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Buyer-seller relationships in international trade: Evidence from U.S. States' 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 entail a fixed cost of trade, but at the same time they generate relationship capital, which adds bilateral specific value to the traded products. Differences in the face-to-face communication intensity of traded goods, bilateral travel costs and foreign market size 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. I also find that trade flows in R&D intensive manufactures and goods facing contractual frictions are most dependent on face-to-face meetings. The econometric identification exploits the cross-state variation in bilateral exports and business-class air travelers by foreign country and time period, circumventing any spurious correlation induced by cross-country differences driving aggregate travel and trade patterns.

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 – turns out to be essential.[1] In-person meetings facilitate information sharing, necessary for product innovations and for better meeting markets' needs.[2]

The importance of personal interactions in international trade has become increasingly recognized by trade economists. A direct connection between face-to-face communication and exporting is implicit in several distinct literatures. For example, the incomplete contracts literature relies on the key assumption that firms make relationship-specific investments, such as the production of inputs specialized for the needs of a single final good producer.[3] This degree of input customization presumably requires considerable amounts of complex information exchanged within a buyer-seller link for successful outsourcing, suggestive of information becoming an input into product adaptation. Moreover, close communication between firms impacts international trade even absent of customization

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[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. In line with business surveys, 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).

[3] See for example Grossman and Helpman (2002), Antras (2003).

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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.[4] Finally, a different rationale for the use of communication in trade is provided by the informative advertising literature.[5] Advertising delivers product information to buyers, who are otherwise unaware of the varieties available in the market. Thus, consumers' willingness to buy traded goods is directly dependent on the information provided by the sellers at a cost.[6]

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 (such as the volume of telephone calls, or extent of internet penetration) cannot distinguish between its use for production or personal consumption purposes. 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.[7]

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 proceeds in three steps. First, I investigate the extent to which personal interactions, facilitated by international air travel, represent a valuable input to trade in complex manufactures. Second, I examine whether the direct dependence of international business class air travel on trade flows is robust in the face of common covariates, overcoming concerns of spurious correlation. Third, by exploiting industry level variation in manufacturing exports, I estimate the face-to-face communication intensity of trade across manufacturing sectors, and investigate whether there is any systematic variation between the estimates and external measures of product complexity.

A preview of the data I will describe later in more detail reveals a direct relation between international business class air travel and international trade. Fig. 1 plots by state the volume of bilateral manufacturing exports against the number of U.S. outbound business-class air travelers for each foreign destination country. Fig. 2 shows a similar graph, but now the data cut holds the foreign destination country constant and displays the intra-national variation in bilateral exports and business class air travelers across geographic locations. Both data plots reveal a strong correlation between in-person business meetings and international trade. But the correlations may also be spurious if they are an artifact of systematic differences across source and destination 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 same time provides attractive touristic destinations. This justifies the need of a more rigorous econometric analysis to establish the extent to which in-person meetings are valued in international trade.

To guide the empirical strategy, I formalize an exporter's decision to undertake costly international travel for trade related purposes. When buyers across foreign markets have heterogeneous tastes for the available products and sources, export firms may have an incentive to invest in building partnerships with foreign buyers in order to enhance the desirability of their products and secure large export sales. Personal interactions among trade partners entail a fixed cost of trade, but at the same time they generate relationship capital, which enters as an input into products' market specific appeal. By becoming a choice variable in the firm's profit maximization problem, in-person meetings can be expressed as a direct function of the volume of exports and of the relationship intensity of the traded goods, conditional on travel costs. I take these predictions to the data and estimate an aggregate input demand equation for business-class air travel to determine its responsiveness to changes in the scale and composition of U.S. manufacturing exports. Intuitively, if buyer–seller interactions are necessary for trade in complex manufactures, then one should observe a match across narrowly defined geographic locations (i.e., U.S. states) between export patterns and business class air travel demands for the same importing country.

Central in motivating the estimation strategy and data sources are considerations regarding the econometric identification. International air travel may be spuriously related to trade volumes when observed at highly aggregated level and when identified from cross-country variation. This is because both bilateral travel and trade flows are in large part determined by gravity-type variables (economic size, income, distance, cultural barriers), and they respond to the same transportation cost shocks. To overcome identification concerns, this paper employs data disaggregated by U.S. state and foreign country. The intra-national geographic dimension provides sufficient cross-state variation in exports and air travel patterns to permit full control of the time-varying country pair characteristics, this way removing any potential for spurious correlation driven by cross-country differences. Furthermore, the regional disaggregation of the U.S. data uncovers another important source of variation: cross-state differences in agglomeration patterns and industrial specialization. Since the regional economic geography is predetermined at the time destination-specific business-class air travel decisions are made, intra-national geography essentially serves the role of an exogenous cross-sectional shock to observed trade patterns. This provides the empirical motivation for the model specification used in this paper. That is, by using an input demand estimation approach with bilateral air travel flows regressed on trade variables, the model identification exploits the exogenous variation in the volume and composition of exports induced by regional agglomeration and industrial specialization factors.

