0.091*	-0.055**	-0.079**	-0.076**	-0.080**	-0.083**	-0.070*
	(0.046)	(0.011)	(0.012)	(0.012)	(0.012)	(0.028)	(0.027)
Total Exports	0.137**	0.120**	0.174**	0.164**	0.181**	0.220**	0.192**
	(0.044)	(0.009)	(0.011)	(0.010)	(0.010)	(0.018)	(0.017)
Export Composition	0.483**	0.152**	0.121**	0.116**	0.070+	0.171*	0.164*
	(0.099)	(0.036)	(0.040)	(0.036)	(0.038)	(0.070)	(0.067)
GDP origin region	0.071	0.567+	0.613+		0.616+	1.137+	
	(0.721)	(0.329)	(0.363)		(0.346)	(0.619)	
Foreign-Born Pop.	0.441**		0.257**	0.234**	0.249**	0.238**	0.218**
	(0.060)		(0.013)	(0.013)	(0.012)	(0.022)	(0.022)
Herfindahl Index	-0.153*	-0.130**	-0.166**	-0.153**	-0.117**	-0.223**	-0.194**
	(0.065)	(0.020)	(0.023)	(0.022)	(0.021)	(0.039)	(0.038)
Foreign Affiliate Employm.	0.120**						
	(0.031)						
Economy Travel		0.607**					
		(0.014)					
Direct Flight Indicator			0.166**	0.030			
			(0.020)	(0.158)			
Int'l Gateway*Country Ind.					0.093		
					(0.483)		
Number Departures						0.039**	0.039
						(0.006)	(0.031)
Direct*Region-Year Ind.	no	no	no	yes	no	no	no
Departures*Region-Year Ind.	no	no	no	no	no	no	yes
Observations	677	7836	7842	7842	7842	3037	3037
R-squared	0.819	0.718	0.644	0.668	0.678	0.675	0.717

$^{**}p < 0.01;^{*}p < 0.05;^{+}p < 0.1$. Robust standard errors are reported in parentheses.
Notes: The table contains robustness sand sensitivity exercises for the baseline model given by equation (19) in the text. All continuous variables are in logs. All specifications include region and country-year fixed effects, and instrument for airfares using distance*oil price (log). The countries with per-capita GDP above the sample median are defined as high income countries.

Table 4: Econometric Robustness and Sensitivity Analysis

Dependent variable:	Business/Economy Travelers (log)	Business Travelers (log)			Business Travelers (log)	
		All but NAFTA	High Income	Low Income	Inbound	In&Out-bound
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Airfare Business/Econ. (log)	-0.044**					
	(0.012)					
Airfare (log)		-0.083**	-0.056**	-0.119**	-0.148**	-0.121**
		(0.012)	(0.016)	(0.019)	(0.018)	(0.020)
Total Exports (log)	0.086**	0.192**	0.186**	0.165**	0.161**	0.169**
	(0.010)	(0.011)	(0.014)	(0.016)	(0.011)	(0.010)
Export Composition (log)	0.170**	0.126**	0.110*	0.145*	0.145**	0.161**
	(0.037)	(0.041)	(0.053)	(0.059)	(0.043)	(0.038)
GDP origin region (log)	0.590+	0.593	0.436	1.029	0.313	0.783*
	(0.347)	(0.366)	(0.408)	(0.650)	(0.400)	(0.357)
Foreign-Born Pop. (log)	-0.202**	0.278**	0.227**	0.311**	0.276**	0.283**
	(0.012)	(0.013)	(0.015)	(0.020)	(0.013)	(0.012)
Herfindahl Index (log)	-0.109**	-0.166**	-0.157**	-0.159**	-0.134**	-0.157**
	(0.021)	(0.023)	(0.028)	(0.035)	(0.024)	(0.021)
Country-year fixed effects	yes	yes	yes	yes	yes	yes
Region fixed effects	yes	yes	yes	yes	yes	yes
Observations	7836	7638	4534	3303	7649	8453
R-squared	0.192	0.648	0.69	0.635	0.628	0.661
First stage statistics						
Partial R2, 1st stage	0.46	0.55	0.57	0.52	0.46	0.42
Partial F, 1st stage	2380.31	2861.66	1598.4	1159.65	1786.01	1521.01

