Extended Gravity*

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Abstract

Exporting firms often enter foreign markets that are similar to their previous export destinations. We develop a dynamic model in which a firm's exports in a market may depend on how similar the market is to the firm's home country (gravity) and to its previous export destinations (extended gravity). Given the large number of export paths from which forward-looking firms may choose, we use a moment inequality approach to estimate our model. Our estimates indicate that sharing similarities with a prior export destination in terms of geographic location, language, and income per capita jointly reduces the cost of foreign market entry by 69% to 90%. Reductions due to geographic location (25% to 38%) and language (29% to 36%) have the largest effect. Extended gravity thus has a large impact on export entry costs.

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1 Introduction

Exporting firms continuously enter and exit foreign countries, and the decision of which countries to export to is an important determinant of aggregate trade flows.[1] When selecting which countries to enter, firms tend to choose markets similar to their prior export destinations.[2] We establish that this cross-country correlation in firms' export decisions occurs because entry costs in a market are smaller for firms that have previously exported to similar markets. We refer to this path dependence in entry costs as *extended gravity*.

Extended gravity has significant implications for trade policy. It predicts that reducing trade barriers in a country will increase entry not only in its own market but also in other markets that are connected to it through extended gravity. This suggests that import policies in one country generate externalities for other countries. As for export policy, extended gravity implies that export promotion measures will have the largest impact when targeted toward destination countries that share characteristics with large export markets.

We estimate a new model of firm export dynamics. In our model, entry costs in a market depend on how similar it is both to the firm's home country and to other countries to which the firm has previously exported. Our model is thus consistent with gravity in that it allows the firm's export probability to be higher in markets close to its country of origin. However, our model also allows the firm's export entry decision in a market to depend on its previous export history in any market. While gravity reflects proximity between origin and destination markets, extended gravity depends on the proximity between past and subsequent destinations. Furthermore, our model imposes only weak restrictions on how firms both determine the set of countries to which they consider exporting and forecast the profits they would obtain upon entering these markets. We introduce a moment inequality approach that exploits these weak assumptions on firms' consideration and information sets in order to estimate bounds on the impact of extended gravity on entry costs.

In our estimation, we use a firm-level dataset for Chile that includes information on exports by year and destination as well as on a broad set of firm characteristics for the period 1995–2005. We estimate our model for the chemicals sector, which is consistently among the top two manufacturing sectors in Chile by volume of exports during our sample period. Our estimates show that similarity in geographic location, language, and income per capita with a prior export destination jointly reduce the cost of foreign market entry by 69% to 90%. Similarity in geographic location (25% to 38%) and language (29% to 36%) have the largest impact. Conversely, we cannot rule out that similarity in income per capita has no extended gravity effects.

Extended gravity is consistent with foreign market entry requiring a costly adaptation process: some firms are better prepared to enter certain countries because they have previously served

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[1] See Bernard et al. (2007, 2010), Hillberry and Hummels (2008), and Head and Mayer (2014).

[2] For evidence on spatial correlation in export entry, see Section 2 of this paper and Evenett and Venables (2002), Lawless (2009, 2013), Albornoz et al. (2012), Chaney (2014), Defever et al. (2015), and Meinen (2015).

similar markets and have thus already partly completed this adaptation. This process may entail changes in the branding, labeling, and packaging of the product, as well as product modifications that reflect local tastes or legal requirements imposed by national regulators.[3]

In order to test our hypothesis that extended gravity impacts export entry costs, we rely on a dynamic multi-country model to structurally identify costs that may depend on gravity and extended gravity. We account for gravity by allowing these costs to depend on whether each destination shares a continent, language, or similar income per capita with Chile. In contrast, extended gravity depends on whether the destination shares a border, continent, language, or similar income per capita with a country to which the firm exported in the previous year. If extended gravity is important, firms in our framework should decide whether to enter a country taking into account the impact of this decision on future entry costs in other markets.

The standard approach to the estimation of dynamic entry models relies on deriving choice probabilities from a theoretical framework and finding the parameter values that maximize the likelihood of the entry choices observed in the data (Das et al., 2007). This approach is not feasible in our setting. Evaluating these probabilities involves examining the dynamic implications of every possible bundle of export destinations. Given the cardinality of the potential choice set (for a given number of countries J, this set includes 2^J elements), computing the value function for each of its elements is infeasible unless very strong simplifying assumptions are imposed on the firm's consideration set and state vector.[4] The impossibility of computing this value function implies that we cannot solve the model and perform counterfactuals. However, using moment inequalities, we can estimate bounds on the effect of extended gravity on export entry costs. Our estimator does not require computing the value function of the firm nor artificially reducing the dimensionality of the firm's choice set or state vector.

Our inequalities come from applying a discrete analogue of Euler's perturbation method. Specifically, we impose one-period deviations on the observed export path of each firm. Our moment inequalities are robust to different assumptions on: (a) how forward-looking firms are, as captured by their planning horizons; (b) firms' consideration sets; and (c) firms' information sets. In addition, our inequalities do not impose any parametric restriction on the distribution of firms' expectational errors, which may vary flexibly across firms, countries, and periods.

In identifying extended gravity effects from firms' export choices, we face the challenge of separating path dependence from unobserved heterogeneity. Unobservable (to the researcher) determinants of the decision to export that are specific to each firm and correlated both over time and across countries that share geographic location, a language, or similar income per capita generate export paths similar to those that we would observe if these extended gravity factors

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[3] Adaptation may also involve searching for a local distributor (Chaney, 2014, 2016, 2018; Bernard et al., 2018; Bernard and Moxnes, 2018) or hiring workers with knowledge of specific markets (Labanca et al., 2014).

[4] For example, even if the firm's consideration set includes only 20 destinations and the expected profits in each of them depend on a single state variable that takes only five values, the state vector will include over 10^{13} elements. As we show through simulations in Online Appendix G, misspecifications of the firm's consideration and information sets may significantly bias the estimates of the impact of extended gravity on entry costs.

were an important determinant of firms' choices. In order to separately identify the effect of these unobservables from the impact of extended gravity, we allow the firm's export decision to depend on unobserved effects that are specific to each firm and year, but common across countries that are located in the same continent, share a language, or have similar income per capita.

Our estimates show that extended gravity has a significant effect on entry costs. Previously serving a market that shares a border with a destination (e.g. Poland and Germany) reduces entry costs by 25% to 38%.[5] Sharing a continent without sharing a border (e.g. Poland and France) reduces entry costs by 19% to 29%, and sharing only language (e.g. Portugal and Brazil) by 29% to 36%. Our estimates of the effect of having similar income per capita are less informative: the reduction in entry costs may be any number smaller than 29%. The combined effect of all four extended gravity covariates is between 69% and 90%, which implies that, for example, a Chilean firm exporting to Germany will face subsequent entry costs in Austria that are between a tenth and a third of the costs faced by a firm that exports only to destinations that do not share any extended gravity covariate with Austria.

Our paper is related to several strands of the literature. First, it relates to papers that estimate export entry costs. Das et al. (2007) estimate the fixed and sunk costs of breaking into exporting generally. Dickstein and Morales (2018) estimate fixed and sunk costs by destination, but ignore the presence of extended gravity effects.[6] In contrast to this prior literature, we estimate the impact of extended gravity on export entry costs.

Second, our paper relates to previous work showing that firms tend to export to countries similar to their prior destinations: e.g. Eaton et al. (2008), Lawless (2009, 2013), Albornoz et al. (2012), Chaney (2014), and Defever et al. (2015). Except for Chaney (2014), none of these papers structurally estimates a model of forward-looking firms that incorporates a mechanism rationalizing this export behavior. We build such a model, emphasizing the importance of entry cost dynamics to explain observed export dynamics, and identify extended gravity effects under weak assumptions on firms' information and consideration sets and planning horizons.

Third, our paper introduces a new moment inequality procedure for multiple discreteness problems (Hendel, 1999). These are decision problems in which agents violate the single-choice assumption inherent to multinomial discrete choice models. These problems feature in the store-network choice literature (Jia, 2008; Holmes, 2011; Ellickson et al., 2013; Zheng, 2016), in the demand estimation literature (Allenby et al., 2002, 2007; Dubé, 2004), and in the work on multinational companies (Tintelnot, 2017) and on the sourcing decisions of importers (Antràs et al., 2017). In these papers, the set including all bundles of alternatives an agent may choose is very large. The literature contains three approaches to dealing with these large-dimensional discrete choice sets: first, exploiting the increasing or decreasing differences property of the

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[5] We report here projections of a 95% confidence set (see Section 5 for details).

[6] Additional estimates are provided in Roberts and Tybout (1997), Arkolakis (2010), Moxnes (2010), Aw et al. (2011), Eaton et al. (2014, 2016), Irarrazabal et al. (2015), Fitzgerald et al. (2017), Ruhl and Willis (2017), Bai et al. (2017) and Arkolakis et al. (2019).

agent's objective function (Jia, 2008; Antràs et al., 2017; Arkolakis and Eckert, 2017); second, modeling multiple discreteness problems as an aggregation of simple discrete choices made at different points in time (Hendel, 1999; Sieg and Zhang, 2012; Arcidiacono et al., 2016); and third, using moment inequalities (Holmes, 2011).

Fourth, our paper contributes to an empirical literature on moment inequalities.[7] Our approach is closest to that in Holmes (2011), but differs from it in that we do not form inequalities by changing the order in which we observe firms entering markets. We implement instead a discrete analogue of Euler's perturbation method (Hansen and Singleton, 1982; Luttmer, 1999), building inequalities that are valid under weak restrictions on firms' expectations.

