The Gravity of Experience*

Pushan Dutt†
INSEAD

Ana Maria Santacreu
Federal Reserve Bank of St. Louis

Daniel A. Traca
NOVA School of Business and Economics

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Abstract

In this paper, we establish the importance of experience in international trade for reducing trade costs and facilitating bilateral trade. In an augmented gravity framework, with a very comprehensive set of fixed-effects and trend variables, we find that a 1% increase in experience at the country-pair level reduces trade costs by 0.12% and increases bilateral exports by 0.48%. We utilize multiple identification strategies including difference-in-difference, matching, and instrumental variables. To provide insights into the mechanism by which experience increases bilateral trade, we employ both placebo tests and model based tests. These tests indicate that there are spillovers in experience and that experience reduces bilateral trade costs, especially variable trade costs. To further illustrate our findings, we build a trade model with heterogeneous firms where export-experience reduces variable trade costs, introducing heterogeneity in firm entry decisions for export markets and dynamics for the extensive and intensive margins.

JEL Classification: F10, F14

Keywords: Gravity model; Trade costs; Experience; Extensive and intensive margin

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† Corresponding author: INSEAD, 1 Ayer Rajah Avenue, Singapore 138676; Pushan.Dutt@insead.edu

1 Introduction

World trade has exploded over the last few decades, a phenomenon often associated with a decline in trade costs. However, the underlying determinants of trade costs remain poorly understood (Head and Mayer, 2013a). Multiple studies have identified a persistent and even rising role for gravity variables such as distance, borders, language and colonial ties (Disdier and Head (2008); Head and Mayer (2013a); Head and Mayer (2013b); Egger and Lassmann (2012) and Head, Mayer and Ries (2010)). Prior work, in order to reconcile these persistent effects of such gravity variables for trade, often alludes to informational costs, cultural differences, and the importance of business and social networks in overcoming informal barriers to international trade (Rauch, 1999; Greif, 1994, Chaney 2014). For instance, Grossman (1998) argues that estimated distance effects are too large to be explained by shipping costs and that cultural differences and lack of familiarity account for the persistence of distance, while Anderson and van Wincoop (2004) stress the role of information barriers, contracting costs and insecurity. Head, Mayer and Ries (2010) attribute the decline in trade between countries that shared a colonial link to the depreciation of trade-promoting capital embodied in institutions and networks. Head and Mayer (2013b), drawing on the analogy of dark matter, coin the term 'dark trade cost' and argue that these gravity variables capture some unmeasured and unknown sources of resistance.[1]

In this paper, we take as given that there are some unobserved or 'dark' trade costs, only some of which are captured by traditional gravity variables. Our main hypothesis is that a key factor driving the decline in such trade costs is the cumulative experience in international trade. When a country starts exporting to a new destination, a large component of trade costs is related to the novelty and uncertainty of selling in an unfamiliar environment, identifying customer preferences, engaging with foreign shipping agents, customs officials or consumers, and navigating an uncharted legal and

[1] Head and Mayer (2013b) show that 72%–96% of the trade costs associated with distance and borders are attributable to the dark sources (read unknown) sources of resistance. Some papers attempt to directly incorporate these forces through networks (Rauch and Trindade, 2002), immigartion links (Head and Ries, 1998, Bastos and Silva, 2012), contractual enforcement problems (Anderson and Marcouiller, 2002, and Berkowitz et al 2006) , corruption (Dutt and Traca, 2010), or learning (Allen, 2014 and Chaney, 2014), or bilateral trust (Guiso, Sapienza and Zingales, 2009).

regulatory context (see Anderson and van Wincoop, 2004; Kneller and Pisu, 2011). Experience from repeated local interaction can be effective in gaining familiarity, acquiring information, and building contacts. These in turn, contribute to dampening costs associated with the shipment, border crossing, and distribution in the destination country. Hence the accumulation of experience works to overcome the informational, contractual and cultural barriers, some of which are captured by gravity variables, suggesting that experience reduces trade costs and expands bilateral trade flows. Our paper first establishes a strong and robust role for experience in bilateral trade between pairs of countries, using both aggregate trade as well as trade disaggregated at the 4-digit level. We pay particular care to omitted variable concerns by employing multiple identification strategies. Second, we employ both model-based and placebo tests to shed light on the mechanisms by which experience increases bilateral trade.

Our empirical specification augments the bilateral gravity equation, the literature´s workhorse, to account for the role of experience, measured at the level of the country-pair. We base our experience measure on the number of years of positive trade between a pair of countries. At the country-pair level, we have sufficient variability in experience, both across countries and over time, which allows us to measure experience precisely and identify its importance in lowering trade costs and increasing trade.[2] We allow for both depreciation in experience over time and for diminishing returns in experience for trade. In a baseline gravity specification, with country-year fixed effects, we estimate that a 1% increase in experience increases bilateral trade by 0.9%. In terms of number of years, for a county-pair with the median level of experience, an extra year of trade raises trade by nearly 4%.

Interpreting the estimates of experience as causal requires that experience at the country-pair level is exogenous to unobserved bilateral trade costs. This is especially challenging in our context since omitted variables affect both the current value of trade and our experience measure based on the number of years of strictly positive trade. We first account for this with a very demanding specification that includes, in addition to the country-year fixed effects, country-pair fixed effects,

[2] Data on bilateral trade is consistently available from 1948. By contrast, firm-level trade data is not widely available for large numbers of country-pairs and usually span short time-series. With firm data, there are also censoring and selection (firms die or are acquired) issues.

and country-pair specific trends. Country-pair effects account for all time-invariant unobserved variables that effect both experience and bilateral trade while the pair-specific trends accounts for secular decline in unobserved trade costs at the country-pair level. In this preferred specification, which is essentially a difference-in-difference specification, we rely on *breaks* in experience to identify the coefficient. For country-pairs with an unbroken trading relationship, experience will be absorbed by the dummies and pair-specific trends. Identification relies on a temporary termination and subsequent re-initiation of trade which induces a break in the experience measure. Here we find that a elasticity of trade with respect to experience of 0.45. Equivalently, an extra year of trade between a county-pair raises trade by 2%. This is a very robust finding - it survives a battery of checks where we use different estimation techniques (parametric and non-parametric), deploy alternate samples and data sets, and account for measurement error in our experience variable.

It is well known that a significant proportion of the trade matrix is populated with zeros. In our previous identification strategy, we ignore country-pairs that have never traded with one another. More importantly, firms self-select into exporting, and a gravity model that ignores zeros and fails to account for this self-selection yields biased estimates (Helpman, Meitz and Rubinstein, 2008.) This is a concern for us given that our experience measure is based on the aggregation of a dummy variable that takes the value 1 during years of strictly positive exports at the country-pair level, and 0 otherwise. To correct for this bias, we adopt the two-step methodology of Helpman, Melitz and Rubinstein (HMR) that explicitly models zeros and corrects for the self-selection of firms into export markets. We use the same exclusion restriction as HMR (a variable that affects the initiation of trade but not the volume of trade) and show that our estimates for experience remain unaffected.

Our next identification strategy uses two instruments for experience at the country-pair-year level, drawing on the geographic spread of export (e.g., Chaney 2014) and historical ties between countries (Mitchener and Weidenmier, 2008). The first instrument uses experience of the exporter in countries that are contiguous to the destination but not part of the same preferential trade arrangement as the destination. The second instrument uses experience in countries that were the same empire or the same administrative entity as the destination for a long period (25-50 years in the twentieth century, 75 years in the nineteenth and 100 years before.) Our main identifying assumption for a causal interpretation is that omitted trade-costs making a given destination differentially more attractive for a particular exporting country for both experience and bilateral exports are orthogonal to the exporter experience in the destination's neighbors and experience in countries that were the same administrative entity in the past. We are able to demonstrate that our instruments are strong and we provide some evidence on the validity of the exclusion restriction.

Our final identification strategy uses the matching approach of Abadie and Imbens (2006) and applies it to cross-sectional data, one year at a time. We define high and low experience as a treatment, divide country-pairs into a treatment and control group, where countries in the treatment group have high experience. We use very stringent matching criteria to match country-pairs, matching exactly on all gravity variables, more coarsely on country size, and restrict matches to the same exporter and subsequently to the same importer. This ensures that the treatment and control groups are comparable on all observable dimensions and differ only in experience, that our estimates of the effect of experience does not rely on either outliers or functional form assumptions of the gravity model.

Finally, the use of aggregated bilateral trade data does not allow us to account for composition effects, which could bias our results on the role of experience increasing trade. Sectors that have a lower elasticity with respect to distance could be trading more over time due to specialization. To control for this possibility, we run our augmented gravity equation using country-product-level data at the 4-digit level of disaggregation (with the caveat that we have a shorter sample of data since we are using product level data that span the period 1962-1999). Even when we control for composition effects, we obtain a similar coefficient for experience with such disaggregate data. With this data, we are also able to deploy an alternate identification strategy where we restrict the exporting country to a single origin and add industry-year and destination-year fixed-effects. Here identification relies on variation in experience by 4-digit sectors over time. We pick 5 of the largest exporting countries: USA, China, Japan, Germany and India and find an experience elasticity of trade ranging from 0.65 to 0.81.

Overall, our results imply a causal role of experience for trade. Motivated by our empirical findings, we turn to understanding the mechanisms by which experience affects trade costs. We begin by conducting a series of placebo tests to evaluate whether experience allows exporters to learn about unobserved trade costs (unobserved to the econometrician) in the destination market. First, we show that *importing* experience does not matter for bilateral exports, allowing us to rule out the possibility that our export experience measure is some proxy for slow moving bilateral ties. Second, we construct placebo experience measures by a) randomly assigning experience in a destination to its neighbor and b) by constructing experience measures which coincide with our original experience measure only a fraction of the time. The coefficients and significance of these measures allow us to confirm that it is indeed experience of the origin in the destination that matters. Finally, we replace bilateral exports with bilateral FDI and show that export experience matters negatively for FDI between country-pairs. This allows us to infer that our export experience is not simply a proxy for deeper integration between country-pairs (which would increase FDI) but is likely related to bilateral trade costs, which should boost exports and reduce FDI (an alternate way to serve the destination market).

Next, we decompose the effect of experience on bilateral exports into an effect on the extensive (number of products at the 6-digit level) and on the intensive margins of trade (average exports per product). Within a standard Melitz-Chaney heterogenous firm model, this allows us to understand whether exports reduce fixed and/or variable costs of trade and whether there are spillovers in experience. We find a positive effect of experience on both margins. Such a finding within models suggests a) spillovers in experience since the extensive margin adjusts; and b) that experience must decrease the bilateral variable costs of trade since the intensive margin increases with experience. If experience reduced only the fixed costs of trade, the intensive margin would either decline (in the presence of spillovers in experience) or remain unchanged (in the absence of spillovers).

We close by examining the robustness to misspecification and the sensitivity of our estimates of the point estimate for experience using a recent methodology proposed by Athey and Imbens (2015). Here we are also able to show that experience matters more for countries that are remote in the sense that they are distant, non-contiguous, do not share linguistic, legal or colonial ties, and are not members of trading arrangements. Such remote countries are also ones that have higher unobserved trade costs and to the extent that experience reduces trade costs, it should play a stronger role in facilitating bilateral trade.

To shed more light on these mechanisms, we build a dynamic version of Chaney's (2008) model of heterogeneous firms, where variable trade costs decline as experience is accumulated over time. We show when firms benefit from the experience of their peers, entry in the first period of trade is similar to Chaney (2008). However, different from other static models of trade with heterogenous firms, the extensive margin increases with experience, as non-exporters see their trade costs declining from the experience of the incumbents. The effect on the intensive margin is more complex: the larger exports of incumbents (who see their variable trade costs decline) conflict with the entry of smaller, new exporters, so the effect on the intensive margin is ambiguous (zero if productivity distribution is Pareto but may be positive for other plausible distributions). Next we simulate the model by generating an artificial sample of country-pairs that differ in the parameters governing the international trade costs (both variable and fixed trade costs and experience) and choose parameters to generate a distribution of experience, exports and output similar to that in our data. We then run a similar regression with the simulated data of bilateral trade on experience. We show that what matters is export experience that reduces the variable costs of trade. The exercise illustrates the main mechanism of how experience affects trade costs and trade and allows us to compare the results to those in our empirical section.

Our paper contributes to the trade costs and gravity literature in three ways. First, we establish a causal role for experience in bridging "unmeasured" trade costs associated with informational barriers and cultural differences within the gravity framework. We also provide insights into the mechanisms by which experience reduces trade costs. Second, we develop a model where trade costs are dynamic and evolve over time, driven by the accumulation of experience. Our model introduces dynamic paths of entry into exports and of export volumes in a simple and intuitive way. Third, we provide both direct and indirect evidence that the effects of experience are shared among exporters and non-exporters, which complements the recent literature focusing on the role of networks and search in export decision (Eaton et al, 2012; Chaney, 2014).

The remainder of the paper is organized as follows. Section 2 augments the traditional gravity specification with experience at the bilateral level; Section 3 presents our empirical estimates of experience utilizing a series of identification strategies, correction for zeros, and for composition effects; Section 4 examines the mechanism by which experience increases trade; Section 5 presents some further robustness checks; Section 6 introduces experience in a standard Chaney (2008) model to examine the evolution of the extensive and intensive margins, simulates the model and compares the results from the simulated data to those in our empirical section; Section 7 concludes.