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 manufacturing sectors – measured as the dependence of business air travel demand on industry level exports – is shown to be positively correlated with existing measures of product complexity, such as the industry R&D intensity, Nunn's (2007) measure of contract intensity, 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 trade in goods facing contractual frictions is most dependent on face-to-face meetings (Leamer and Storper, 2001). It is important to point however that in spite of the compelling case that regional economic geography provides in support of the exogeneity of the trade variables, this estimation strategy cannot guarantee an insulation of the trade variables from all other possible sources of

[4] See for example Grossman and Rossi-Hansberg (2008), Head et al. (2009), Keller and Yeaple (2010).

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

[6] 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).

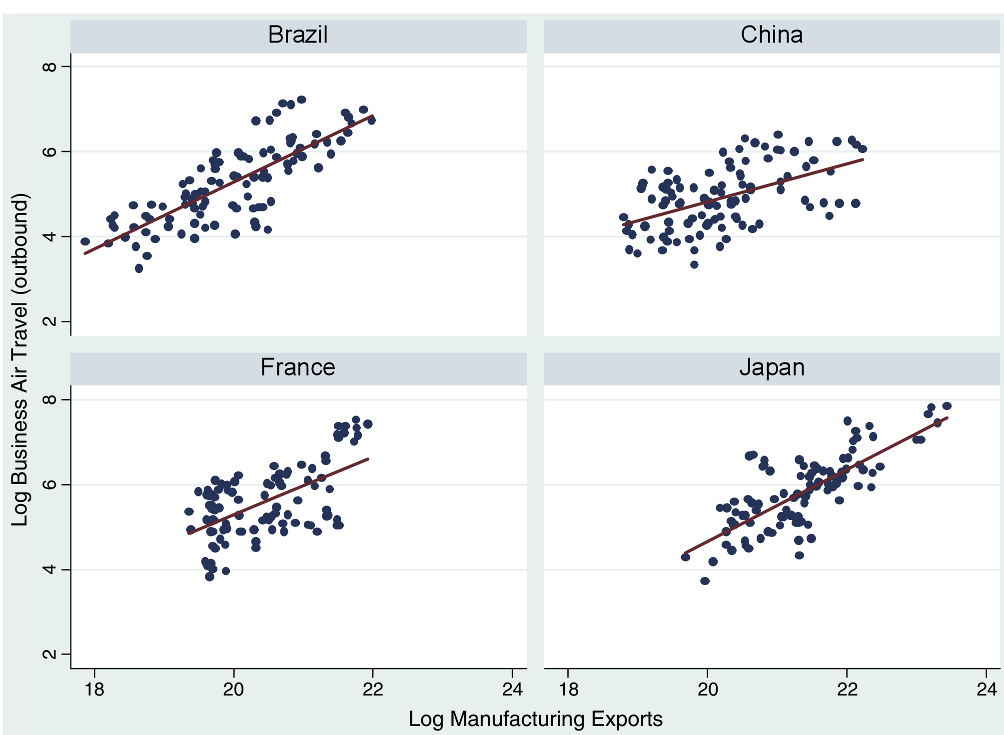
[7] Considering the business-class air passengers as representing business people traveling for business purposes is consistent with existing evidence from the airline industry. For example, British Airways reports that “three quarters of people we carry in first class are top executives or own their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

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

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

endogeneity; so the caveat that the estimation results establish correlation rather than causality applies.

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



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

Fig. 2. Intra-national distribution of exports and outbound business air travel by destination country.

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: first, it departs from the gravity equation model by proposing an input demand estimation approach to highlight the relation between in-person business meetings and export flows; second, it uses a novel identification strategy that exploits the intra-national distribution of production and trade activities; and finally, it provides industry level evidence of systematic variation in the travel intensity of trade according to the complexity of the traded goods.

The empirical results of this paper also relate to work on the distance puzzle and the geography of trade.[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, 2003; Head et al., 2009). 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; Duranton and Storper, 2008). However, direct empirical evidence in support of these insights is scarce, and this paper tries to fill this gap.