Fifth, extended gravity has implications for the interpretation of gravity equations. The standard gravity equation (Tinbergen, 1962) predicts that trade flows between two countries depend only on their size and measures of trade resistance between them. Anderson and van Wincoop (2003) take into account third-country effects through multilateral resistance terms: given two countries, higher barriers between one of them and the rest of the world raises imports from the other one. Extended gravity works in the opposite direction: it increases exports to markets that share characteristics with a large number of countries, especially if those markets require high adaptation costs to enter.

The rest of the paper is organized as follows. Section 2 describes our data and presents reduced-form evidence that motivates the rest of the paper. Section 3 introduces a model of entry into export markets, and Section 4 derives moment inequalities from it. Section 5 describes our inference approach, and sections 6 and 7 present the results. Section 8 concludes.

2 Data and Reduced-Form Evidence

In this section, we describe our sources of data and provide evidence suggestive of the relevance of extended gravity in determining firms' export destinations. We also discuss alternative mechanisms that may generate similar export behavior. This discussion informs the specification of the model introduced in Section 3, which we use as the basis for an estimation approach aimed at controlling for these alternative mechanisms when measuring extended gravity effects.

2.1 Data Sources

Our data covers the period 1995–2005 and comes from two separate sources. The first is the Chilean customs database, which covers the universe of exports of Chilean firms. The second is the Chilean Annual Industrial Survey (*Encuesta Nacional Industrial Anual*, or ENIA), which includes all manufacturing plants with at least ten workers. We aggregate the plant-level information in ENIA to obtain firm-level information, and merge it with the customs data using firm

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[7] See, for example, Katz (2007), Ishii (2008), Ho (2009), Pakes (2010), Ho and Pakes (2014), Eizenberg (2014), Pakes et al. (2015), Pakes and Porter (2015), Illanes (2017), Wollmann (2018), and Dickstein and Morales (2018).

identifiers. We thus observe both the export and the domestic activity of each firm.

Our dataset includes all firms operating in the chemicals sector (sector 24 ISIC rev. 3.1), which is among the top two Chilean manufacturing sectors by volume of exports in every sample year. We observe both exporters and non-exporters, and use for estimation an unbalanced panel that includes all firms active for at least two consecutive years between 1995 and 2005. An observation is a firm-country-year combination. The per-year average number of firm-country pairs with positive exports is approximately 650, out of which around 150 correspond to firms that were not exporting to the same country in the previous year, and around 125 correspond to firms that did not export to the same country in the following year. These export events are generated by a per-year average of 110 firms exporting to around 70 countries in total. For each firm-year-country combination, we have information on the value of goods sold in US dollars, which we transform into year 2000 values using the US CPI.

We complement our customs-ENIA data with a database of country characteristics. We obtain information on the primary official language, continent, and names of bordering countries for each possible destination market from CEPII (Mayer and Zignago, 2011). The data on real GDP per capita come from the World Bank World Development Indicators. We construct our gravity and extended gravity variables using these country characteristics.

The gravity variables relate Chile to each destination. Our structural analysis exploits information on four distinct dummy variables that equal one for destinations that do not share border, continent, language, or similar income per capita with Chile.[8] We denote them as "Grav. Border", "Grav. Cont.", "Grav. Lang.", and "Grav. GDPpc."[9] The extended gravity variables relate each potential destination to a firm's prior export bundle. We define separate dummies for sharing a border, continent, language, or similar income per capita with at least one country the firm exported to in the previous year, and not with Chile itself. We denote them as "Ext. Grav. Border", "Ext. Grav. Cont.", "Ext. Grav. Lang.", and "Ext. Grav. GDPpc." Thus, an extended gravity dummy equals one for a firm-country-year observation if the country does not share the corresponding characteristic with Chile but shares it with some other country to which the firm exported in the previous year.[10]

2.2 Motivating Evidence

Table 1 shows export entry probabilities conditional on each extended gravity variable we consider. The overall entry probability is 0.66%. If extended gravity effects are important, the entry

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[8] The World Bank classifies countries as low-income if their GDP per capita is 735 USD or less, as lower-middle-income if it is between 736 and 2,935 USD, upper-middle-income if it is between 2,936 and 9,075 USD, and high-income if it is 9,076 USD or more. Chile belongs to the upper-middle-income group. Whenever two countries belong to the same group, we refer to them as "sharing similar income per capita."

[9] Formally, $(\text{Grav. Cont.})_j = 1 - \text{continent}(h, j)$, where $\text{continent}(h, j)$ is a dummy variable that equals one if countries h and j share continent. The other three gravity variables are defined analogously.

[10] Formally, $(\text{Ext. Grav. Cont.})_{ijt} = (1 - d_{ijt-1}) \times (1 - \text{continent}(h, j)) \times \mathbb{1}\{\sum_{j'} d_{ij't-1} \times \text{continent}(j, j') \geq 0\}$, where d_{ijt-1} is a dummy variable that equals one if firm i exports to destination j in year $t-1$, and $\mathbb{1}\{A\}$ is an indicator function that equals one if A is true. The other three extended gravity variables are defined analogously.

probability in a potential destination will be, *ceteris paribus*, larger among firms that exported in the previous year to markets that share some extended gravity variable with it. The evidence in Table 1 is suggestive of the presence of extended gravity effects.[11] The probability of entering a destination conditional on previously exporting to a connected market is always larger than the unconditional one. This probability increase depends on the characteristic shared between both markets: it is more than twofold if both markets share income per capita or language, more than fourfold if they share continent, and approximately tenfold if they share a border.

Table 1: Entry Probabilities

	Probability of Entry	Number of Entries
Overall:	0.66%	1638
Extended Gravity:		
If Ext. Grav. Border = 1	6.74%	397
If Ext. Grav. Cont. = 1	2.79%	525
If Ext. Grav. Lang. = 1	1.59%	205
If Ext. Grav. GDPpc = 1	1.53%	588
If All Ext. Grav. = 0	0.31%	770

Notes: The entry probability in a country equals the number of firms exporting to it in year t and not in year $t-1$, divided by the number of non-exporters in year $t-1$. Table 1 presents averages across countries of these probabilities.

The evidence in Table 1 is only suggestive of the presence of extended gravity. Other economic forces can also explain these findings.

First, suppose that firms rank countries by proximity to Chile and spread out gradually to more distant markets. In this case, two countries ranked consecutively will likely belong to the same continent and, thus, a firm already exporting to a continent will be more likely to subsequently enter other countries in the same continent. This correlation in export entry, however, would be driven by distance between Chile and each destination (gravity), not by distance between destinations (extended gravity). It is thus key to account for gravity in order to correctly identify extended gravity.

Second, the higher probability of exporting to a country among firms previously exporting to related markets could reflect similarity in firm-specific demand or trade costs across these markets. Under this interpretation, for example, the higher probability of exporting to a market for a firm previously exporting to a bordering country would not be due to a reduction in entry costs caused by this export experience (state dependence), but to similarity in preferences for this firm's output among customers living in these two countries (unobserved heterogeneity).[12] In order to correctly identify extended gravity, it is thus key to allow firms' export decisions

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[11] In Online Appendix D, we describe the export entry decisions of a firm in our sample whose export path is illustrative of the importance of extended gravity effects.

[12] For example, some firms may be more likely to export to European countries and others more likely to export to Asian countries, and these patterns may be entirely due to factors unobserved to us (e.g. firms sell different varieties that are differentially demanded in different continents) and correlated over time.

to depend on serially correlated firm- and year-specific unobserved covariates that are common across groups of countries that share the extended gravity variables we consider.

Third, the patterns documented in Table 1 could also be due to the combined effect of two forces: (a) most firms do not export at all or export only to a small number of destinations, while a few firms export widely; (b) the more countries a firm exports to, the more likely it is that every new destination shares some characteristic with one of its previous destinations. Thus, correctly identifying extended gravity requires accounting for factors that make some firms more likely to export to any country, as well as correctly modeling the set of potential new export destinations that each firm considers in each time period (i.e. the firm's consideration set).[13]

Finally, even if one can conclude that exporting to a country does indeed increase the probability of subsequently exporting to other destinations that share some characteristic with it, there are still different mechanisms that may generate this path dependence in export entry. Our aim is to show that one mechanism present in the data is the reduction in export entry costs due to extended gravity. When identifying this channel, it is key to control for two alternative sources of path dependence. First, extended gravity variables may impact export profits through channels other than the reduction in export entry costs; e.g. through a reduction in the marginal costs of exporting. Second, extended gravity variables may affect not the actual export profits that a firm obtains upon entry but only the expectation that this firm has about them when deciding which destinations to enter. This change in expectations would be due to changes in the firm's information set; e.g. as firms export to a country, they learn about the demand for their products in that country and in countries similar to it. Thus, when identifying the impact of extended gravity, it is important to control for the possible impact of the firm's prior export destinations on its marginal costs of exporting and information sets.

2.3 Reduced-Form Specifications

As an intermediate step between the motivating evidence in Table 1 and the structural estimates in sections 6 and 7, we present here additional evidence on the empirical relevance of extended gravity. This evidence is based on reduced-form binary choice models of the probability that a firm exports to each foreign country. These models account for some (but not all) of the alternative potential explanations of the entry probabilities in Table 1 discussed in Section 2.2.