2 Experience and the gravity equation

The gravity equation is the current workhorse for estimating the importance of trade costs for bilateral trade. There are several theoretical frameworks supporting the gravity specification, with exports from country o (exporter/origin) to country d (importer/destination) in time t, denoted by $X_{od,t}$, given as

$$\ln X_{od,t} = \alpha_o \mu_{o,t} + \alpha_d \mu_{d,t} - \theta \ln \tau_{od,t} + e_{od,t} \tag{1}$$

$\mu_{o,t}$ and $\mu_{d,t}$ are exporter and importer-year dummies that capture attributes of the exporting- and the importing-country, respectively, including size and their multilateral trade resistance (Anderson and van Wincoop, 2003). $\tau_{od,t}$ measures bilateral trade costs, with $-\theta$ as the elasticity of exports with respect to trade costs.[3] In the standard equation $\ln \tau_{od,t}$ is specified in terms of bilateral gravity variables, as shown below.

$$\ln \tau_{od,t} = \sum_{m=1}^{M} \gamma_m z_{od,t}^m \tag{2}$$

where $z_{od,t}^m$ are the M gravity variables and γ_m are parameters. Head and Mayer (2013a) perform a meta-analysis and identify as main variables the trade and currency agreements, capturing trade policy, and distance, contiguity, shared language, and colonial links, which measure geographic, cultural, and historical barriers. Substituting (2) in (1) yields an estimable specification

$$\ln X_{od,t} = \alpha_o \mu_{o,t} + \alpha_d \mu_{d,t} - \sum_{m=1}^{M} \theta \gamma_m z_{od,t}^m + e_{od,t} \tag{3}$$

[3] θ has different interpretations depending on the micro-foundations for the gravity equation. It is the elasticity of substitution (minus one) among varieties in Anderson and van Wincoop (2003), the parameter in the Pareto distribution of firm productivities in Chaney (2008) and the parameter governing the dispersion of labour requirements across goods and countries in Eaton and Kortum (2002).

This equation can be estimated using data on bilateral trade flows and the bilateral gravity variables. For bilateral trade flows, two data sources are available. First, International Monetary Fund's *Direction of Trade Statistics* DOTS provides data on aggregate bilateral exports from 208 exporters to 208 importers over the time period 1948-2006. Second, UNCTAD's COMTRADE provides data on bilateral trade between pairs of countries at the Harmonized System 6-digit (HS-6) level of disaggregation. The HS-6 data spans 5017 product categories, for the time period 1988-2006 for 183 importers and 248 exporters. For each year, COMTRADE covers more than 99% of all world trade. The advantage of the DOTS data is the coverage over time, while the COMTRADE data allows us to decompose total exports into an extensive and an intensive margin.[4]

For the gravity variables, we use data from the CEPII gravity database (www.cepii.fr). Geographic distance is measured as the logarithm of the distance (in kilometers) between the two most populous cities. Contiguity is a dummy variable that takes the value 1 if the country-pair shares a common border. Common language is captured by a dummy that equals 1 if the country-pair shares a common official language. Colonial relationship takes the value 1 if a country-pair was ever in a colonial relationship (one country was the colonizer and the other colonized or vice versa). Data on these variables are obtained from the CEPII gravity databases (www.cepii.fr). We also create a dummy variable that captures common law legal origins, from Glaeser and Shleifer (2002) (other finer classifications of civil law, Scandinavian law did not seem to matter). We include also policy-related gravity variables, from Head and Mayer (2013b). We use a dummy variable that captures membership in a currency union. Data on currency unions are from Head, Ries and Mayer (2010). Multilateral market access is captured a dummy variable that takes the value 1 if both trading partners are members of the GATT/WTO and 0 otherwise. Bilateral preferential trade arrangements are captured by a dummy variable which takes the value 1 if both trading partners are members in a preferential trade arrangement (PTA). Data on WTO membership and PTAs are from the CEPII and updated via the WTO website (www.wto.org). Unilateral preferential access is in terms of the Generalized System of Preferences (GSP) where trade preferences are granted on

[4] We use the former to measure experience at the bilateral level and the latter to measure bilateral trade and the extensive and intensive margins.

a non-reciprocal basis by developed countries to developing countries. We code a dummy variable as 1 if the importing county grants a GSP to exporter. GSP data are from Andrew Rose's website and updated from the WTO website.

2.1 Measuring experience

We measure experience using the DOTS database. For any pair of countries o and d at time t in our sample, experience is based on the number of years with strictly positive exports from o to d from 1948 or year of independence to year $t-1$. While past cumulated exports from the origin to the destination country environment is a natural measure of (stock of) experience, such a measure is influenced by the unit value of exports. In addition to changes in the price of exports, experience based on past exports would also be influenced by changes in the sectorial composition of country's exports, both in terms of comparisons across countries and its evolution in time, creating unwanted spurious variation.[5]

Figure 1 shows the distribution of number of years of strictly positive trade since 1948 for all country-pairs in the year 2006: 3.1% of the country-pairs have just initiated trade (experience equals 0 years,) while the median and the mean trading relationship are for 14 and 21.7 years. The variable is right-censored for country-pairs that had strictly positive trade on or before 1948: 7.8% of the country-pairs have a trading relationship at the maximum of 58 years (from 1948 to 2006). Finally, the peak around years 13 and 14 arises from the breakup of the Soviet Union and of Yugoslavia and Czechoslovakia in 1992.[6] In robustness checks, we will account for zero trade, for the censoring of the experience variable, and for the formation of new countries in Eastern Europe

[5] We recognize that our measure of experience does not distinguish between small and large shipments and assumes that experience spills over. We check the sensitivity of our results to dropping small shipments. Subsequently, as a further robustness check, we use the cumulated value of exports at the 4-digit industry level as our experience measure. With disaggregate data, changes in composition and unit values are also less of a concern.

[6] In constructing the experience variable, we coded all countries that were formerly part of the Soviet Union, Czechoslovakia and Yugoslavia as new countries and set experience to zero in their first year of trade after 1992. The exceptions are trade with the Soviet Union which was merged with Russia and with West Germany which was merged with Germany. These choices, while reasonable since exporters plausibly faced a new environment, may also create measurement error in experience.

around 1992-1993.

2.2 A non-parametric look at the data

We start with a non-parametric approach to provide evidence on the importance of experience for bilateral trade. We estimate equation (3) with a complete set of 58 dummy variables, one for the number of years of strictly positive trade, so that experience is simply the cumulated number of years of trade. This specification is flexible in that it makes no functional form assumption and allows for diminishing returns in experience. We include all gravity variables as well as county-year fixed effects. With 0 years of trade as the omitted category, each coefficient captures the cumulated impact of experience on bilateral trade for a country-pair relative to a country-pair with zero experience. These coefficient estimates along with the 95% confidence bounds are shown in Figure 2.

The figure illustrates three findings. First, all the experience dummies are significant at 1%. Second, in terms of magnitude, the coefficient estimates imply a very strong role for experience. An additional year of experience, on average, increases bilateral trade by 6%. Alternately, comparing trade between a country-pair with the median level of experience of 22 years, to a country-pair with 0 experience (or half the experience), trade in the former is 165% (66%) higher. Another way to think of the magnitude, is that 5 years of experience is equivalent to both country-pairs joining a preferential trading area or sharing a common language, while 9 years of experience is equivalent to a colonial link or sharing a common currency.[7] Third, the relationship seems approximately log-linear. We do see some evidence for non-linear effects - visually, we see a stronger role for experience from years 1-13 and a decline thereafter.[8]

We next introduce a single flexible measure of the stock of experience in the gravity model, where we allow for depreciation in experience and employ a flexible log-log specification that can capture diminishing returns of trade with respect to experience.

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[7] We base these comparisons on structural gravity estimates in the recent survey paper by Head and Mayer (2013a).

[8] The slight decline at 58 years of experience is an artefact of the COMTRADE data - this decline does not show up if we use the DOTS data.

2.3 Experience-adjusted gravity specification

We follow the learning-by-doing literature and construct an experience measure (Levitt, List and Syverson, 2013) that allows for the depreciation of experience or "forgetting". We code a variable $I_{od,t} = 1$ if there are strictly positive exports from o to d at data t, and define experience at time t as accumulated according to a perpetual-inventory process:

$$E_{od,t} = I_{od,t-1} + \delta E_{od,t-1}$$

The experience for country pair od at time t is the sum of two components: a fraction δ of the previous accumulated experience and the existence of strictly positive trade in the previous period. δ parametrizes the fraction of experience that is retained from one period to the next with $\delta = 1$ indicating complete retention where past interactions count as much as recent interactions and $\delta = 0$ indicating complete forgetting or depreciation. With $\delta = 1$, experience is simply the cumulated number of years of strictly positive trade.

Given that Figure 2 suggests diminishing returns, we use the natural log of experience.[9] Our experience-adjusted specification for trade costs

$$\ln \tau_{od,t} = \sum_{m=1}^{M} \gamma_m z_{od,t}^m - \lambda \ln (E_{od,t}) \tag{4}$$

We expect $\lambda > 0$ with $\lambda < 1$ implying diminishing returns in experience for trade costs. Substituting in (1) yields an estimable specification for the gravity equation that accounts for the effect of experience.

$$\ln X_{od,t} = \alpha_o \mu_{o,t} + \alpha_d \mu_{d,t} - \sum_{m=1}^{M} \theta \gamma_m z_{od,t}^m + \theta \lambda \ln (E_{od,t}) + e_{od,t} \tag{5}$$

[9] We also carried out a series of tests to choose the functional form for experience. First, we tried the standard Box-Cox transformation. Unfortunately, as is common in datasets with a large number of observations, the test rejects the log-specification in favor of the linear and the linear in favor of the log. Other tests such as the Cox-Pesaran test and the Davidson-Mackinnon J-test yield a similar finding. We follow prior practice and pick the specification with the lowest chi-square statistic in the Box-Cox test and the lowest z-statistic in the Cox-Pesaran test and the J-test. This selects the log specification for experience.

The coefficient $\theta\lambda$ is the experience elasticity of trade, with $\theta\lambda < 1$ implying diminishing returns in experience for bilateral trade.

Therefore, we estimate the following non-linear system of equations

$$\ln X_{od,t} = \alpha_o \mu_{o,t} + \alpha_d \mu_{d,t} - \sum_{m=1}^{M} \theta \gamma_m z_{od,t}^m + \theta\lambda \ln\left(E_{od,t}\right) + e_{od,t} \quad (6a)$$

$$E_{od,t} = I_{od,t-1} + \delta E_{od,t-1} \quad (6b)$$

We estimate equations (6a and 6b) by non-linear least squares to obtain estimates for the retention parameter δ, and for the elasticity of export with respect to experience, $\theta\lambda$. We use the aggregate COMTRADE data to measure bilateral trade flows, the DOTS data starting in 1948 to measure experience, and the previously described measures of gravity variables. Given that non-linear least squares is difficult to implement with a large set of dummies, we first obtain a robust estimate of δ with increasingly comprehensive sets of fixed-effects, and use this estimate to construct the stock of experience. We then use this experience measure and deploy multiple identification strategies to establish the effect of experience on trade. These include a difference-in-difference technique with pair-specific fixed effects and pair-specific trends, an instrumental variables estimate, and finally matching models. In all specifications, standard errors are adjusted for clustering on country-pairs to account for serial-correlation.

Column (1) in Table 1 uses a very basic specification without any fixed-effects. We estimate a retention rate of 0.963 implying that slightly less than 4% of experience is lost each year. While we can statistically reject that $\delta = 1$, substantively it is very close to 1. Column (2) adds a time trend. The time trend term is actually negative rather than positive, and the estimated experience elasticity is slightly higher. Therefore it is accumulated experience that matters rather than the passage of time since initiation of trade. Column (3) uses time dummies instead of a time trend which leaves the estimates for retention and experience unaffected. Column (4) uses 188 exporter dummies, 169 importer dummies and 18 year dummies and is the most demanding specification in the non-linear least-squares context. The coefficient on the retention parameter exceeds but is very close to 1, while the elasticity of trade with respect to experience declines marginally to 0.798. Overall our δ parameter remains close to 1 as we add more comprehensive set of fixed-effects.

Country-year fixed-effects, which is the preferred specification for gravity models (Head and Mayer, 2013a), entails the use of 5487 dummies which is infeasible with non-linear least squares in terms of computational power. Therefore, we used a simpler way to identify the coefficient for δ. We constructed the experience variable for various values of $\delta \in [0, 1.5]$ in increments of 0.05. We then used this variable in the gravity equation with country-year dummies and picked the value of δ that yields the best fit.[10] This results in $\delta = 0.995$. In all subsequent specifications, of the gravity equation with country-year dummies we set $\delta = 0.995$. Column (5) in Table 1 shows the elasticity of trade with respect to experience is 0.887. If θ is the Pareto shape parameter from Chaney (2008) or the parameter governing the dispersion of labour requirements across goods and countries in Eaton and Kortum (2002), then a reasonable value is $\theta = 4$. Our estimate in Column (5) of Table 1 implies that $\lambda = 0.221$ so that trade costs decline by 0.221% for every 1% increase in experience. Overall, while there is very little loss in experience over time, we do have diminishing returns in experience for trade costs and overall trade.

Finally, if we estimate a traditional gravity equation without experience as an independent variable we obtain coefficients on the gravity variables that are significantly higher in absolute terms (14% for distance and legal system; 4% for contiguity; 4% for colonial link; and 37% for language). In other words, accounting for experience significantly reduces the magnitude of the coefficients for the traditional gravity variables.

3 Identification

Absent a randomized controlled experiment, which is obviously infeasible in the context of countries, establishing causality is a challenge. We employ a variety of identification strategies to provide evidence that experience matters strongly for bilateral trade. Since identification assumptions are not entirely free of criticism we deploy a multitude of identification strategies, robustness checks, and placebo tests, and show that the cumulative evidence strongly confirms the importance of experience.

[10] GDP in the importer and exporter country are subsumed within country-year fixed effects.