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). Furthermore, the findings bring to attention additional benefits that a country could enjoy when lowering the barriers associated with the temporary cross-border movements of people. Policy can help in lowering such cross-border travel costs by liberalizing trade in air transport services (Cristea and Hummels, 2010), and also by relaxing the restrictions imposed on temporary visits through visa programs.

The remainder of this paper is structured as follows. Section 2 outlines testable predictions regarding an exporter's optimal demand for in-person business meetings, and discusses the econometric strategy. Section 3 describes the data and sample construction. The estimation results, including industry level analyses, are discussed in Section 4. Section 5 concludes.

2. Framework and model specification

This section outlines a simple framework to illustrate how in-person meetings between buyers and sellers may affect export decisions and trade patterns. I provide the basic intuition for an exporter's decision to undertake costly travel and build ties with foreign partners in return for larger export sales, and refer the reader to the online appendix for a formal derivation of the model. Then I proceed to describe the resulting empirical specification and the main identification strategy.

2.1. Framework

The starting point of the analysis is the consideration that in-person meetings are a valuable input to international trade, contributing to the desirability and success of an export product in the foreign market. While business surveys highlight a variety of reasons justifying in-person meetings between trade partners (e.g., negotiate new contracts, build trust, maintain good partnerships, customize products, provide after-sale service, etc.), this paper makes no distinction between such empirically unobservable motives. As a consequence, it puts as little structure as possible on the role of face-to-face communication in international trade, and only assumes that: 1) in-person meetings entail travel costs, which are part of a firms' fixed export cost; 2) the interactions that such meetings facilitate add value to the trade partnerships, being reflected in buyers' higher willingness to import products from familiar sellers; and 3) the amount of interaction between foreign trade partners is endogenously chosen by the exporter based on the characteristics of the traded product and of the foreign markets served.

This initial structure can be embedded into a static heterogeneous firms model of trade with the following features. Buyers across foreign markets have unique valuations for the available differentiated products, and these valuations are based on two distinct preference components: one that is product specific and identical across buyers in all markets (e.g., 'standard' product quality), and one that is trade pair specific and captures any favorable attribute that makes an export shipment particular to a trade relationship (e.g., 'relationship-specific' product appeal).[10] It is assumed that a product's relationship specific appeal depends directly on the degree of personal interactions between trade partners; that is, by generating relationship capital such as trust, reciprocal commitment or information sharing, face-to-face meetings have the potential to improve a trade transaction and add value to the exported varieties. As a consequence, exporters may find it optimal to invest resources and build partnerships with foreign buyers in order to improve the perceived appeal of their products and ensure large export sales. While personal interactions between trade partners entail traveling costs taking the form of fixed costs of trade, they also enter with different intensities as inputs into products' relationship-specific appeal. And since personal interactions affect both the level of the fixed export cost and the return to exporting, they become an endogenous component and thus a choice variable in the firm's profit maximization problem.[11]

This framework lends itself to a straightforward derivation of an optimal demand for in-person meetings. Its level is determined primarily by product and foreign market characteristics as well as bilateral trade costs. I derive the following firm-level prediction, which becomes the micro-foundation for the baseline empirical specification of the paper.

Proposition. *All else equal, the optimal interaction level between an exporter and foreign buyer is positively related to the productivity of the firm, the size of the foreign market and the relationship intensity of the differentiated good sector; and it is negatively related to the "iceberg" trade cost, and the elasticity of substitution between varieties.*

[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), product standards (Moenius, 2005). See Rauch (2001) for a comprehensive literature survey.

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

[11] Formally, a firm's maximization problem can be written as:

$$\pi_{sjh}\left(i_{sjh}\right) = [p_{sh} - mc_s]x_{sjh}\left(i_{sjh}\right) - F_{sjh}\left(i_{sjh}\right), \quad \text{with} \quad F_{sjh} = c_{sh} i_{sjh}$$

where s, j, h indexes the export region, import country and differentiated good, respectively; i_{sjh} denotes the amount of personal interactions between the trade partners, obtained at the travel unit cost c_{sj}; p_{sh} is the f.o.b. export price, mc_s is the marginal cost of production, and x_{sjh} is the import quantity demanded, given by a CES demand function with preference weight $\lambda_{sjh} = (i_{sjh})^{\theta_h}$.

The intuition for this Proposition can be summarized 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 by using it costlessly to enhance the valuation of each unit shipped to that market. This leads to higher export profits from increased sales per buyer. Therefore, countries with large market potential – either because of economic size, geographical proximity (low "iceberg" trade costs) or reduced competition (low elasticity of substitution) – 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}.