Notes: The table contains robustness sand sensitivity exercises for the baseline model given by equation (19) in the text. All specifications include region and country-year fixed effects, and instrument for airfares using distance*oil price (log). The countries with per-capita GDP above the sample median are defined as high income countries. Robust standard errors are reported in parentheses. $^{**}p < 0.01;^{*} p < 0.05;^{+} p < 0.1$

Table 5: Information Intensities Across Manufacturing Sectors

		Export shares	
NAICS	Description	Coefficient	St. Dev.
333	Machinery, Except Electrical	0.081**	(0.014)
334	Computer And Electronic Products	0.057**	(0.013)
339	Misc. Manufactured Commodities	0.047**	(0.011)
332	Fabricated Metal Products, Nesoi	0.043**	(0.010)
311	Food And Kindred Products	0.029**	(0.007)
336	Transportation Equipment	0.027**	(0.008)
335	Electrical Equipm., Appliances, Compon.	0.018+	(0.010)
316	Leather And Allied Products	0.018**	(0.005)
331	Primary Metal Manufacturing	0.016*	(0.006)
327	Nonmetallic Mineral Products	0.016*	(0.008)
322	Paper	0.014*	(0.006)
326	Plastics And Rubber Products	0.013	(0.010)
321	Wood Products	0.012*	(0.006)
324	Petroleum And Coal Products	0.011*	(0.005)
323	Printed Matter and Related Prod.	0.007	(0.008)
325	Chemicals	0.006	(0.010)
315	Apparel And Accessories	0.004	(0.006)
337	Furniture And Fixtures	0.000	(0.007)
312	Beverages And Tobacco Prod.	-0.006	(0.005)
314	Textile Mill Products	-0.009	(0.006)
313	Textiles And Fabrics	-0.025**	(0.007)
	Observations	5893	
	R-squared	0.695	

$^{**}p < 0.01;^{*} p < 0.05;^{+} p < 0.1$. Robust standard errors are reported in parentheses.

Note: The table contains estimates for the regression given by equation (20) in the text. The unreported coefficients for airfare, total bilateral exports, region GDP and foreign born population have expected signs and magnitudes. Sectors with zero export shares pose a problem because of the impossibility to take logs. A restricted sample is used instead, that excludes all the US region- foreign country pairs with trade in fewer than 16 manufacturing sectors. The zero export share values for the remaining observations are replaced with sample averages computed over all regions that export in that sector, in the same year and destination market.

Table 6: Correlation between Information Intensities and Product Complexity

	Sector R&D intensity (NSF data)	Contract intensity (Nunn, 2007)	Rauch Index
Information Intensities:			
All Manufacturing (21 sectors)		0.448*	0.312
Manufacturing with R&D data (15 sectors)	0.575*	0.492+	0.489+

$^{**}p < 0.01;^{*} p < 0.05;^{+} p < 0.1$

Notes: The correlation coefficients are computed using the estimates of information intensity across 3-digit NAICS sectors, reported in Table 5. R&D expenditure shares represent the average percentage of R&D expenditures in net sales (NSF data). Contract intensity is constructed by Nunn (2007) and represents the proportion of differentiated intermediate inputs used in the production of a given final good. The Rauch Index is constructed as the fraction of differentiated sectors within each 3-digit NAICS sector, using Rauch (1999) liberal classification of goods.

A Theory Appendix

A.1 Proof of Proposition 1

- Information transmission is positively related to the productivity of the firm φ:

$$\frac{\partial i^*_{sjh}}{\partial \varphi} = \frac{\sigma - 1}{1-\theta_h}\left[\frac{\theta_h}{\sigma c_{sj}} B_{sjh}\right]^{\frac{1}{1-\theta_h}} \varphi^{\frac{\sigma-1}{1-\theta_h}-1} > 0 \tag{23}$$

- Information transmission is positively related to the size of the destination market $\mu_j Y_j$:

$$\frac{\partial i^*_{sjh}}{\partial(\mu_{jh} Y_j)} = \frac{\partial i^*_{sjh}}{\partial B_{sjh}} \frac{\partial B_{sjh}}{\partial(\mu_{jh} Y_j)} = \frac{1}{1-\theta_h}\left[\frac{\theta_h}{\sigma c_{sj}} \varphi^{\sigma-1} B_{sjh}\right]^{\frac{1}{1-\theta_h}} \frac{1}{\mu_{jh} Y_j} > 0 \tag{24}$$