3.1 Dyadic fixed-effects, pair-specific trends, and lagged dependent variable

Our baseline estimate of the elasticity of trade for experience is reproduced in Column 1 of Table 2. This specification uses country-year fixed effects and relies on variation in experience both across country-pairs and within country-pairs over time. The fixed-effects absorb any effects that are particular to changes in variables at the exporter-year level and the importer-year level (e.g., investment in ports, infrastructure, doing business indicators that facilitate or impede trade, changes in the relative importance of sectors at both the exporting or the importing country). While we also use the standard array of pair-specific gravity variables, they remain necessarily incomplete.[11] For instance, any unobserved dyadic effects that affect both the onset of trade (and therefore our experience measure) as well as trade today would lead to an upward bias in our coefficient on experience. Therefore, we account for unobserved time-invariant dyadic effects by including 25,581 dyadic fixed effects. Since these dyadic effects are time-invariant, we also include pair-specific linear time-trends, one for every country-pair. This is the most demanding specification accounting for all exporter and importer-year terms, all time-invariant characteristics at the dyadic level, as well as for any unobserved country-pair specific variables that evolve in a linear fashion. For instance, if we believe that trade barriers between country-pairs decline in a gradual fashion (e.g., elimination of tariffs after joining a trading arrangement happens only gradually) these should be accounted to some extent, though not entirely, by the pair-specific trends.

In this specification, which is essentially a difference-in-difference specification, identification relies on breaks in trade. For country-pairs with a break in trade, the dummy for strictly positive trade $I_{od,t}$ switches from 1 to 0. When trade re-starts for this pair, the experience measure corresponding to this observation is lower, given that the retention parameter $\delta < 1$. On the other hand, for country-pairs that have traded continuously since 1948 (e.g., US and Canada,) the experience

[11] We also experimented with multiple bilateral gravity variables as additional controls. These include the share of migrants from destination in the origin country (to capture networks,) a dummy that takes the value 1 if both countries are democracies (positive Polity score), political ideology of the ruler in power (coding ideology as left-wing vs. right wing from the Database of Political Institutions), a dummy for country-pairs that were part of the same country in the past (e.g., India and Pakistan,) and further refinements of the colonial links and language dummies (see Dutt and Traca 2010). Our results remain unaffected by these permutations.

measure will be absorbed by the country-year dummies or by the pair-specific trends. Column 2 in Table 2 shows that the experience elasticity of trade declines to 0.436 but remains statistically significant and substantive. The estimate implies that for a country-pair with the median level of experience, an additional year of trade increases bilateral exports by 2%.

Next, we attempt to account for slow moving unobserved dyadic influences on trade that may not evolve in a linear fashion by including a lagged dependent variable following Eichengreen and Irwin (1997). This specification also allows us to distinguish between the short vs. long run effect of experience. This estimate is shown in Column 3 of Table 2. [12] The coefficient on experience declines marginally to 0.333. However, this coefficient captures only the short-run experience elasticity of trade. Our estimates imply that the long-run experience elasticity of trade equals $\frac{0.333}{(1-0.720)} = 0.358$. In fact, we are unable to reject that this long-run estimate of experience elasticity equals the estimate in Column 2.[13]

3.2 Zeros in the trade matrix

Recent papers by Helpman, Melitz and Rubinstein (2008), Evenett and Venables (2002), and Haveman and Hummels (2004) all highlight the prevalence of zero bilateral trade flows. For the bilateral DOTS data used to construct experience, 25% of all possible bilateral trade flows show a zero value. Unobserved trade costs can endogenously create zeros and taking logs removes them from the sample, creating selection bias. In fact, our previous identification strategy ignores country-pairs that have never traded with one another and have experience of zero for the entire time period of the study. This information is potentially important and ignoring it may bias our estimates. More importantly, Helpman, Melitz and Rubinstein (2008), henceforth HMR (2008), argue that firms self-select (or not) into exporting, which leads to a heterogeneity bias, driven by changes in the composition of firms that export. Since our experience measure is constructed on the basis of the dummy $I_{od,t}$ that takes the value 1 when there is strictly positive trade between origin and

[12] The Least Squares Dummy Variables estimator, is inconsistent in the presence of lagged dependent variables. However when the number of time periods is large, as is the case here, this bias goes to zero.

[13] This test yields a chi-square test statistic of 0.56 and a p-value of 0.45. Adding further lags of the dependent variable increases the coefficient estimate for experience.

destination, this is also likely to bias our estimate of experience.

We adopt the two-step HMR methodology and estimate a probit model that predicts the probability of strictly positive trade, for each year in the panel, $\rho_{od,t}$, using the gravity variables and country-fixed effects. For the exclusion restrictions, we follow HMR (2008) and use a common religion index in the probit model: $\sum_k (\mathrm{R}_{k,o} \times \mathrm{R}_{k,d})$,where $\mathrm{R}_{k,j}$ is the share of religion k in country j ($j = o, d$). HMR argue that this variable is affects the fixed costs of trade and therefore the probability of trade but not the variable costs of trade[14]. Next for each year we use the probit model to predict two values: a latent variable z_{od} that determines self-selection into exports as $\widehat{z}^*_{od} = \Phi^{-1}(\rho_{od})$ and the second $\widehat{\overline{\eta}}^*_{od} = \phi\left(\frac{\widehat{\overline{z}}^*_{od}}{\Phi(\widehat{\overline{z}}^*_{od} \cdot)}\right)$ which is the inverse Mills ratio.[15] In the second-step, HMR claim that the following transformation of the gravity equation gives consistent estimates

$$\log X_{od,t} = \alpha_o \mu_{o,t} + \alpha_d \mu_{d,t} + e_{od} * t - \sum_{m=1}^{M} \theta \gamma_m z^m_{od,t} + \theta \lambda \ln (E_{od,t}) + \beta_{e,\eta} \widehat{\overline{\eta}}^*_{od,t} + \widehat{\overline{z}}^*_{od,t} + \widehat{\overline{z}}^{*2}_{od,t} + \widehat{\overline{z}}^{*3}_{od,t} + e_{od,t}$$

where $\widehat{\overline{z}}^*_{od,t} = \widehat{z}^*_{od} + \widehat{\overline{\eta}}^*_{od}$ for each year t. The polynomial in $\widehat{\overline{z}}^*_{od,t}$ is an approximation of an arbitrary increasing function of the latent variable $z_{od,t}$, which controls for firm-level heterogeneity and $\widehat{\overline{\eta}}^*_{od,t}$ is Heckman correction for sample selection bias, again estimated year by year.

Column 4 in Table 2 shows that correcting for sample selection and heterogeneity bias, we see a marginal increase in the coefficient estimate of experience to 0.440. The inverse Mills ratio and the polynomial in $\hat{\bar{z}}^*_{od,t}$ (not shown) are significant at 1%, with signs similar to ones obtained in HMR (2008), showing the importance of correcting for the biases associated with zeros in the trade matrix. Similar to HMR, we find that the bias correction are dominated by the influence of unobserved firm heterogeneity rather than sample selection. [16]

[14] The set of religions we use is more comprehensive than that of HMR (2008), including k = Bahais, Buddhist, Chinese Universist, Christianity, Confucian, Ethnoreligionist, Hinduism, Jainism, Judaism, Islam, Shinto, Sikhism, Taoists and Zoroastrian. The data are from the Association of Religion Data Archives.

[15] HMR show that z_{od} is the ratio of the export profits of the most efficient firm to the common fixed export cost for exporters from o to d, is a latent variable and selection of firms into export markets is a monotonic function of this variable.

[16] We also use the methodology of Santos Silva and Tenreyro (2006) that treats bilateral trade as a count variable

3.3 Instrumental variable estimates

Even with a very comprehensive set of fixed-effects and dyadic trends, we only account for selection on observables. Any unobserved time-varying bilateral variable not captured by the pair-specific trends that affects both the onset of trade and trade flows, can still result in biased estimates. Therefore, our second identification strategy relies on instruments for experience $E_{od,t}$. As instruments, we need variables that are correlated with our causal variable of interest, namely experience, but uncorrelated with any other determinants of bilateral exports. In particular, the instrument should matter strongly for experience (strong instrument) but should not affect bilateral exports except through the experience channel (exclusion restriction).

We draw on recent work on the geographic spread of exports to construct our instruments. Chaney (2014) builds a network model of trade and shows that if a firm exports to a destination, it is then more likely to subsequently enter a new destination that is geographically close to the first destination. Evenett and Venables (2002) examine 23 developing countries between 1970 and 1997, and show that a product is more likely to be exported from a certain country if the origin country is supplying the same product to nearby markets. Carrère and Strauss-Kahn (2014) use product level data for non-OECD exporters and find that experience is first acquired in neighboring, easy to access destinations before reaching to more distant, richer partners and ultimately serving the OECD.[17] We exploit this pattern of the geographic spread of exports to construct our first instrument for experience as the experience of the origin o in all countries that are contiguous to destination, and take the simple average across all neighbors. For this to be valid, it instrument should be strongly correlated with experience in the destination, but exogenous to unobserved trade

and uses the Poisson Pseudo-Maximum Likelihood (PPML) to estimate the coefficients. Since the dependent variable is trade, rather than the log of trade, it also accounts for zeros in the trade matrix. When we apply the PPML methodology we obtain a statistically significant coefficient of 0.577 for experience.

[17] Morales et al. (2015) use Chilean data to show that the entry of an exporter in a particular market increases the likelihood of his entry into other similar markets. In particular, they find that firms are more likely to export to countries sharing a border with countries to which they were exporting in the previous period. Similarly, Eaton et al (2008) use data on Colombian exporters to show that these exporters use neighboring markets as stepping stones to other Latin American markets.

costs faced by exporters from o in the destination d. To ensure that this is a valid instrument, we average only over neighboring countries of d that are not part of a preferential trading arrangement with d. Under a PTA, there may be spatial correlation in unobserved trade costs and excluding these countries may invalidate the exclusion restriction. Call this instrument $E^{nbr}_{od,t}$.

Our second instrument relies on historical links between destination countries based on whether they were part of the same empire and/or administrative entity in the past (Mitchener and Weidenmier, 2008). We average the experience of o over countries that were or are the same state or the same administrative entity for a long period (25-50 years in the twentieth century, 75 years in the nineteenth and 100 years before) as the destination d. This definition covers countries belonged to the same empire (Austro-Hungarian, Persian, Turkish), countries that have been divided (Czechoslovakia, Yugoslavia, India) and countries that belong to the same administrative colonial area (e.g., Philippines and Mexico were subordinated to the New Spain viceroyalty). The data are from CEPII.[18] Call this instrument $E^{same}_{od,t}$.

Our key identifying assumption is that experience of the origin in the neighbors of the destination and experience in countries that were historically part of the same state/empire/administrative entity as the destination is unrelated to bilateral exports from o to d (except through its effect on experience $E_{od,t}$). Overall, we identify the experience effect on bilateral trade by basing it on the systematic component of experience for the neighbors of the destination, and experience in countries that were the same as the destination, rather than destination-specific idiosyncrasies. We continue to implement our preferred specification which includes country-year and country-pair dummies as well as pair-specific trends. Inclusion of these comprehensive set of controls allows us to guard against a wide range of threats to our identifying assumption.

Column 5 in Table 2 reports a first-stage partial R^2 of 0.33 and a first-stage F-statistic of 1339.44 which easily clears the first-stage relevance tests, including the Stock-Yogo weak instruments test, indicating that our instruments are strong.[19] The coefficient on experience increases marginally

[18]Note that 444 country-pairs are neighbors but not part of the same country while 150 country-pairs were part of the same country in the past but are non-contiguous.

[19]The first-stage yields: $E_{od,t} = \underset{(0.112)}{0.404} E^{nbr}_{od,t} + \underset{(0.110)}{0.253} E^{same}_{od,t} + controls$

to 0.481. In fact, the instrumental variable estimates are qualitatively and quantitatively similar to those presented in Column 2 of Table 2. Column 7 of Table 2 also reports the Hansen J-test of overidentification (OID) restrictions, which tests the null hypothesis of overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. Rejection of this null hypothesis casts doubt on the validity of the instruments. As Table 2 shows we obtain a $p-$value of 0.31 showing that our instruments are uncorrelated with the error term in the second-stage gravity equation.

The OID test is not a true test of the exclusion restrictions. It simply checks if all subsets of the instruments asymptotically return the same estimate of the effect of experience. While we use a comprehensive set of dummies and trends, it could be argued that an exporter's experience in neighboring countries simply reflects its region-specific exporting strategy. In this case, experience in neighbors affects bilateral trade not only via experience but also via some unmeasured channel that is exporter-region-year specific. To guard against this possible violation, we also included exporter-region-year dummies in the IV specification.[20] We then obtain a significant coefficient on experience of 0.372 (not shown).

We also evaluated the validity of the instruments by restricting our sample to only oil exporters. It seems reasonable that these countries are likely to export to a destination regardless of whether they have experience in the neighboring countries or in countries that were the same as the destination. We can think of these exporting countries as "always takers" - countries where the instrument does not matter for experience. Any relationship between the instruments and the log of exports for such exporters is indicative of violation of the exclusion restrictions. For these countries, a reduced form regression of the two instruments (and other gravity variables) on bilateral exports shows that these instruments are statistically insignificant.

[20] The regional classification is East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, North America, South Asia and Sub-Saharan Africa.

3.4 Matching estimate

In standard gravity specifications, since we cannot measure trade costs directly, researchers tend to include only their proximate determinants. At the same time, the standard gravity equation implicitly assumes that the relationship between the log of trade and these proxies such as distance, language, colonial ties etc. of true trading costs is linear. This assumption may be questionable. For instance, sharing a common colonial history (and thus similar institutions) and geographic distance may interact with one another so that their effect may not be their summed effects in isolation. Similarly, the existence of border effects implies a non-linear effect of distance. In other words, proxies for trade costs (including experience) may affect bilateral trade in more complex non-linear ways.[21] More importantly, in our context, country-pairs that broadly have a lot of experience in trade may differ systematically from those with little or no experience (lack common support). These country-pairs are not randomly selected, and pooling such different country-pairs may yield an upward bias in our coefficient estimates.

