The Gravity of Experience

Preliminary & Incomplete

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January 2014

Abstract

This paper addresses how the market-specific experience of exporters affects bilateral trade. In the empirical framework of the gravity equation, we show that trade flows increase, along the extensive and the intensive margins, as the experience of bilateral trade at the level of country-pairs rises. Moreover, we address the extent to which experience affects the trade taxing effect of traditional remoteness variables. We also look at the implications of experience in the context of a model of trade with heterogenous firms, providing a framework where trade costs are dynamic and firm-specific.

JEL Classification: F10, F14

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

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1 Introduction

World trade has exploded over the last few decades, a phenomenon often associated with the decline in trade costs. Surprisingly, according to Helpman, Melitz and Rubinstein, henceforth HMR, (2008), virtually all that growth has occurred between country-pairs that were already trading in 1970, rather than due to the emergence of trade between new trading partners. Figure 1 shows that this finding is persistent even over a longer time frame. We use the IMF-DOTS data over the period 1948-2006 and decompose the evolution of world trade into trade between country-pairs with strictly positive trade prior to 1950 and the emergence of trade between new trading partners. Over the subsequent 55 years, less than 25% of the increase in world trade is attributed to the emergence of new trading partners, and 75% to the increase in trade between partners that had strictly positive trade prior to 1950. The puzzle is why the decline in trade costs that contributed to the growth of trade in established trading partners had such a minor impact in the creation of new trade partnerships.

In this paper, we argue that a key factor driving the decline in trade costs is the cumulative experience of trade across country-pairs. When two countries start trading with each other, a large component of trade costs is related to the novelty and uncertainty of selling in an unfamilar environment, engaging with foreign shipping agents, customs officials or consumers, and navigating an uncharted legal and regulatory context (Anderson and Van Wincoop, 2004). Experience from repeated local interaction is effective in gaining familiarity, thus contributing to dampen the effect of costs associated with the shipment, border crossing and distribution in the destination country. Hence, the effect of trade costs on trade volumes is likely to decline as experience is accummulated over time in a bilateral relationship, helping explain the dramatic growth of trade among established country-pairs that is found empirically.

We analyze the effect of experience on trade flows using the gravity model, which looks at the impact of variations in gravity variables that affect trade costs on the volume of trade, and has been the workhorse of the empirical analysis of trade costs. According to Head and Mayer´s (2013a) meta-analysis, the main gravity variables are the trade and currency agreements between pairs of countries and measures of cultural, linguistic and geographical remoteness, including contiguity, shared language, distance and colonial links. Prior work to address the high and persistent effects of these remoteness variables often relates them to informational barriers and cultural differences (Anderson and van Wincoop, 2004). Several authors have also pointed out the importance of business and social networks in overcoming barriers to international trade (Chaney, 2011; Rauch, 1999; Greif, 1994). Head, Ries and Mayer (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.[1] Our paper introduces the notion that, in addition to networks and institutions, experience of exporters also works to overcome the informational, contractual and cultural barriers that are associated with remoteness variables, suggesting that experience affects the impact of trade costs on bilateral trade flows.[2]

Our empirical specification adjusts the gravity equation to account for the role of experience, which we measure as the number of previous years of positive trade between a pair of countries. We add as regressors to the standard gravity equation both the cumulative experience of the country-pair, as well as the interaction of experience with the remoteness variables highlighted by Head and Mayer (2013a). We find that experience has a positive and significant effect on trade flows and its effect is stronger for country-pairs that are distant and do not share a border, a colonial history or a common legal system. Furthermore, the effect of these remoteness variables on trade flows declines with experience. The one exception is common language, which seems to dampen the effect of experience on trade costs, suggesting that experience does not matter in the same extent for all the remoteness variables.

We then decompose the impact of experience on the extensive margin, defined as the number of HS-6 products traded, and the intensive margin, defined as the value of exports per product. We find that experience has an almost identical effect on both margins of trade. However, the interaction between experience and our remoteness variables works mainly on the extensive margin, suggesting that as country-pairs acummulate experience, trade costs become less important for the introduction of new products, rather than for the volume of already traded products. Our findings are robust to a battery of checks - different methods used to estimate the gravity equation, accounting for endogeneity and measurement error in our experience variable, different measures of the extensive and intensive margins, and to the use of various sub-samples or sub time-periods over which to estimate the gravity equation.

Our empirical results suggest that the accummulation of experience reduces the effect of trade costs on

[1] Some papers attempt to measure these soft trade barriers and the role of networks directly. Rauch and Trindade (2002) find a substantial trade-enhancing effect of Chinese networks and argue that these networks reduce information barriers to trade. Head and Ries (1998) find smaller effects of immigration links for Canadian bilateral trade. Anderson and Marcouiller (2002) show that insecurity, associated both with contractual enforcement problems and opacity of regulations, lowers trade substantially. Dutt and Traca (2010) show that corruption impedes trade when formal tariff barriers are low. Allen (2012) develops a trade model that explicitly incorporates the search process producers use to acquire information about market conditions. For regional agricultural trade in the Philipines, he finds that 93% of the observed gravity relationship is due to informational frictions rather than transport costs.

[2] This implies that the effect of remoteness variables is, in fact, heterogeneous and conditional on some omitted variables; namely experience. Head and Mayer (2013b) show that the effect of distance is heterogeneous with lower impacts for larger trade flows.

trade flows, which helps explain the increase in bilateral trade observed for country-pairs that are already trading with each other. In this sense, trade costs become endogenous and their effect evolves over time. To shed light on these findings, we develop a dynamic model of international trade that introduces endogenous trade costs through experience. We then perform a numerical exercise to illustrate its main mechanisms. We build upon Chaney's (2008) model of heterogeneous firms and fixed costs of exports, and extend it to a dynamic setting in which firms face trade costs that decrease as experience is accummulated over time. Our setting gives rise to three types of firms: firms that enter whenever trade is allowed between two countries (pioneers); firms that enter as trade costs decline through experience (laggards); and firms that never enter (non-exporters). We consider two ways in which firms can accummulate experience: first, we look at the case where the firm benefits only from its own-experience; second, we address the case where experience of firms is shared across all the potential exporters. The predictions of our model for total trade are consistent with our empirical findings. However, which margin of trade drives this effect depends heavily on how the firm captures the benefits of experience. In the first case, in which firms benefit only from own-experience, there is more entry in the first period that trade is allowed that what the Chaney model would predict. The main reason is that some less productive forward-looking firms are willing to make negative profits in the first periods if they expect to benefit from higher future profits as they accummulate experience. Over time, the intensive margin of trade increases, as incumbents that are accummulating experience face lower trade costs. The extensive margin, however, does not increase over time, and in particular, it declines due to the general equilibrium effects associated with an increase in wages.

In the second case, in which firms benefit from the experience of their peers, entry in the first period that trade is allowed is similar to the Chaney (2008) model, because the effects are external. Different from the previous case, the extensive margin now increases over time, as non-exporters see their trade costs declining from the experience of the incumbents. The effect on the intensive margin is now complex, with the larger exports of incumbents (who see their variable trade costs falling) conflicting with the entry of smaller, new exporters. Therefore, a model that is consistent with our empirical findings, both on trade flows and on the margins of trade needs to consider the effect of experience to be shared across firms.

The rest of the paper is organized as follows. Section 2 augments the traditional gravity specification with experience at the bilateral level allowing for both a direct effect of experience and for its effect to be moderated by traditional gravity variables. Section 2 lists the variables and data we use and Section 3 presents our empirical findings. Section 4 introduces experience in a standard Melitz/Chaney model to examine the evolution of the extensive and intensive margins.

2 An experience-adjusted gravity equation

2.1 Trade costs and the gravity equation

Trade costs capture the extra costs that a firm bears to sell goods in a foreign country, including (i) transportation costs, enhanced by poor infrastructure and low security, (ii) border-crossing costs, associated with tariffs and the corruption costs and delays in institutionally weaker and highly regulated environments and (ii) distribution costs that are heightened from dealing with distribution partners in countries where contract enforcement is feeble and finding the preferences of customers that are culturally and linguistically different.[3]

The gravity equation is the current workhorse for estimating the importance of trade costs for bilateral trade. There are several theory frameworks supporting the gravity specification, yielding the logarithm of exports from country o (exporter/origin) to country d (importer/destination) in time t, denoted by $X_{od,t}$, as shown below (Head and Mayer, 2013a).

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

$\mu_{o,t}$ 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 $\nu > 0$ as the elasticity of exports with respect to trade costs.[4] In the standard equation $\ln \tau_{od,t}$ is specified in terms of M gravity variables, denoted by $z_{od,t}$, including distance, as shown below.

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

The gravity variables must be bilateral to prevent collinearity with the country-year dummies. Head and Mayer (2013a) perform a meta-analysis and identify as main variables the trade and currency agreements including both countries, capturing trade policy, and contiguity, shared language, distance and colonial links, which determine cultural, linguistic and geographical remoteness. Note that the policy variables are

[3] Anderson and Van Wincoop (2004) estimate that trade costs are equivalent to a 170 percent ad-valorem tax equivalent for a representative rich country, including a 21 percent for transportation costs, 44 percent for border-crossing costs and 55 percent for distribution costs. Head and Mayer (2013) coin the term 'dark trade cost' - that 72%–96% of the trade costs associated with distance and borders are attributable to the dark sources (read unknown) sources of resistance.

[4] ν has different interpretations depending on the micro-foundations for the gravity equation. It is the elasticity of substitution 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).

time-varying while the remoteness variables are time-invariant. Substituting (2) in (1) yields an estimable specification.

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

2.2 Experience and trade costs

Our hypothesis is that trade costs fall when experience by exporters increases. Exporting to a new geographic market entails the discovery of (i) the cheapest, most reliable transport; (ii) the best way to get goods through customs, (iii) the right partner for distributing and promoting the goods locally or (iv) the preferences and dispositions of customers. Eaton et al. (2011) and Freund and Pierola (2010) emphasize learning in a destination country, where producers need to incur costs to find new buyers or new products.[5] Allen (2012) models a search process to acquire market information, and, for regional agricultural trade in the Philippines, finds that 93% of the observed gravity relationship is related to informational frictions rather than transport costs.

Although firms may discover through pre-entry research, experience is a vital element of the process. The initial contact with a new market environment unavoidably raises unexpected challenges that push the firm to find quick, imperfect solutions that imply higher trade costs. Experience with the local reality helps the firm gain familiarity and find better, cheaper solutions for future shipments, lowering trade costs. For instance, Artopoulos, Friel and Hallak (2010) use four detailed case studies of export firms in Argentina to show that export success stems from a firm's experience in the business community of the destination country.

Moreover, in addition to benefiting the firm, experience is also likely to be shared among networks of firms, such that the experience acquired historically by exporters contributes to increased familiarity by fellow exporters, and even by entering non-exporters (improving the effectiveness of pre-entry research). Rauch and Trindade (2002) find a substantial trade-enhancing effect of Chinese networks and argue that these networks reduce information barriers to trade. Head and Ries (1998) find smaller effects of sharing of the benefits of experience through immigration links for Canadian bilateral trade.