All models discussed in this section assume that, for every possible destination,

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\begin{aligned}
d_{ijt} = \mathbb{1}\{&\beta_1 \, \text{revenue}_{ijt} + \beta_2 \, \text{gravity}_j + \beta_3(1 - d_{ijt-1}) + \beta_4[(1 - d_{ijt-1}) \times \text{gravity}_j] \\
&+ \beta_5 \text{ext.gravity}_{ijt} + u_{ic_j} + \nu_{ijt} > 0\}, \qquad (1)
\end{aligned}
$$

where d_{ijt} is a dummy variable that equals one if firm i exports to country j at year t, "revenue"

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[13] As a first step towards addressing this concern, we present in Appendix A.1 entry probabilities analogous to those in Table 1, separately for firms of different size and firms with different number of prior export destinations: the entry patterns described in Table 1 also hold for these subsets of firms.

is a proxy for the export revenue that i would obtain in j at t if it were to export to it, "gravity" and "ext.gravity" are vectors of observed gravity and extended gravity covariates, respectively, and u_{ic_j} and ν_{ijt} capture unobserved (to the researcher) determinants of firms' export decisions. Specifically, u_{ic_j} captures determinants that are firm-specific but both constant over time and common to all countries in the country group or "cluster" to which j belongs, denoted as c_j; conversely, ν_{ijt} allows for variation in unobserved export determinants across firms, countries and years. The parameter vector $\beta \equiv (\beta_1, \beta_2', \beta_3, \beta_4', \beta_5')'$ determines the impact of "revenue", "gravity", and "ext.gravity" on the firm's export decisions, with the parameter vector β_5 determining the impact of the extended gravity variables of interest.

We assume that the variables $\{u_{ic}; \forall\ i, c\}$ are independent across firms and country clusters, and that each of them follows a normal distribution with mean zero and unknown variance σ_c^2. The variables $\{\nu_{ijt}; \forall\ i, j, t\}$ are assumed to be independent across firms, countries and years, and each of them follows a logistic distribution with location parameter equal to zero and scale parameter equal to one; thus, denoting the variance of ν_{ijt} as σ_ν^2, it holds that $\sigma_\nu^2 = \pi^2/3$. These assumptions imply that the probability that a firm exports to a country in a given year conditional on "revenue", "gravity", and "ext.gravity" follows a mixed logit model. The covariance of the unobserved export determinants of this model is

$$cov(u_{ic_j} + \nu_{ijt}, u_{i'c_{j'}} + \nu_{i'j't'}) = \begin{cases} \sigma_c^2 + \sigma_\nu^2 & \text{if } i = i',\ j = j', \text{ and } t = t', \\ \sigma_c^2 & \text{if } i = i',\ c_j = c_{j'}, \text{ and } j \neq j' \text{ or } t \neq t', \\ 0 & \text{otherwise.} \end{cases} \tag{2}$$

Thus, different definitions of country clusters $c = 1, \ldots, C$ imply different correlation patterns in the unobserved determinants of the firm's export decisions.

We do not observe potential export revenues for every firm-country-year triplet; no information on the export revenue that firms could have obtained in markets to which they did not export is available in the data. We construct our proxy for these potential export revenues, which corresponds to the variable "revenue" in equation (1), by projecting the observed export revenues of those firm-country-year triplets with positive exports on covariates that we observe for every firm, country and year.[14] Independently of the covariates we use to construct our proxy, obtaining estimates of the mixed logit parameters that are not affected by sample selection bias requires all variables affecting export revenues not controlled for by those covariates to be unknown to the firm when deciding which export markets to enter. To illustrate the robustness of our baseline mixed logit estimates to this potential source of bias, we present in Table A.5 in Appendix A.3.2 estimates based on a specification in which we proxy for potential export revenues using a variable directly observed for every firm, country, and year: domestic revenues.

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[14] Table E.1 in Online Appendix E presents projection estimates for nine different sets of covariates. In spite of the large differences across these sets, Table E.2 shows that the pairwise correlation coefficients of the export revenue proxies generated by these nine specifications are close to one. Consequently, our mixed logit estimates are robust to the export revenue proxy we use in estimation (see Table A.4 in Appendix A.3.2).

We present maximum likelihood estimates of β and σ_c in Table 2; see Appendix A.3.1 for estimation details. The models whose estimates we report in the different columns of Table 2 differ only in the definition of the country clusters. The model in column I assumes that two countries j and j' belong to the same cluster, $c_j = c_{j'}$, if they share continent, language, and similar income per capita. The model in column II defines broader groups: $c_j = c_{j'}$ if j and j' share continent and language, independently of their income per capita. As described in the notes to Table 2, the models in columns III to VII allow for other partitions of countries. The estimates of the extended gravity parameters are generally positive and statistically significant. The only exceptions are those in which the country clusters correspond exactly to groups of countries sharing an extended gravity covariate; e.g. in column V, each cluster c corresponds to a continent and the estimate of the continent extended gravity parameter becomes non significant.

The point estimates reported in Table 2 are affected by the scale normalization $\sigma_\nu^2 = \pi^2/3$. However, the ratio of any two estimates is scale invariant and indicates the relative impact of the corresponding covariates on the firm's export probability. The estimates in column I thus imply that the increase in the probability of exporting in year t to a market j that does not share a border, continent, language, or similar income per capita with Chile caused by exporting in $t-1$ to a market that shares both a border and a continent with j is approximately 46% of the increase that exporting to j itself in $t-1$ would have caused.[15] If the two markets only share continent, the relative increase in export probability would be 31%. The relative increase in export probability is approximately 6% for extended gravity in language and slightly above 14% for similarity in income per capita. The relative impact of previously exporting to a country that shares all four extended gravity variables with a destination is thus close to 66%. The estimates in columns II to VII yield similar predictions. In sum, nothing facilitates export participation in a far away country as much as having exported to it in the previous year, but previous exports to similar countries have a quantitatively important effect.

Relative to the entry probabilities in Table 1, the estimates in Table 2 strengthen the evidence in support of the presence of extended gravity. The model in equation (1) addresses some of the identification concerns raised in Section 2.2: (a) by allowing d_{ijt} to depend on "gravity", it controls for the effect of gravity on a firm's export status; (b) by allowing d_{ijt} to depend on u_{ic_j}, it accounts for the possible presence of constant-over-time firm-specific unobserved covariates that are common across groups of countries that share the extended gravity variables we consider; (c) by allowing our revenue proxy to depend on the extended gravity covariates whose impact on entry costs we aim to identify, we control for the effect that these covariates may have on exports through a reduction in the marginal costs of exporting.[16]

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[15] The ratio of the sum of the coefficients on "Entry × Ext. Grav. Border" and "Entry × Ext. Grav. Cont." to the sum of the coefficients on "Entry", "Entry × Grav. Border", "Entry × Grav. Cont.", "Entry × Grav. Lang.", and "Entry × Grav. GDPpc" is $(0.761 + 1.551)/(2.183 + 0.919 + 1.031 + 0.146 + 0.727) = 0.462$.

[16] A comparison of the estimates in Table 2 to those in Table A.3 (in Appendix A.2) and in Table A.4 (in Appendix A.3.2) reveals that accounting for the identification concerns in (b) and (c) has little impact on the extended gravity estimates. Conversely, the estimates in Table A.6 (in Appendix A.3.3) show that controlling for