In an idealized setting, we would randomly assign some country-pairs to a treatment group of high experience in exports and others to a control group of low experience. Of course such randomized experiments are not possible in the context of countries. We therefore adopt a matching approach to ensure that country-pairs with high and low experience in trade are as comparable as possible along key observables. The matching methodology has several advantages. It ensures overlap and comparability between country-pairs with high and low experience so that we can be assured that the results are not are not being driven by outliers and are not sensitive to specific functional form assumptions of the gravity equation (Heckman et al. 1997, Imbens 2004). To the extent that matching is on observables, it also reduces biases due to endogeneity in experience (Dehejia and Wahba 1999). Finally, identification relies on a pure cross-sectional comparison, which complements the ones shown so far. Therefore, our next identification strategy relies on matching models and applies it to the cross-sectional data.[22]

[21] Eicher, Henn, and Papageorgiou (2012) also highlight that the variety of estimates of say PTAs in gravity equations reflect model uncertainty.

[22] See Baier and Bergstrand (2009) for a matching estimate of the treatment effect of an FTA.

Since these models apply to the average effect of a binary treatment, we first convert an experience measure into a binary measure, by defining the treatment indicator as 1 if E_{od} for country-pair exceeds the median in 2004 across country pairs (this translates into 13 years of positive trade.) As in all matching models, the key goal is to prune observations so that the remaining data is balanced in terms of the covariates between the treated and control groups. Instead of using approximate matching based on Mahalanobis distance or propensity score, we implement very stringent matching criteria. We matched exactly on all binary gravity variables, and on year by default (we present estimates only for the year 2004 in the table) and employed coarsened exact matching (CEM) using 10 bins for distance and country size (GDP in origin or destination.)[23] We also restrict matches first to the same exporting country and then to the same importing country. This yields a sample of 6,259 observations when we match on the exporter in Column 6 and 5,823 observations in Column 7 when we match in importer. For each exporting (importing) country, a control and treated destination (origin) show identical values for all discrete gravity variables, and very similar values in terms of distance and GDP, with high and low experience as the only difference.[24] Identification does not rely on country-pairs where experience is always greater (or always lower) than the median experience (example, US-Canada and US-India where experience exceeds the median for both). We rely on many-to-many matching to fully utilize available data, and use CEM-generated weights to infer "average treatment effect on the treated (ATET)" (Imbens 2004, Iacus et al. 2011 and 2012.) We examine the average treatment effect on the treated (ATET) since our sample includes only country-pairs with strictly positive trade (with the log of trade as the outcome variable, all zero trade observations are dropped.) After pruning the observations to achieve balance, we also added the gravity variables and exporter and country fixed effects as controls (Iacus et al. 2011).

[23] Our distance classification is finer than Eaton and Kortum (2002) who decompose distance effects into only four intervals.

[24] As an example, when we restrict matches to the same exporter, Turkey as exporter and Botswana as importer are a country-pair in the control group with 9 years of positive trade in 2004 while Turkey and Zimbabwe pair are in the treatment group with 24 years of positive trade. If we match on importer, then Haiti has only 5 years of positive exports to Thailand while Honduras has 22 years of experience exporting to Thailand. Honduras-Thailand are in the treatment group while Haiti-Thailand are in the control group.

In both Columns 6 and 7 of Table 2, we find that coefficients that are similar to the pooled estimate in Column 1 - an experience elasticity close to 1. To show that this is not an artefact of the choice of year, Figures 3a and 3b show the estimate and confidence interval for average treatment effect for experience for each of the years from 1988-2006. The magnitude of the estimated coefficient is very similar over the years and tightly estimated from 1992 onwards. In the initial years, while the coefficient on experience is significant, the confidence intervals are broad. This is due to the use of the very stringent matching criteria so that we obtain few matches in the initial years of the sample.[25]

3.5 Composition effects: Augmented gravity with disaggregate data

The use of aggregated bilateral trade data does not allow us to account for composition effects, which could bias our results on the role of experience in increasing trade. For instance, our results may reflect that sectors with a lower elasticity with respect to distance (or other trade costs) are exporting more over time due to increased specialization. To control for this possibility, we run our augmented gravity equation using country-product-level data at the 4-digit level of disaggregation with the caveat that we have a shorter sample of data since we are using product level data that span the period 1962-1999. With disaggregate data, we also exploit variation in experience within country-pairs across industries and over time to identify the effect of experience. It also allows us to construct multiple measures of experience - at the industry-country-pair level, as well as destination-specific experience across sectors. The latter captures spillovers in experience across 4-digit sectors.[26]

We use the bilateral commodity trade data from NBER-UN (Feenstra et al, 2005) available at the 4-digit SITC Rev. 2 level of disaggregation. Even though we lack rich firm-level trade data to

[25] We also coded experience as a multi-valued treatment in intervals of 5 years and find similar results. These results are available upon request.

[26] Spillovers are partly facilitated by trade associations and export promotion bodies (Lederman, Olarreaga and Payton, 2010), worker mobility (Molina and Muendler, 2013), and partly by simple observation (Segura-Cayuela and Vilarrubia, 2008). For instance, Artopoulos et al (2011) use a detailed case study of firms from four export sectors in Argentina, to show how pioneers' export experience diffuses to other firrms who follow the pioneer into exporting.

accurately measure firm export experience for a large set of destinations, the 4-digit commodity trade data is a reasonably good compromise. It spans years 1962-1999 allowing us to measure experience relatively accurately, and covers 98% of world trade. With disaggregate data, we implement another change - measuring experience as cumulated exports rather than cumulated years of positive trade. With aggregate data, since changes in composition of exports over time and in unit values create measurement error in our experience variable, we chose to base the experience measure on number of years of trade. At the disaggregate level, the concerns related to changes in the composition of exports or in unit values over time are mitigated, though not completely eliminated. Therefore, our experience measures are based on the cumulated value of trade, rather than an indicator variable that captures trade vs. no-trade. The measure is more aligned with the learning-by-doing literature and also allows us to capture the intensity of experience since we now distinguish between 'small' and 'large' trade flows.[27][28]

While the NBER-UN 4-digit export data starts in 1962, a significant product reclassification was undertaken in 1983 (from SITC Rev 1 to SITC Rev 2). Given the potential for this re-classification inducing measurement error, for estimation we use data only from 1984 onwards.

We construct own experience at the industry-country-pair level $E^k_{od,t}$ as

$$E^k_{od,t} = X^k_{od,t-1} + \delta_1 E^k_{od,t-1} \tag{7a}$$

where $X^j_{od,t-1}$ is the value of exports from o to d in 4-digit industry k and δ_1 is the retention parameter for own-learning. Next, for each origin country, we also measure destination-specific experience as

$$E_{od,t} = \sum_k X^k_{od,t-1} + \delta_2 E_{od,t-1} \tag{7b}$$

This measure is based on the sum of exports across sectors to a particular destination and captures spillovers across 4-digit industries. We allow for a distinct retention parameter δ_2. For completeness, we also include a measure of industry-specific experience which is based on cumulating exports

[27] The NBER-UN data set includes data provided they exceed $10,000 per year.

[28] Our results also work when we measure experience in terms of years of positive trade.

across destinations for each sector.

$$E^k_{o,t} = \sum_d X^k_{od,t-1} + \delta_3 E^k_{o,t-1} \tag{7c}$$

The industry-specific experience is related to the comparative advantage of a particular sector as well as to experience in production reducing production costs, rather than to experience in exporting to a particular destination that reduces trade costs. We use these three experience measures in a gravity equation for exports at the industry-country-pair level.

$$\ln X^k_{od,t} = \alpha_o \mu_o + \alpha_d \mu_d + \alpha_t \mu_t - \sum_{m=1}^{M} \theta \gamma_m z^m_{od,t} + \theta \lambda_1 \ln \left(E^k_{od,t} \right) + \theta \lambda_2 \ln \left(E_{od,t} \right) + \theta \lambda_3 \ln \left(E^k_{o,t} \right) + e_{od,t} \tag{7d}$$

As with the aggregate data, we estimate equations (7a)-(7d) using non-linear least squares, estimating the three retention parameters indexed by δ and the three experience elasticities indexed by $\theta\lambda$. With more than 5 million observations, we estimate this system first without any dummies (Column 1 in Table 6) and then with origin, destination, and time fixed effects (Column 2 in Table 6). In both specifications we estimate an elasticity of export experience that is industry and destination specific of 0.9 and a retention parameter $\delta_1 = 0.64$. The retention parameter δ_2 for the destination-specific experience is 0.002 in Column 1 and declines to 0 when we add the fixed-effects. This suggests that for destination-specific experience across sectors, there is almost no retention beyond the previous period. At the same time, we do observe spillovers across sectors - a 1% increase in destination-specific experience across sectors, increases bilateral sectorial trade by 0.055%. We can think of this as a lower bound for spillovers since $E^k_{od,t}$ aggregates all trade within each 4-digit sector for a particular. Therefore, the estimated coefficient also encapsulates spillovers across sub-categories within a 4-digit sector.

Using more comprehensive fixed effects is computationally infeasible. Therefore, in Column 3, we set the retention parameters to the estimates in Column 2, and re-estimate the equation (7d) with exporter-year and importer-year fixed effects. We observe a slight decline in the coefficient of own experience and a more than halving of the coefficient for destination-specific experience. Despite the decline, there still remains a significant role for both own and destination-specific experience.

Next, we evaluate the robustness of experience to an alternate identification strategy with disaggregate data. We restrict the exporting country to a single origin and add industry-year and destination-year fixed-effects. Since we restrict the data to a single origin country, identification relies on variation in experience by 4-digit industry over time. In this specification, coefficients on destination-specific and industry-specific experience are subsumed in the destination-year fixed-effects and industry-year fixed-effects, as are all gravity variables including all unobserved pair-specific trade costs. We pick 5 of the largest exporters: USA, China, Japan, Germany and India. For each of these we find an experience elasticity of trade ranging from 0.653 to 0.813, which is higher than that of our preferred specification in the aggregate data (with country-pair dummies and pair-specific trends). The higher coefficient is reasonable since learning opportunities within a particular sector selling in a destination are likely to be stronger.

Overall, we are able to confirm that our results are not driven by composition effects and that there are spillovers in experience.

4 The Mechanism

Next we turn our attention to understanding the mechanisms by which experience promotes bilateral trade. Our contention is that experience allows exporters to learn about trade costs, especially unobserved trade costs (unobserved to the econometrician) in the destination market. We evaluate this in two ways. First, we carry out a series of placebo tests that indicate that export experience of the origin in the destination, reduces bilateral trade costs in the destination. Second, we decompose bilateral exports into an extensive and intensive goods margin, and draw on a standard Melitz-Chaney model to interpret the effect of experience.

4.1 Placebo tests

In our first placebo test, we examine whether the *importing* experience of country o from d matters for *exports* from o to d. To the extent that the importing experience at the country-pair level also cumulates slowly over time, a significant effect of this variable would lead us to suspect that our exporting experience measure is some proxy for slow moving bilateral ties and not destination-specific trade costs encountered by exporters. This would render the interpretation of our findings questionable. Row 1 of Table 4 shows that importing experience of the origin from the destination does not matter for bilateral exports from the origin to the destination.

Second, we randomly varied the dummy for strictly positive trade $I_{od,t}$. For each country pair, we generated a random sequence of 0's and 1's and replaced the dummy $I_{od,t}$ with this random sequence. An experience measure for such a random sequence does not matter for bilateral trade as shown on Row 2. Next, we replaced $I_{od,t}$ only for each pair's first 50% of the observations and subsequently only for the second 50% of the observations. We used these two perturbations to construct additional placebo experience measures. Note that these measures coincide with our experience measure exactly half the time. Row 3 shows that replacing the first 50% of $I_{od,t}$ renders this placebo experience measure insignificant. This indicates that the first 50% of the experience measure has significant informational content, consistent with a retention parameter $\delta < 1$ and diminishing returns in experience. When we replace only the second 50% of $I_{od,t}$,the new placebo measure coincides with our original experience measure for the first 50% of the observations. Not surprisingly, since initial experience counts for more, Row 4 shows that the placebo experience measure that coincides with the original experience measure for the first 50% of observations does matter for bilateral exports. The lower coefficient of 0.13 also seems reasonable - while the first few years of trading experience is critical, additional accumulation of experience matters as well. If we include our original experience measure and either or both of these placebo experience measures, then the placebo measures are insignificant while the original experience measure continues to be strongly significant.

Third, we followed a quasi-randomization procedure and assigned the experience of each exporter in a particular destination to the alphabetical neighbor of the destination country from the same region. This allows us to check if our experience measure is simply picking up omitted variables that are specific to a particular region. Row 5 shows that this placebo measure does not affect bilateral exports. Next, we assign the experience of each exporter in a particular destination to the alphabetical neighbor of the exporter from the same region. Row 6 shows we obtain a negative coefficient on this placebo experience measure. Overall, these placebo tests demonstrate that it is the experience of the exporter in the destination that really matters for bilateral exports.

Finally, it may be argued that our experience measure is simply a proxy for deeper integration between country-pairs, which may manifest itself as harmonization of worker, product and environmental standards, IP regulations, tax rules, etc. In fact, recent preferential trading arrangements increasingly emphasize such issues over formal trade barriers. As such our experience may be unrelated to unobserved pair-specific trade costs. To examine this, we replace the dependent variable with a measure of bilateral FDI stock from CEPII, available for a single year 2004.[29] We find a strong *negative* role for experience (see Row 7 of Table 4). To the extent that export experience facilitates bilateral trade by reducing trade costs, our finding is consistent with the contention that FDI and exports are substitutes for serving a particular destination.[30]

4.2 The margins of international trade

Next, we analyze the effect of experience on the extensive and intensive product margins of international trade. Chaney (2008) provides closed-form solutions of how declines in variable and fixed bilateral trade costs affect the two margins, under the assumption that firm productivities follow a Pareto distribution. Examining the coefficient on experience for the two margins thereby allows us to infer whether experience reduces the fixed vs. variable costs of trade and whether there are spillovers in experience.