To the extent that the benefits of experience are related to the familiarity with local context it creates, the number of interactions between exporters and the destination country environment (e.g. the number of shipments) is a natural measure of experience. However, in the context of the gravity equation, with data available only at the level of country-pairs, experience must be measured as an aggregation of the experience

[5] In contrast, in Albornoz et al (2012) uncertainty is not destination-specific and firms learn about export profitability as a whole.

of all the exporter and importer firms involved in trade from o to d. Letting $E_{od,t}$ denote the stock of experience at t for country-pair od, we capture the hypothesis that experience lowers trade costs on the gravity equation, by defining the following experience-adjusted specification for trade costs

$$\ln \tau_{od,t} = \sum_{m=1}^{M} \gamma_m z_{od,t}^m - \lambda_{od} E_{od,t} \quad \text{where } \lambda_{od} > 0 \tag{4}$$

Assuming, for now, that $\lambda_{od} = \lambda$, $\forall od$ (constant across country-pairs), we can use this in (1) to obtain an estimable specification for the gravity equation that accounts for the direct effect of experience

Simplified Experience-Adjusted Gravity Equation

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

2.3 Remoteness and the impact of experience

The scope to benefit from experience is related to the informational barriers and cultural differences that it helps bridge. To the extent that these barriers are heterogenous, the impact of experience is also likely to vary across country pairs, challenging the notion that λ_{od} in (4) is constant. Several authors have argued that these informational and cultural barriers, which are very difficult to measure, are strongly associated with the subset of gravity variables that measure *remoteness*, at the level of the country-pair. Anderson and van Wincoop (2004) speculate that the high estimates for distance, in fact, reflect information barriers, contracting costs and insecurity that are not appropriately controlled for by traditional gravity variables. Head and Mayer (2013b) argue that "cultural difference and inadequate information manifest themselves most strongly at national borders and over distance" and this is reflected in the coefficients for distance and the border dummy.[6]

Given the difficulty in measuring the cultural and information barriers that define the scope for experience, and to the extent that the remoteness also reflects such trade barriers, we argue that the variation in λ_{od} across country-pairs is associated with the subset of gravity variables measuring remoteness. Following Head and Mayer (2013a), we stress proximity, contiguity, shared language, shared legal systems and colonial links as the remoteness variables of interest, and express λ_{od} in terms of the these variables, as shown below

$$\lambda_{od} = \hat{\lambda} + \textstyle\sum_{m \in \Lambda} \hat{\lambda}_m \; z_{od}^m > 0 \tag{6}$$

[6] Some papers attempt to measure these trade barriers directly. Anderson and Marcouiller (2002) show that insecurity, associated both with contractual enforcement problems and opacity of regulations lowers trade substantially, while Dutt and Traca (2010) show that corruption impedes trade when formal tariff barriers are low.

where Λ denotes the subset of gravity variables that capture remoteness. After substituting in (4) and then in (1), this yields:

Generalized Experience-Adjusted Gravity Equation

$$\begin{aligned} \ln X_{od,t} &= \nu\hat{\lambda}\ E_{od,t} - \sum_{m\in\Lambda} \nu\gamma_m\ z_{od}^m + \sum_{m\in\Lambda} \nu\hat{\lambda}_m\ z_{od}^m E_{od,t} \\ &\quad - \sum_{m\in M\setminus\Lambda} \nu\gamma_m z_{od,t}^m + \alpha_o\mu_{o,t} + \alpha_d\mu_{d,t} + e_{od,t} \end{aligned} \tag{7}$$

Interestingly, the role of remoteness on the effects of experience, depicted by the $\hat{\lambda}_m$´s, is non-trivial. To see this, let us take language as an example and see how it affects the impact of experience on trade costs. On one hand, in the long-term, experience is likely to have a stronger effect for exporters from countries that do not share the same language. They start with higher trade costs associated with the language difference, which are eventually brought down as the exporter learns the new language or finds a local contact that speaks its language, for example. From this perspective, the *scope* for gaining from experience is larger, when the two countries do not share a language. On the other hand, in the short-term, if the two countries share the same language, the process of acquiring familiarity proceeds much faster, through conversations with locals or by reading local literature, for example. From this perspective, the *pace* of gaining from experience is smaller, when the two countries do not share a language.

In general terms, the **scope** to gain familiarity through experience is larger when remoteness is higher. Experience emerges as means to bridge this remoteness, allowing exporters to discover ways to overcome some of the challenges it creates - and the wider the bridge, the larger are the effects of experience. On the other hand, many aspects of familiarity actually increase the **pace** of the benefits of experience. When remoteness is smaller, the benefits from experience, although smaller in scope, accrue much faster. Here, proximity works as a facilitator, expanding pace at which experience lowers trade costs. In the context of the linear specification in (7), this implies an ambiguous sign for the λ_m´s: for a variable m in Λ, $\hat{\lambda}_m > 0$ when the scope effect dominates, and $\hat{\lambda}_m < 0$ when the pace effect dominates.[7]

Note that, under (7), the traditional effect of gravity variables capturing remoteness is mediated by experience, i.e. for m in Λ, $d\ln X_{od,t}/dz_{od}^m = \nu(-\gamma_m + \hat{\lambda}_m E_{od,t})$. The ambiguity of the impact of remoteness on the effect of experience on trade cost ($\hat{\lambda}_m$), related to the conflicting effects on the pace and scope, implies that the effect of experience on the impact of remoteness variables on trade is also ambiguous. When the

[7] A more complex non-linear formulation for the scope and pace of the benefits of experience might set the trade cost as: $\tau_{od,t} = \tilde{\tau}_{od} \exp \sigma_{od} \left(\frac{1}{(1+E_{od,t})^{\pi_{od}}} - 1 \right)$ where $\tilde{\tau}_{od}$ is the initial trade cost, $\sigma_{od} > 0$ captures the scope and $\pi_{od} > 0$ captures the pace. An increase in σ_{od} and in π_{od} lower the trade cost. In this context, an increase in remoteness raises σ_{od} and lowers π_{od}. Our specification implies a linear approximation to such a specification.

scope effect dominates, $\hat{\lambda}_m > 0$, experience lowers the effect of remoteness on trade cost. When the pace effect dominates, $\hat{\lambda}_m < 0$, experience actually increases the impact of remoteness beyond its initial level. This means that the effect of each remoteness variable is heterogeneous, as suggested by Head and Mayer (2013b), who show that the effect of distance is heterogeneous (non-constant) with lower impacts for larger trade flows. Estimating the gravity equation without accounting for experience implies capturing the effects of the gravity variables for the average level of experience for the country-pairs in the sample.

3 Data and Variables

3.1 Experience

Although the benefits of experience depend on the number of interactions between exporters and the destination country environment (e.g. the number of shipments), in the context of the gravity literature, experience must be defined at the level of the units of observation, namely the country-pairs, and from the available data. We proxy experience using the number of years for which the country-pair has had positive trade. We prefer this to the alternative of taking the accumulated value of exports because the latter is influenced by the unit value of exports. In this case, experience would be influenced by changes in the sectoral composition of country´s exports, both in terms of comparisons across countries and its evolution in time, creating unwanted spurious variation.

We use the International Monetary Fund's *Direction of Trade Statistics* (DOTS) to construct our experience variable. This database provides data on bilateral exports from 208 exporters to 208 importers over the time period 1948-2006. For any pair of countries o and d at time t in our sample, we calculate experience as the number of years where o had strictly positive exports to d up until the year $t-1$. Figure 2 shows the distribution of the length of trading relationship in 2006, for all country-pairs (including those with zero trade flows in that year): 4.2% of the country-pairs have traded for 0 years, the median and the mean trading relationship lasted for 14 and 21.7 years, respectively. The experience variable is right-censored for country-pairs that had strictly positive trade in 1948: 6.8% of the country-pairs have a trading relationship at the maximum of 58 years (2006-1948).

To address the potential for measurement error, we also use an alternative dataset from the Correlates of War (COW) Project, which tracks bilateral trade from 1870-2006 (supplementing the DOTS data with data from Barbieri (2002) and Barbieri, Keshk and Pollins (2012). In 2006, the median trading relationship was 23.2 years. The correlation between the COW and the DOTS measures exceeds 0.8 for each of the

years in our sample (1988-2006), rising to 0.91 in the year 2006.[8] 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. For instance, the COW-based experience assumes trade with the Austro-Hungarian as trade with both Austria and Hungary and assigns trade with Zanzibar as trade with Tanzania. At the same time, much of the data is mising prior to 1948. Thereore, experience constructed on the basis of this data is also not free of measurement error. For this reason, we will use the DOTS-based measure for experience, and will use the COW-based measure only as a robustness test.

3.2 Bilateral Trade and Extensive and Intensive Margins

We follow the literature and provide a decomposition of the empirical effects of experience on the extensive and the intensive margins. Our decomposition emerges from a simplified model with firm-heterogeneity, where bilateral exports $X_{od,t}$ can be decomposed as

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

the product of the extensive ($N_{od,t}$), i.e. number of sectors/goods traded,and the intensive margins ($\overline{x}_{od,t}$), i.e. the volume of trade per product/sector. Since the gravity specification is implemented in terms of the natural logs, the sum of the estimated coefficients for the two margins equals the coefficient on the standard gravity specification with total bilateral exports. Following Eaton, Kortum and Kramarz (2004), Bernard et al. (2007), and Flam and Nordstrom (2006), the bilateral extensive margin is a count of the number of HS-6 products exported from country o to country d at time t, while the bilateral intensive margin is defined as the exports per product.

The lack of disaggregated data in DOTS (used to measure experience) prevents us from constructing the intensive and extensive margins, which we need as dependent variables, with this data. Hence we use UNCTAD's COMTRADE database to obtain bilateral trade flows, and the extensive and intensive margins of trade. COMTRADE provides data on bilateral trade between pairs of countries at the Harmonized System 6-digit (HS-6) level of disaggregation.[9] We construct a database on the trade flows and their extensive and intensive margins, for the period 1988-2006.[10] For each year in our sample, our data spans more than 99% of all world trade.

[8] We restrict our sample to 1988-2006 since we decompose total trade into an extensive and intensive margin based on COMTRADE HS-6 data. The latter are available only from 1988 onwards.

[9] UNCTAD provides the HS-6 data over the period 1988-2006 for 183 importers and 248 exporters. There are 5017 product categories or lines at the HS-6 level.

[10] In our dataset, the extensive margin is the highest between US and Canada, with the US exporting 4930 products to Canada

3.3 Gravity variables

Our list of trade cost determinants come from the meta-analyses of Disdier and Head (2008) and Head and Mayer (2013a). The remoteness gravity variables include geographic distance, contiguity, common language and colonial links. 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 links is measured using two variables, that take 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 legal origins, from Glaeser and Shleifer (2002) (other finer classifications of civil law, Scandinavian law did not seem to matter).

As suggested in our specification, we include also policy-related gravity variables, from Head and Mayer (2013b), which we consider impervious to experience. We include one variable related to currency sharing and three related to preferential market access: multilateral, bilateral, and unilateral. 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 by two dummy variables: one takes the value 1 if both trading partners are members of the GATT/WTO and 0 otherwise; the other takes the value 1 if neither countries in a country-pair are WTO members. The category where only one country in a pair is a WTO member is the omitted category. 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 gravity databases (www.cepii.fr) 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 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.

in the year 1994, 98% of all 5017 HS-6 product categories. We also observe that 70% of all bilateral exports is in less than 100 categories amongst all country-pairs that exhibit strictly positive exports. In terms of the intensive margin, we observe the highest intensive margins for oil exporters such as Angola, Iran, Iraq, Libya and Saudi Arabia.

4 Empirical Findings

4.1 Simplified Experience-Adjusted Gravity

We start by examining the role of experience by estimating the simplified experience-adjusted gravity in (5), using the measure of experience outlined above. The estimation of the gravity equation has been subject to an intense econometric debate over the last decade. In line with Head and Mayer (2013a), our baseline results rely on least-squares estimation of the panel, using country-specific fixed-effects and with standard errors adjusted for clustering on country-pairs. We address also the potential for biases through a series of robustness checks. First, we look at the potential for biases associated with our data on experience, namely the censoring and endogeneity of the experience variable. Second, we look at biases that are pervasive in the gravity literature, such as the presence of structural zeros and heteroskedastic errors (Santos Silva and Tenreyro, 2006) or the omitted changes in the distribution of exporting firms (Helpman, Melitz and Rubenstein, 2008).

4.1.1 Baseline results

Table 1 presents our baseline estimates for (5). All models are jointly significant at the 1% level and account for at least 52% of the variation in trade flows and margins. Columns (1)-(3) examine the impact of experience (based on the DOTS data) on bilateral trade, extensive and intensive margins respectively. We confirm the role of experience on all three variables of interest - a one standard deviation increase in experience results in a 50% increase in the extensive and intensive margins and a 100% increase bilateral trade. Another way to interpret the magnitude of the coefficients is to compare bilateral trade for a country-pair that has just commenced trade in say 2006 (Burundi and Haiti) vs. a country-pair that has been trading continuously since independence (44 years for Burundi and USA). The coefficient estimates imply that bilateral trade is 264% higher in the latter.