Table 2: Mixed Logit

Variables: (β)	I	II	III	IV	V	VI	VII
Revenue	1.366^{a}	1.294^{a}	1.516^{a}	1.269^{a}	1.536^{a}	1.709^{a}	1.645^{a}
	(5.414)	(5.126)	(6.098)	(5.086)	(5.901)	(6.341)	(6.442)
Grav. Border	-0.315^{a}	-0.268^{a}	-0.125	-0.182^{b}	-0.191^{b}	-0.060	-0.054
	(-3.187)	(-2.759)	(-1.303)	(-1.908)	(1.919)	(-0.672)	(0.557)
Grav. Cont.	-0.037	-0.049	-0.244^{b}	-0.268^{a}	-0.055	-0.336^{a}	-0.327^{a}
	(-0.356)	(-0.476)	(-2.491)	(-2.651)	(-0.558)	(-3.506)	(-3.404)
Grav. Lang.	-0.725^{a}	-0.670^{a}	-0.650^{a}	-0.614^{a}	-0.625^{a}	-0.575^{a}	-0.582^{a}
	(-7.664)	(-7.259)	(-7.599)	(-6.713)	(-7.048)	(-6.810)	(-6.899)
Grav. GDPpc	0.179^{b}	0.141^{c}	0.151^{b}	0.196^{a}	0.078	0.055	0.052
	(2.343)	(1.925)	(2.119)	(2.697)	(1.062)	(0.767)	(0.728)
Grav. FTA	-0.302^{a}	-0.260^{a}	-0.306^{a}	-0.303^{a}	-0.319^{a}	-0.337^{a}	-0.376^{a}
	(-4.979)	(-4.233)	(-5.163)	(-5.138)	(-5.358)	(-5.758)	(-6.402)
Entry	-2.183^{a}	-2.356^{a}	-2.655^{a}	-2.950^{a}	-3.401^{a}	-2.909^{a}	-2.604^{a}
	(-3.881)	(-4.232)	(-4.919)	(-5.433)	(-5.984)	(-5.452)	(-4.955)
Entry × Grav. Dist.	-0.124^{c} (-1.651)	-0.128^{c} (-1.726)	-0.075 (-1.048)	-0.035 (-0.481)	0.020 (0.271)	-0.068 (-0.955)	-0.091 (-1.296)
Entry × Grav. Border	-0.919^{a} (-6.793)	-0.910^{a} (-6.793)	-1.094^{a} (-8.215)	-1.087^{a} (-8.201)	-1.174^{a} (-8.546)	-1.149^{a} (-8.686)	-1.182^{a} (-8.875)
Entry × Grav. Cont.	-1.031^{a} (-6.927)	-0.864^{a} (-5.854)	-0.709^{a} (-4.934)	-1.032^{a} (-7.223)	0.275^{c} (1.898)	-0.734^{a} (-5.373)	-0.914^{a} (-6.629)
Entry × Grav. Lang.	-0.146 (-1.151)	-0.164 (-1.316)	-0.396^{a} (-3.313)	-0.180 (1.464)	-0.381^{a} (-3.173)	-0.004 (-0.031)	-0.428^{a} (-3.620)
Entry × Grav. GDPpc	-0.727^{a} (-6.509)	-0.623^{a} (-5.904)	-0.561^{a} (-5.113)	-0.691^{b} (-6.259)	-0.273^{a} (-2.596)	-0.386^{a} (-3.764)	0.019 (0.168)
Ext. Grav. Border	0.761^{a}	0.830^{a}	0.792^{a}	0.872^{a}	0.699^{a}	0.941^{a}	0.889^{a}
	(9.814)	(11.141)	(10.814)	(11.928)	(9.556)	(13.321)	(12.579)
Ext. Grav. Cont.	1.551^{a}	1.263^{a}	1.305^{a}	1.467^{a}	0.200	1.182^{a}	1.467^{a}
	(16.990)	(14.216)	(14.600)	(17.044)	(1.262)	(14.488)	(18.378)
Ext. Grav. Lang.	0.279^{a}	0.294^{a}	0.251^{a}	0.224^{b}	-0.131	-0.112	0.236^{a}
	(2.863)	(3.126)	(2.736)	(2.401)	(-1.356)	(-1.259)	(2.665)
Ext. Grav. GDPpc	0.708^{a}	0.657^{a}	0.570^{a}	0.574^{a}	0.229^{a}	0.429^{a}	-0.056
	(7.809)	(7.719)	(6.253)	(6.480)	(2.765)	(5.307)	(-0.598)
Firm RE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Continent RE	Yes	Yes	Yes	No	Yes	No	No
Language RE	Yes	Yes	No	Yes	No	Yes	No
GDPpc group RE	Yes	No	Yes	Yes	No	No	Yes
Std. Dev. RE: (σ_c)	9.373^{a}	8.915^{a}	9.170^{a}	9.273^{a}	5.741^{a}	8.207^{a}	8.826^{a}
	(63.291)	(60.601)	(61.728)	(66.225)	(46.948)	(48.781)	(54.347)
Num. Obs.	234,896	234,896	234,896	234,896	234,896	234,896	234,896
Num. Obs. per (i, c_j)	23	40	46	40	133	93	232

Notes: *a* denotes 1% significance, *b* denotes 5% significance, *c* denotes 10% significance. Estimates are obtained by MLE, and t-statistics are in parentheses. The dependent variable is a dummy for positive exports. The variable "Revenue" is an export revenue proxy (in tens of millions of year 2000 USD) constructed using the estimates in Column I of Table E.1 in Online Appendix E. The variable "Entry" is a dummy that takes value one if the firm did not export to the corresponding country in the previous year; i.e. "Entry" = $1 - d_{ijt-1}$. Column I includes firm-continent-language-GDPpc-specific random effects. Column II includes firm-continent-language-specific random effects. Column III includes firm-continent-GDPpc-specific random effects. Column IV includes firm-language-GDPpc-specific random effects. Column V includes firm-continent-specific random effects. Column VI includes firm-language-specific random effects. Column VII includes firm-GDPpc-specific random effects.

The model in equation (1) still fails to address some of the concerns raised in Section 2.2. First, by assuming that the firm evaluates the trade-offs of exporting to every foreign country, it imposes the assumption that the firm's consideration set includes all of them. Second, by assuming that, at the time of deciding which countries to export to, firms predict without error their potential export revenues, it imposes that firms have perfect foresight of all foreign demand and supply shocks. Third, by assuming that firms do not internalize the effect of their current export choices on future profits (firms are static optimizers), it severely restricts firms' planning horizons. We focus below on computing extended gravity estimates while imposing weaker restrictions on firms' consideration and information sets, and planning horizons.

3 Empirical Model

We present here the model that guides our identification of the impact of extended gravity on firms' export choices. We model firms that are located in a country h and that choose which countries to export to.[17] We denote the set of firms active in h at period t as N_t, and the set of all foreign countries as J. The creation and destruction of firms is treated as exogenous.

3.1 Demand, Variable Trade Costs, and Market Structure

Firms face an isoelastic demand in every country: $q_{ijt} = p_{ijt}^{-\eta} P_{jt}^{\eta-1} Y_{jt}$. The quantity demanded, q_{ijt}, thus depends on the price the firm sets, p_{ijt}, the total expenditure in the market, Y_{jt}, and the price index, P_{jt}, which captures the competition the firm faces in this market.

Firms have constant marginal production costs w_{it}. When selling to a market, they face "iceberg" trade costs: they must ship τ_{ijt} units of output for one unit to reach market j. These costs account for transport costs and for *ad valorem* tariffs imposed by country j on goods originating from h. The marginal cost of selling in market j is thus $\tau_{ijt} w_{it}$.

Conditional on entering a foreign market, exporters behave as monopolistically competitive firms and, thus, the revenue firm i obtains if it exports to market j at period t is

$$r_{ijt} \equiv p_{ijt} q_{ijt} = \left[\frac{\eta}{\eta - 1} \frac{\tau_{ijt} w_{it}}{P_{jt}} \right]^{1-\eta} Y_{jt}. \tag{3}$$

We model the impact of variable trade costs on revenues as

$$\tau_{ijt}^{1-\eta} = \exp(\xi_{jt} + \xi_i + (X_{ijt}^{\tau})' \xi^{\tau}) + \varepsilon_{ijt}^{\tau}, \tag{4}$$

where ξ_{jt} is a country- and period-specific term, ξ_i is a firm-specific term, and X_{ijt}^{τ} is a vector that incorporates the firm's lagged export status in market j, d_{ijt-1}, the firm's (log) marginal production costs, $\ln(w_{it})$, and the four extended gravity variables, "Ext. Grav. Border", "Ext.

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the impact of gravity on firms' exports is key for the correct identification of extended gravity.

[17] In our empirical application, the market h is Chile. For ease of notation, we eliminate the subindex h.

Grav. Cont.", "Ext. Grav. Lang.", and "Ext. Grav. GDPpc".[18] The variable ε^{τ}_{ijt} accounts for all other determinants of variable trade costs, and we assume that

$$\mathbb{E}_{jt}[\varepsilon^{\tau}_{ijt}|X^{\tau}_{ijt}, d_{ijt}, \mathcal{J}_{it}] = 0, \tag{5}$$

where $\mathbb{E}_{jt}[\cdot]$ denotes an expectation conditional on a destination-period pair jt, and $\mathcal{J}_{it}$ is firm i's information set when deciding where to export in period t.

As we show in Appendix B, combining equations (3) and (4) and rewriting the firm's marginal production costs, w_{it}, as a function of its domestic sales, gives

$$r_{ijt} = \exp(\alpha_{jt} + \alpha_i + (X^r_{ijt})'\alpha^r) + \varepsilon^R_{ijt}, \tag{6}$$

where α_{jt} is a country- and period-specific term common to all firms, α_i is a firm-specific term, and X^r_{ijt} is a vector that includes the firm's lagged export status in market j, the firm's (log) domestic sales, and all four extended gravity variables. The variable ε^R_{ijt} is a function of the trade costs term ε^{τ}_{ijt}, and the mean independence restriction in equation (5) implies

$$\mathbb{E}_{jt}[\varepsilon^R_{ijt}|X^r_{ijt}, d_{ijt}, \mathcal{J}_{it}] = 0. \tag{7}$$

Our estimation procedure relies on equations (6) and (7) to build a proxy for the potential export revenues r_{ijt} of every firm, country, and period.[19] Equation (6) allows this proxy to depend on gravity (through α_{jt}), on extended gravity, and on firms' domestic sales and lagged export status.[20] The term ε^R_{ijt} is unobserved and accounts for any residual variation in export revenues (Eaton et al., 2011). Importantly, equation (7) implies that ε^R_{ijt} does not affect firm i's decision of whether to export to market j at t, as captured by d_{ijt}. Failure of this mean-independence restriction could generate selection bias in our extended gravity estimates. However, as discussed in Section 2.3, a comparison of the reduced-form extended gravity estimates in Table 2 and Table A.5 (in Appendix A.3.2) suggests that this source of bias is not prevalent in our setting.

3.2 Fixed and Sunk Export Costs

Exporters face fixed costs that are independent of their export history and how much they sell to a destination; e.g. costs of advertising and participating in trade fairs. We assume

$$f_{ijt} = f^o_j + u_{ic_jt} + \varepsilon^F_{ijt}, \tag{8}$$

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[18] A model in which τ_{ijt} is a demand shifter is isomorphic to ours; the effect of w_{it} on τ_{ijt} may thus capture a link between productivity and quality (Verhoogen, 2008; Kugler and Verhoogen, 2012; Fieler et al., 2018).

[19] Equations (3) to (5) play no role in our analysis except for serving as basis for our export revenue proxy. Thus, we attach no structural interpretation to the parameters entering equation (6); its role is purely predictive.