Following Eaton, Kortum, and Kramarz (2004), Bernard, Jensen, Redding and Schott (2007), and Flam and Nordstrom (2007) we decompose bilateral exports $X_{od,t}$ as the product of an extensive margin ($N_{od,t}$), defined as the number of 6-digit products traded, and an intensive margin ($\overline{x}_{od,t}$), defined as the volume of exports per product so that

$$X_{od,t} = N_{od,t} * \overline{x}_{od,t} \tag{8}$$

Interpreting each 6-digit sector as a firm allows us to map our empirical findings to the Chaney (2008) model.

[29] In this cross-section, we include only exporter and importer fixed-effects.

[30] We also experimented with sales of foreign affiliates of multinationals from origin o, in country d.The coefficient on the export experience measure is again negative but insignificant.

In Chaney (2008), a reduction in either fixed or variable costs leads to more entry into a bilateral export market and thus increases the extensive margin. A reduction in *fixed* costs typically reduces the intensive margin: the increase in entry does not affect export sales of incumbents and the average exports per firm is brought down even further by the fact that the entrants are less productive and enter at a smaller scale than incumbents. A reduction in *variable* costs increases the export revenues of incumbents, but this is counteracted by entry of new firms with lower productivities and hence lowers sales than the incumbents. When productivities follow a Pareto distribution, the average export per product does not change so the intensive margin is unaffected by a change in variable costs. Dutt et al (2013) show how this knife-edge result changes for distributions other than Pareto. With other plausible distributions a drop in variable costs leads to an increase in the intensive margin.

If experience reduces bilateral trade costs, the effect on the each margin will depend upon a) whether there are spillovers in experience across sectors/firms and b) whether experience reduces the fixed or variable costs of trade. Consider a scenario where there are no spillovers in experience and experience reduces only the fixed costs of trade of incumbents. In this scenario, neither the extensive nor the intensive margin is affected by experience. Alternately, if experience reduces variable trade costs but there are again no spillovers in experience, we should expect no adjustments in the extensive margin along with an increase in the intensive margin. Here the number of products exported should remain unaffected as potential entrants do not benefit from experience while incumbent firms increase their exports raising the export per product. Therefore, the extensive margin will increase with experience only if there are spillovers in experience. If experience spills over and reduces only the fixed costs of trade, the intensive margin should decline (there is no impact on exports of incumbent firms but the new entrants enter at a smaller scale reducing export per product). Finally, if experience spills over and reduces the variable costs of trade, the impact on the intensive margin is ambiguous - exports of incumbent firms increase which raises export per product but entry at a smaller scale reduces export per product. The effect is zero for the Pareto distribution but positive for other plausible distributions.

Table 5 shows the effect of experience on the two margins of trade for our baseline specification and a specification that adds dyadic fixed effects and dyadic trends. Columns 1-3 show that both margins increase with experience, with approximately 43% of the increase in overall trade coming via an adjustment of the extensive margin, and 54% coming via the intensive margin. Adding dyadic effects and pair-specific trends in Columns 4-6 does not affect the sign and significance of experience on the two margins, but now 60% of the effect of experience on trade is via the extensive margin and 40% via the intensive margin. Overall, both margins increase with accumulated experience.

The fact that the extensive margin increases with experience indicates that there are spillovers in experience across 6-digit sectors, with stronger effects in the more demanding specification. This is in line with our findings with disaggregate data where we demonstrate spillovers in experience across 4-digit sectors. The fact that the intensive margin increases with experience allows us to rule out the case that experience reduces only the fixed costs of trade. Overall, these results are consistent with a mechanism where export experience spills over across firms/sectors and where experience reduces the variable costs of trade.

5 Robustness checks

5.1 Model misspecification

In arriving at our point estimate for the elasticity of exports with respect to experience, and the standard error of this estimate (call this σ_1), we assumed that the log of experience affects the log of exports in a linear fashion, with all other gravity variables entering independently. Plausibly, different choices for this specification decision may lead to different point estimates of the effect of the experience. For instance, experience may matter more for certain country pairs, say those which are more distant, non-contiguous, and lack colonial, legal, or linguistic links. Athey and Imbens (2015) suggest a new test of robustness to such specification choices by supplementing conventional standard error of the point estimate with a scalar measure of the sensitivity of the estimates to a range of alternative models. We implement their test by splitting the sample into subsamples based on covariate values of every gravity variable, estimating the model separately for each subsample, and then combining the results to form a new weighted estimate of the overall effect.[31] The weights used are the fraction of observations in each subsample. The Athey and Imbens robustness measure is the standard deviation of the point estimate of the effect of the experience over the set of models(call this σ_2). A high value of $\frac{\sigma_2}{\sigma_1}$ indicates that point estimate is non-robust and sensitive to model specification.[32]

To the extent that these gravity variables are proxies for unobserved trade costs, we should expect a higher coefficient for experience when countries are remote in the sense that they are geographically distant, non-contiguous, not members of any WTO/PTA/GSP, do not share a common language, or colonial ties. This would also support our contention that the mechanism by which experience matters is via a reduction in unobserved trade costs.

Our baseline specification is the one in Column 2 of Table 2 (includes time-varying gravity variables, country-year and country-pair dummies and pair-specific trends) which yields a coefficient on experience of 0.438 and a standard error of 0.069 (shown as σ_1 in the next to last row of Table 6). Each row in Table 6 shows the coefficient on experience for a sample split based on one gravity variable. For the time-varying binary variables such as WTO, PTA and GSP membership, we split the sample based on the values taken by these variables for the first year of data so that the sub-samples include the same country-pairs for all years. For distance, we split the sample into three subsamples based on mean ± 1 standard deviation of distance. The last column shows the weighted average of the coefficient estimates over these sample splits.

We see that experience matters more in country-pairs that do not share WTO, PTA and GSP membership, and that do not share a common currency. Experience also has a bigger effect on dyads that are non-contiguous, that do not share a colonial relationship, or a common law legal system. The coefficient for experience is very similar regardless of whether country-pairs share a common language or not. The exception is distance - the effect of experience initially increases and then declines with distance in the three sample splits.

[31] Each of these specifications nests the baseline model as a special case.

[32] Athey and Imbens (2015) compare the ratio $\frac{\sigma_2}{\sigma_1}$ of an experimental setting with randomization to a non-experimental setting. In the experimental setting this ratio is 0.2 while it equals 3.338 for the nonexperimental data. They infer that the results for the experimental data are far more robust than those for the nonexperimental data.

In terms of the Athey-Imbens robustness test, the standard deviation of estimates across model specifications is 0.016 (shown as σ_2 in Table 6). $\frac{\sigma_2}{\sigma_1} = 0.232$ so that the standard error of estimates across models is 23% of the baseline standard error of 0.069. Therefore, our results are robust to misspecification while the heterogeneity in the effect of experience is in line with our contention that experience matters more for countries that are remote as measured by standard gravity variables.

5.2 Censoring, country re-classification, small shipments

Next, we perform a further set of robustness checks where we continue to include country-year and pair-specific fixed-effects as well as pair-specific trends. First, our experience variable based on the DOTS data is right-censored at 50.46 (equivalent to 58 years of continuous trade since 1948 with a retention parameter of 0.995). To account for the right-censoring, we added a dummy variable for all censored observations. Including this dummy does not change the sign, significance, or magnitude of the estimates. An alternative dataset from the Correlates of War (COW) Project tracks bilateral trade from 1870-2006 (Barbieri, Keshk and Pollins, 2012). Relying on this data to construct experience may mitigate the right-censoring concern. However, the COW data, by going further back in time, requires fairly strong assumptions about shifts in country identities through division, unification, and emergence from colonial rule. Of more concern is the fact that COW provides trade data on former colonies in Asia, Africa and Latin America only when they become independent. In contrast, the DOTS data captures bilateral data for these countries prior to colonization. Therefore, experience constructed on the basis of COW data is also not free of measurement error. For this reason, we use the DOTS-based measure as our main measure of experience, and use the COW-based measure to examine the impact of censoring at 58 years. With experience constructed using COW data, the coefficient on experience declines slightly to 0.364.[33]

Our findings for experience may be confounded by shifting political boundaries in Easter Europe following the collapse of communism. Therefore, we sequentially dropped 14 countries that were part of the Soviet Union, the 4 countries that formerly constituted Yugoslavia, and finally Czech Republic and Slovakia. In all cases, we observe a marginal increase in the coefficient of experience.

[33] All results are available upon request.

Finally, in the DOTS data, trade below \$5,000 is set to zero, given the accuracy levels acknowledged by the IMF. Therefore, very small shipments are excluded in constructing our experience measure. Beyond \$5000, we do give the same weight to small and large shipments in constructing the experience measure, based as it is on dummies for positive bilateral trade. This may lead to an over-estimation of the effect of experience. We therefore evaluate the sensitivity of our results to dropping small shipments by dropping the smallest 1 and 5% of bilateral export shipments. There is a marginal decline in the coefficient for experience to 0.397 and 0.389 but it remains strongly significant.

6 An Illustrative Model

Now, we introduce a model to illustrate the mechanisms behind the results of the empirical section, namely the impact of experience on trade flows and the role of experience spillovers on the dynamics of entry (the extensive margin). The illustrative nature of the exercise has pushed us to choose simplicity, rather than developing a complex model of the learning processes of firms in export markets (see Chaney, 2014).

We build on the Melitz (2003) and Chaney (2008) two-country model of heterogeneous firms with fixed costs of exports, introducing the impact of experience in lowering trade costs. The two countries, denoted o (origin) and d (destination) are symmetric, facing the same structural parameters governing preferences, technology and trade costs. In each country i at time t there is a non-traded final good, Y_{it}, produced competitively using a continuum of differentiated traded intermediate goods from each country, according to

$$Y_{it} = \left(\int_{k \in O,D} x_{kit}^{\frac{\varepsilon-1}{\varepsilon}} dk\right)^{\frac{\varepsilon}{\varepsilon-1}} \qquad i = o, d \tag{9}$$

where $\varepsilon \gg 1$ is the elasticity of substitution, and x_{kit} is the intermediate k used in the production of the final good in country i. Intermediate k may be in the continuum O or D, if produced, respectively, in o or d. Two elements should be noted. First, intermediates from o used in d are the exports from o to d, whereas, conversely, the intermediates from d used in o are the exports from d to o. Second, the elasticity of substitution between domestic intermediates is similar to that between domestic and foreign intermediates. Profit maximization by the producers of the final good yield the demand for intermediate k

$$x_{kit} = \left(\frac{p_{kit}}{P_{it}}\right)^{-\varepsilon} Y_{it}, \qquad i = o, d \tag{10}$$

where p_{kit} is the price of intermediate k in i, and P_{it} is the price of Y_{it} with

$$P_{it}^{1-\varepsilon} = \int_{k \in O,D} p_{kit}^{1-\varepsilon} dk, \qquad i = o, d \tag{11}$$

Each intermediate good k is produced by a monopolistic competitive firm according to $x_{kt} = a_k l_{kt}$, where a_k is the firm's productivity and l_{kt} is labor, the only factor of production in our model. Hence its unit cost of production is W_{it}/a_k, where W_{it} is the nominal wage in the country of firm k. The distribution of productivity is constant over time and symmetric across countries, captured by the density $g(a)$ on the support $[1, +\infty]$. In line with Chaney (2008), we simplify and assume that g follows a Pareto distribution, with a scaling parameter $\theta \gg 1$, such that: $g(a) = \theta a^{-(\theta+1)}$ and $P(a > \bar{a}) = \bar{a}^{-\theta}$.

Exports of each intermediate good k is subject to trade costs. There is a fixed export cost, which we assume is prohibitive at the beginning of time, but lowers to $F < \infty$ after a probabilistic event, which allows exports to begin. We will denote by $t = 0$ the time of this event. We assume that the fixed cost is constant, common to all firms and set in terms of the final good. There is also a variable (iceberg) trade cost. To capture the notion that variable trade costs decline as exporters increase familiarity with the local context and discover better and cheaper ways to transport, clear customs and distribute, we set the iceberg trade cost of intermediate k, τ_{kt}, as a function of experience, denoted by $E_{kt} \geq 0$:

$$\tau_{kt} = \tilde{\tau}(g + E_{kt})^{-\lambda} \tag{12}$$

where $\tilde{\tau} > 1$, g is positive but small, and $\lambda \geq 0$ governs the elasticity of the variable trade cost to experience.[34]

[34] If we set $\lambda = 0$, the model reverts to Chaney (2008). Parameter $g \gtrsim 0$ ensures that the iceberg cost is not prohibitive when $E = 0$. It becomes redundant when $E \gg 0$.