2.2. Model specification

Aggregating firm level travel decisions across all sectors in region s exporting to country j at time t, it can be shown that conditional on air travel costs, the total demand for international business meetings is a direct function of the volume of bilateral exports and their composition in terms of complex, relationship-intensive manufactures.[12] This testable prediction delivers the following estimation model:

$$lnTrav_{sjt} = \beta_1 lnFare_{sjt} + \beta_2 lnX_{sjt} + \beta_3 ln\left(\sum_h \theta_h z_{sjht}\right) + \epsilon_{sjt}, \quad z_{sjht} \equiv \frac{X_{sjht}}{X_{sjt}} \tag{1}$$

where s, j, and t index the U.S. export region, foreign import country and year, respectively. $Trav_{sjt}$ represents the total demand for in-person meetings and is measured by the number of outbound business-class air passengers traveling from region s to country j at a given point in time; $Fare_{sjt}$ stands for the unit cost of international travel and is measured by the average business class air fare; X_{sjt} represents total manufacturing exports, and finally θ_h measures the dependence of trade in sector h on buyer-seller interactions; thus, the export composition term $\sum_h \theta_h z_{sjht}$ captures the average relationship intensity of exports, and is going to be measured as the(trade-share weighted) average fraction of varieties that are differentiated according to Rauch's (1999) classification of goods.

Given the hypothesis that business travel is an input to trade in complex manufactures, the theory predicts that conditional on unit travel 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 and are valued in international trade, then one should observe a systematic relation between regions' specialization in communication intensive goods and their demand for international business travel. Under the alternative hypothesis when international trade is not mediated by face-to-face meetings (i.e., $\theta_h = 0 \, \forall h$), the composition of exports should not be related in any systematic way to the 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 spurious correlation driven by cross-country differences. To make this point transparent, take as an example the size of population and the per capita income level at origin and destination: these two variables are frequently used in gravity equation models to predict bilateral trade volumes, but at the same time they are considered key determinants of air passenger traffic in empirical industrial organization studies.[13] Undoubtedly, the set of variables that affect both the aggregate air travel and trade flows is extensive, including factors like geography, quality of infrastructure, level of development or exchange rates. To eliminate any sources of spurious correlation or endogeneity coming from cross-country differences, I include in the regression model importer-year fixed effects.[14] 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 a matrix Z_{sjt} of bilateral controls, as well as region and foreign country-year fixed effects (α_s and α_{jt} respectively), the baseline regression model from Eq. (1) becomes:

$$\begin{aligned} lnTrav_{sjt} = {} & \beta_1 lnFare_{sjt} + \beta_2 lnX_{sjt} + \beta_3 lnComposit_{sjt} + \beta_4 lnGDP_{st} \\ & + Z_{sjt}\beta + \alpha_s + \alpha_{jt} + \varepsilon_{sjt}. \end{aligned} \tag{2}$$

The econometric identification relies on two sources of variation: one coming from the intra-national location of U.S. manufacturing firms that export to country j at time t (i.e., variation in *export volumes* across origin regions 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 regions s for a given (j,t) pair). For reasons outside of the outlined framework but grounded in the economic geography literature, the cross-regional variation in the volume and composition of bilateral exports is to a large extent independent of the demand for business class air travel. This orthogonality of the trade variables can be motivated, for example, by factor endowment differences, industrial specialization, or historical patterns of economic agglomeration.

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 the main candidates are the ethnic networks and the equilibrium number of exporters in a region-country pair (i.e., firm extensive margin). For the first case, Rauch and Trindade (2002) provide convincing evidence that ethnic networks facilitate international trade, especially trade in differentiated goods. However, 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 include in the matrix Z_{sj} of bilateral controls the size of foreign-born population living in U.S. region s that originates from country j. The second omitted variable candidate – the number of exporters within a bilateral region-country pair – raises concerns essentially because both the volume of bilateral business-class air travel and of bilateral trade are a direct function of the equilibrium number of firms from source region s that export to foreign country j. So, a positive correlation between total air travel demands and bilateral export flows may be driven entirely by the extensive margin of trade, with no intensive margin variation coming from firm level decisions about the optimal frequency with which face-to-face meetings are used in trading complex manufactures. Furthermore, controlling for the number of active exporters is important also to the extent that the variation in the extensive margin across sectors is systematically related to the degree of product differentiation, and possibly to the relationship-intensity of the traded goods.