[20] Ruhl and Willis (2017) document the dependency of r_{ijt} on d_{ijt-1}, which the literature attributes to firms' learning (Albornoz et al., 2012; Berman et al., 2017), partial-year effects (Bernard et al., 2017; Gumpert et al., 2018), and customer capital accumulation (Fitzgerald et al., 2017; Piveteau, 2018). The results in Online Appendix E show that our proxy is robust to the specification of the vector of covariates X^r_{ijt} entering equation (6).

where, as reminder, c_j indexes the "cluster" of countries to which j belongs (e.g. countries located in the same continent as j). We model the observable part of fixed costs, f_j^o, as

$$f_j^o = \gamma_0^F + \gamma_c^F(\text{Grav. Cont.})_j + \gamma_l^F(\text{Grav. Lang.})_j + \gamma_g^F(\text{Grav. GDPpc})_j, \tag{9}$$

with each gravity term defined as in footnote 9. Both u_{ic_jt} and ε_{ijt}^F are unobserved to the researcher. We assume that

$$\mathbb{E}[\varepsilon_{ijt}^F | d_{ijt}, \mathcal{J}_{it}] = 0. \tag{10}$$

As discussed in Section 2.2, correctly identifying extended gravity requires controlling for the impact on firms' export decisions of firm-specific unobserved (to the researcher) covariates that are correlated over time and across countries that share any extended gravity variable. We allow for such covariates through the term u_{ic_jt}: we do not restrict its correlation across firms, groups of countries, and periods, nor its relationship to firms' export decisions. Thus, our model allows firms to observe u_{ic_jt} when deciding where to export.[21]

Exporters to a destination to which they did not export in the previous period also face sunk entry costs. These are independent of the quantity exported and account for the cost of building distribution networks, hiring workers with specific skills (e.g. knowledge of foreign languages), and adapting products to destination-specific preferences and legal requirements. We assume

$$s_{ijt} = s_j^o - e_{ijt}^o + \varepsilon_{ijt}^S. \tag{11}$$

The observable part of sunk costs depends both on gravity

$$s_j^o = \gamma_0^S + \gamma_c^S(\text{Grav. Cont.})_j + \gamma_l^S(\text{Grav. Lang.})_j + \gamma_g^S(\text{Grav. GDPpc})_j, \tag{12}$$

and extended gravity

$$\begin{aligned} e_{ijt}^o = {} & \gamma_b^E(\text{Ext. Grav. Border})_{ijt} + \gamma_c^E(\text{Ext. Grav. Cont.})_{ijt} + \gamma_l^E(\text{Ext. Grav. Lang.})_{ijt} \\ & + \gamma_g^E(\text{Ext. Grav. GDPpc})_{ijt}, \end{aligned} \tag{13}$$

with each extended gravity variable defined as in footnote 10. The term ε_{ijt}^S is unobserved to the researcher and we assume that

$$\mathbb{E}[\varepsilon_{ijt}^S | d_{ijt}, \mathcal{J}_{it}] = 0. \tag{14}$$

Our definition of the extended gravity variables entering e_{ijt}^o restricts the timing at which export events must happen for firms to benefit from extended gravity. For a firm entering country j at

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[21] Our baseline results assume that $c_j = c$ for all j; as a robustness check, we also present results in which we classify countries into groups c_j according to their continent, language, or income per capita.

period t, extended gravity depends only on its export destinations at period $t-1$: the destinations in any previous period and the countries other than j that it also enters at t do not impact its sunk costs in country j. In our estimation, each period corresponds to a year and the assumption that the effect of prior exports on subsequent entry costs lasts only one year is consistent with Roberts and Tybout (1997). The assumption that extended gravity requires sequential entry is imposed for simplicity; at a computational cost, our methodology can be adjusted to identify additional extended gravity effects that arise when entry into similar destinations is simultaneous.[22]

3.3 Export Profits

The assumptions above imply that the potential static profits of exporting to a country j are

$$\pi_{ijt} = r_{ijt} - \tau_{ijt} w_{it} q_{ijt} - f_{ijt} - (1 - d_{ijt-1}) s_{ijt} = \eta^{-1} r_{ijt} - f_{ijt} - (1 - d_{ijt-1}) s_{ijt}, \tag{15}$$

and the total potential static profits of exporting to a bundle b of destinations are

$$\pi_{ibt} = \sum_{j \in b} \pi_{ijt}. \tag{16}$$

Through the dependency of export revenues and sunk costs on last period's exports, π_{ibt} depends on the export bundle chosen in $t-1$. However, conditional on the $t-1$ export bundle, prior years' export destinations have no impact on the static profits in period t. The export bundle in $t-2$ thus directly affects the static profits in period $t-1$, but it affects those at t only indirectly through the optimal set of export destinations in $t-1$. Thus, static export profits exhibit one-period dependence.

3.4 Optimal Export Destinations

While we use b to denote a generic bundle of countries that a firm may choose to export to, we use o_{it} to denote the export bundle actually chosen by firm i at period t. Formally, o_{it} is a vector that indicates the export status in each of the J export markets: $o_{it} = (d_{i1t}, \dots, d_{ijt}, \dots, d_{iJt})$. Assumption 1 indicates how firms choose the vector o_{it} in every time period.

Assumption 1 *For every firm i and period t, let o_{it} denote the observed bundle of export destinations, $\mathcal{J}_{it}$ denote the information set, and $\mathcal{B}_{it}$ denote the consideration set. Then*

$$o_{it} = \underset{b \in \mathcal{B}_{it}}{\operatorname{argmax}} \, \mathbb{E}\left[\Pi_{ibt,L_{it}} | \mathcal{J}_{it}\right], \tag{17}$$

where $\mathbb{E}[\cdot]$ denotes the expectation consistent with the data generating process and

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[22] A continuous-time framework would allow for a more flexible modeling of the relationship between the intensity of extended gravity effects and the time lag between different export events. However, the yearly nature of our data imposes challenges for the estimation of continuous-time models (see Arcidiacono et al., 2016).

$$\Pi_{ibt,L_{it}} = \pi_{ibt} + \sum_{l=1}^{L_{it}} \delta^l \pi_{io_{it+l}(b)t+l}, \tag{18}$$

where δ is the discount factor and $o_{it+l}(b)$ denotes the optimal export bundle that firm i would choose at period $t+l$ if it had exported to the countries in bundle b at period t.

Assumption 1 characterizes the firm's observed export bundle as the outcome of an optimization problem defined by three elements: (1) the L_{it}-periods-ahead discounted sum of profits $\Pi_{ibt,L_{it}}$; (2) the consideration set $\mathcal{B}_{it}$ or set of export bundles among which the firm selects its preferred one; and (3) the information set $\mathcal{J}_{it}$ or set of variables the firm uses to predict its potential export profits in each of the bundles included in $\mathcal{B}_{it}$. Identifying the impact of extended gravity on sunk costs requires imposing restrictions on these three elements of the optimization problem. Assumptions 2 to 4 indicate the restrictions we impose.

Assumption 2 $L_{it} \geq 1$.

This assumption imposes only weak restrictions on how forward-looking firms are when deciding where to export. Our model is compatible with firms taking into account the effect of their current choices on future profits in any of the two following ways: (a) any finite number $p \geq 1$ of periods ahead, $L_{it} = p$; or, (b) an infinite number of periods ahead, $L_{it} = \infty$ (i.e. perfectly forward-looking firms). Furthermore, different firms may have different planning horizons, and these may change over time; i.e. L_{it} may be different from $L_{i't'}$ for $i \neq i'$ or $t \neq t'$.

Equation (17) imposes that firms' expectations are rational but leaves their information sets unrestricted. Assumption 3 indicates the restriction we impose on them.

Assumption 3 $Z_{it} \subseteq \mathcal{J}_{it}$*, where* Z_{it} *is a vector of observed covariates.*

We assume that the researcher observes a vector Z_{it} that is included in the firm's information set $\mathcal{J}_{it}$.[23] When specifying the content of Z_{it}, we face a trade-off. The larger it is, the stronger the informational assumption we are imposing and, thus, the more likely it is that some of the variables we include in Z_{it} do not belong to the true information set $\mathcal{J}_{it}$. At the same time, as we discuss below, the larger the content of Z_{it}, the more information we can exploit in estimation. To compute our estimates, we specify the vector Z_{it} as

$$Z_{it} = (Z_{ijt}, j = 1, \ldots, J), \tag{19a}$$

$$Z_{ijt} = (f^o_j, s^o_j, e^o_{ijt}, d_{ijt-1}), \tag{19b}$$

where, as a reminder, f^o_j, s^o_j, and e^o_{ijt} are components of fixed and sunk costs that depend exclusively on gravity and extended gravity variables, and d_{ijt-1} captures the lagged export

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[23] Whenever we indicate that a vector Z_{it} is included in the information set $\mathcal{J}_{it}$, $Z_{it} \subseteq \mathcal{J}_{it}$, we formally mean that the distribution of Z_{it} conditional on $\mathcal{J}_{it}$ is degenerate.

status of the firm in country j. Equation (19) thus only requires firms to know whether each foreign country shares continent, language, or similar income per capita either with Chile or with at least one country to which they exported in the previous year. It is reasonable to assume that all potential exporters have this information.