- Information transmission is positively related to the information intensity θ of a sector:

$$\frac{\partial i^*_{sjh}}{\partial \theta_h} = \frac{1}{1-\theta_h}\left[\frac{\theta_h}{\sigma c_{sj}} \varphi^{\sigma-1} B_{sjh}\right]^{\frac{1}{1-\theta_h}} \left[\frac{1}{1-\theta_h} ln\left(\frac{\theta_h}{\sigma c_{sj}} \varphi^{\sigma-1} B_{sjh}\right) + \frac{1}{\theta_h}\right] > 0 \tag{25}$$

  From the normalization $\lambda_{sjh} \geq 1$, in equilibrium $\left(\frac{\theta_h}{\sigma c_{sj}}\right)\varphi^{\sigma-1} B_{sjh} \geq 1$ must hold. This implies that the log term in the above expression takes non-negative values.

- Information transmission is negatively related to the "iceberg" trade cost τ_{sj}:

$$\frac{\partial i^*_{sjh}}{\partial \tau_{sj}} = \frac{\partial i^*_{sjh}}{\partial B_{sjh}} \frac{\partial B_{sjh}}{\partial \tau_{sj}} = \frac{1}{1-\theta_h}\left[\frac{\theta_h}{\sigma c_{sj}} \varphi^{\sigma-1} B_{sjh}\right]^{\frac{1}{1-\theta_h}} \frac{1-\sigma}{\tau_{sj}} < 0 \tag{26}$$

- Information transmission is negatively related to the elasticity of substitution σ:

$$\frac{\partial i^*_{sjh}}{\partial \sigma} = \frac{1}{1-\theta_h}\left[\frac{\theta_h}{\sigma c_{sj}} \varphi^{\sigma-1} B_{sjh}\right]^{\frac{\theta_h}{1-\theta_h}} \left[-\frac{\theta_h}{\sigma^2 c_{sj}} \varphi^{\sigma-1} B_{sjh} + \frac{\theta_h}{\sigma c_{sj}} \frac{\partial\left(\varphi^{\sigma-1} B_{sjh}\right)}{\partial \sigma}\right]$$

$$\text{where} \quad \frac{\partial\left(\varphi^{\sigma-1} B_{sjh}\right)}{\partial \sigma} = \left(\frac{\sigma}{\sigma-1} \frac{\tau_{sj} w_s}{\varphi}\right)^{1-\sigma} \frac{\mu_{sh} Y_j}{P_{jh}} \left[\frac{1}{\sigma} - ln\left(\frac{\sigma}{\sigma-1} \frac{\tau_{sj} w_s}{\varphi}\right)\right] \tag{27}$$

  After substitution, it becomes clear that the sign of $\frac{\partial i^*_{sjh}}{\partial \sigma}$ depends on the log of the quality-adjusted export price. If in equilibrium the following holds $p_{sj} = \frac{\sigma}{\sigma-1} \frac{\tau_{sj} w_s}{\varphi} \geq 1$, then $\frac{\partial i^*_{sjh}}{\partial \sigma} < 0$.

A.2 Herfindahl-Hirschman Index

This section derives the relation between the sector level Herfindahl-Hirschman Index (HHI) and the industry structure parameter A as defined in equation (18), under the assumptions that $\theta_h = 0$ across all sectors and information is an exogenous cost (as defined in (17)).

The HHI computed over all US exporters in sector h and destination market j can be written as:

$$HHI_{jh} = \sum_s \left(M_s \int_{\overline{\varphi}_{sjh}} \left(s_{sjh}(\varphi)\right)^2 dG(\varphi) \right), \qquad \text{with} \qquad s_{sjh}(\varphi) \equiv r^*_{sjh}(\varphi)/X_{jh} \tag{28}$$

where $s_{sjh}(\varphi)$ is the market share of a firm with productivity φ exporting from region s to destination market j; $r^*_s jh(\varphi)$ represents its export revenue, and X_{jh} is the total sales of US exporters in market j. Multiplying and dividing the firm's market share $s_{sjh}(\varphi)$ by the state exports X_{sjh} in sector h and destination j, then substituting for state exports in the denominator using equation (19) and for the fixed costs using the zero profit condition, a firm's export market share becomes:

$$s_{sjh}(\varphi) = \frac{r^*_{sjh}(\varphi)}{X_{sjh}} \frac{X_{sjh}}{X_{jh}} = \frac{\sigma A}{N_{sjh}} \left(\frac{\varphi}{\overline{\varphi}_{sjh}} \right)^{\sigma-1} v_{sjh}, \qquad \text{with} \qquad v_{sjh} \equiv \frac{X_{sjh}}{X_{jh}} \tag{29}$$

where v_{sjh} is the export share of region s in sector h and market j. Squaring the firm market share s_{sjh} and substituting it into the definition of HHI given in (28), after solving the integral and using the fact that the equilibrium number of exporters is given by $N_{sjh} = M_s\big(1 - G(\overline{\varphi}_{ijh}\big)$, one obtains:

$$HHI_{jh}(\varphi) = \frac{(\sigma A)^2}{2\sigma A - 1} \cdot \frac{\Gamma_{jh}}{N_j h}, \qquad \text{with} \qquad \Gamma_{jh} = \sum_s \frac{v^2_{sjh}}{N_{sjh}/N_{jh}} \tag{30}$$

where $\kappa > 2(\sigma - 1)$ is set by assumption to ensure a finite solution. This also implies that $2\sigma A > 1$. Since the available data on sector level HHI is reported by the US Census for the domestic market, then it is useful to calculate the expression in (30) with the US as the destination market j. Assuming that the trade costs – transportation and information costs – are identical across states when selling domestically, i.e. $c_{s,US} = c_{US}$ and $\tau_{sUS} = \tau_{US}$, $\forall s$, then by applying equation (18) one can show that in a given sector h the share of state s sales in total US domestic sales (i.e., $X_{s,US,h}/X_{US,h}$) is exactly the same as the fraction of state s producers in total US domestic producers (i.e., $N_{s,US,h}/N_{US,h}$). This implies the gamma term is exactly equal to one. Therefore:

$$HHI_{US,h} = K(A) \frac{1}{N_{US,h}}, \qquad \text{with} \quad K(A) = \frac{\sigma A}{2 - (1/\sigma A)} \tag{31}$$

Conditional on the number of US firms in a sector, the HHI is inversely related to the industry structure parameter A. The negative correlation is going to be stronger if the number of producer in a given sector h varies with parameter A such that $\partial N_{US,h}/\partial A > 0$. This would be true if the US has more firms in sectors with low elasticity of substitutionσ and/or high shape parameter κ. Taking it a step further, one could use the relation: $N_{US,h} = A\frac{X_{US,h}}{F_{US,h}}$, which is obtained from equation (18) combined with the assumption that $F_{s,US,h} = F_{US,h}$ $\forall s$, in order to get[42].:

$$HHI_{US,h} = \frac{K(A)}{A} \frac{F_{US,h}}{X_{US,h}} \tag{32}$$

The trade-weighted average HHI across all sectors is then computed in the same way as the export composition term: $HHI_{sj} \equiv \sum_h \left(HHI_{US,h} \frac{X_{sjh}}{X_{sj}} \right)$, with $X_{sj} = \sum_h X_{sjh}$. Rewriting, it becomes:

$$HHI_{sj} = \sum_h \left(F_{US,h} \frac{K(A)}{A} \cdot \frac{X_{sjh}/X_{US,jh}}{X_{sj}} \cdot \frac{X_{US,jh}}{X_{US,h}} \right) \tag{33}$$

[42]It is still the case that $\frac{\partial\left(K(A)/A\right)}{\partial A} < 0$, so the inverse relation between HHI and A still holds.

This shows that besides the industry structure parameter A, the average concentration across exporting sectors depends on three other dimensions: 1) the fixed costs of industry h for domestic sales; 2). the importance of source region s in exports to country j and sector h(i.e., $X_{sjh}/X_{US,jh}$), normalized by the size of bilateral exports; and 3) the accessibility of destination j to US producers in sector h (i.e., $X_{US,jh}/X_{US,h}$).