That said, count data on the number of firms exporting from U.S. state s to foreign country j is very difficult to get. Instead, I proxy for the extensive margin channel using available measures of industry concentration. In particular, I construct an export market concentration index at bilateral level, by averaging the industry Herfindahl–Hirschman Index (HHI) across all the sectors recording positive

[12] The online appendix provides the formal derivations and a detailed discussion of the underlying structure of the aggregate variables.

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

[14] 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, language, cultural or historical ties).

exports within a bilateral trade pair, and using the sectors' trade shares in total bilateral trade as weights. The advantage of using a comprehensive indicator like the Herfindahl–Hirschman Index to proxy for the firm extensive margin of trade comes from the fact that it combines two pieces of information that are of relevance to the econometric exercise of this paper: first, it captures information about the equilibrium number of firms in a sector (and implicitly about the average size of the fixed costs in that sector); and second, it incorporates information about asymmetries in the structure of industries (e.g., extent of firm level heterogeneity, degree of product substitution). The latter point is important for the model identification, as it ensures that the effect of the export composition term (i.e., overall relationship-intensity of bilateral trade) on the demand for business-class travel is not an artifact of the omitted industrial structure composite.[15]

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 to exploit a novel source of exogenous variation: intra-national geography.

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, such as class type. I remove from the dataset all the domestic itineraries, and distinguish the remaining international tickets based on class type (economy, business) and direction of travel (inbound, outbound).[16] For the most part, 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.[17] 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 mismeasurement, I will directly address this sampling limitation in the robustness exercises.[18]

The state level export data by destination country is provided by the US Census Bureau. In the Origin of Movement (OM) series, 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".[19] 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 in the estimation model 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: $\sum_h \theta_h X_{sjht}/X_{sjt}$, with h representing a 3-digit NAICS sector.

In the original datasets, both travel and trade flows are observed at US state level; however, 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.[20] The resulting sample is an unbalanced panel covering 93 foreign destinations (see the list provided in Appendix Table A3) over the period 1998–2003.[21] 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.[22]

Given the importance of the intra-national geographic 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. This is not that surprising, since 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 relationship-specific valuation attributed to a bilateral trade flow, is similar in magnitude to the variation in regional exports arising from cross-state differences (e.g., from comparing, for

[15] The online appendix provides a formal derivation of the determinants of the Herfindahl–Hirschman Index in the context of a standard heterogeneous firm model of trade with Pareto distributed productivities. See also Hart (1975) for a decomposition of the Herfindahl–Hirschman Index into the number of firms in the market and the coefficient of variation of firm sizes.

[16] Since the ticket class is reported for each flight segment of an itinerary, I define as business class any ticket that has a distance-weighted average share of business or first class segments greater than one half.

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

[18] 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 mismeasurement in the DB1B sample is much reduced after controlling for origin and destination fixed effects. See the online data appendix for details.

[19] http://www.wisertrade.org. Cassey (2009) also describes the OM state exports data and its limitations.

[20] 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.

[21] 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.

[22] 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.

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

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.

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 investigate if the residual variation in state exports is systematically related to face-to-face communication, as measured by international 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: $\frac{X^h_{region}}{X^h} / \frac{GDP_{region}}{GDP}$, 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 the regions in proportion to the regions' economic sizes (case which corresponds to an index of 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 evidence that international travel is an input to trade across national borders. Second, I establish that the direct relation between international business class air travel and international trade is robust across specifications, in the sense that it is not driven by common covariates, sample construction or a particular subset of foreign 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. Baseline results

Table 2 reports the estimates from the baseline model given by Eq. (2). The first column includes the OLS results. Since the regression model is a demand equation, airfares are endogenous to air travel flows. In column 2, and in all the remaining estimations reported in this paper, I instrument for air fares using the interaction between the 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%. 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%.

While extensive in coverage, the structure of origin and destination-time fixed effects does not account for all potential sources of endogeneity or spurious correlation. As mentioned previously, there is reason to believe that ethnic networks influence not only the volume and composition of exports, but also the demand for international air travel services (even in the absence of trade-related motives). To account for this, I add to the baseline regression the size of foreign-born population in the U.S. region s that originates from country j. 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.[23]

Finally, column 4 of Table 2 includes the average Herfindahl–Hirschman Index (HHI) across exporting sectors as a control for the 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 remains unaffected by 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 provide empirical evidence for the hypothesis that in-person meetings are a valuable input to international trade. Conditional on travel costs, exporters that produce complex manufactures and face large foreign demands invest

[23] 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 Hanson and Xiang (2011). Results are very similar with those reported in column 3 of Table 2.