Beyond the minimal content required in equation (19), we do not impose any assumption on firms' information sets. The variables not in Z_{it} that complete the information set $\mathcal{J}_{it}$ may thus vary flexibly across firms and years. Different firms may thus have different information on the export revenue they would obtain in each market, r_{ijt}, and on the fixed cost component u_{ic_jt}. These differences may be due to differential investments in acquiring information or differences in export experience across markets (consistent with within-firm learning).[24]

Equation (17) also leaves unrestricted the consideration set $\mathcal{B}_{it}$. The potential choice set among which firms may choose their optimal export bundle includes all combinations of foreign countries. Given that the total number of countries is very large, it is unrealistic to assume that firms evaluate the trade-offs, as captured by the function $\mathbb{E}[\Pi_{ibt,L_{it}}|\mathcal{J}_{it}]$, of exporting to each of the 2^J possible bundles of countries. The consideration set $\mathcal{B}_{it}$ is thus likely smaller than the potential choice set. However, the lack of data on firms' consideration sets makes it hard to correctly specify $\mathcal{B}_{it}$ for every firm and period in our sample. For this reason, we impose only a minimal content requirement on firms' consideration sets.

Assumption 4 *$\mathcal{A}_{it} \subseteq \mathcal{B}_{it}$, where $\mathcal{A}_{it}$ is known to the researcher.*

This assumption imposes that the researcher must list the elements of a subset $\mathcal{A}_{it}$ of the true consideration set $\mathcal{B}_{it}$. To compute our estimates, we specify the set $\mathcal{A}_{it}$ as

$$\mathcal{A}_{it} = \{o_{it}\} \cup \{o_{it}^{j \to j'}, \forall j = 1, \ldots, J, \text{ and } j' = 1, \ldots, J \text{ such that } j' \in \mathcal{A}_{ijt}\}, \tag{20a}$$

$$\mathcal{A}_{ijt} = \{j' = 1, \ldots, J \text{ such that } f_j^o = f_{j'}^o \text{ and } u_{ic_jt} = u_{ic_{j'}t}\}, \tag{20b}$$

where $o_{it}^{j \to j'}$ is the bundle that results from swapping an observed destination j for an alternative one j'. Formally, for a bundle o_{it} with $d_{ijt} = 1$ and $d_{ij't} = 0$, the bundle $o_{it}^{j \to j'} = (d'_{i1t}, \ldots, d'_{iJt})$ verifies: (a) $d'_{ij''t} = d_{ij''t}$ if $j'' \neq j$ and $j'' \neq j'$; (b) $d'_{ijt} = d_{ijt} - 1$; and (c) $d'_{ij't} = d_{ij't} + 1$. According to equation (20a), $\mathcal{A}_{it}$ includes the observed bundle, o_{it}, plus all other ones built by swapping an observed destination j for an alternative one j' that belongs to the set $\mathcal{A}_{ijt}$. According to equation (20b), $\mathcal{A}_{ijt}$ includes all countries j' that share with j: (a) the component of fixed costs f_j^o, defined in equation (9); and (b) the unobserved fixed costs term u_{ic_jt}, defined in equation (8). Requirement (a) implies that both j and j' must have the same gravity relationship to the home country of the firm: either both or none of them share continent, language, or similar income per capita with country h. Depending on how we define the cluster of countries c_j, requirement

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[24] Dickstein and Morales (2018) find that large firms have more information relevant to predict r_{ijt} than small firms, and their evidence suggests that this informational advantage is due to larger investments in acquiring information. Multiple papers provide evidence consistent with within-firm learning (Albornoz et al., 2012; Timoshenko, 2015a,b; Bastos et al., 2018; Fitzgerald et al., 2017; Berman et al., 2017; Arkolakis et al., 2018).

(b) may additionally require j and j' to share a continent, language or similar income per capita with each other.[25] Assumption 4 and equation (20) thus imply consideration sets that include *at least* the observed choice, o_{it}, plus small perturbations around it. The set of bundles not in $\mathcal{A}_{it}$ that complete the consideration set $\mathcal{B}_{it}$ may vary flexibly across firms and years.

3.5 Parameters to Identify, Identification Approach and Prior Literature

The unknown model parameters are the demand elasticity η; the discount factor δ; the export revenue parameters entering equation (6),

$$\alpha \equiv (\{\alpha_{jt}\}_{j,t}, \{\alpha_i\}_i, \alpha^r); \tag{21}$$

the fixed and sunk costs parameters entering equations (9), (12), and (13),

$$\gamma \equiv (\gamma_0^F, \gamma_c^F, \gamma_l^F, \gamma_g^F, \gamma_0^S, \gamma_c^S, \gamma_l^S, \gamma_g^S, \gamma_b^E, \gamma_c^E, \gamma_l^E, \gamma_g^E); \tag{22}$$

the planning horizon L_{it}, information set $\mathcal{J}_{it}$, and consideration set $\mathcal{B}_{it}$ of every firm i and year t in the sample; and the joint distribution of the unobserved determinants of export revenues, fixed and sunk costs, defined respectively in equations (6), (8), and (11).

Prior literature that has estimated single-agent export entry models has done so by assuming away extended gravity effects, $\gamma_b^E = \gamma_c^E = \gamma_l^E = \gamma_g^E = 0$; fixing the value of δ to a number close to one; specifying the exact planning horizon, L_{it}, and the precise content of both the information and consideration sets, $\mathcal{J}_{it}$ and $\mathcal{B}_{it}$, of every firm and year in the sample; and imposing parametric restrictions on the distributions of the unobserved determinants of export profits. Given these assumptions, the remaining parameters are point identified. This approach is inadequate in our setting. Once we allow the extended gravity parameters to differ from zero, computational feasibility forces us to impose strong assumptions on planning horizons and information and consideration sets, so that we can estimate the remaining parameters through maximum likelihood or a method of moments approach.[26]

Even if computational feasibility was not a constraint, imposing precise definitions of the firm's planning horizon, and information and consideration sets, is undesirable. As the simulation in Online Appendix G illustrates, extended gravity estimates are biased if these model elements are misspecified. Given the lack of data on these model elements and our focus on identifying the extended gravity parameters, we opt for imposing only the relatively weak restrictions indicated in assumptions 2 to 4 and equations (19) and (20). Imposing only these weak restrictions is not

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[25] For example, if we assume that c_j includes all countries located in the same continent as j ($c_j = c_{j'}$ if j and j' belong to the same continent), requirement (a) implies that either both or none of j and j' have Spanish as their official language (Chile's official language) and share similar income per capita with Chile; and requirement (b) requires both j and j' to be located in the same continent. We could thus, hypothetically, swap the United Kingdom for Germany, but not for the United States, as they are located in different continents.

[26] A method of moments approach is feasible if $L_{it} = 0$ for all it pairs and $\mathcal{J}_{it}$ is such that firms have perfect foresight; see Jia (2008), Tintelnot (2017), Antràs et al. (2017), and Arkolakis and Eckert (2017).

without costs: they are not strong enough to point identify the extended gravity parameters and, furthermore, the resulting model is not suitable to analyze how firms' export decisions change in response to counterfactual changes in the environment.

We quantify the importance of extended gravity in reducing export entry costs by computing confidence sets for the following vector of *relative* extended gravity parameters:

$$\kappa \equiv (\kappa_b, \kappa_c, \kappa_l, \kappa_g) \equiv \left(\frac{\gamma_b^E}{\gamma_{all}^S}, \frac{\gamma_c^E}{\gamma_{all}^S}, \frac{\gamma_l^E}{\gamma_{all}^S}, \frac{\gamma_g^E}{\gamma_{all}^S} \right), \qquad \gamma_{all}^S \equiv \gamma_0^S + \gamma_c^S + \gamma_l^S + \gamma_g^S. \tag{23}$$

The parameter κ_b captures the relative reduction due to extended gravity in border in the sunk costs of entering a country that differs from Chile in all three gravity variables included in our analysis. The parameters κ_c, κ_l and κ_g capture analogous relative reductions due to extended gravity in continent, language and similarity in income per capita. For example, for a firm entering Germany, κ_g indicates the relative reduction in sunk costs if the firm was previously exporting to the United States, κ_c indicates the corresponding reduction if it was previously exporting to Romania, $\kappa_c + \kappa_g$ if previously exporting to Spain, $\kappa_b + \kappa_c + \kappa_g$ if exporting to France, and $\kappa_b + \kappa_c + \kappa_l + \kappa_g$ if exporting to Austria. Focusing on identifying the parameter vector κ, instead of the vector γ, has several advantages. First, the value of κ is independent of the units in which export sales are measured and, thus, easier to interpret. Second, identifying bounds on κ does not require fixing any parameter to a normalizing constant and, thus, these bounds are scale-invariant. Third, the assumptions required to identify κ are weaker than those needed to identify all elements of γ.[27] Fourth, it is computationally much simpler.[28]

4 Deriving Moment Inequalities

In Section 4.1, we derive conditional moment inequalities from the model described in Section 3. We transform these conditional moment inequalities into unconditional ones in Section 4.2. Finally, in Section 4.3, we illustrate how these unconditional moment inequalities may be used to compute bounds on the elements of the extended gravity parameter vector κ.