6.1 Entry into exports

The inclusion of time introduces a dynamic dimension for exports. For now, we will take the viewpoint of the firm producing intermediate k in country o, and focus on its decision to export to d - hence the subscript kd denotes variables that capture the activity of firm k (from o) in d. After the event that lowers the fixed cost at $t = 0$, the firm must decide whether or not to enter into the export market, and how much to export in each period $t \geq 0$. Firms are forward-looking and we assume that once a firm starts to export, it remains an exporter forever.[35] The present discounted value of all future export profits, contingent on exporting from $t_{kd} \geq 0$ onwards, is

$$\begin{aligned} V(t_{kd}|a_k) &= 0 + \sum_{t=t_{kd}}^{+\infty} \rho^{-t} R_{kdt} dt \qquad \text{where} \\ R_{kdt} &= \left(p_{kdt} - \frac{\tau_{kdt} W_{ot}}{a_k} \right) x_{kdt} - F \end{aligned} \tag{13}$$

The firm chooses when/whether to start exporting, t_{kd}, and then how much to export, x_{kdt}, to maximize $V(.|a_k)$. If $\max V(.|a_k) < 0$, the firm will never export k to d. The pricing decision is static, and the traditional mark-up rule: $p_{kdt} = (\varepsilon/\varepsilon - 1)\, \tau_{kdt} W_{ot}/a_k$ yields the amount of k exported to d as

$$x_{kdt} = \left(\frac{\varepsilon}{\varepsilon - 1} \frac{\tau_{kdt} W_{ot}}{a_k} \right)^{-\varepsilon} \frac{Y_{dt}}{P_{dt}^{-\varepsilon}} \tag{14}$$

and the profits from exporting to d as:

$$\begin{aligned} R_{kdt} &= \tilde{\varepsilon} \left(\frac{a_k}{\tau_{kdt} W_{ot}} \right)^{\varepsilon - 1} \frac{Y_{dt}}{P_{dt}^{-\varepsilon}} - F \\ \text{where } \tilde{\varepsilon} &= (\varepsilon - 1)^{\varepsilon - 1} / \varepsilon^{\varepsilon} \end{aligned} \tag{15}$$

For simplicity, we assume proximity to a steady-state where the aggregate variables W_{ot}, Y_{dt} and P_{dt} can be taken as constant by the firm, in its decision on entry. Later, we will discuss the general equilibrium considerations and confirm the existence of such steady-state. In this case, the trade-off facing the firm relative to the timing of entry is given by

$$\frac{\partial V}{\partial t_{kd}} = \rho^{-t_{kd}} \left[-R_{kdt_{kd}} + \sum_{t=t_{kd}}^{+\infty} \rho^{-(t-t_{kd})} \frac{\partial R_{kdt}}{\partial \tau_{kdt}} \frac{\partial \tau_{kdt}}{\partial E_{kdt}} \frac{\partial E_{kdt}}{\partial t_{kd}} dt \right] \tag{16}$$

[35] This will be true in the equilibrium of the model, since there are no shocks that could make the firm exit, after entry. In the empirical data, there is evidence of breaks in bilateral trade flows - see section 3.2.

Delaying entry (increasing t_{kd}) has two potentially conflicting effects. One the one hand, there are the profits of the period, captured by the first term $-R_{kdt_{kd}}$, which can be either positive or negative. On the other, there are the losses on experience associated with delaying entry by one period, captured in the second term, which is negative, provided delaying entry lowers experience ($\partial E_{kdt}/\partial t_{kd} < 0$). When the operational profits are positive ($R_{kdt_{kd}} > 0$), the choice is clearly to enter. When the firm faces negative operational profits at time of entry ($R_{kdt_{kd}} < 0$), the firm faces a trade-off.

6.2 Experience and the dynamics of entry

Firm k, and all other firms, for that matter, benefit from its experience and that of its peers. Following the specification of the empirical model, we assume that: (i) Experience grows every year that there are positive exports to d (but is independent of the volume of exports), and (ii) there is a cumulative depreciation of the effect of past experience. $E_{kdt} = E_{dt} = I_{dt-1} + \delta E_{dt-1} = \sum_{i=1}^{t} \delta^{t-i} I_{di-1}$. If there is no interruption of trade for a country-pair, i.e. $I_{dt} = 1$ for $t > 0$, we obtain $E_{dt} = \left(1 - \delta^t\right)/(1-\delta)$. Note that, when trade starts, $t = 0$, experience is zero; and when $t = +\infty$, it grows to an upper bound: $(1-\delta)^{-1}$. Our preferred specification - column 5 in Table 1 - estimated $\delta = 0.995$.

With this specification of experience, we obtain $\partial E_{kdt}/\partial t_{kd} = 0$ in (16) and $\partial V/\partial t_{kd}$ is negative (i.e. the firm enters) when R_{kdt} is positive. Firms have no incentive to take short term losses, because their gains from experience do not depend on their own entry decision, but on those of its preceding (more productive) peers. With t^*_{kd} denoting the optimal period of entry for firm k, the conditions for optimality imply three types of behavior by firms, in terms of exporting to d: (a) some firms are pioneers that start exporting from period 0 ($\partial V\left(t^*_{kd} = 0\right)/\partial t_{kd} \leq 0, t^*_{kd} = 0$), (b) other firms are laggards that opt to begin exporting at a later stage ($\partial V\left(t^*_{kd} > 0\right)/\partial t_{kd} = 0, t^*_{kd} > 0$), and finally, (c) non-exporters opt out of exporting to d for the foreseeable future ($V\left(t^*_{kd}\right) < 0$). Hence, different from Chaney (2008), we introduce a dynamic path of firm entry, due to the effect of experience on trade costs at the firm-level.

From (15) and (16), the marginal firm at t, i.e. the firm that satisfies the interior solution

$(\partial V(t)/\partial t = -R_{kd} = 0)$, has productivity $\bar{a}_{dt}$:

$$\bar{a}_{dt} = \left(F \frac{P_{dt}^{-\varepsilon}}{\tilde{\varepsilon} Y_{dt}} \right)^{\frac{1}{\varepsilon - 1}} W_{ot} \quad \tilde{\tau} \left[g + E_{dt} \right]^{-\lambda} \tag{17}$$

which declines with E_{dt}. Moreover, since $\partial V(t)/\partial t = -R_{kd}$ is decreasing, and $V(t|a_k)$ increasing, in a_k, all firms with higher productivity, $a_k > \bar{a}_{dt}$, are also exporting.

The dynamics of entry unfolds as follows. Firms with productivity $a_k \geq \bar{a}_{d0} = \left(F \frac{P_{d0}^{-\varepsilon}}{\tilde{\varepsilon} Y_{d0}} \right)^{\frac{1}{\varepsilon-1}} W_{o0} \tilde{\tau} g^{-\lambda}$ are pioneers. Firms of lower productivity may enter as experience increases: since $E_{dt} = \left(1 - \delta^t\right)/(1 - \delta)$, the firm with productivity $a_k < \bar{a}_{d0}$ enters into exports at t_{kd}^* given by:

$$\frac{1 - \delta^{t_{kd}^*}}{1 - \delta} = \left(F \frac{P_{dt}^{-\varepsilon}}{\tilde{\varepsilon} Y_{dt}} \right)^{\frac{1}{\lambda(\varepsilon - 1)}} \left(\frac{\tilde{\tau} W_{ot}}{a_k} \right)^{\frac{1}{\lambda}} - g$$

Since E is bounded, $\bar{a}_{dt}$ has a lower bound, and firms with productivity $a_k \leq \left(F \frac{P_{dt}^{-\varepsilon}}{\tilde{\varepsilon} Y_{dt}} \right)^{\frac{1}{\varepsilon-1}} W_{ot} \tilde{\tau} \left[g + (1 - \delta)^{-1} \right]^{-\lambda}$ never export.

Finally, we define the extensive margin as the mass of firms from o exporting to d, given by

$$\begin{aligned} N_{dt} &\equiv \int_{k \in O, a_k > \bar{a}_{dt}} g(a_k) da_k = \int_{k \in O, a_k > \bar{a}_{dt}} -\theta a_k^{-(\theta+1)} da_k = \bar{a}_{dt}^{-\theta} \\ &= F^{-\frac{\theta}{\varepsilon-1}} \left(\frac{P_{dt}^{-\varepsilon}}{\tilde{\varepsilon} Y_{dt}} \right)^{-\frac{\theta}{\varepsilon-1}} W_{ot}^{-\theta} \tilde{\tau}^{-\theta} \left[g + E_{dt} \right]^{\theta\lambda} \end{aligned} \tag{18}$$

with total exports given by[36]

$$\begin{aligned} X_{dt} &\equiv \int_{a_k > \bar{a}_{dt}} p_{kt} x_{kt} \quad \theta a_k^{-(\theta+1)} da_k = \\ & \frac{\theta \varepsilon}{\theta - (\varepsilon - 1)} F^{1 - \frac{\theta}{\varepsilon - 1}} \quad \left(\frac{P_{dt}^{-\varepsilon}}{\tilde{\varepsilon} Y_{dt}} \right)^{-\frac{\theta}{\varepsilon-1}} W_{ot}^{-\theta} \tilde{\tau}^{-\theta} \left[g + E_{dt} \right]^{\theta\lambda} \end{aligned} \tag{19}$$

and the intensive margin, i.e. the average volume of exports by exporter, as

$$\frac{X_{dt}}{N_{dt}} = \frac{\theta \varepsilon}{\theta - (\varepsilon - 1)} \ F$$

The presence of laggards, who share the benefits from the experience of incumbents, implies that extensive margin increases with experience. The implications of experience for the intensive

[36] To obtain the expression for N, we assume $\theta > (\varepsilon - 1)$, as usual in the literature (Melitz, 2003)

margin are more complex. While the exports of incumbents grow due to lower variable costs, the lower exports of laggards (with weaker productivity) that enter into exports reduce the average exports per firm. The implication is that the impact on the intensive margin is ambiguous. Under a Pareto distribution, as assumed here, the two effects cancel out and declines in the variable trade cost leave the intensive margin unaffected - as shown in the previous equation. Dutt et al. (2013) show that, for other plausible distributions, the incumbent effect dominates and the decline in the variable component of trade costs raises the intensive margin which would be in accordance with our empirical results in Section 4.1.

The log-linearization of the expressions for total exports and the extensive margin, eliminating g, yield an expression that is close to our empirical specification

$$\ln X_{odt} = \ln \frac{\theta \varepsilon \tilde{\varXi}^{\frac{\theta}{\varepsilon-1}}}{\theta-(\varepsilon-1)} + \frac{\theta}{\varepsilon-1} \ln \frac{Y_{dt}}{P_{dt}^{-\varepsilon}} - \theta \ln W_{ot} - \left[\theta \ln \tilde{\tau}_{odt} + \left(\frac{\theta}{\varepsilon-1} - 1\right) \ln F_{od}\right] + \lambda\theta \ln E_{odt} \quad (20)$$

where we have introduced the subscript o for the exporting country. This expression mirrors the empirical gravity equation estimated in (6a), with the first term captured by the constant, the second and third terms captured by country-year dummies, and the terms within the squared brackets proxied by the gravity variables, or the dyadic fixed effects and dyadic trends. The accumulation of experience expands bilateral trade with elasticity $\lambda\theta$, a term that was estimated previously in reduced form - column (5) in Table 1 - as $\lambda\theta = 0.884$.

6.3 General equilibrium considerations

Next we introduce general equilibrium conditions to determine W_{ot}, Y_{dt} and P_{dt}. First, the prices of the final goods, given in (11), yield

$$P_{dt}^{1-\varepsilon} = \frac{\varepsilon\theta}{\varepsilon-1} \left(\int_{\bar{a}_t}^{\infty} \frac{\tau_{kdt}^{1-\varepsilon} W_{ot}^{1-\varepsilon}}{a_k} a_k^{-(\theta+1)} da_k + \int_1^{\infty} \frac{W_{dt}^{1-\varepsilon}}{a_k} a_k^{-(\theta+1)} da_k \right) = \frac{\varepsilon}{\varepsilon-1} \frac{\theta}{\theta+1} \left(\tau_{kdt}^{1-\varepsilon} W_{ot}^{1-\varepsilon} \bar{a}_t^{-(\theta+1)} + W_{dt}^{1-\varepsilon} \quad (21)$$

In the labor market, demand includes the production of intermediates for the domestic final good, $L_o \equiv \int_1^{\infty} \frac{x_{kot}}{a_k} \theta a_k^{-(\theta+1)} da_k$, and for the foreign final good, $L_d \equiv \int_{\bar{a}_{dt}}^{\infty} \frac{x_{kdt}}{a_k} \theta a_k^{-(\theta+1)} da_k$. From (14), the equilibrium can be written

$$\bar{L} = \frac{\theta}{\theta-(\varepsilon-1)} \left(\frac{\varepsilon}{\varepsilon-1}\right)^{-\varepsilon} \frac{Y_{dt}}{P_{dt}^{-\varepsilon}} W_{ot}^{-\varepsilon} \left[1 + \bar{a}_{dt}^{\varepsilon-1-\theta}\right] \quad (22)$$

where $\bar{a}_{dt}$ is given in (17) and $\bar{L}$ is labor supply. Corresponding equations to (21) and (22) exist for the trade partner. Finally, (assuming financial autarky), from (19), the trade balance condition $X_{odt} = X_{dot}$ yields

$$\frac{Y_{dt}}{(W_{ot}/P_{dt})^{\varepsilon-1}} = \frac{Y_{ot}}{W_{dt}^{\varepsilon-1}} \tag{23}$$

The model provides 5 equations, which, taking the final good from o as numeraire: $P_{ot} = 1$, allow us to obtain P_{dt}, W_{ot}, W_{dt}, Y_{ot} and Y_{dt}, in terms of L_o, F, $\tilde{\tau}$ and E_t. We assume that countries are symmetric in that they face the same parameters. This implies that $P_{dt} = 1$, $W_{ot} = W_{dt} = W_t$ and $Y_{ot} = Y_{dt} = Y_t$, rendering (21)-(23) into

$$\begin{aligned}
\frac{\varepsilon}{\varepsilon-1}\frac{\theta}{\theta+1}W_t^{1-\varepsilon}\ \left[\tilde{\tau}^{1-\varepsilon}[g+E_t]^{\lambda(\varepsilon-1)}\bar{a}_t^{\ -(\theta+1)}+1\right] &= 1\\
\frac{\theta}{\theta-(\varepsilon-1)}\left(\frac{\varepsilon}{\varepsilon-1}\right)^{-\varepsilon}Y_tW_t^{-\varepsilon}\ \left[\bar{a}_t^{\varepsilon-1-\theta}+1\right] &= \bar{L}
\end{aligned}$$

Bilateral trade and the extensive margin can be obtained from W_t and Y_t, as follows

$$X_t = \frac{\theta\varepsilon}{\theta-(\varepsilon-1)}F^{1-\frac{\theta}{\varepsilon-1}}\quad(\tilde{\varepsilon}Y_t)^{\frac{\theta}{\varepsilon-1}}\,W_t^{-\theta}\tilde{\tau}^{-\theta}\,[g+E_t]^{\theta\lambda}\qquad N_t = F^{-\frac{\theta}{\varepsilon-1}}\,(\tilde{\varepsilon}Y_t)^{\frac{\theta}{\varepsilon-1}}\,W_t^{-\theta}\tilde{\tau}^{-\theta}\,[g+E_t]^{\theta\lambda} \tag{24}$$

Experience, given above as $E_t = \frac{1-\delta^t}{1-\delta}$, determines the influence of the accumulation of experience over time on the system. The accumulation of experience yield a decline in trade costs which, in addition to expanding bilateral trade and the extensive margin, supports in increase in output and real wages through the enhanced gains from trade. This process of economic growth stops the long-run (steady-state) equilibrium, when experience reaches an upper bound given by $Lim_{t\to\infty}E_t = (1-\delta)^{-1}$. In the transition of experience accumulation, the expansion of output further contributes to the rise in exports generated directly by experience, while the rise in wages works to slow down trade growth.