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 Eq. (2) in the text.

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.[24] 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 differences in industrial specialization and agglomeration patterns across the U.S. states induce exogenous variation in the volume and composition of exports. 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 of infrastructure, income or productivity shocks, geography and access to world markets, just to name a few.[25] Therefore, if there are factors that still make the volume and composition of exports correlated with the regression residuals, then they must have source s by country j variation and be uncorrelated with the other bilateral controls, such as 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.[26] I proceed by accounting first for omitted variables that are correlated with both travel and trade flows. Then, I explicitly control for variables that are only correlated with business class air travel flows undertaken for trade related purposes to remove their systematic variation from the residual business-class air travel demand, and thus mitigate the potential for reverse causality effects.

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 coefficients of interest.[27]

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 results via reverse causality effects. To illustrate this point, consider for example 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 done for trade related purposes. The first variable that I consider is an indicator for the availability of direct flights connecting a U.S. region and a foreign destination country. The third column of Table 3 reports the results. Compared to the preferred baseline specification (Table 2 column 4),

[24] 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 outlines framework, since exports are a direct function of in-person meetings. Thus, exogenous factors that shift the air travel demand, implicitly affect exports as well.

[25] 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.

[26] 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.

[27] 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.

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 Eq. (2) 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.

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 U.S. regions that host major international gateway airports with destination country dummies.[28] 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 in export flows by extracting systematic variation from the residual business class air travel demands, however they do not overturn the expected sign and significance of the variables of interest. In spite of the extensive set of controls, one should be cautious in inferring causality effects 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.

To strengthen the results of the paper, next I perform several robustness exercises: first, I address the mis-measurement in the business-class air travel variable, and then I verify the stability of estimates across several subsamples.

When describing the data in Section 3, I have pointed out the under-representation problem affecting the available 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 the variables' effects on the relative demand for business class air travel, the results confirm the previous findings that the scale of exports and their composition in terms of complex manufactures have a significant and positive impact on business-class air travel flows.

The following columns of Table 4 examine the stability of the coefficients of interest across various sub-samples. The estimates in column 2 are obtained after eliminating all the bilateral pairs involving Canada or Mexico due to their proximity to the U.S., with 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.[29] In columns 5 and 6 of Table 4

[28] 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.

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

Table 4
Econometric robustness and sensitivity analysis.

Dependent variable	Business/economy travelers (log)	Business travelers (log)			Business travelers (log)		Business travelers (log)	
		No NAFTA	High income	Low income	Inbound	In and out-bound	No zeros	Zeros
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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)		
Distance oil price (log)							−0.366**	−0.362*
	(0.012)						(0.151)	(0.151)
Total exports (log)	0.086**	0.192**	0.186**	0.165**	0.161**	0.169**	0.134**	0.138**
	(0.010)	(0.011)	(0.014)	(0.016)	(0.011)	(0.010)	(0.032)	(0.032)
Export composition (log)	0.170**	0.126**	0.110*	0.145*	0.145**	0.161**	0.224**	0.229**
	(0.037)	(0.041)	(0.053)	(0.059)	(0.043)	(0.038)	(0.073)	(0.072)
GDP origin region (log)	0.590+	0.593	0.436	1.029	0.313	0.783*	−0.033	−0.006
	(0.347)	(0.366)	(0.408)	(0.650)	(0.400)	(0.357)	(0.761)	(0.763)
Foreign-born pop. (log)	−0.202**	0.278**	0.227**	0.311**	0.276**	0.283**	0.304**	0.305**
	(0.012)	(0.013)	(0.015)	(0.020)	(0.013)	(0.012)	(0.025)	(0.025)
Herfindahl index (log)	−0.109**	−0.166**	−0.157**	−0.159**	−0.134**	−0.157**	−0.213**	−0.213**
	(0.021)	(0.023)	(0.028)	(0.035)	(0.024)	(0.021)	(0.039)	(0.039)
Country-year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Region fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	7836	7638	4534	3303	7649	8453	7842	9113
R-squared	0.192	0.648	0.690	0.635	0.628	0.661	n.a.	n.a.
First stage statistics								
Partial R2, 1st stage	0.46	0.55	0.57	0.52	0.46	0.42	n.a.	n.a.
Partial F, 1st stage	2380.31	2861.66	1598.4	1159.65	1786.01	1521.01	n.a.	n.a.