Using the expression for sector level export equation (12) after substituting for the assumptions in expression (17), it can be shown that $\frac{X_{sjh}/X_{US,jh}}{X_{sj}}$ depends only on importer j specific variables.[43]. Further, if we impose the following separability assumptions on the fixed cost requirement and the expenditure shares:

$$\text{Assumption (A1):} \quad \bar{i}_{jh} = f_j f_h \qquad\qquad \text{Assumption (A2):} \quad \mu_{jh} = \mu_j \mu_h$$

then $\frac{X_{US,jh}}{X_{US,h}}$ also becomes a function of importer specific variables.[44]

Thus, under certain assumptions on the sector level fixed costs and expenditure shares, the (trade-share weighted) average HHI captures in essence the covariance between the fixed export costs and an expression inversely related to the industry structure parameter A:

$$HHI_{sj} = \Psi_j \Xi_j \sum_h \left(\frac{K(A)}{A} \cdot F_{US,h} \right) \tag{34}$$

B Data Appendix

This section describes the construction of the air travel sample and other variables of interest.

Guided by practices in the empirical industrial organization literature (Brueckner, 2003; Whalen, 2007), the original DB1B dataset is restricted in several ways to conform to the paper's empirical objectives and also reduce the incidence of coding errors. First, I drop the domestic flights and all international flights transiting the U.S. in order to focus only on international flights that either depart or arrive in the contiguous U.S. states. Second, I drop circuitous tickets defined as tickets that have more than one trip break points. This is because of difficulties in assigning circuitous itineraries to unique bilateral origin-destination pairs. A ticket's single trip break point is then used to identify the destination of the travelers. Third, to reduce the incidence of coding errors in ticket prices, I remove the price information from the following records:[45] a). tickets whose fares are marked as unreliable by the indicator variable assigned by the Department of Transportation (DOT); b). tickets with fares below \$100 and/or outside the range 1/4 to 4 times the geometric

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[43] $\frac{X_{sjh}}{X_{US,jg}} = \frac{X_{sjh}}{\sum_s X_{sjg}} = \frac{M_s\left(\tau_{sj}w_s\right)^{-\kappa}\left(\bar{i}_{sj}\right)^{1-\frac{\kappa}{\sigma-1}}}{\sum_s\left(M_s\left(\tau_{sj}w_s\right)^{-\kappa}\left(\bar{i}_{sj}\right)^{1-\frac{\kappa}{\sigma-1}}\right)}$. Normalizing by the size of the bilateral exports, this becomes:

$$\frac{X_{sjh}/X_{US,jh}}{X_{sj}} = \frac{1}{\sum_s\left(M_s\left(\tau_{sj}w_s\right)^{-\kappa}\left(\bar{i}_{sj}\right)^{1-\frac{\kappa}{\sigma-1}}\right)} \cdot \frac{1}{\sum_h\left(\left(\frac{\mu_{jh}Y_j}{P_{jh}}\right)^{\frac{\kappa}{\sigma-1}}\left(\bar{i}_{jh}\right)^{1-\frac{\kappa}{\sigma-1}}\right)} \equiv \Psi_j$$

[44] $\frac{X_{US,jh}}{X_{US,h}} = \frac{\sum_s X_{sjh}}{\sum_s X_{s,US,h}} = \frac{\left(\frac{\mu_j Y_j}{\tilde{P}_j}\right)\left(f_j\right)^{1-\frac{\kappa}{\sigma-1}} \cdot \sum_s\left(M_s\left(\tau_{sj}w_s\right)^{-k}\left(c_{sj}\right)^{1-\frac{\kappa}{\sigma-1}}\right)}{\left(\frac{\mu_{US}Y_{US}}{\tilde{P}_{US}}\right)\left(f_{US}\right)^{1-\frac{\kappa}{\sigma-1}} \cdot \sum_s\left(M_s\left(\tau_{US,j}w_s\right)^{-k}\left(c_{US,j}\right)^{1-\frac{\kappa}{\sigma-1}}\right)} \equiv \Xi_j$

[45] I do not drop the record entirely from the sample because it can still bring information about other ticket characteristics that are less noisy such as the number of travelers. Dropping these observations would not change the results however.

average fare for a US state-foreign country pair; b). highly unusual tickets of more than eight flight segments per itinerary (respectively more than four flight segments for one-way itineraries). After cleaning the air fare variable of noisy values, I define the ticket price as a single-direction fare and replace the fares of round-trip tickets with one-half the value listed in the DB1B data. This is done in order to have prices that are comparable across airline tickets. I then apply the same procedure for the flight distance variable, in order to get single-direction distances across tickets.