6.4 A numerical exercise

Now, we perform a simple numerical exercise that estimates the effect of experience on bilateral trade. We simulate data for a sample of 201 symmetric country-pairs and estimate the effect of experience using a regression approach. The purpose of this exercise is to understand how a simple model of dynamic trade costs, including its general equilibrium effects, can produce some of the results found in Section 3. It is important to stress that this is not a full-fledge calibration exercise.

The structural parameters of the model are: $\theta, \delta, \lambda, \varepsilon$ and g. Our preferred empirical estimates, in column (2) of Table 2, matched against the structural coefficients in (20), suggest $\lambda\theta = 0.438$ and $\delta = 0.995$. With the Pareto parameter (θ) set to 3.8 (see Ghironi and Melitz, 2005), we obtain $\lambda = 0.232$. We choose $g = 0.01$ and set the elasticity of substitution (ε) to 3.4.[37]

Our data-generating sample of 201 country-pairs varies along three dimensions: (1) the iceberg transport cost parameter $\tilde{\tau}$; (ii) the fixed cost of exports F; and (iii) the number of years that each country-pair has been trading, t. Following Ghironi and Melitz (2005), the constellation of parameters for these 201 symmetric country-pairs is set as follows. The iceberg transport cost, $\tilde{\tau}$, is set randomly from the interval $[1.2, 1.7]$, based on estimates from the literature using distance and geography variables. The number of years of experience is also set randomly from the distribution in our dataset, with a maximum at 56. Then, the fixed cost is calibrated so that (1) the share of exporting firms lies between $[0.1, 0.7]$ and (2) the distribution of total exports is not too far from that in the data.

Based on this data on trade costs and experience, and the ensuing total exports obtained from (24), for each of the 201 country-pairs, we run a regression that mimics the gravity specification, with the gravity variables replaced by our measures of trade costs:

$$log(X_{ij}) = \beta_0 + \beta_1 logE_{ij} + \beta_2 log(\tilde{\tau}_{ij}) + \beta_2 log(F_{ij}) + \beta_4 log(Y) + u_t$$

where $E_{ij} = \frac{1-\delta^{t_{ij}}}{1-\delta}$. Compared with the standard gravity specification, the effects of the domestic incomes in the two countries, captured in (6a) with the two country-time dummies and in (20) with the terms on Y_d and W_o, are replaced here with a single parameter β_4, because domestic income and wages in both countries are the same due to symmetry. Moreover, given the data generation procedure, Y is endogenously determined by trade costs and experience, raising the potential for collinearity and reduced significance.

The regression results with and without Y are reported in Table 7. In the regression without

[37] The literature has found values for ε ranging from 1.5 to 10. We follow Ghironi and Melitz (2005), setting $\varepsilon = 3.4$.

Y, trade costs and experience have the expected effects and are both statistically and economically significant. The inclusion of Y lowers the significance of the estimates, namely of the parameter on variable trade costs, due to collinearity. Moreover, it lowers the magnitude of the effects of fixed costs and experience, because Y captures the indirect effect of these variables on trade flows, through the rise in income (gains from trade). This indirect effect explains also why the coefficient of experience is slightly higher than $\lambda\theta = 0.438$ when income is not included. Hence our simple dynamic model where trade costs decrease with experience has the elements to help us understand the results from Section 2.

As a final robustness check, we simulated a version of the model in which experience does not matter, but where iceberg transport costs vary over time. To be consistent with the previous quantitative exercise, we calibrate this process so that the effective trade costs evolve over time according to $\tau = \tilde{\tau} * \frac{1-\delta^{t_{ij}}}{1-\delta}$. That is, the variable trade costs decrease over time for reasons that do not necessarily have to do with experience. When we estimate the standard gravity equation on the same 201 simulated country pairs, consistent with the model, we obtain a negative and statistically coefficient on both the iceberg and fixed trade costs and a positive coefficient on output. Adding our measure of experience, yields a coefficient of 0 for experience, while both iceberg transport costs and fixed costs continue to have negative and statistically significant coefficients. Our findings suggest that in a gravity equation derived from a model that does not explicitly account for experience, adding experience as an additional regressor results in an insignificant effect of this variable.

7 Conclusion

In this paper we show that experience matters for bilateral trade flows, and that the effect is strong and persistent. Our non-parametric estimates show that an additional year, on average, increases bilateral trade by approximately 6%, while a parametric specification that controls for country and country-pair fixed effects as well as pair-specific trends and gravity variables, estimates an elasticity of bilateral trade with respect to our measure of experience of 0.48%. We find also that the association of experience with the rise in years of positive trade is subject to a small but significant depreciation, which suggests an upper-bound for experience. We employ multiple identification strategies, account for composition effects, and confirm the robustness of our results to traditional econometric concerns of the gravity literature.

A series of placebo and model-based tests helps shed light on how experience matters for bilateral trade. Our results are consistent with experience reducing the variable costs of trade and with spillovers in experience. We recognize that there are interesting dynamics and spillovers at the firm level as an emerging literature has started to document (e.g., Eaton et al, 2012) and that we are unable to shed much light on. However, with the short time-span of existing firm-level data, measuring experience accurately at the firm-level is a non-trivial task. Addressing the specific effects of experience at the firm-level, and the spillovers across firms remains a challenge for future work, as the time span of firm-level datasets expands.

We also illustrate the impact of experience in a simple dynamic model of international trade with heterogeneous firms, where experience lowers variable trade costs and its benefits are shared across firms. This introduces export pioneers and laggards into the static specification of Melitz-Chaney, a phenomenon in concordance with empirical (Iacovone and Javorcik, 2010) and theoretical work on export emergence (Hausman and Rodrik, 2003). We show that overall exports and the extensive margin increases with experience, which generates rises in wages and output. Subsequently, we rely on the model to generate an artificial sample with differing trade costs (both variable and fixed trade costs) and experience, chosen to generate a distribution of exports and output consistent with the data. Regressions on the simulated data support a positive effect of experience on bilateral trade.

Given our finding that the benefits from experience tend to be shared among firms and industries, the presence of dynamic effects opens the possibility of external effects and the scope for policy: supporting the entry of early exporters, even temporarily, may lower the trade costs for non-exporters and encourage entry. Reassessing the role of export-promotion in this general, and of export promoting agencies, from the normative and positive perspectives (e.g. in the East-Asian miracle), remains a challenge for future research.

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Table 1: Experience and Bilateral Trade: Aggregate Data

	(1)	(2)	(3)	(4)	(5)
Retention parameter δ	0.963***	0.961***	0.962***	1.019***	0.995
	(0.002)	(0.002)	(0.002)	(0.001)	
Experience	0.753***	0.817***	0.817***	0.798***	0.887***
	(0.011)	(0.011)	(0.011)	(0.009)	(0.018)
Both in GATT/WTO	-0.048***	0.022**	0.020*	0.010	0.193***
	(0.011)	(0.011)	(0.011)	(0.018)	(0.062)
PTA	0.279***	0.258***	0.258***	0.719***	0.724***
	(0.011)	(0.011)	(0.011)	(0.02)	(0.053)
GSP	0.174***	0.021	0.025*	0.157***	0.241***
	(0.015)	(0.015)	(0.015)	(0.018)	(0.048)
Common currency	0.375***	0.414***	0.409***	0.163***	0.278**
	(0.045)	(0.045)	(0.045)	(0.043)	(0.121)
Distance	-1.127***	-1.134***	-1.132***	-1.261***	-1.259***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.018)
Contiguity	0.878***	0.839***	0.842***	0.563***	0.537***
	(0.028)	(0.029)	(0.029)	(0.028)	(0.082)
Colonial relationship	0.869***	0.877***	0.867***	0.913***	0.946***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.088)
Common language	0.362***	0.356***	0.357***	0.423***	0.449***
	(0.015)	(0.015)	(0.015)	(0.016)	(0.039)
Common law	0.83***	0.788***	0.794***	0.406***	0.380***
	(0.018)	(0.018)	(0.018)	(0.021)	(0.053)
GDP exporter	1.018***	1.016***	1.017***	0.443***	
	(0.003)	(0.003)	(0.003)	(0.023)	
GDP importer	0.873***	0.869***	0.873***	0.690***	
	(0.002)	(0.002)	(0.002)	(0.027)	
Time trend		-0.070***			
		(0.001)			
Time dummies	No	No	Yes	Yes	NA
Country dummies	No	No	No	Yes	NA
Country-year dummies	No	No	No	No	Yes
Observations	226223	226223	226223	226223	240873
R-squared	0.69	0.69	0.69	0.76	0.76

Standard errors in parentheses are clustered on country-pair: * significant at 10%; ** significant at 5%; *** significant at 1%

Columns 1-4 show non-linear least squares estimates; Column 5 uses δ with best fit

Table 2: Identification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline	Pair-fixed effects	Pair-fixed effects + lagged DV	HMR correction	IV estimate	Matching estimate	Matching estimate
Experience	0.887***	0.438***	0.333***	0.440***	0.481***	1.024***	1.022***
	(0.018)	(0.069)	(0.100)	(0.069)	(0.114)	(0.122)	(0.116)
Both in GATT/WTO	0.193***	-0.053	-0.063	-0.068	-0.054	0.025	-0.062
	(0.062)	(0.065)	(0.066)	(0.071)	(0.065)	(0.234)	(0.293)
PTA	0.724***	-0.052	-0.010	-0.076	-0.051	0.196	1.727***
	(0.053)	(0.048)	(0.046)	(0.055)	(0.048)	(0.223)	(0.276)
GSP	0.241***	0.122	0.085	0.079	0.121	0.329	0.532
	(0.048)	(0.109)	(0.104)	(0.115)	(0.109)	(0.559)	(0.461)
Common currency	0.278**	0.105**	0.077*	0.212**	0.104**	-0.121	0.938
	(0.121)	(0.049)	(0.044)	(0.100)	(0.049)	(0.539)	(0.915)
Distance	-1.259***					-1.588***	-1.571***
	(0.018)					(0.085)	(0.085)
Contiguity	0.537***					2.885***	0.972
	(0.082)					(0.582)	(0.697)
Colonial relationship	0.946***					0.957**	0.685
	(0.088)					(0.461)	(0.666)
Common language	0.449***					0.603***	0.659***
	(0.039)					(0.188)	(0.179)
Common law	0.380***					0.303	0.278
	(0.053)					(0.216)	(0.211)
Lagged trade			0.068***				
			(0.006)				
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair dummies	No	Yes	Yes	Yes	Yes	No	No
Pair specific trends	No	Yes	Yes	Yes	Yes	NA	NA
Observations	240873	240873	203650	219215	240873	6259	5823
R-squared	0.76	0.94	0.94	0.93	0.94	0.67	0.61
First-stage F-statistic					1339.44**		
First-stage Partial R^2					0.33		
OID test p-value					0.31		

Standard errors in parentheses are clustered on country-pair;
* significant at 10%; ** significant at 5%; *** significant at 1%
Retention parameter $\delta = 0.995$;
Column 4 includes the inverse Mills ratio that accounts for the selection bias and a polynomial term that accounts for the heterogeneity bias
Columns 6 and 7 use data only for year 2004; Column 6 matches on all gravity variables, GDP in destination and same exporter; Column 7 matches on all gravity variables, GDP in origin, and same importer

Table 3: Experience and Bilateral Trade: Disaggregate Data

	(1) Pooled	(2) Pooled	(3) Pooled	(4) USA	(5) China	(6) Germany	(7) Japan	(9) India
Retention parameter δ_1	0.649***	0.636***	0.636	0.636	0.636	0.636	0.636	0.636
	(0.0005)	(0.0005)						
Retention parameter δ_2	0.002***	0.000001***	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
	(0.0004)	(0)						
Retention parameter δ_3	1.368***	1.350***	1.350	1.350	1.350	1.350	1.350	1.350
	(0.001)	(0.001)						
Experience (destination and industry-specific)	0.946***	0.878***	0.741***	0.763***	0.715***	0.813***	0.743***	0.653***
	(0.003)	(0.002)	(0.004)	(0.012)	(0.019)	(0.010)	(0.013)	(0.018)
Destination-specific experience (across 4-digit industries)	0.054***	0.055***	0.021***					
	(0.001)	(0.001)	(0.003)					
Industry-specific experience (across destinations)	1.107***	1.114***	0.139***					
	(0.001)	(0.001)	(0.004)					
Both in GATT/WTO	0.005***	-0.069***	0.037					
	(0.002)	(0.002)	(0.032)					
PTA	0.090***	0.201***	0.046***					
	(0.002)	(0.002)	(0.011)					
GSP	0.058***	-0.044***	-0.045***					
	(0.002)	(0.006)	(0.012)					
Common currency	0.110***	-0.047***	-0.074**					
	(0.006)	(0.001)	(0.030)					
Distance	-0.208***	-0.257***	-0.046***					
	(0.001)	(0.003)	(0.007)					
Contiguity	0.345***	0.271***	0.096***					
	(0.003)	(0.002)	(0.018)					
Colonial relationship	0.040***	0.179***	-0.017					
	(0.002)	(0.002)	(0.015)					
Common language	0.172***	0.062***	-0.004					
	(0.002)	(0.002)	(0.013)					
Common law	0.097***	0.013***	0.017					
	(0.002)	(0.001)	(0.014)					
GDP exporter	0.070***	0.086***						
	(0.001)	(0.001)						
GDP importer	0.256***	0.293***						
	(0.001)	(0.005)						
Time dummies	No	Yes	NA	NA	NA	NA	NA	NA
Country dummies	No	Yes	NA	NA	NA	NA	NA	NA
Country-year dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year dummies	No	No	No	Yes	Yes	Yes	Yes	Yes
Observations	5084671	5084671	5084671	507494	201630	266319	335204	110595
R-squared	0.40	0.43	0.74	0.82	0.82	0.87	0.84	0.76