Confirming the results established in the literature, the direct effect of virtually all gravity variables identify them as trade costs. Proximity, contiguity, colonial relationships, sharing of languages and similarity of legal systems foster trade, through both the intensive and the extensive margins; with the exception of contiguity and common language which have an insignificant effect on the intensive margin. The estimates of the policy variables are also in line with the literature: WTO and PTA increases trade, with effect of the WTO mainly on the extensive margin (see Dutt, Mihov and Van Zandt, 2013), while the common currency dummy increases total export via the intensive margin.

It should be noted that, 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 (16% for distance and legal system; 3% for contiguity; 6% for colonial link; and 39% for language). In other words, accounting for experience significantly reduces the magnitude of the coefficients for the traditional gravity variables.

4.1.2 Censoring and Omitted Variables

Our experience variable based on the DOTS data is right-censored at 58 years. To account for the right-censoring, we add a dummy variable for all DOTS-based censored observations (with experience at 58). Including this does not change either the sign, significance or magnitude of the estimates.[11] We also estimate the gravity equation using the COW dataset as a measure of experience. Columns (4)-(6) provide estimates, confirming that experience significantly increases both overall trade and each of the two margins.

Another concern is that omitted variables may drive both the experience measure and trade flows. In particular, omission of some determinant of $\tau_{od,t}$ which may have played a role in the decision to initiate exports from o to d, may create endogeneity bias, as experience may simply be capturing the effect of this determinant on the dependent variables. To account for this, we experimented multiple bilateral gravity variables as additional controls. These include the common religion dummy from Helpman, Melitz and Rubinstein (2008), 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.

A second methodology to address the potential omitted variables bias is to add country-pair dummies to the standard specification of the trade cost $\tau_{od,t}$. These dummies will account for all time-invariant bilateral trade costs, including those that may be responsible for the initiation of trade and the extent of experience. Note that, to prevent collinearity, we must remove all time-invariant bilateral variables; namely, those capturing dimensions of remoteness. Columns (7)-(9) present the estimates. Here we find a stronger role for experience - the coefficient continues to be significant and there is a 40% increase in the magnitude of the effects. These within-estimates imply that a one standard deviation increase in experience results

[11] Dropping the censored observations (Austin and Brunner, 2003) entails removing all country-pairs that had strictly positive trade in 1948. Since the increase in the volume of trade since then is mainly attributed to the expansion of trade between these pairs, rather than the emergence of new trading partnerships (Helpman, Melitz and Rubinstein, 2008), we lose 62.5% of our observations, that accounts for a majority of world trade.

in a 71% increase in the extensive margin, a 74% increase in the intensive margin and a 145% increase in bilateral trade. Overall the results suggest that even accounting for time-invariant variables that may have affected the decision at the time that trade started and that may continue to impact trade today, we find a strong role for experience.

Note that, the effects of policy gravity variables, which can be estimated from variations in time, are different from the baseline estimate yielding that WTO increases total exports through the extensive margin, PTA and the common currency dummy increase the intensive margin but reduce the extensive margin, while GSP does not significantly impact either margin.

4.1.3 Accounting for Zeros and Heteroskedasticity

Recent papers by Helpman, Melitz and Rubinstein (2008), Anderson and van Wincoop (2004), Evenett and Venables (2002), and Haveman and Hummels (2004) all highlight the prevalence of zero bilateral trade flows. For the bilateral trade data over the period 1988-2006, 37% 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 accounting for zeros, the first question to consider is whether they are statistical, in the sense that they occur due to rounding or the existence of thresholds, or structural, in the sense that unobserved trade costs of exporting may lead to zeros in the trade matrix. We address each of these in turn.

Statistical zeros can arise either when trade is reported only if it exceeds a threshold or when importers report trade aggregated across countries. We follow the procedure of Eaton and Kortum (2001) who use a Tobit specification to account for statistical zeros.[12] The effect of experience, accounting for the presence of zeros, is shown in Columns (1)-(3) of Table 2. We confirm that experience significantly influences both margins of trade, with a significant increase in the coefficient for the intensive margin, as expected; while the coefficient remains the same for the extensive margin (because for 99.9% of the cases the censoring point is set to 1 (0 in log terms)).

Second, Helpman, Melitz and Rubinstein (2008), henceforth HMR (2008), argue that the zeros in the trade matrix are not statistical but structural, due to fixed costs of exporting. They show that, in this case, firms self-select (or not) into exporting, which causes not just a selection bias but also a heterogeneity bias, due to changes in the composition of firms that export. We adopt the HMR (2008) methodology to

[12] The methodology assumes that we observe trade only if trade exceeds some threshold level a. Below this minimum level a, zero trade is recorded. To implement this, we calculate destination-year specific censoring points: $a_{dt} = \min_o\{X_{od,t}\}$ as the minimum value of trade across all exporters to each destination each year. We then replace the observed zeros in the trade matrix by a_{dt} and estimate this in a Tobit specification with destination-year specific censoring points.

account for these biases. In the first-stage, we estimate a probit that predicts the probability of having positive trade, for each year in the panel, $\varrho_{od,t}$, using the gravity variables and country-fixed effects.[13] For the exclusion restrictions, we follow HMR (2008) and use a common religion index: $\sum_k (\mathrm{R}_{k,o} \times \mathrm{R}_{k,d})$,where $\mathrm{R}_{k,j}$ is the share of religion k in country j $(j = o, d)$.[14] HMR (2008) show that including a polynomial in $\hat{\tilde{z}}^*_{od,t} = \Phi^{-1}\left(\varrho_{od,t}\right) + \hat{\tilde{\eta}}^*_{od,t}$ (where Φ is the cdf of the unit-normal distribution and $\hat{\tilde{\eta}}^*_{od}$ is the inverse Mills ratio) controls for firm-level heterogeneity and self-selection.

The results for the second-stage regression (which also uses country-year fixed-effects), including the bias-correcting variables, are shown in Columns (4)-(6) of Table 2.[15] We confirm that experience increases bilateral trade, on the extensive margin and the intensive margin of exports, with coefficients very similar to those in the baseline specification of Table 1. The inverse Mills ratio and the polynomial in $\hat{\tilde{z}}^*_{od,t}$ are significant at 1%, with signs similar to ones obtained in HMR (2008), showing the importance of correcting for the biases associated with structural zeros.

Finally, we use the methodology of Santos Silva and Tenreyro (2006) who show that log-linear specification of the gravity model in the presence of heteroskedasticity leads to inconsistent estimates.[16] Their methodology treats bilateral trade as a count variable 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. Since our panel data yields 5513 country-year dummies, we apply the PPML methodology for a single year with exporter and importer fixed-effects, to obtain convergence.[17] The estimates for year 2004 are shown in Columns (7)-(9) of Table 2. Here the coefficient on experience for the extensive and intensive margins remains strongly significant and virtually unchanged compared to the HMR (2008) specification. The coefficient on experience for overall trade declines somewhat but remains significant.

[13] We use the IMF's DOTS database to code zero vs. positive exports between country-pairs, and confirm these by cross-checking with the COMTRADE and the World Trade Flows Database.

[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] Since some countries export to, or import from, all other countries in a particular year, fixed exporter and importer effects cannot be estimated in the probit equation, and all observations with that particular exporter or importer are dropped. As a result, the number of observations declines to 220,366.

[16] If the error term in the standard log specification is heteroskedastic, its log is not orthogonal to the log of the regressors, leading to inconsistent estimates of the gravity elasticities.

[17] A well-known problem with the PPML estimator is that the maximum likelihood function does not converge when there are many dummies.

4.2 Generalized Experience-Adjusted Gravity

In this section, we allow for heterogeneity in the effects of experience, examining whether the coefficient on experience, λ_{od}, varies across country-pairs according to their geographical, cultural and linguistic *remoteness*. As discussed before, in the linear specification, the expected sign of the mediating effects of remoteness, $\hat{\lambda}_m$, is ambiguous, depending on the scope and pace effects. The scope effect captures how higher remoteness increases how much the pair can benefit from experience, while the pace effect is related to how lower remoteness increases the speed at which the benefits from experience accrue.

We estimate equation (7), interacting our DOTS-based experience measure with each of the remoteness, time-invariant variables. The results for total exports and for the extensive and intensive margins are shown in Table 3A. The results for the extensive margin, in Column (2), mirror the findings for total exports in Column (1). For the intensive margins, the results in Column (3) are varied.

To evaluate the moderating effect of each remoteness variable of experience on total trade and the two margins, we report in Table 3B, the (average) marginal effects of experience for various values of the remoteness variables. These are based on the coefficient estimates in Table 3A. Note that the remoteness variables, with the exception of distance, are dummies. Therefore for distance we report the marginal effects at one standard deviation above and one standard deviation below the mean. The average marginal effect of experience for total exports, evaluated at the sample mean of each remoteness variable, is 0.06, 0.029 for the extensive margin and 0.031 for the intensive margin. These are nearly identical to the estimate obtained in Column (1) of Table 1. At the same time, experience positively affects bilateral trade and the two margins regardless of the exact value of the remoteness variable. However, the effect of experience on exports is stronger in countries that are further away, non-contiguous, that have no colonial links and do not share a common legal system. In contrast, the role of experience is stronger when countries share a common language. That is, experience matters more when a country-pair shares a common language, while for all other remoteness variables, experience matters more when the country-pairs are more remote.

The second column shows that the effect of experience on the extensive margin is moderated in exactly the same way as that for bilateral exports. The impact of experience is stronger for those that are distant, non-contiguous and lack colonial and legal links. However, sharing a common language strengthens the effect of experience. For the intensive margin in the third column, we find that the effect of experience does not depend on any of the remoteness variables, except distance and colonial ties. For countries that are proximate and have colonial links, experience matters less for the intensive margin.

Table 3A also implies that the estimates for the traditional gravity are conditional on experience. We see that while distance impedes trade, its effect declines with experience. Similarly, the effect of borders as a

barrier to trade declines with experience. Colonial links and sharing a common law legal system facilitates trade but their role declines with cumulated experience. The exception is language - sharing a language enhances trade and its effect increases with experience which is in line with Egger and Lassman (2012) who find an increasing effect of language over time. Our findings suggest that the effect of traditional gravity variables as barriers to trade are heterogeneous and conditional on experience. To some extent, this can account for varying estimates of coefficients of these gravity variable. Our results imply that these estimates will depend on both the time-period and the sub-sample used to estimate these coefficients. Not accounting for experience means that the coefficients capture the effect of these variables at some mean level of experience which depends critically on the sample time period and countries used to estimate these coefficients.

In Table 3C, we show the effect of each remoteness variable on bilateral exports, at varying points of the sample distribution of experience. For comparison, the first two columns report the median and mean coefficient estimates from the meta-analysis of Head and Mayer (2013a).[18] Geographical proximity, a common border and legal systems and colonial links are important facilitators of trade, but their impact diminishes with experience. In other words, while our estimates confirm the importance of remoteness in trade flows, we show that country-pairs by accumulating experience in trading with one another can lower these barriers over time. For example, distance always impedes trade while sharing a border always facilitates trade, regardless of how long the countries have been trading; only when countries have been trading close to 182 (63) years, does the distance (adjacency) effect fade to zero. Common language is the only variable for which we obtain the reverse effect - common language facilitates bilateral exports because of its direct effect on trade costs, and because it accentuates the benefits of experience. Comparing our distance estimates to the meta-analysis of Head and Mayer (2013a) we see that the coefficient of distance coincides only when experience is close to 39 years. This suggests that the gravity specifications in their meta-analysis include country-pairs that have been trading for around that time, on average - this is not surprising, given the observation of Helpman, Melitz and Rubinstein (2008) that trade has been basically between the same country-pairs that were trading before the 1970´s.

[18] Head and Mayer (2013a) in their meta-analysis of 159 papers and 2500 gravity estimates report the median and mean estimates of commonly used gravity variables. They do not report average estimates for common colonizer and common law. They report estimates from structural gravity equations that use either country fixed effects or ratio-type method, to account for the multilateral trade resistance terms.

4.2.1 Robustness Checks

We are able to replicate our results nearly exactly when we use the measure of experience based on the COW data or when add a dummy variable for countries whose experience is censored at 58.[19] These estimates are not presented for reasons of space. We do not estimate a specification with country-pair fixed-effects since the exclusion of remoteness variables means that the interpretation of their interaction terms is nonsensical and their impact on trade flows cannot be obtained.