Notes: The table contains robustness sand sensitivity exercises for the baseline model given by Eq. (2) in the text. All specifications include region and country-year fixed effects, and instrument for airfares using distance oilprice (log). The countries with per-capita GDP above the sample median are defined as high income countries. Robust standard errors are reported in parentheses. $p<0.01$; $p<0.05$; $^{+}p<0.1$.

I re-estimate the preferred model on the sample of inbound business-class travelers, and respectively a combined sample of inbound and outbound travelers, in order to verify whether the main results depend on the particular direction of air travel.[30] Overall, the sensitivity analysis exercises confirm the stability of coefficients across sub-samples, reinforcing the findings from the baseline regression model.

Finally, the last two columns reported in Table 4 address the problem of zero observations in the business-class air travel flows. Of the total number of potential trade pairs over the sample period (17 U.S. regions × 93 destinations × 6 years = 9486 observations), the estimation sample accounts for 83% of them, and almost all of the 17% missing observations represent zeros in business-class air travel flows.[31] To exploit the information available in the zero travel flows, I follow Silva and Tenreyro (2006) and re-estimate the model using Poisson Pseudo Maximum Likelihood (PPML) estimation method. For comparison purposes, column 7 reports the PPML estimates obtained from the restricted sample, and column 8 reports the results obtained from the balanced panel with zero business-class air travel flows included.[32] The increase in the trade coefficients once accounting for zeros is consistent with the observation that bilateral air travel flows are more likely to be zero in small markets with low export value flows, trading less differentiated products. As expected, the results with Poisson do not overturn the previous findings, in spite of differences in the magnitude of the coefficients of interest.

4.3. Face-to-face communication intensity of trade across sectors

In this subsection, I investigate in which manufacturing sectors is trade more dependent on buyer-seller interactions via face-to-face communication. To do that, I exploit the level of disaggregation in the U.S. state export data (21 manufacturing sectors) and estimate the responsiveness of business class air travel flows to industry level exports. Starting from the baseline specification given by Eq. (2), I allow the sector level export shares to take different slope coefficients[33]:

$$lnTrav_{sjt} = \beta_1 lnFare_{sjt} + \beta_2 lnX_{sjt} + \sum_h \delta_h lnz_{sjht} + \beta_4 lnGDP_{st} + Z\beta + \alpha_s + \alpha_{jt} + \varepsilon_{sjt} \qquad (3)$$

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 across the manufacturing sectors. Their identification relies on the observed patterns of specialization across U.S. state exports. More precisely, the sector specific slope coefficients are identified from variation across U.S. 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 model reduces the potential for spurious correlation induced by the co-location of industries with different face-to-face communication intensities. However, this also imposes an empirical

[30] 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.

[31] Less than 1% of the omitted observations are export zeros.

[32] Since the zero travel observations do not have price information, I estimate the model by replacing the airfare variable with the average (economy-class) flight distance interacted with oil prices (i.e., the instrument used for airfares in 2SLS estimations).

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

Table 5
Face-to-face communication intensities across manufacturing sectors.

NAICS	Description	*Export shares*	
		Coefficient	St. Dev.
333	Machinery, except electrical	0.071**	(0.017)
334	Computer and electronic products	0.055**	(0.013)
339	Misc. Manufactured commodities	0.044**	(0.012)
332	Fabricated metal products, nesoi	0.034**	(0.010)
336	Transportation equipment	0.023**	(0.008)
331	Primary metal manufacturing	0.019**	(0.004)
335	Electrical equipm., appliances, compon.	0.019*	(0.010)
311	Food and kindred products	0.016**	(0.006)
326	Plastics and rubber products	0.014	(0.009)
327	Nonmetallic mineral products	0.009	(0.006)
321	Wood products	0.007**	(0.003)
325	Chemicals	0.007	(0.010)
323	Printed Matter and Related Prod.	0.005	(0.005)
312	Beverages and tobacco prod.	0.004*	(0.002)
322	Paper	0.003	(0.005)
315	Apparel and accessories	0.002	(0.003)
316	Leather and allied products	0.002	(0.002)
324	Petroleum and coal products	0.002	(0.003)
313	Textiles and fabrics	−0.001	(0.003)
314	Textile mill products	−0.001	(0.003)
337	Furniture and fixtures	−0.003	(0.003)
	Observations	5928	
	R-squared	0.691	

$p<0.01$; $p<0.05$; $^{+}p<0.1$. Robust standard errors are reported in parentheses.
Note: The table contains estimates for the regression given by Eq. (3) 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.