Standard errors in parentheses are clustered on country-pair: * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Placebo tests

Specification	Coefficient on experience	Coefficient on placebo variable
1. Import experience of exporter		0.065
		(0.062)
2. Randomize dummy for all years of positive trade		0.007
		(0.042)
3. Randomize dummy for positive trade (for less than median years of experience)		0.043
		(0.050)
4. Randomize dummy for positive trade (for more than median years of experience)		0.130**
		(0.062)
5. Assign experience to alphabetical neighbor of importer from same region		0.042
		(0.037)
6. Assign experience to alphabetical neighbor of exporter from same region		-0.068*
		(0.035)
7. FDI stock as dependent variable	-0.084**	
	(0.035)	

Standard errors in parentheses are clustered on country-pair: * significant at 10%; ** significant at 5%; *** significant at 1%. The retention parameter δ is set to 0.995 in all rows and columns. All specifications include country-year, country-pair dummies and pair-specific trends.

Table 5: Extensive and Intensive Margins of Trade

	(1) Bilateral Exports	(2) Extensive margin	(3) Intensive margin	(4) Bilateral Exports	(5) Extensive margin	(6) Intensive margin
Experience	0.887***	0.378***	0.509***	0.438***	0.155***	0.283***
	(0.018)	(0.010)	(0.014)	(0.069)	(0.027)	(0.061)
Both in GATT/WTO	0.193***	0.259***	-0.066	-0.053	-0.017	-0.036
	(0.062)	(0.036)	(0.046)	(0.065)	(0.029)	(0.057)
PTA	0.724***	0.460***	0.264***	-0.052	-0.041*	-0.011
	(0.053)	(0.033)	(0.038)	(0.048)	(0.023)	(0.041)
GSP	0.241***	0.177***	0.064*	0.122	0.057	0.064
	(0.048)	(0.024)	(0.039)	(0.109)	(0.038)	(0.099)
Common currency	0.278**	0.091	0.187**	0.105**	0.030	0.075*
	(0.121)	(0.078)	(0.079)	(0.049)	(0.026)	(0.044)
Distance	-1.259***	-0.854***	-0.405***			
	(0.018)	(0.012)	(0.012)			
Contiguity	0.537***	0.431***	0.105**			
	(0.082)	(0.065)	(0.052)			
Colonial relationship	0.946***	0.629***	0.317***			
	(0.088)	(0.059)	(0.056)			
Common language	0.449***	0.497***	-0.048			
	(0.039)	(0.024)	(0.030)			
Common law	0.380***	0.150***	0.229***			
	(0.053)	(0.029)	(0.041)			
Country-year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair dummies	No	No	No	Yes	Yes	Yes
Pair-specific trends	No	No	No	Yes	Yes	Yes
Observations	240873	240873	240873	240873	240873	240873
R-squared	0.76	0.84	0.54	0.94	0.97	0.85

The retention parameter δ is set to 0.995 in all columns.
Standard errors in parentheses are clustered on country-pair: * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Variation of Coefficient on Experience Across Model Specifications

Variable		Coefficient on experience [Gravity variable = 0]		Coefficient on experience [Gravity variable = 1]	Weighted average of coefficient on experience
Split On Gravity Variable					
Both in GATT/WTO		0.455		0.394	0.458
PTA		0.453		0.356	0.438
GSP		0.457		0.249	0.436
Common currency		0.434		0.072	0.436
Contiguity		0.441		-0.086	0.435
Colonial relationship		0.446		-2.276	0.397
Common language		0.431		0.401	0.432
Common law		0.446		0.321	0.434
Distance		0.331	0.400	0.456	0.432
Standard deviation of coefficient estimates (σ_2)	0.016				
Standard Error of coefficient estimate from baseline model (σ_1)	0.069				
σ_2 / σ_1	0.232				

All specifications include country-year, country-pair dummies and pair-specific trends.
All splits are based on binary variables except for distance; for distance we split the sample into three parts, 1 std. dev. above mean, mean ± 1 std dev, and 1 std. dev. below mean

Table 7: Regression results from simulated data

	(1)	(2)
Experience (E)	0.430***	0.440***
	(0.000)	(0.001)
Variable (Iceberg) Trade Cost (τ)	0.026	-0.100***
	(0.004)	(0.114)
Fixed Trade Cost (F)	-3.193***	-3.275***
	(0.003)	(0.009)
Income (Y)	0.583***	
	(0.012)	
Constant	-1.339	-1.034
	(0.008)	(0.013)
Observations	201	201
R-squared	0.99	0.99

Standard errors in parentheses are clustered on country-pair:
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1: Distribution of Experience in 2006

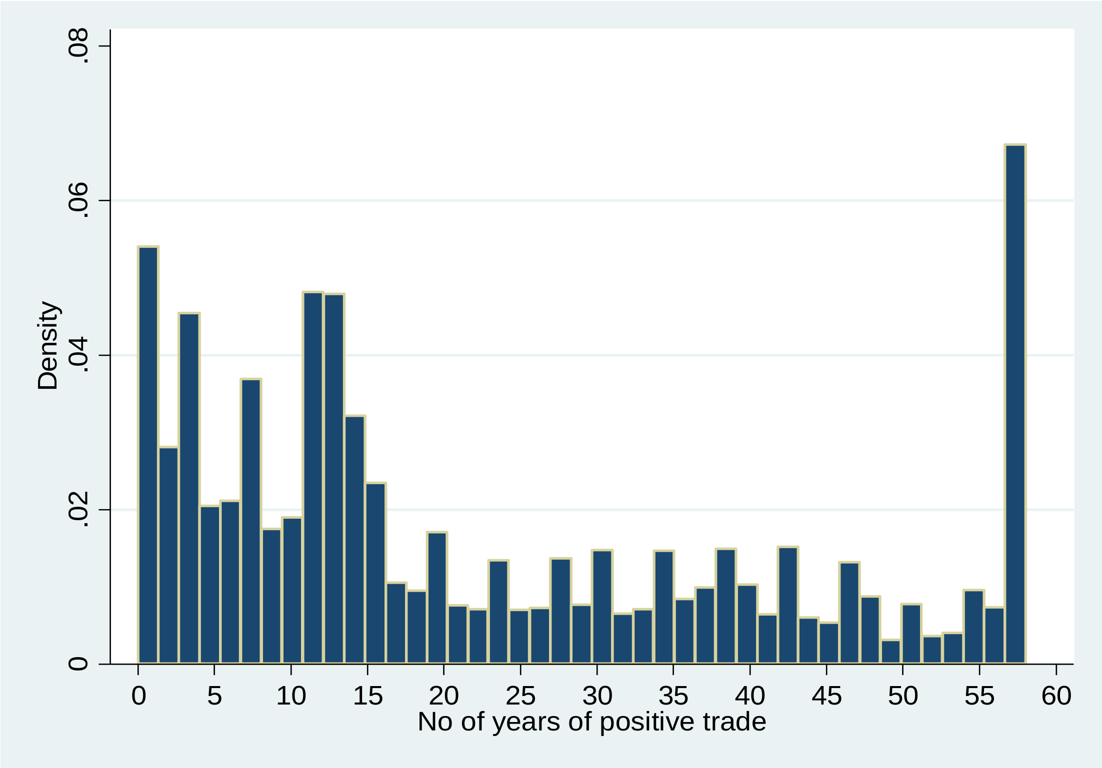
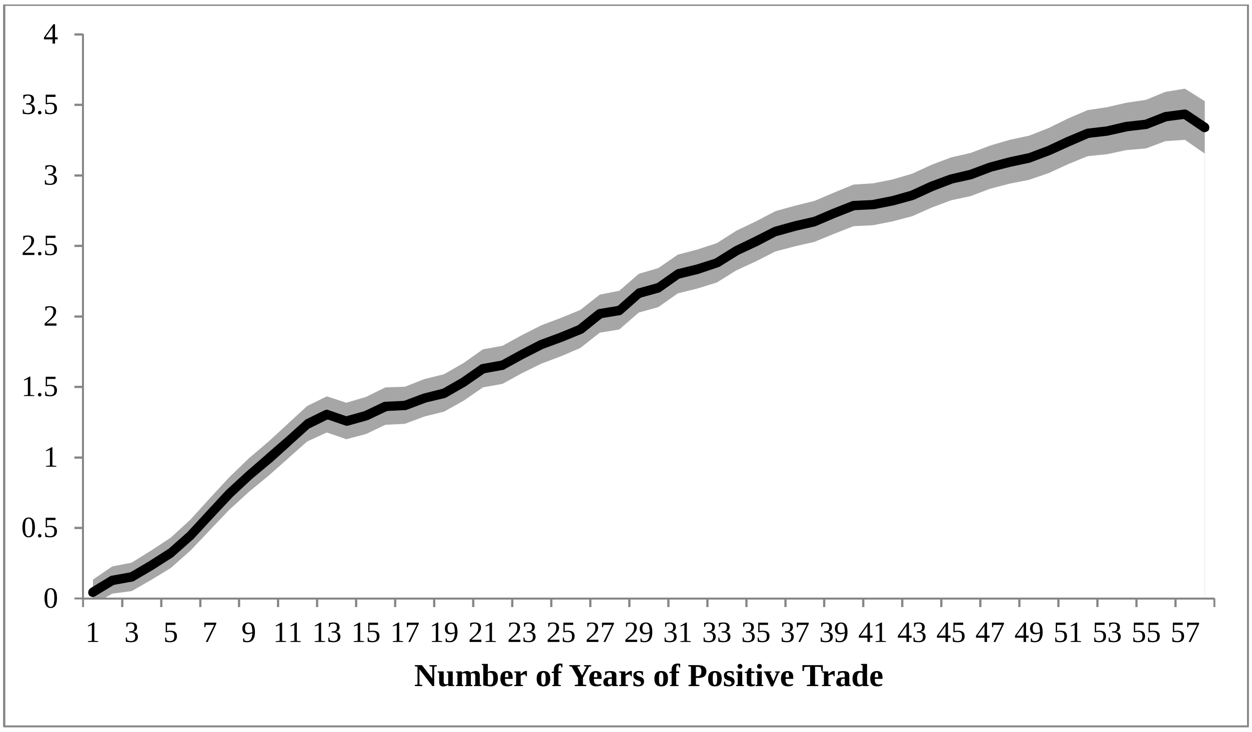
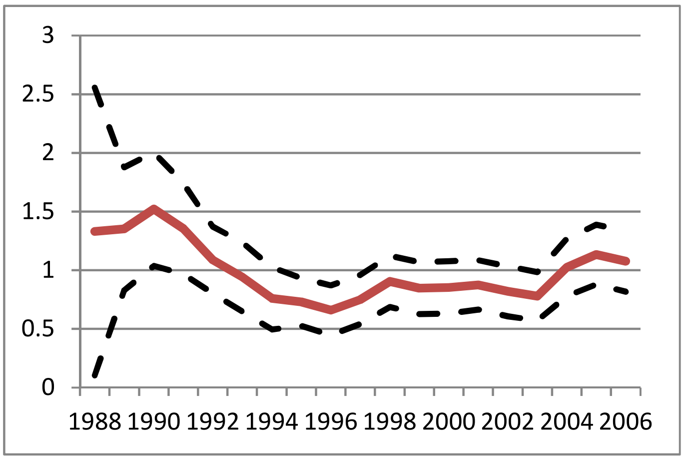


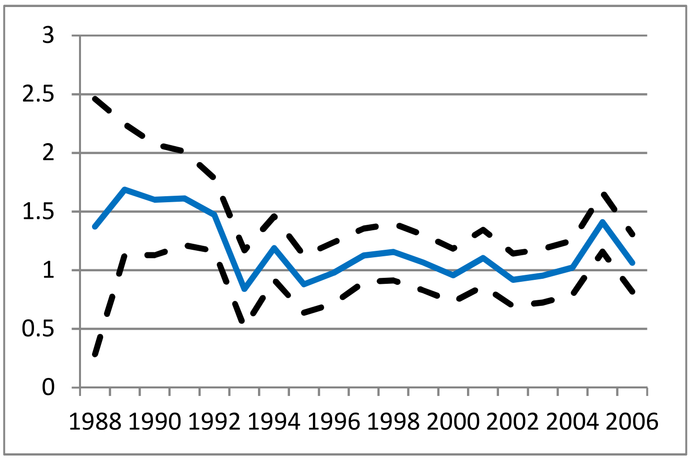
Figure 2: Cumulative Effect of Experience on Logged Bilateral Trade (Coefficient estimate with 95% confidence interval)



Figures 3a and 3b: Matching Estimate for Experience by Year and 95% Confidence Interval



3a: Matched on exporter



3b: Matched on importer