Table 4 examines the robustness of our results to the presence of zeros, heterogeneity and selection bias by using the same Tobit and HMR specification as before. Overall, the impact of experience on trade costs is nearly identical to the previous model, for total exports and the extensive margin. In the Tobit specification, the differences are that sharing a common law system increases the intensive margin, but experience moderates this effect, and that sharing a common language increases the intensive margin, an effect that becomes stronger with experience. With the HMR correction, the results remain virtually unchanged except that the impact of virtually all trade cost determinants is smaller in absolute terms, capturing the correction of the bias associated with heterogeneity. As before, the inverse Mills ratio is significant and the polynomial terms in $\hat{\hat{z}}^*_{od,t}$ are significant in all regressions, with signs similar to the ones obtained in HMR (2008), confirming the importance of correcting for heterogeneity bias.[20] [21]

Next we used alternate weighted measures of the extensive and intensive margins following Feenstra and Kee (2008) and Hummels and Klenow (2005). We obtain nearly identical results with these alternate measures of the margins. We also estimated coefficients for various country sub-samples, by classifying countries as OECD vs. non-OECD. The strongest role for experience (both direct and interacted with the gravity variables) are for the sub-sample when both countries in a country-pair are outside the OECD, followed by when exactly one country in a pair is in the OECD. The weakest role for experience is when both countries are OECD members.

Overall, we find fairly strong evidence for the role of experience in affecting bilateral trade, through the extensive and intensive margins of exports. The effect on the extensive margin suggests that experience in exporting a subset of HS-6 lines increases the probability of exporting other HS-6 lines. At the same time,

[19] In the latter specification, we also interacted this dummy with the gravity variables.

[20] Since it can be argued that the common religion dummy is not a plausible exclusion restriction, especially for the extensive margin (which is affected by both fixed and variable trade costs) we tried one additional permutation. We dropped the exclusion restriction and relied for identification on the non-linearity of the inverse Mills ratio. We get nearly identical results to those reported in Table 4.

[21] Convergence becomes an issue with the PPML methodology when we use multiple interaction terms. However, with one interaction at a time, we obtain very similar results.

the coefficient on the intensive margin suggests that experience matters at the level of increasing exports in each product line. These findings are robust to censoring problems and to demanding specifications to account for omitted variables, which may affect our experience variable. We account also for traditional concerns in the estimation of the gravity equation such as bias due to statistical zeros, heteroskedasticity in a log-linear specification and changes in the composition of exporting firms.

When looking at the role of remoteness variables as determinants of the impact of experience (captured by their interaction), we find that remoteness increases the impact of experience, is dominant for virtually all variables. Symmetrically, this means that experience works to bridge these remoteness variables, reducing their trade-inhibiting effect over time. The only exception is common language, which works to expand the trade facilitating role of experience.

Our results also suggest an alternate explanation for the persistence of distance and border effects. To the extent that country-pairs more or less continuously trade with one another we would expect their influence to decline over time. But the countervailing influence comes from the emergence of trade between new country-pairs - the expansion of trade at the extensive partner margin. Lacking experience, the distance and border effects are large for such country-pairs which tends to inflate the distance and border coefficients.

5 Theory

Now, we introduce a simple model to help shed light on the implications of the experience-trade costs nexus scrutinized in the empirical section on the theory of international trade. We focus on a model of heterogenous firms, departing from the approach of Melitz (2003) and Chaney (2008) by including a mechanism where trade costs decline with experience. This generates a dynamic process of entry into exporting.

5.1 Set Up

There is a continuum of $\tilde{K}$ differentiated goods, where each good k is produced by a single firm (although a firm can produce more than one good). Consider country d, a potential export destination for firms from country o, where preferences in d are given by $U_{dt} = (\int_{k\in\tilde{K}} x_{kt}^{\frac{\varepsilon-1}{\varepsilon}} dk)^{\frac{\varepsilon}{\varepsilon-1}}$, with $\varepsilon \gg 1$ the elasticity of substitution and x_{kdt} the demand of good k from county d at t, given by

$$x_{kdt} = \frac{p_{kdt}^{-\varepsilon} Y_{dt}}{P_{dt}^{1-\varepsilon}}, \quad P_{dt}^{1-\varepsilon} = \int_{k\in\tilde{K}} p_{kdt}^{1-\varepsilon} \tag{9}$$

where p_{kdt} is the price of k and Y_{dt} is nominal expenditure in d at time t.

Firms in o produce the subset of goods $K_o \subset \tilde{K}$. Good k faces a unit production cost of W_{ot}/a_k, where W_{ot} is the wage in o at time t and a_k is productivity for k. The distribution of productivity in o is constant over time and captured by the density $g(a)$ on the support $[1, +\infty]$. In line with Chaney (2008), we simplify by assuming that g follows a Pareto distribution, with a scaling parameter $\theta \gg 1$, such that: $g(a) = \theta a^{-(\theta+1)}$ and $\Pr(a > \bar{a}) = \bar{a}^{-\theta}$.

To export to d, the firm producing k faces fixed and variable (iceberg) export costs, in addition to its production costs. As discussed in the empirical model, trade costs decline as the exporter accumulates experience with the local context and discovers better and cheaper ways to transport, clear customs and distribute in country j. We model this by setting the variable and fixed trade costs of k to j at t as a function of experience, denoted by $E_{kdt} \geq 0$, as follows:

$$\tau_{kdt} = \begin{cases} \tilde{\tau}_d e^{\varpi \prime Z - \lambda_\tau E_{kdt}} & \text{for } E_{kdt} \leq \overline{E} \\ \tilde{\tau}_d e^{\varpi \prime Z - \lambda_\tau \overline{E}} & \text{for } E_{kodt} > \overline{E} \end{cases} ; \quad F_{kdt} = \begin{cases} \tilde{F}_d e^{\phi \prime Z - \lambda_F E_{kdt}} & \text{for } E_{kdt} \leq \overline{E} \\ \tilde{F}_d e^{\phi \prime Z - \lambda_F \overline{E}} & \text{for } E_{kdt} > \overline{E} \end{cases} ; \tag{10}$$

τ_{kdt} and F_{kdt} are the iceberg and fixed costs, respectively, to export k to d at t. Z is a vector of gravity variables (including remoteness and policy variables), with $\varpi \geq 0$ and $\phi \geq 0$ capturing their impact on iceberg and fixed trade costs, respectively. $\tilde{\tau}$ and $\tilde{F}$ are residuals that capture non-identifiable determinants of trade costs and can be country-pair specific. We allow trade costs to decline with experience, taking $\lambda_\tau > 0$ and $\lambda_F > 0$ as scalars that capture the impact on iceberg and fixed costs, respectively. $\overline{E}$ is the upper bound on experience, which yields a lower bound for trade costs given by $\tilde{\tau}_d e^{\varpi \prime Z - \lambda_\tau \overline{E}} \geq 1$ and $\tilde{F}_d e^{\phi \prime Z - \lambda_F \overline{E}} \geq 0$. This model reverts to Chaney (2008), when $\lambda_\tau = \lambda_F = 0$, where $e^{\varpi \prime Z}\tilde{\tau}$ and $e^{\phi \prime Z}\tilde{F}$ become trade costs.

5.2 Entry into exports

The inclusion of time requires a historical dimension for the exports from o to d. In the beginning of time $\tilde{\tau}_d$ and $\tilde{F}_d$ are prohibitive ($\tilde{F}_d = \tilde{\tau}_d = +\infty$), such that no firm from o ever considers exporting to d. There is a probabilistic event that lowers $\tilde{\tau}$ and $\tilde{F}$ to a level where exports may begin. We will denote by $t = 0$ the time of this event.

After that, firms in o must decide whether and how much to export to d. Firms are forward-looking. Assume, for now, that once a firm starts to export, it remains an exporter forever.[22] Then, the key decisions are when to begin exporting and how much to export. The discounted value of export profits at time 0 for

[22] This is true in equilibrium, since there are no factors that could make the firm leave afterwards.

a firm that begins exporting k to d at $t_k \geq 0$ is given by

$$\begin{aligned} V(t_k|a_k) &= 0 + \int_{t_k}^{+\infty} e^{-\rho t} R_{kt} dt \\ \text{where } R_{kt} &= \left(p_{kt} - \frac{\tau_{kt} W_t}{a_k} \right) x_{kt} - F_{kt} \end{aligned} \tag{11}$$

where we have omitted the o subscript in W and the od subscripts in x, p, τ, and F (and later in P and Y). R_{kt} refers to the firm's profits.

In accordance with our empirical approach, we take the number of years of experience as the key driver of discovery. Then, as the benefits of discovery do not depend on the volume of exports, the pricing decision is static, and the traditional CES mark-up rule, $p_{kt} = (\varepsilon/\varepsilon - 1)\, \tau_{kt} W_t / a_k$, yields the value of exports to d as

$$x_{kt} = \left(\frac{\varepsilon - 1}{\varepsilon} \frac{a_k}{\tau_{kt} W_t} \right)^{\varepsilon - 1} \frac{Y_t}{P_t^{1-\varepsilon}} \tag{12}$$

while the optimal profits from exporting to d becomes:

$$\begin{aligned} R_{kt} &= \tilde{\varepsilon} \left(\frac{a_k}{\tau_{kt} W_t} \right)^{\varepsilon - 1} \frac{Y_t}{P_t^{1-\varepsilon}} - F_{kt} \\ \text{where } \tilde{\varepsilon} &= (\varepsilon - 1)^{\varepsilon - 1} \varepsilon^{-\varepsilon} \end{aligned} \tag{13}$$

The firm must decide whether or not it wants to export x_{kt}. In fact, it chooses t_k, and then x_{kt}, to maximize $V(.|a_k)$. If $\max V(.|a_k) < 0$, the firm will choose not to export k to j ever. The trade-offs facing the firm are depicted in $\partial V / \partial t_k$, given by

$$\frac{\partial V}{\partial t_k} = e^{-\rho t_k} \left[-R_{kt_k} + \int_{t_k}^{+\infty} e^{-\rho(t - t_k)} \left((\varepsilon - 1) \tilde{\varepsilon} \tau_{kt}^{-\varepsilon} \left(\frac{a_k}{W_t} \frac{P_t}{Y_t^{1/(1-\varepsilon)}} \right)^{\varepsilon - 1} \lambda_\tau + \lambda_F \right) \frac{\partial E_{kt}}{\partial t_k} dt \right] \tag{14}$$

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

With t_k^* denoting the optimal period of entry for firm k, the conditions for optimality imply three types of behavior by firms, in term of exporting to d: (a) some firms are pioneers that start exporting from period 0 ($\partial V\left(t_k^* = 0\right) / \partial t_k \leq 0, t_k^* = 0$), (b) other firms are laggards that opt to begin exporting at a later stage ($\partial V\left(t_k^* > 0\right) / \partial t_k = 0, t_k^* > 0$), and finally, (c) non-exporters opt out of exporting to j for the foreseeable future ($V\left(t_k^*\right) < 0$). Hence we introduce the possibility of a dynamic path of entry for firms, due to the effect of experience on the trade costs of firms, departing from Chaney (2008).

5.3 Experience and the dynamics of the margins of trade

In this section, we discuss the equilibrium outcomes for the export decisions depicted in equations (12)-(14). We explore three scenarios: first, a benchmark where there is no role for experience (Chaney, 2008); second, the case where experience is confined to the firm´s own experience; finally, third, the case where thre is shared experience across all domestic firms. We address the implications for exports from o to d, and decompose this into the extensive margin, i.e. mass of exporting firms, and the intensive margin, i.e. exports per firm.

Now, given the inter-temporal elements of the decision to enter into exports, the time paths for W_t and $Y_t/P_t^{1-\varepsilon}$ are critical for the firm´s decision (see eqs. 12 and 13). Moreover, from a general equilibrium standpoint, the decisions by the firms from o about exporting to d have consequences for the labor markets in o and for good´s markets in d, which implies that W_t and $Y_t/P_t^{1-\varepsilon}$ are endogenous. For simplicity, we assume away general equilibrium considerations in this section and take these variables as constant. In the next section, we look at the general equilibrium aspects, through a numerical exercise.