4.1 One-period Deviations

We apply a discrete analogue of Euler's perturbation method to derive inequalities: we compare the stream of profits along a firm's observed sequence of bundles with the stream along alternative sequences that differ from the observed one in just one period. Denoting the observed sequence as $o_{i1}^T = \{\dots, o_{it-1}, o_{it}, o_{it+1}, \dots\}$, we form inequalities by comparing the expected discounted

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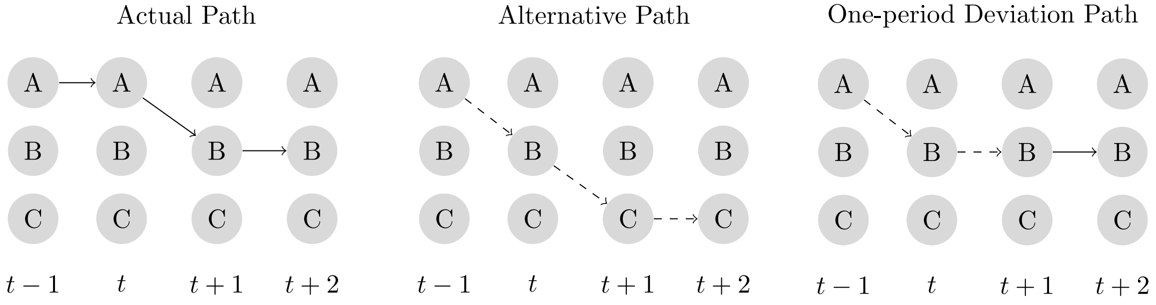
[27] E.g. identifying γ_0^F requires parametric restrictions on the distribution of u_{ic_jt}, and identifying γ_0^F, γ_c^F, γ_l^F, and γ_g^F requires expanding the set $\mathcal{A}_{it}$ to include alternative export bundles that differ from the observed one both in the number of export destinations and in the gravity characteristics of the countries included in them.

[28] Ho and Rosen (2017) discuss how the computational cost of standard moment inequality inference procedures increases with the dimensionality of the parameter vector to estimate.

Figure 1: Actual and Counterfactual Path: Example



The left panel describes the actual export path: the firm chooses destination A in periods $t-1$ and t, and destination B in periods $t+1$ and $t+2$. The middle panel describes the path that would have been optimal conditional on choosing destination B in year t. The right panel describes a one-period deviation path from the actual one: it is identical to the actual path except for swapping destination A for destination B in period t. The solid arrows denote transitions observed in the data; the dotted arrows denote counterfactual transitions.

sum of profits generated by it to that generated by an alternative sequence that differs from o_{i1}^{T} in the bundle chosen at t, $\{\dots, o_{it-1}, o_{it}^{j\to j'}, o_{it+1}, \dots\}$, where, as a reminder, $o_{it}^{j\to j'}$ is the bundle that results from swapping destination j by j' in o_{it}. Given the one-period dependence in export profits imposed in our model (see Section 3.3), the difference in the discounted sum of profits generated by the observed and the alternative paths depends only on the difference in static profits at periods t, $\pi_{ijj't}$, and $t+1$, $\pi_{ijj't+1}$,

$$\underbrace{\pi_{ijt} - \pi_{ij't}}_{\pi_{ijj't}} + \underbrace{\delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi_{ij''t+1}^{j\to j'})}_{\pi_{ijj't+1}}, \tag{24}$$

where $\pi_{ij''t+1}^{j\to j'}$ are the potential profits of i in country j'' and period $t+1$ if it chooses $o_{it}^{j\to j'}$ at t.

To provide intuition on equation (24), we present in Figure 1 an example of a firm that must choose whether or not to export to three possible markets. The left panel describes the firm's observed path: it chooses market A at periods $t-1$ and t, and market B at periods $t+1$ and $t+2$. From Assumption 1, these are the firm's optimal export destinations in each period. The middle panel describes the choice that would have been optimal at $t+1$ and $t+2$ if the firm had deviated from the optimal path and chosen destination B at t. The right panel describes an alternative path built as a one-period deviation from the observed one: it deviates from it only in that market B is chosen at period t. Using the model's notation: $o_{it} = (d_{iAt}, d_{iBt}, d_{iCt}) = (1,0,0)$ and $o_{it}^{A\to B} = (0,1,0)$. The static profits of exporting at period $t+2$ are independent of the choice made by the firm at t: profits exhibit one-period dependence and, thus, depend on export history only through the previous period's export bundle. This is why period $t+2$ static profits do not enter equation (24). Conversely, the difference in static profits at periods t and $t+1$ between the actual and the period-t deviating path will generally be different from zero.

Proposition 1 shows how we use one-period deviations to derive moment inequalities.

Proposition 1 *Suppose assumptions 1, 2, and 3 hold; then, for any pair of countries j and j' such that $o_{it}^{j\to j'} \in \mathcal{B}_{it}$, and any Z_{it},*

$$\mathbb{E}\big[\pi_{ijj't} + \delta\pi_{ijj't+1} \big| d_{ijt}(1-d_{ij't}) = 1, Z_{it}\big] \geq 0. \tag{25}$$

The proof of Proposition 1 is in Appendix C.1. Equation (25) indicates that, conditional on any vector of covariates included in the firm's information set, Z_{it}, and firm i exporting to country j and not to j' in period t ($d_{ijt}(1-d_{ij't}) = 1$), the expected discounted sum of profits along the observed export path is weakly larger than the expected discounted sum along an alternative path that swaps the observed destination j for the alternative j' at period t. Equation (25) is a revealed preference inequality and, thus, for it to hold, the bundle $o_{it}^{j\to j'}$ must belong to the consideration set of the firm at period t, $\mathcal{B}_{it}$.

To gain intuition on the inequality in equation (25), we use again the example in Figure 1. Since, according to the left panel, destination A was chosen at period t, Assumption 1 implies that, conditional on the information available to the firm at period t, the firm weakly prefers the optimal export path that includes destination A at t (in the left panel) to the optimal path that includes destination B at t (in the middle panel). However, once country B is selected at period t, choices in subsequent periods that are optimal conditional on this choice (in the middle panel) must be preferred over choices that would have been optimal only if destination A had been selected at t (in the right panel). Transitivity of preferences thus ensures that the optimal path described in the left panel is, given the information available to the firm at t, weakly preferred over the one-period deviation path described in the right panel.[29]

The inequality in equation (25) illustrates how the general approach in Pakes (2010) and Pakes et al. (2015) can be applied to single-agent dynamic discrete choice models. Our strategy of using one-period deviations to build estimating equations follows the methodology in Hansen and Singleton (1982) and Luttmer (1999), but is adapted to our moment inequality setting.[30] Our inequalities do not condition on choices that the firm makes in periods later than the deviating period t: this differentiates our inequalities from those in Holmes (2011) and Illanes (2017), and it is important for the interpretation of $(\varepsilon_{ijt}^R, \varepsilon_{ijt}^F, \varepsilon_{ijt}^S)$ as expectational errors.[31]

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[29] According to Proposition 1, it need not be the case that the realized or ex post difference in profits is positive. Formally, our model does not imply that $d_{ijt}(1-d_{ij't})(\pi_{ijj't} + \delta\pi_{ijj't+1}) \geq 0$ for every i, j, j' and t.

[30] Arcidiacono and Miller (2011), Scott (2013), Aguirregabiria and Magesan (2013, 2018), and Traiberman (2018) also use one-period deviations to estimate dynamic discrete choice models. These papers, however, fully specify the agents' planning horizon, and information and consideration sets. Also, for every realization of these information sets, these procedures require estimating nonparametrically the probability that any alternative in the consideration set is chosen. Given the dimensionality of any reasonable specification of the information and consideration sets in our setting, performing this nonparametric estimation is infeasible in our case.

[31] Equations (6), (8) and (11) assume that $\mathbb{E}[(\varepsilon_{ijt}^R, \varepsilon_{ijt}^F, \varepsilon_{ijt}^S)|d_{ijt}, \mathcal{J}_{it}] = 0$. This is consistent with the interpreta-

4.2 From Conditional to Unconditional Moment Inequalities

The inequalities in equation (25) have two properties that complicate their applicability in estimation. First, they condition on a particular pair of destinations j and j', implying that the number of inequalities that one can construct is larger than the sample size. Second, they condition on the vector Z_{it}, which may take many values. These two characteristics imply that the sample analogue of most of the moments in equation (25) will average over very few observations. To facilitate estimation, we exploit the many conditional moment inequalities in equation (25) to derive a small number of unconditional inequalities that aggregate across pairs of actual and counterfactual destinations and across observations with different values of Z_{it}.[32] Using only a small number of inequalities, while convenient, may entail a loss of information. However, as Section 6 shows, the inequalities we employ generate economically meaningful bounds on the parameters of interest. Proposition 2 characterizes our unconditional inequalities.

Proposition 2 *Suppose equation* (20a)*, equation* (25)*, and Assumption 4 hold; then, for any function* $\Psi(\cdot)$ *such that*

$$\Psi(Z_{ijt}, Z_{ij't}) \geq 0 \tag{26}$$

for all values of $(Z_{ijt}, Z_{ij't})$ *in its support, it holds that*

$$\mathbb{E}\left[\sum_{j=1}^{J}\sum_{j'\in\mathcal{A}_{ijt}}\Psi(Z_{ijt}, Z_{ij't})d_{ijt}(1-d_{ij't})(\pi_{ijj't}+\delta\pi_{ijj't+1})\right] \geq 0. \tag{27}$$

The inequality in equation (27) sums over all country pairs (j, j') such that: (a) j is an export destination of the firm at period t and j' is not; and (b) all bundles formed by swapping country j for country j' belong to a set $\mathcal{A}_{it}$ that is a subset of the consideration set $\mathcal{B}_{it}$ (see Assumption 4). When summing over all these country pairs, the inequality in equation (27) weights each of them according to a function $\Psi(\cdot)$ that verifies two conditions: (a) it is weakly positive; and (b) it is a function only of the variables in the conditioning set of the conditional moment in equation (25). Thus, as we show in Online Appendix F.1, the unconditional inequality in equation (27) is a direct implication of the conditional one in equation (25) and of Assumption 4.