challenge in terms of handling the industry level export shares that are zero or missing. Since a zero value in one sector compromises the use of the entire vector of trade shares corresponding to that bilateral pair data point, I remove the region–country pairs that have positive trade in fewer than 75% of the sectors; and for the remaining pairs I replace the missing observations for the sector export shares, i.e. z_{sjht}, with a value that is one order of magnitude smaller than the minimum corresponding sample value. This strategy is intended to mimic the literature's solution to dealing with zeros in trade flows, which is to add a small positive value to the zero trade flows prior to taking logs.[34]

Table 5 reports the results. A simple inspection of the sector level coefficients that are positive and significant confirms the insight that complex manufactures are primarily the type of traded goods whose exports require personal interactions between trade partners (Leamer and Storper, 2001). The most 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

Table 6
Correlation between face-to-face communication intensities and product complexity.

	Sector R&D intensity (NSF data)	Contract intensity (Nunn, 2007)	Rauch index
F2F Communication Intensities			
All manufacturing (21 sectors)		0.454*	0.346
Manufacturing with R&D data (15 sectors)	0.656**	0.548*	0.488+

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

product complexity. First I use the average sector level R&D expenditure shares reported by the National Science Foundation (NSF).[35] Then, I take Nunn's (2007) measure of contract intensity, calculated as the proportion of differentiated intermediate inputs that are used in the production of a final good (based on Rauch's, 1999 classification). This measure captures the technological sophistication of a good but also the extent of contractual negotiation that go into its production. Finally, I take Rauch's classification of goods and use it directly to compute the prevalence of differentiated products in each sector.[36] 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 estimates of face-to-face communication intensity 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 involve 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 an essential mean for transferring non-codifiable knowledge.[37]

5. Conclusions

This paper examines the importance of in-person meetings for trade in complex manufactures. The starting point is an exporter's decision to undertake costly travels and meet with foreign trade partners in order to build relationship capital needed in expanding export sales. This set-up leads to a demand equation for in-person meetings. Differences in goods dependence on face-to-face communication, bilateral travel costs and foreign market potential together determine the optimal interaction level within a buyer–seller relationship. These predictions are strongly supported by US state

[34] By removing the region–country pairs that trade in fewer than 75% of sectors, I lose about 25% of the initial sample. In choosing this truncation level, I had to balances the tradeoff between keeping it to a low level the number of export share imputations per bilateral trade pair, while accounting for most of the U.S. bilateral trade flows. In unreported results, I have experimented with lower truncation values, as well as with alternative specifications, for example the Log-Lin specification where the export shares are included in levels rather than the log form to allow for actual zeros in the estimation. Overall the results do not change qualitatively, in the sense that the raking of sectors in terms of face-to-face communication intensity and their conformity with outside measured of product complexity are consistent throughout.

[35] The sector level R&D expenditure shares data is taken from Table 26 in the 2003 Survey of Industrial Research and Development, published by the National Science Foundation (NSF). In calculating the correlation coefficients reported in Table 6, I use the average of R&D expenditure shares over the period 1999–2003.

[36] Since Nunn's contract intensity measure relies on Rauch's classification of goods, the two indicators are not independent measures of product complexity.

[37] This insight is encountered in regional economics (Gaspar and Glaeser, 1998) and information spillovers literatures (Jaffe et al., 1993; Audretsch and Stephen, 1996). Related to this, Hovhannisyan and Keller (2010) provide empirical evidence that inward business travelers raise a country's rate of innovation.

level data on international business class air travel and on manufacturing exports over the period 1998–2003. From industry analysis, I also find that the estimated relationship intensities of trade across manufacturing sectors 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 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 the actual cost imposed by existing restrictions on international air travel. In light of this paper's evidence that business class air travel is valued in international trade, there is additional reason to evaluate the factors that inhibit air passenger traffic. For example, how restrictive are the regulations governing international aviation markets, and what is the impact of recent liberalization efforts? Also, 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.

Appendix A. 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[38]: 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 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.

[38] 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.

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.[39] 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:

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

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.[40]

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,[41] 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).

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

[40] 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).

[41] 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.

Appendix B. Appendix tables

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 and 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	0.26	99.73	99.73
		(max = 0.04)	(max = 0.42)	(min = 99.56)	(min = 99.56)
Avg. export share of total regional exports (%)	–	0.015	0.63	99.63	99.56
		(max = 0.32)	(max = 11.14)	(min = 88.84)	(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

Appendix C. Supplementary data

Supplementary data to this article can be found online at doi:10.1016/j.jinteco.2011.02.003.

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