5.3.1 Benchmark: No discovery (Chaney, 2008)

We begin by setting a benchmark with the standard case, where experience does not change trade costs, i.e. $\lambda_\tau = \lambda_F = 0$, and trade costs are constant over time and identical for all goods. Under these conditions, (14) implies

Proposition 1 Under no discovery, all firms with productivity above

$$\mathring{a} \equiv \tilde{\varepsilon}^{\frac{1}{1-\varepsilon}} \left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{1}{1-\varepsilon}} W \quad (e^{\varpi' Z}\tilde{\tau}) \left(e^{\phi' Z}\tilde{F}\right)^{\frac{1}{\varepsilon-1}} \tag{15}$$

earn positive profits and enter into exports at $t = 0$ (pioneers), while the remaining firms do not enter.

Proof If $\lambda_\tau = \lambda_F = 0$ the second term in (14) disappears, yielding $\partial V/\partial t_k = -e^{-\rho t_k} R_{kt}$. Moreover, since τ_{kt} and F_{kt} are constant, from (12) and (13), x_{kt} and R_{kt} are also constant. So, firms with $R_{kt} > 0$ ($\partial V/\partial t_k < 0, \forall t_k; V > 0$) enter at $t = 0$ and earn positive profits, while those with $R_{kt} < 0$ ($\partial V/\partial t_k > 0, \forall t_k$) never enter. Let $\mathring{a}$ denote the productivity level, such that $R_{kt}(\mathring{a}) = 0$. Since R_{kt} is increasing in a_k, all firms with productivity above $\mathring{a}$ enter at $t = 0$ and earn positive profits.∘

Since exporting firms are defined as those with productivity above threshold, we can express the value of their exports (X), their mass (N), i.e. the extensive margin, and (therefore) the average exports per firm

(X/N), i.e. the intensive margin, using[23]

$$
\begin{aligned}
N &\equiv \int_{a_k>a} g(a_k)da_k = a^{-\theta} && (16)\\
X &\equiv \int_{a_k>a} \left(\frac{\varepsilon-1}{\varepsilon}\frac{a_k}{\tau_{kt}W}\right)^{\varepsilon-1}\frac{Y}{P^{1-\varepsilon}} \quad \theta a_k^{-(\theta+1)}da_k = && (17)\\
&= \frac{\theta\left(\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon-1}}{\theta-(\varepsilon-1)}\frac{Y}{P^{1-\varepsilon}}W^{1-\varepsilon}\tau_{kt}^{1-\varepsilon}a^{(\varepsilon-1)-\theta}
\end{aligned}
$$

Given (15), total exports and the extensive and intensive margins can be expressed for the benchmark case as:

$$
\begin{aligned}
\mathring{X} &= \frac{\theta\varepsilon\tilde{\varepsilon}^{\frac{\theta}{\varepsilon-1}}}{\theta-(\varepsilon-1)}\left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{\theta}{\varepsilon-1}}W^{-\theta}\ \left(e^{\varpi\prime Z}\tilde{\tau}\right)^{-\theta}\left(e^{\phi\prime Z}\tilde{F}\right)^{1-\frac{\theta}{\varepsilon-1}}\\
\mathring{N} &= \tilde{\varepsilon}^{\frac{\theta}{\varepsilon-1}}\left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{\theta}{\varepsilon-1}}\ \left(e^{\varpi\prime Z}\tilde{\tau}W\right)^{-\theta}\left(e^{\phi\prime Z}\tilde{F}\right)^{-\frac{\theta}{\varepsilon-1}} \qquad (18)\\
\mathring{X}/\mathring{N} &= \frac{\theta\varepsilon}{\theta-(\varepsilon-1)}\ \left(e^{\phi\prime Z}\tilde{F}\right)
\end{aligned}
$$

The interpretation of these results is now standard in the literature, and follows straight from Chaney (2008). A decline in a gravity variable z^m in Z expands total trade, whether it affects fixed or variable costs. It expands the extensive margin, by increasing profit margins (variable costs) or lowering fixed costs, encouraging entry into exporting.

The impact on the intensive margin is subject to conflicting effects: when the variable component falls, the exports of incumbents rise, but since entrants have lower than average exports, due to lower productivity, the impact on average exports is ambiguous. As Chaney (2008) argues, under a Pareto distribution, such as this paper assumes, the two effects cancel out and declines in the variable trade cost leave the intensive margin unaffected. Dutt, Mihov and Van Zandt (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. On the other hand, if the fixed component of trade costs falls, the exports of incumbents are unaffected, which implies that the lower exports of entrants reduces the intensive margin. In any case, these effects on the intensive margin are dominated by the positive effects on the extensive margin, resulting in an increase in trade flows from a decline in either the fixed or variable component of trade costs.

These results are captured in Columns (1) and (4) of Table 6. Note that, in this case, there are no dynamics for the extensive or the intensive margin (eq. 18 does not depend on t), because trade cost do not change with time.

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

5.3.2 Discovery through own-experience

Now we look at the case where only the firm´s own experience, defined as the number of years since the firm began exporting, contributes to changes in trade costs. We take $E_{kt}^f = \mu\,(t - t_k)$, $\mu \geq 0$, imposing an upper bound on experience l, such that $E_{kt}^f = \mu l$, for $t - t_k > l$. A key difference from Chaney (2008) is that since E_{kt}^f increases with t_k, trade costs are different across firms, depending of their experience, and change over time.

It is natural to assume that the firm internalizes the impact of its entry decision on the discovery process. In these circumstances, we obtain

Proposition 2 When firms discover through own-experience, all firms with productivity above

$$\hat{a} \equiv \tilde{\varepsilon}^{\frac{1}{1-\varepsilon}} \left(\frac{Y}{P^{1-\varepsilon}}\right)^{-\frac{1}{\varepsilon-1}} W \ \left(\tilde{\tau} e^{\varpi' Z}\right) \left(\tilde{F} e^{\phi' Z}\right)^{\frac{1}{\varepsilon-1}} \left(\frac{1-\Phi}{1+\varsigma}\right)^{\frac{1}{\varepsilon-1}} \tag{19}$$

with:

$$\begin{aligned} \Phi &= \frac{\lambda_F \mu}{\lambda_F \mu + \rho}\left(1 - e^{-[\lambda_F \mu + \rho] l}\right) \text{ and } \varsigma = \frac{(\varepsilon-1)\lambda_\tau \mu}{(\varepsilon-1)\lambda_\tau \mu - \rho}\left(e^{[(\varepsilon-1)\lambda_\tau \mu - \rho] l} - 1\right) \\ 0 &< (1-\Phi)/(1-\varsigma) < 1 \end{aligned}$$

enter at $t = 0$ (pioneers), while the remaining firms do not enter.

Proof Under E_{kt}^f, with discovery bounded at μl and $\partial E_{kt}/\partial t_k = -\mu$, (14) yields

$$\left.\frac{\partial V}{\partial t_k}\right|_{E^f} = e^{-\rho t_k}\left[-\tilde{\varepsilon}\left(\frac{a_k}{\tilde{\tau} e^{\varpi' Z} W}\right)^{\varepsilon-1} \frac{Y}{P^{1-\varepsilon}}(1-\varsigma) + \tilde{F} e^{\phi' Z}(1-\Phi)\right]$$

where ς and Φ are given above. Note that $\partial V/\partial t_k \geq 0$ implies $R_{kt}|_{E_{kt}^f = 0} \geq 0$. Hence all firms where $\partial V/\partial t_k \geq 0$, i.e. those with productivity higher than $\hat{a}$, enter at $t = 0$, while all other firms do not enter.$\circ$

Comparing (15) and (19) we obtain that the threshold of entry is lower when firms benefit from their own-experience ($\hat{a} < \mathring{a}$). Because firms internalize these dynamic gains, marginal firms choose to enter as pioneers, even if they make temporary losses. Eventually, this leads to profitability, as trade costs fall, and these marginal firms recoup the losses. Hence we can solve for total exports and its composing margins, as follows

$$\begin{aligned} \hat{X} &= \frac{\theta \varepsilon \tilde{\varepsilon}^{\frac{\theta}{\varepsilon-1}}}{\theta - (\varepsilon-1)}\left(\frac{Y}{P_j^{1-\varepsilon}}\right)^{\frac{\theta}{\varepsilon-1}} W^{-\theta} \ \left(\tilde{\tau} e^{\varpi' Z - \lambda_\tau \mu t}\right)^{-\theta}\left(\frac{1-\Phi}{1+\varsigma}\tilde{F} e^{\phi Z}\right)^{1-\frac{\theta}{\varepsilon-1}} \\ \hat{N} &= \tilde{\varepsilon}^{\frac{\theta}{\varepsilon-1}}\left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{\theta}{\varepsilon-1}} W^{-\theta} \ \left(\tilde{\tau} e^{\varpi' Z}\right)^{-\theta}\left(\frac{1-\Phi}{1+\varsigma}\tilde{F} e^{\phi' Z}\right)^{-\frac{\theta}{\varepsilon-1}} > \mathring{N} \\ \frac{\hat{X}}{\hat{N}} &= \frac{\theta\varepsilon}{\theta-(\varepsilon-1)}\left(\frac{1-\Phi}{1+\varsigma}\tilde{F} e^{\phi' Z}\right) e^{\theta \lambda_\tau \mu t} \end{aligned} \tag{20}$$

The impact of own-experience can be assessed from these expressions. Now, trade costs change through time, as exporters accumulate experience, rendering the path for exports dynamic. The effect of experience is related to its impact on trade costs and the potential for anticipation by firms. First note that, because non-exporters fail to benefit from the experience of incumbents, experience accumulated through the passage of time has no effect on entry, which implies that the extensive margin does not depend on t. Because profitability is only affected by presence in the market, there is no point in delaying entry. On the other hand, the intensive margin and total exports rise with the passage of time and the accumulation of experience by incumbents, provided discovery contributed to lowering variable trade costs. These results are depicted in Columns (2) and (5) of table 6.

5.3.3 Discovery through shared experience

This section addresses the case where the benefits of experience are shared by other firms, including non-exporters (through networks of firms), with spillovers from experience contributing to decline in trade costs, even for non-incumbents. For simplicity, we take the extreme case where all firms in o simultaneously and identically benefit from the experience of active exporters, and set the experience of firm k in terms of industry experience: $E^s_{kt} = \sigma t$, $\sigma \geq 0$, reaching an upper bound for $t = n$.[24] Note that this measure of experience is closer to the one captured in our empirical work, and thus more relevant to interpret our empirical results.

In such setting, the firm benefits from experience whether or not it is in the market, and trade costs does not depend on its own actions, namely the time it enters into exports. Hence the incentives for entry of firm k change as industry experience evolves, yielding an interesting dynamic of entry depicted in the following proposition

Proposition 3 When firms discover through industry experience, all firms with productivity above

$$\bar{a}_t \equiv \tilde{\varepsilon}^{\frac{1}{1-\varepsilon}} \left(\frac{Y}{P^{1-\varepsilon}}\right)^{-\frac{1}{\varepsilon-1}} W \left(\tilde{\tau} e^{\varpi\prime Z - \lambda_\tau \sigma t}\right) \left(\tilde{F} e^{Z\prime\phi - \lambda_F \sigma t}\right)^{\frac{1}{\varepsilon-1}} \tag{21}$$

are in the market at time t.

Proof Under E^s_{kt}, $\partial E_{kt}/\partial t_k = 0$ and the second term in (14) disappears, yielding $\partial V/\partial t_k = -e^{-\rho t_k} R_{kt}|_{D^s_{kt}=\sigma t}$. The interior solution yields $t^*(a_k)$, the optimal time of entry for firm k, where $\partial t^*/\partial a_k < 0$, i.e. less productive firms enter later. Inverting to obtain $a(t)$ we obtain $\bar{a}_t$, depicting the firm that enters at time t. Firms with productivity higher than $\bar{a}_0$ enter at time 0, since $\partial V/\partial t_k(t_k = 0) < 0$.∘

[24] Recall that $t = 0$ is the time when pioneers begin exporting and industry experience starts.

When experience is shared, the firm enters when, and only if, there are non-negative profits. The firm has no incentive to take short term losses (as in the case of own-experience), because its gains from experience do not depend on its own entry decision (but on that of its preceding peers). Hence, at time 0, all firms with productivity higher than $\bar{a}_0$ enter into exporting as pioneers. Then, the benefits of their experience accrue not only for them, but are shared with all potential exporters from i. Some firms that did not find it profitable to export at time 0, do so once their trade costs (variable or fixed) decline due to shared experience: firms with productivity $\bar{a}_t < \bar{a}_0$ enter at $t > 0$ and become laggards.