After filtering the DB1B ticket data, I use a DOT concordance (amended with US Census country codes) to assign to each ticket's origin and final destination airport codes the corresponding US state and foreign country respectively. I then allocate each contiguous US state to a larger US aviation region. Clustering neighboring US states into aviation regions is necessary because many large international airports are sufficiently close to a state's borders to be able to serve out-of-state air travelers. The allocation of states to regions is listed in the Appendix Table A1, and follows two criteria: states that share access to a large gateway airport are grouped together, and each region must include at least one major hub or gateway airport.[46] Some foreign countries in the sample are also grouped into larger world geographic regions (generally small and less developed countries). The need to cluster foreign countries into world regions is dictated by the format of the original foreign-born population dataset provided by the U.S. Census.

Using the resulting airline ticket dataset, I create several new ticket-level variables that are of interest for the purpose of this paper. First, I construct an indicator for the direction of air travel in order to distinguish between outbound flight tickets (i.e., itineraries that originate in the US and have the final destination abroad) and inbound flight tickets (i.e., itineraries that start in a foreign country and arrive at a destination in the US). Then, I create an indicator variable for round trip tickets, defined as itineraries that originate and terminate in the same city. Finally, since in the original DB1B dataset the class type variable is specific to each flight segment of an itinerary, I create an indicator variable that assigns the class type – business or economy – to the entire travel itinerary. I consider as business class any itinerary that has a distance-weighted fraction of business/first class flight segments greater than one half. That is, I compute the following statistic:

$$\text{business\_class} = \sum_{s=1}^{S} \left(\frac{\text{segment dist}_s}{\text{total ticket dist}}\right) \cdot I_s(1 = \text{business/first class})$$

where s indexes a flight segment and S is the total number of flight segments of a given airline ticket. If business_class ≥ 0.5 (i.e., more than 50% of the trip distance is flown at business or first class), then the itinerary is considered a business class ticket.[47]

After creating these additional air travel variables, I can now dispense of the ticket level detail by collapsing the dataset into US region – destination country – year observations, separately for inbound and outbound travel, and within each directional flow separately for business and economy class travel. Flight distances and air fares are computed as passenger-weighted averages. Air fares are deflated by the US GDP deflator in order to be expressed in constant US dollars. I separate the obtained dataset into outbound and inbound air travel samples. An observation in the resulting outbound sample corresponds for example, to business class air travel in year 2000 departing from the U.S. Southwest region to arrive to Japan and indicates the total number of business class travelers[48], the average business class air fare and the average business class trip distance, combined over the one-way and round-trip flights (as long as they have the same origin region and foreign destination country).

[46] The classification of airports is provided by the Federal Aviation Administration (FAA).

[47] This definition of business class tickets is more restrictive than computing the simple fraction of segments traveled at business class, which is what has been used in the industrial organization literature (e.g., Brueckner, 2003).

[48] The number of travelers is going to be measured in multiples of 10, as the original data is a 10% sample.

The final step is to merge the resulting air travel dataset with the US manufacturing exports data. For doing that, first the export values from the state level Origin of Movement series provided by the US Census are collapsed across all manufacturing sectors into US region – destination country – year observations. So now the bilateral outbound (inbound) air travel and export flows have the same aggregation level. The merge is then realized by US region-destination country-year. A summary of the outcome is presented in the Appendix Table A2. While the merge is not exact, the dropped bilateral pairs make a very small share of not more than 0.5% of total US manufacturing exports by value. Adding the auxiliary data sources to this sample raises no challenges and generates precise merging.