Total exports and its composing margins are

$$\begin{aligned}
\bar{X} &= \frac{\theta\varepsilon\tilde{c}^{\frac{\theta}{\varepsilon-1}}}{\theta-(\varepsilon-1)}\left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{\theta}{\varepsilon-1}} W^{-\theta}\ \left(\tilde{\tau}e^{\varpi\prime Z-\lambda_\tau\sigma t}\right)^{-\theta}\left(\tilde{F}e^{\phi\prime Z-\lambda_F\sigma t}\right)^{1-\frac{\theta}{\varepsilon-1}} \\
\bar{N} &= \tilde{c}^{\frac{\theta}{\varepsilon-1}}\left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{\theta}{\varepsilon-1}} W^{-\theta}\ \left(\tilde{\tau}e^{\varpi\prime Z-\lambda_\tau\sigma t}\right)^{-\theta}\left(\tilde{F}e^{\phi\prime Z-\lambda_F\sigma t}\right)^{-\frac{\theta}{\varepsilon-1}} \qquad (22) \\
\frac{\bar{X}}{\bar{N}} &= \frac{\theta\varepsilon}{\theta-(\varepsilon-1)}\ \left(\tilde{F}e^{\phi\prime Z-\lambda_F\sigma t}\right)
\end{aligned}$$

Unlike the case where firms discover through own-experience, the emergence of laggards when experience is shared implies that extensive margin increases with t, as experience accumulates. The implications of the decline in trade costs for the intensive margin are more complex. While the exports of incumbents grow due to lower variable costs, the lower exports of laggards (with weaker productivity) reduce the average exports per firm. The implication is that, when shared experience lowers variable costs for all firms, the impact on the intensive margin is ambiguous (canceling out to zero for the special case of the pareto distribution discussed here). When shared experience lowers fixed trade costs, the exports of incumbents are unaffected and the intensive margin actually declines due to the composition effect of entry by smaller, less productive laggards. These results are depicted in Columns (3) and (6) of table 6.

5.4 General Equilibrium

5.4.1 Closing the model

In this section, we extend the previous analysis, looking at the effects of experience in general equilibrium, where W_{ot}, Y_{dt} and P_{dt} are allowed to adjust, as experience unfolds. We will assume a two-country world, denoting the countries as o and d, as before. With L_o denoting labor supply in o, labor market clearing yields

$$L_o = \int l_{ko,t}g(a_k)dk + \int l_{kd,t}g(a_k)dk$$

where $l_{ko,t}$ is labor for domestic consumption and $l_{kd,t}$ is labor for exports to d. For sector k, labor requirements for production and transport of exports to j are: $l_{kd,t} = \tau_{kt} x_{kd,t}/a_k$, which, given $p_{kj,t} = (\varepsilon/(\varepsilon-1))\,\tau_{kt} W_{ot}/a_k$, yields $l_{kd,t} = X_{kd,t}\left(\frac{\varepsilon-1}{\varepsilon}\right)/W_{ot}$, where $X_{kd,t} = p_{kd,t}x_{kd,t}$ are nominal exports tod$j$. For domestic production, simply take $\tau_{kt} = 1$, to obtain $l_{ko,t} = H_{ko,t}\left(\frac{\varepsilon-1}{\varepsilon}\right)/W_{ot}$. Substituting in the labor market clearing condition, we have

$$W_{ot}L_o = \frac{\varepsilon-1}{\varepsilon}\left[\int H_{ko,t}g(a_k)dk + \int X_{kd,t}g(a_k)dk\right] = \frac{\varepsilon-1}{\varepsilon}\left(D_{ot} + X_{dt}\right) \tag{23}$$

where X_{dt} is given in (17) (and operationalized in eqs. 18, 20 and 22) and H_{ot} is given by

$$H_{ot} = \frac{\theta\left(\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon-1}}{\theta-(\varepsilon-1)}\left(\frac{1}{W_{ot}}\right)^{\varepsilon-1}\frac{Y_{ot}}{P_{ot}^{1-\varepsilon}} \tag{24}$$

A converse equation could be obtained for labor market clearing in d. Meanwhile, total expenditure in o, on domestic goods and imports, is

$$Y_{ot} = \int H_{ko,t}g(a_k)dk + \int M_{ko,t}g(a_k)dk$$

where $M_{ko,t}$ are imports of k of o. We assume that trade is balanced every period, i.e. total imports of o are equal to total exports to d: $\int M_{ko,t}g(a_k)dk = \int X_{kd,t}g(a_k)dk$. Hence we can express the total expenditure as[25]

$$Y_{ot} = \frac{\varepsilon}{\varepsilon-1}W_{ot}L_o \tag{25}$$

We can solve for P, X, W, D and Y in both countries, using the expression for P in (9), for X in (17), for W in (23), for D in (24) and for Y in (25). To close the model, we take $P_{ot} = 1$ as the numeraire and define P_{dt} as the exchange-rate. Now, we assume that countries o and d are identical and focus on the symmetric equilibrium. Hence we obtain $P_{ot} = P_{dt} = 1$ and all nominal aggregate variables, including the wage, denote real variables.

5.4.2 Numerical exercise

Despite the simplification of symmetry, an analytical solution to the model cannot be reached, and we move forward with a numerical exercise. The exercise simulates the effect of experience following the event that starts trade between the two symmetric countries. It assumes that the impact of experience unfolds over 20 years after that event, with a parameter value that arises from the empirical analysis in the previous

[25] Note that total expenditure overestimates GDP, which must exclude payments of fixed costs.

section. Other parameter values follow standard assumptions in the literature and are presented in Table 5. We discuss in sequence our two scenarios: own-experience and shared-experience.

Figure 3A presents the case of own-experience, where X_t is given by (20), separating the effect on the variable and the fixed trade cost. It plots the behavior of total exports, decomposing the extensive and the intensive margins, along with behavior of real wages, for a period of 20 years. The path of real wages allows us to assess the dynamic gains from trade, as an approximation to the effects on welfare. The figures shows that introduction of general equilibrium effects has limited qualitative impact on the effects of experience. When it lowers fixed costs, there are no effects on the intensive or the extensive margin, or the real wage. The decline in fixed costs of exporters has no impact on the exports or labor demand, and, for non-exporters, there are no gains from experience.

When experience lowers variable trade costs of exporters it leads to an expansion of exports, which is captured here by the expansion of the intensive margin. In general equilibrium this gives rise to an expansion of wages, as labor demand for exports increases, which is shown in the respective quadrant. This wage effect, which was not present in the partial equilibrium analysis leads, here, to a lower profitability of the export sector and a slight decline in the extensive margin, as depicted in quadrant. This effect holds when the elasticity of substitution (ε) is lower than 2: real wages grow at a faster rate than income and the lower trade costs do not compensate the wage rise, pushing marginal exporters out. In the other scenario, where the effect of the wage would be lower than that of experience, the extensive margin would be unaffected: the lack of symmetry arises because, for non exporters, there is no effect of experience and any increase in the wage would simply reinforce the lack of incentives for entry.

Figure 3B looks at the path of the variables, when shared-experience affects the variable or the fixed costs, where X_t is given by (22). In this case, the introduction of general equilibrium shows again that the growth of exports contributes to an increase in the wage, but there is no situation where this reverses the qualitative results of the partial-equilibrium analysis. On one hand, the decline in the fixed cost of non-exporters contributes to an increase in the extensive margin, which produces a negative composition effect on the intensive margin. On the other, the decline in variable costs for exporters and non-exporters, leads to positive effects in the extensive margin and in the intensive margin, although in the latter, this may be weakened by the composition effect.

5.5 Interpreting the empirical results

Table 6 summarizes our theoretical results, separating the effects of variable and fixed trade costs in each of three scenarios discussed. The effects of experience depend on whether it lowers variable or fixed trade

costs, as well as the nature of experience. The main conclusion is the confirmation that experience works to expand trade. Experience works to expand the extensive margin, only when it is shared by domestic firms, as non-exporters enter due to lower trade costs. In the case of own-experience, there is only potential for non-positive effects, through the extensive margin.

For the intensive margin, the effects of experience depend on the conflicting effects of growth of incumbents and the entry of small exporters. In the case where own-experience lowers variable costs, experience generates an unambiguous increase in the intensive margin, because there is no entry of small exporters, who fail to benefit from the decline in trade costs. On the other hand, when shared-experience lowers fixed costs, there is no effect on incumbents and the entry of small exporters lowers the intensive margin.

The results in table 6 allow us to shed light on the empirical results from the previous section. Now, the empirical results emerge from a real-life environment that features a linear combination of all the scenarios in the model (columns in Table 6). Since the various scenarios yield different, often conflicting, predictions for the extensive and intensive margins, depending on whether we focus on variable or fixed trade costs or on own- or shared-experience, the implications for our empirical results on the margins are ambiguous and we must take a conservative approach in linking empirics and theory. Having said this, we can establish some key implications from the empirical results obtained.

On one hand, the estimated role of experience on the extensive margin, which captures the impact of country-pair experience for entry into new HS-6 sectors, implies that shared-experience must play an important role. Hence, the process of discovery from experience takes place not only for the sectors where trade is actually occurring, but also for sectors where trade begins because trade costs (either fixed or variable) fall through discovery from the experience in other sectors. On the other hand, the notion that experience expands the intensive margin means that discovery must play a role in the variable component of trade costs, either from own-experience or, provided we generalize from the Pareto distribution (Dutt, Mihov and Van Zandt 2013), from shared-experience.

6 Conclusion

This paper has addressed the possibility that trade costs, an important determinant of international trade flows, may be affected by the experience of exporting firms. We have established, in the context of the gravity specification, that experience, proxied by the number of previous years with positive trade for each country-pairs, works to expand the intensive and extensive margins of trade. We have also shown experience´s role in reducing the impact of traditional trade costs, associated with cultural, geographic and linguistic remoteness,

with the exception of language difference, whose effects are magnified by experience, due to its effect as a facilitator of discovery from experience. We have confirmed the robustness of these results, not only to traditional econometric concerns of the gravity literature, but also to measurement and omitted variables biases associated with the proxy for experience.

We have also addressed the impact of experience for models of international trade with heterogenous firms. We have addressed two settings: first, when experience lowers only the trade costs of the exporter, and second, when it affects the trade costs of the industry. Our set up departs from traditional models, opening the possibility that trade costs are dynamic and potentially different across firms. Our results show that the effects on the extensive and intensive margins depend on whether experience is shared or not, whether it affects fixed or variable costs and, to a limited extent, whether we account for general equilibrium effects on wages or not. In light of the model, our empirical results confirm that the effects of experience affect variable costs and are at least partially shared across industries.

The expansion of trade, due to the effect of experience, implies that the gains from trade are highly dynamic and that the effect of remoteness (in its multiple dimensions) on trade costs tends to fall with experience. 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 may lower the trade costs for non-exporters and encourage entry. The role of export-promotion in the East-Asian growth may be reassessed in this light.

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Figure 1: Decomposition of World Exports into Trade Between Country-Pairs that Traded Prior to 1950 and Emergence of New Trade

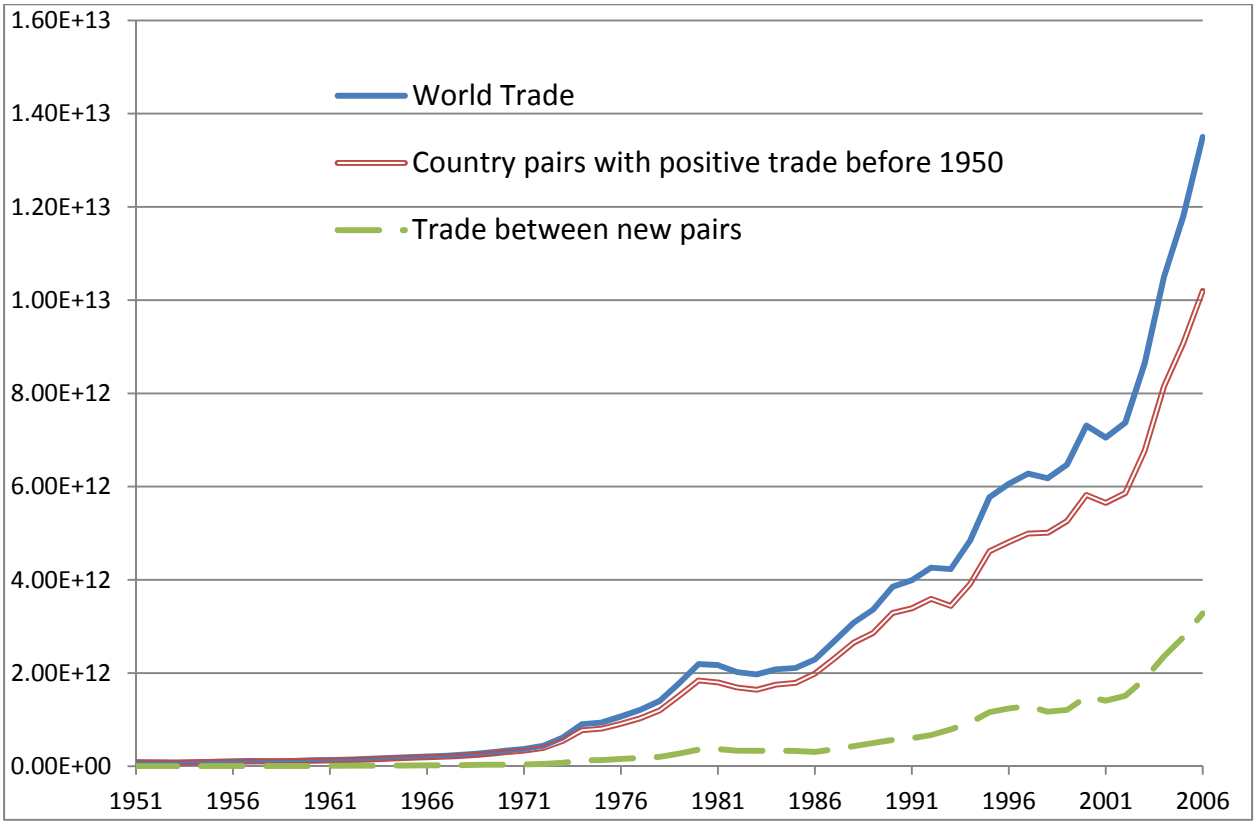


Figure 2: Distribution of Experience in 2006

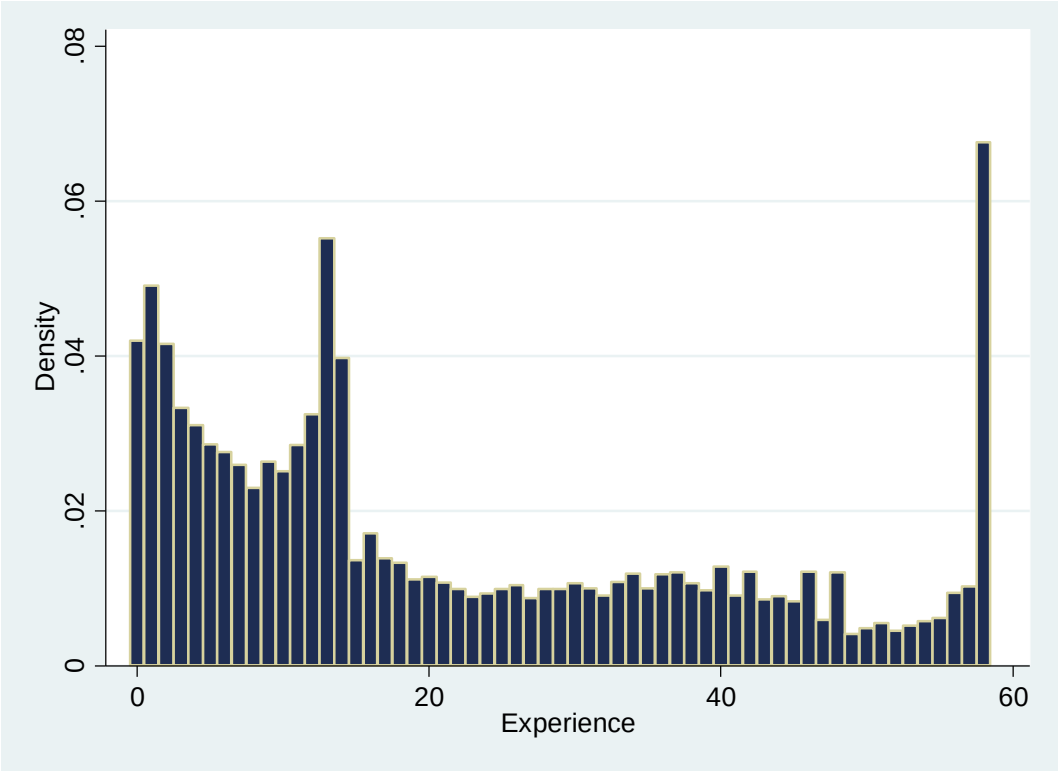
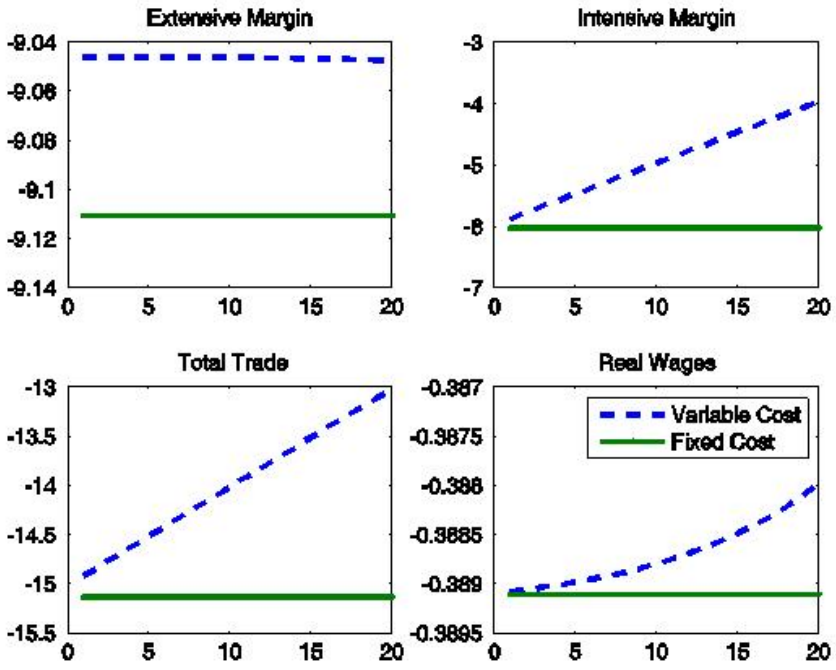


Figure 3: Numerical Exercise

3A. Own-Experience



3B – Shared-Experience

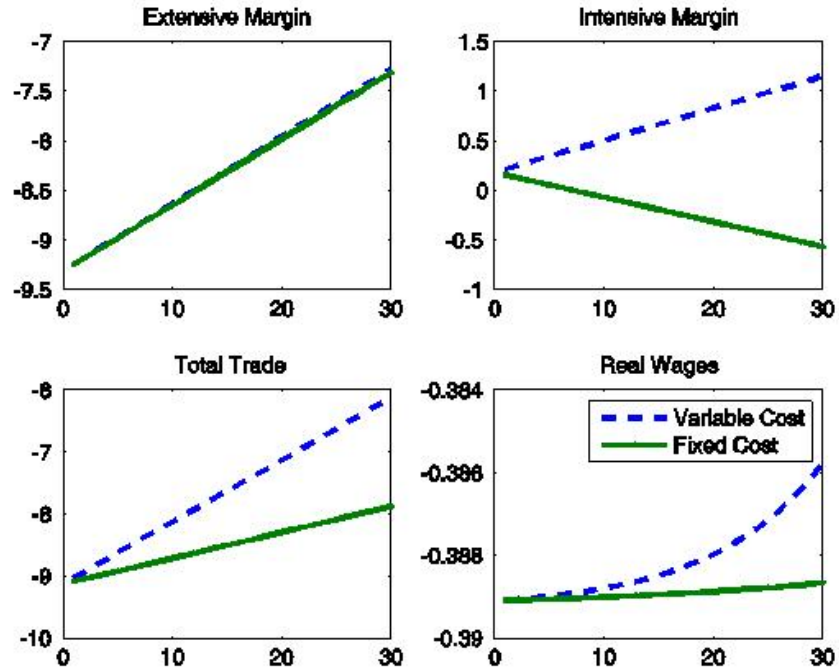


Table 1: The Gravity of Experience

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Experience based on DOTS			Experience based on COW			Country-Pair Dummies		
	Bilateral exports	Extensive margin	Intensive margin	Bilateral exports	Extensive margin	Intensive margin	Bilateral exports	Extensive margin	Intensive margin
Experience	0.060***	0.029***	0.031***	0.032***	0.014***	0.018***	0.084***	0.041***	0.043***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.003)	(0.006)
Distance	-1.217***	-0.819***	-0.398***	-1.267***	-0.870***	-0.397***			
	(0.018)	(0.011)	(0.013)	(0.020)	(0.012)	(0.013)			
Contiguous	0.501***	0.419***	0.082	0.351***	0.324***	0.027			
	(0.083)	(0.064)	(0.053)	(0.093)	(0.071)	(0.053)			
Colonial relationship	0.895***	0.604***	0.291***	1.032***	0.655***	0.376***			
	(0.092)	(0.060)	(0.058)	(0.103)	(0.066)	(0.062)			
Common language	0.397***	0.455***	-0.058*	0.502***	0.544***	-0.042			
	(0.039)	(0.023)	(0.030)	(0.043)	(0.025)	(0.031)			
Common law	0.369***	0.140***	0.229***	0.415***	0.177***	0.238***			
	(0.052)	(0.029)	(0.041)	(0.056)	(0.031)	(0.043)			
Both in WTO	0.079	0.197***	-0.118***	0.125*	0.236***	-0.111**	0.172***	0.219***	-0.047
	(0.061)	(0.035)	(0.044)	(0.069)	(0.041)	(0.051)	(0.056)	(0.029)	(0.047)
PTA	0.566***	0.371***	0.195***	0.756***	0.455***	0.301***	0.053	-0.135***	0.188***
	(0.053)	(0.033)	(0.039)	(0.057)	(0.035)	(0.039)	(0.047)	(0.024)	(0.040)
GSP	0.049	0.054**	-0.005	0.528***	0.301***	0.227***	0.095	-0.026	0.121
	(0.048)	(0.024)	(0.039)	(0.051)	(0.026)	(0.039)	(0.101)	(0.036)	(0.089)
Common currency	0.160	0.018	0.142*	0.033	-0.001	0.035	0.087*	-0.083***	0.170***
	(0.120)	(0.076)	(0.079)	(0.126)	(0.083)	(0.079)	(0.047)	(0.027)	(0.044)
Observations	244938	244938	244938	221891	221891	221891	244938	244938	244938
Country-pairs	26089	26089	26089	22202	22202	22202	26089	26089	26089
R-squared	0.77	0.84	0.54	0.76	0.84	0.52	0.91	0.96	0.78
Country-year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair effects	No	No	No	No	No	No	Yes	Yes	Yes

Standard errors adjusted for clustering on country-pairs in parentheses;* significant at 10%; ** significant at 5%; *** significant at 1%; All columns include a constant (not shown).