C Table Appendix

Table A1: Allocation of U.S. States to Regions

Region	FAA Region / States	Large Hub Airports
	Northwest Mountain:	
1	WA, OR	Seattle, Portland
2	ID, MT, WY, UT, CO	Denver, Salt Lake City
	Western Pacific:	
3	CA, NV	LA, San Diego, San Francisco, Las Vegas
4	AZ, NM	Phoenix
	Southwest:	
5	TX, OK,	Houston, Dallas
	Southern:	
6	LA, AR, TN, MS, AL	New Orleans, LA; Memphis, TN
7	FL	Miami, Ft. Lauderdale, Orlando, Tampa
8	GA, SC, NC	Atlanta, Charlotte-NC
	Central:	
9	MO, NE, KS, IA	Kansas City, St. Louis
	Great Lakes:	
10	SD, ND, MN	Minneapolis/ St. Paul
11	WI, IL, IN	Chicago, Indianapolis
12	MI	Detroit
13	OH, KY	Cincinnati, Cleveland, Louisville KY
	Eastern:	
14	PA	Philadelphia, Pittsburg
15	WV, VA, MD, DC, DE	Washington, Baltimore
16	NJ, NY, CT	JFK, Newark, La Guardia
	New England:	
17	MA, RI, VT, NH, ME	Boston

Note: The Federal Aviation Administration (FAA) defines nine aviation regions within the US. Starting from these predefined regions, I split them further into smaller groups by taking into account the location of large airport hubs. Several states have been included in a different group than their original FAA regional allocation because of their proximity to large airport hubs located in other regions

Table A2: Sample Coverage of the Merged Exports and Air Travel Dataset

	U.S. Region – Foreign Destination Country Pairs with				
	Zero exports	Positive exports		Positive exports & business travel	
	Positive Travel	Zero travel	Economy only	Total	Restricted sample
No. pairs	131	291	1,344	8,084	7856
Avg. export share of total US exports (%)	–	0.012 (max =0.04)	0.26 (max =0.42)	99.73 (min =99.56)	99.73 (min =99.56)
Avg. export share of total regional exports (%)	–	0.015 (max =0.32)	0.63 (max =11.14)	99.63 (min =88.84)	99.56 (min =88.62)

Note: This table reports the summary from merging the export and air travel datasets, once each individual dataset was aggregated at US region by destination country level. The restricted sample represents the sample obtained after dropping the pairs with missing values. For each indicated subsample, I compute the proportion of manufacturing exports in total US manufacturing exports accounted for by the bilateral pairs included in that subsample. In the last row, I redo this calculation at regional level in order to understand, for each source region and year, the share of manufacturing exports covered by the selected bilateral pairs.

Table A3: List of Countries

1	Argentina	32	Honduras	63	Other Northern Europe
2	Armenia	33	Hong Kong	64	Other South America
3	Australia	34	Hungary	65	Other South Central Asia
4	Austria	35	India	66	Other South Eastern Asia
5	Bangladesh	36	Indonesia	67	Other Southern Africa
6	Barbados	37	Iran	68	Other Southern Europe
7	Belarus	38	Ireland	69	Other Western Africa
8	Belgium	39	Israel	70	Other Western Asia
9	Belize	40	Italy	71	Pakistan
10	Bolivia	41	Jamaica	72	Panama
11	Bosnia and Herzegovina	42	Japan	73	Peru
12	Brazil	43	Jordan	74	Philippines
13	Cambodia	44	Korea	75	Poland
14	Canada	45	Laos	76	Polynesia
15	Chile	46	Lebanon	77	Portugal
16	China	47	Luxembourg	78	Romania
17	Colombia	48	Malaysia	79	Russia
18	Costa Rica	49	Melanesia	80	South Africa
19	Czechoslovakia	50	Mexico	81	Spain
20	Dominican Republic	51	Micronesia	82	Sweden
21	Ecuador	52	Middle Africa	83	Switzerland
22	Egypt	53	Netherlands	84	Syria
23	El Salvador	54	New Zealand	85	Taiwan
24	Ethiopia	55	Nicaragua	86	Thailand
25	France	56	Nigeria	87	Trinidad and Tobago
26	Germany	57	Other Caribbean	88	Turkey
27	Ghana	58	Other Eastern Africa	89	Ukraine
28	Greece	59	Other Eastern Asia	90	United Kingdom
29	Guatemala	60	Other Eastern Europe	91	Venezuela
30	Guyana	61	Other Northern Africa	92	Vietnam
31	Haiti	62	Other Northern America	93	Yugoslavia