Table 2: Accounting For Zeros, Heterogeneity and Selection Bias, and Heteroskedasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Tobit Specification			Selection and Heterogeneity Bias			Poisson Pseudo Maximum Likelihood		
	Bilateral exports	Extensive margin	Intensive margin	Bilateral exports	Extensive margin	Intensive margin	Bilateral exports	Extensive margin	Intensive margin
Experience	0.090***	0.037***	0.057***	0.060***	0.027***	0.033***	0.016***	0.024***	0.027***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.007)
Distance	-1.427***	-0.859***	-0.612***	-0.792***	-0.555***	-0.237***	-0.822***	-0.588***	-0.321***
	(0.009)	(0.003)	(0.007)	(0.046)	(0.025)	(0.036)	(0.029)	(0.015)	(0.074)
Contiguous	0.293***	0.373***	-0.132***	0.607***	0.579***	0.028	0.360***	-0.048	0.213
	(0.037)	(0.015)	(0.031)	(0.086)	(0.057)	(0.055)	(0.063)	(0.053)	(0.175)
Colonial relationship	0.813***	0.589***	0.207***	0.935***	0.591***	0.345***	-0.051	0.365***	0.031
	(0.041)	(0.016)	(0.034)	(0.112)	(0.070)	(0.072)	(0.098)	(0.053)	(0.211)
Common language	0.661***	0.505***	0.205***	0.129***	0.286***	-0.158***	0.143*	0.250***	-0.556***
	(0.018)	(0.007)	(0.015)	(0.046)	(0.026)	(0.036)	(0.082)	(0.035)	(0.152)
Common law	0.434***	0.157***	0.291***	0.307***	0.084***	0.223***	0.136	0.191***	0.190
	(0.024)	(0.010)	(0.020)	(0.056)	(0.030)	(0.044)	(0.092)	(0.043)	(0.214)
Both in WTO	-0.166***	0.108***	-0.306***	0.013	0.166***	-0.154***	1.299***	0.403***	-0.673**
	(0.031)	(0.013)	(0.026)	(0.063)	(0.035)	(0.047)	(0.210)	(0.098)	(0.317)
PTA	0.525***	0.368***	0.137***	0.212***	0.094***	0.119**	0.391***	0.205***	0.087
	(0.027)	(0.011)	(0.023)	(0.060)	(0.034)	(0.047)	(0.068)	(0.040)	(0.190)
GSP	-0.056**	0.017*	-0.083***	-0.390***	-0.327***	-0.062	-0.125	0.087**	-0.590***
	(0.023)	(0.009)	(0.020)	(0.057)	(0.027)	(0.046)	(0.133)	(0.034)	(0.187)
Common currency	0.362***	0.060***	0.345***	0.217	0.188**	0.029	-0.022	-0.235***	0.397**
	(0.051)	(0.021)	(0.043)	(0.137)	(0.080)	(0.093)	(0.080)	(0.056)	(0.182)
$\hat{\eta}$*				0.438***	0.450***	-0.012			
				(0.080)	(0.042)	(0.062)			
$\hat{z}$*				1.444***	0.847***	0.596***			
				(0.105)	(0.056)	(0.082)			
$\hat{z}^{*2}$				-0.145***	-0.023**	-0.122***			
				(0.020)	(0.011)	(0.016)			
$\hat{z}^{*3}$				0.006***	-0.004***	0.010***			
				(0.001)	(0.001)	(0.001)			
Observations	298265	298265	23506	220366	220366	220366	23506	23506	23506
Country-pairs	28165	28165	23506	25358	25358	25358	23506	23506	23506
R-squared	0.72	0.92	0.44	0.74	0.83	0.52	0.91	0.81	0.48
Country-year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses;* significant at 10%; ** significant at 5%; *** significant at 1%; All columns include a constant (not shown).

Table 3A: Experience and Trade Costs

	(1)	(2)	(3)
	Bilateral exports	Extensive margin	Intensive margin
Experience	-0.006	-0.011***	0.004
	(0.006)	(0.004)	(0.005)
Distance	-1.401***	-0.929***	-0.472***
	(0.026)	(0.016)	(0.018)
*Distance*Experience*	0.008***	0.005***	0.003***
	(0.001)	(0.000)	(0.001)
Contiguous	1.151***	1.097***	0.054
	(0.169)	(0.120)	(0.098)
*Contiguous*Experience*	-0.018***	-0.020***	0.002
	(0.004)	(0.003)	(0.003)
Colonial relationship	1.875***	1.065***	0.810***
	(0.224)	(0.157)	(0.138)
*Colonial relationship*Experience*	-0.027***	-0.013***	-0.014***
	(0.005)	(0.004)	(0.003)
Common language	0.337***	0.352***	-0.016
	(0.068)	(0.038)	(0.052)
*Common language*Experience*	0.003*	0.004***	-0.001
	(0.002)	(0.001)	(0.001)
Common law	0.580***	0.362***	0.218***
	(0.086)	(0.049)	(0.064)
*Common law*Experience*	-0.009***	-0.009***	0.000
	(0.002)	(0.001)	(0.002)
Both in WTO	0.028	0.161***	-0.133***
	(0.060)	(0.035)	(0.045)
PTA	0.616***	0.407***	0.209***
	(0.053)	(0.032)	(0.039)
GSP	-0.038	-0.004	-0.034
	(0.048)	(0.023)	(0.039)
Common currency	0.228*	0.062	0.166**
	(0.118)	(0.074)	(0.080)
Observations	244938	244938	244938
Country-Pairs	26089	26089	26089
R-squared	0.77	0.85	0.54
Country-year effects	Yes	Yes	Yes

Standard errors in parentheses adjusted for clustering on country-pairs; * significant at 10%; ** significant at 5%; *** significant at 1%; All columns include exporter-year and importer-year fixed effects; All columns include a constant (not shown).

Table 3B: Marginal Effect of Experience on Bilateral Exports & Bilateral Margins

	Bilateral exports	Extensive margin	Intensive margin
Overall	0.059***	0.029***	0.031***
	(0.001)	(0.001)	(0.001)
Distance (Mean –1 std. dev.)	0.053***	0.025***	0.028***
	(0.001)	(0.001)	(0.001)
Distance (Mean +1 std. dev.)	0.066***	0.033***	0.033***
	(0.001)	(0.001)	(0.001)
Contiguity = 0	0.060***	0.029***	0.031***
	(0.001)	(0.001)	(0.001)
Contiguity = 1	0.042***	0.010***	0.032***
	(0.004)	(0.003)	(0.003)
Common language =0	0.059***	0.028***	0.031***
	(0.001)	(0.001)	(0.001)
Common language =1	0.062***	0.033***	0.030***
	(0.002)	(0.001)	(0.002)
Colonial link = 0	0.060***	0.029***	0.031***
	(0.001)	(0.001)	(0.001)
Colonial link = 1	0.033***	0.016***	0.017***
	(0.005)	(0.004)	(0.003)
Common law = 0	0.060***	0.030***	0.031***
	(0.001)	(0.001)	(0.001)
Common law = 1	0.052***	0.021***	0.031***
	(0.003)	(0.002)	(0.002)
Observations	244938	244938	244938

Marginal effects are based on Columns (1)-(3) in Table 3A; Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3C: Magnitude of Effects for Bilateral Exports

	Median Effect	Mean Effect	Minimum Experience (0 years)	First Quartile (8 years)	Median Experience (22 years)	Third Quartile (39 years)	Maximum Experience (58 years)
Distance	-1.14	-1.10	-1.401	-1.340	-1.231	-1.100	-0.953
Contiguity	0.52	0.66	1.151	1.005	0.750	0.440	0.093
Common language	0.33	0.39	0.337	0.363	0.409	0.465	0.528
Colonial link	0.84	0.75	1.875	1.660	1.283	0.826	0.315
Common law			0.580	0.510	0.386	0.236	0.069

Median and Mean effect are from structural gravity estimates shown in Head and Mayer (2013a); The next four columns are based on Column (1) in Table 3A

Table 4: Accounting for Zeros and Correction for Selection and Heterogeneity Bias

	(1)	(2)	(3)	(4)	(5)	(6)
	Tobit Specification			Selection and Heterogeneity Bias		
	Bilateral exports	Extensive margin	Intensive margin	Bilateral exports	Extensive margin	Intensive margin
Experience	-0.084***	-0.023***	-0.080***	0.003	0.007	-0.004
	(0.003)	(0.001)	(0.003)	(0.007)	(0.004)	(0.005)
Distance	-1.878***	-1.014***	-0.969***	-0.962***	-0.619***	-0.343***
	(0.012)	(0.005)	(0.010)	(0.049)	(0.026)	(0.038)
*Distance*Experience*	0.020***	0.007***	0.016***	0.007***	0.002***	0.004***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Contiguous	1.018***	1.080***	-0.136**	1.097***	1.005***	0.092
	(0.076)	(0.030)	(0.064)	(0.177)	(0.119)	(0.098)
*Contiguous*Experience*	-0.016***	-0.020***	0.005***	-0.015***	-0.014***	-0.001
	(0.002)	(0.001)	(0.002)	(0.005)	(0.003)	(0.003)
Colonial relationship	2.735***	1.315***	1.517***	1.906***	1.050***	0.856***
	(0.104)	(0.042)	(0.088)	(0.237)	(0.169)	(0.143)
*Colonial relationship*Experience*	-0.053***	-0.021***	-0.036***	-0.028***	-0.014***	-0.014***
	(0.003)	(0.001)	(0.002)	(0.006)	(0.004)	(0.004)
Common language	0.544***	0.394***	0.181***	0.098	0.180***	-0.083
	(0.030)	(0.012)	(0.025)	(0.073)	(0.040)	(0.057)
*Common language*Experience*	0.007***	0.005***	0.002***	0.003	0.005***	-0.002
	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)
Common law	0.715***	0.350***	0.419***	0.452***	0.248***	0.204***
	(0.037)	(0.015)	(0.031)	(0.089)	(0.050)	(0.067)
*Common law*Experience*	-0.014***	-0.009***	-0.007***	-0.007**	-0.007***	0.000
	(0.001)	(0.000)	(0.001)	(0.003)	(0.001)	(0.002)
Both in WTO	-0.253***	0.067***	-0.361***	-0.044	0.140***	-0.183***
	(0.031)	(0.013)	(0.026)	(0.062)	(0.035)	(0.047)
PTA	0.660***	0.421***	0.235***	0.280***	0.127***	0.153***
	(0.027)	(0.011)	(0.023)	(0.060)	(0.034)	(0.047)
GSP	-0.248***	-0.060***	-0.219***	-0.423***	-0.339***	-0.085*
	(0.023)	(0.009)	(0.020)	(0.057)	(0.027)	(0.046)
Common currency	0.543***	0.125***	0.486***	0.222	0.186**	0.036
	(0.051)	(0.021)	(0.043)	(0.137)	(0.081)	(0.093)
$\hat{\eta}$*				0.438***	0.450***	-0.012
				(0.080)	(0.042)	(0.062)
$\hat{z}$*				1.444***	0.847***	0.596***
				(0.105)	(0.056)	(0.082)
$\hat{z}^{*2}$				-0.145***	-0.023**	-0.122***
				(0.020)	(0.011)	(0.016)
$\hat{z}^{*3}$				0.006***	-0.004***	0.010***
				(0.001)	(0.001)	(0.001)
Observations	298265	298265	298265	220366	220366	220366
Country-Pairs	28165	28165	28165	25358	25358	25358
R-squared	0.76	0.84	0.49	0.74	0.83	0.52
Country-year effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors adjusted for clustering on country-pairs in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; All columns include exporter-year and importer-year fixed effects; All columns include a constant (not shown).

Table 5: Calibrated parameters

Parameters	Value	Definition
ϕ	1	Impact trade cost
Z	1	Impact trade cost
λ_F	0.08	Learning fixed cost
γ	0.5	Non-identif trade cost
ρ	0.99	Discount factor
ε	2.5	Elasticity Substitution
Ω	1	Non-identif trade cost
λ_τ	0.05	Learning variable cost
θ	4	Pareto Parameter
τ	[1,1.2]	Iceberg transport cost
l	20	Domestic learning
n	30	Learning spillovers

Table 6: Summary of effects of experience ($E \uparrow$)

	A. Variable trade costs ($\overline{\omega}$)			B. Fixed trade costs (ϕ)		
	(1) Benchmark	(2) Own-Experience	(3) Shared-Experience	(4) Benchmark	(5) Own-Experience	(6) Shared-Experience
Total Exports	0	> 0	> 0	0	0	> 0
Extensive Margin	0	0	> 0	0	**	> 0
Intensive Margin	0	> 0	*	0	0	< 0
* > 0 under standard distributions (Dutt, Mihov and Van Zandt, 2013); = 0 under Pareto. ** = 0 in partial eq.; < 0 in general eq. when wage effect outweighs experience effect, for incumbents.						