Without adequately restricting the pairs of actual and alternative destinations (j, j') that the moment function in equation (27) sums over, this function will generally depend on the unobserved fixed costs term u_{ic_jt} and all elements of the vector of fixed and sunk costs parameters

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tion of $(\varepsilon^R_{ijt}, \varepsilon^F_{ijt}, \varepsilon^S_{ijt})$ as expectational errors. If we were to apply the inequalities in Holmes (2011) to our setting, we would need to assume that $\mathbb{E}[(\varepsilon^R_{ijt}, \varepsilon^F_{ijt}, \varepsilon^S_{ijt})|d_{ijt'}, \mathcal{J}_{it'}] = 0$ for all t'. If were to apply the inequalities in Illanes (2017) to our setting, we would need to assume that $(\varepsilon^R_{ijt}, \varepsilon^F_{ijt}, \varepsilon^S_{ijt}) \subset \mathcal{J}_{it}$. We opt for our approach because allowing for expectational errors is important to the estimation of export costs (Dickstein and Morales, 2018).

[32] Menzel (2014) and Chernozhukov et al. (2018) introduce inference procedures in settings with many moment inequalities. Andrews and Shi (2013), Chernozhukov et al. (2013), Armstrong (2014, 2015), and Armstrong and Chan (2016) study conditional moment inequality models.

γ. As discussed in footnote 28, computing a confidence set for all elements of γ is very costly. Additionally, if the moment functions we use for estimation depend on u_{ic_jt}, then we need to either assume that it is mean independent both of the firm's information set $\mathcal{J}_{it}$ and its export choice, or impose parametric restrictions on its distribution.[33] Either of these assumptions on u_{ic_jt}, if inaccurate, will bias our estimates. The following proposition indicates how we solve these two problems by restricting the set $\mathcal{A}_{ijt}$ corresponding to each j and the function $\Psi(\cdot)$.

Proposition 3 *Suppose equation* (20b) *holds and*

$$\Psi(Z_{ijt}, Z_{ij't}) = 0 \quad \text{if} \quad s^o_j \neq \gamma^S_{all} \text{ or } s^o_{j'} \neq \gamma^S_{all}, \tag{28}$$

then the moment in equation (27) *depends only on the distribution of observed covariates and the parameter vector* $\theta^* \equiv (\alpha, \kappa, \eta, \gamma^S_{all})$.

The proof of Proposition 3 is in Appendix C.2. This proposition indicates that, if we restrict $\mathcal{A}_{ijt}$ as in equation (20b) and $\Psi(\cdot)$ according to equation (28), then the moment in equation (27) does not depend on unobserved determinants of export profits, and depends on the vector γ only through the parameters γ^S_{all} and κ defined in equation (23).[34]

The following corollary characterizes the set of inequalities we use to estimate bounds on κ.

Corollary 1 *Given propositions 2 and 3 and any K functions* $\{\Psi_k(Z_{ijt}, Z_{ij't})\}_{k=1}^K$ *satisfying equations* (26) *and* (28)*; then, for every* $k = 1, \ldots, K$, *it holds:*

$$\mathbb{m}_k(\theta^*) \equiv \mathbb{E}\left[\sum_{j=1}^{J} \sum_{j' \in \mathcal{A}_{ijt}} \Psi_k(Z_{ijt}, Z_{ij't}) d_{ijt}(1 - d_{ij't})(\pi_{ijj't} + \delta\pi_{ijj't+1})\right] \geq 0. \tag{29}$$

Online Appendix F.2 lists the $K = 10$ instrument functions we use in our estimation. Defining a vector θ of unknown parameters whose true value is θ^*, and denoting by Θ the set of all values of θ such that $\mathbb{m}_k(\theta) \geq 0$, for all $k = 1, \ldots, K$, Corollary 1 implies that $\theta^* \in \Theta$.

4.3 Using Inequalities to Bound Extended Gravity Parameters: Intuition

Through examples, we illustrate here how one can construct inequalities that bound the parameters of interest κ. In Table 3, a firm enters the United Kingdom in year 8, and we consider an alternative path in which it enters Germany instead. Both countries are in Europe and have similar income per capita, but differ in that the former is English-speaking and the latter is

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[33] The mean independence restrictions in equations (7), (10), and (14) guarantee that ε^R_{ijt}, ε^F_{ijt}, and ε^S_{ijt}, respectively, do not enter the moment in equation (27).

[34] The intuition is the following. First, according to equation (20b), destinations j and j' must satisfy that $f^o_j = f^o_{j'}$ and $u_{ic_jt} = u_{ic_{j'}t}$; thus, once impose the definition of $\mathcal{A}_{ijt}$ in equation (20b), the moment in equation (27) differences out all terms that depend on $(\gamma^F_0, \gamma^F_c, \gamma^F_l, \gamma^F_g)$ and $(u_{ic_jt}, u_{ic_{j'}t})$. Second, according to equation (28), j and j' must share no gravity characteristic with Chile; thus, once we impose the restriction on $\Psi(\cdot)$ in equation (28), the moment in equation (27) depends on $(\gamma^S_0, \gamma^S_c, \gamma^S_l, \gamma^S_g)$ only through the scalar γ^S_{all}.

Table 3: Example of a 1-period Export Event

		$t = 7$	$t = 8$	$t = 9$
Observed	United Kingdom	0	1	0
	Germany	0	0	0
Alternative	United Kingdom	0	0	0
	Germany	0	1	0

German-speaking. Assume that the firm exported only to the United States in year 7 and does not export anywhere in year 9. Therefore, in terms of extended gravity effects, the actual and counterfactual paths differ in that the firm benefits from extended gravity in language in the former but not in the latter. Indexing the observed destination with j and the alternative one with j', the difference in year 8 static profits between actual and counterfactual paths is:

$$\begin{aligned}\pi_{ijj'8} &= \eta^{-1} r_{ij8} - f_{ij8} - s_{ij8} - (\eta^{-1} r_{ij'8} - f_{ij'8} - s_{ij'8}) \\ &= \eta^{-1}(r_{ij8} - r_{ij'8}) - (u_{ic_j 8} - u_{ic_{j'}8}) - (\varepsilon^F_{ij8} - \varepsilon^F_{ij'8}) + (e^o_{ij8} - e^o_{ij'8}) - (\varepsilon^S_{ij8} - \varepsilon^S_{ij'8}) \\ &= \eta^{-1}(r_{ij8} - r_{ij'8}) - (u_{ic_j 8} - u_{ic_{j'}8}) - (\varepsilon^F_{ij8} - \varepsilon^F_{ij'8}) + \gamma^E_l - (\varepsilon^S_{ij8} - \varepsilon^S_{ij'8}) \\ &= \eta^{-1}(r^o_{ij8} - r^o_{ij'8} + \varepsilon^R_{ij8} - \varepsilon^R_{ij'8}) - (u_{ic_j 8} - u_{ic_{j'}8}) - (\varepsilon^F_{ij8} - \varepsilon^F_{ij'8}) + \gamma^E_l - (\varepsilon^S_{ij8} - \varepsilon^S_{ij'8}),\end{aligned} \tag{30}$$

where the first line uses equation (15); the second line applies equations (8) and (11), and takes into account that Germany and the United Kingdom share all gravity variables affecting the observable components of fixed costs, $f^o_j = f^o_{j'}$, and sunk costs, $s^o_j = s^o_{j'}$; the third line exploits that the firm's single export destination in year 7 shares language with j but not with j'; and the fourth line uses the expression for export revenues in equation (6), with the notational simplification $r^o_{ijt} \equiv \exp(\alpha_{jt} + \alpha_i + (X^r_{ijt})'\alpha^r)$. As the firm does not export in year 9, its export profits in this year are zero both in the actual and counterfactual paths, and then

$$d_{ij''9}(\pi_{ij''9} - \pi^{j \to j'}_{ij''9}) = 0, \qquad \text{for all } j'' \in J. \tag{31}$$

The difference in profits in equation (24) thus simplifies to $\pi_{ijj'8} + \delta\pi_{ijj'9} = \pi_{ijj'8}$ with $\pi_{ijj'8}$ defined as in equation (30). Furthermore, given the definition of the set of possible alternative destinations to country j, $\mathcal{A}_{ijt}$, in equation (20b), country j' is a valid alternative destination to j only if $u_{ic_j t} = u_{ic_{j'} t}$ for every firm i and year t; i.e. Germany is a valid alternative to the United Kingdom only if we assume that $u_{ic_{uk} t} = u_{ic_{ger} t}$, where c_{uk} and c_{ger} denote the clusters of countries to which the United Kingdom and Germany belong, respectively. Imposing this assumption, the difference in profits in equation (24) becomes

$$\begin{aligned}\pi_{ijj'8} + \delta\pi_{ijj'9} &= \eta^{-1}(r^o_{ij8} - r^o_{ij'8} + \varepsilon^R_{ij8} - \varepsilon^R_{ij'8}) - (\varepsilon^F_{ij8} - \varepsilon^F_{ij'8}) + \gamma^E_l - (\varepsilon^S_{ij8} - \varepsilon^S_{ij'8}) \\ &= \gamma^S_{all}(\tilde{\eta}^{-1}(r^o_{ij8} - r^o_{ij'8} + \varepsilon^R_{ij8} - \varepsilon^R_{ij'8}) + \kappa_l) - \varepsilon^F_{ij8} + \varepsilon^F_{ij'8} - \varepsilon^S_{ij8} + \varepsilon^S_{ij'8},\end{aligned} \tag{32}$$

where the second line rewrites the difference in profits as a function of the relative extended gravity parameter of interest κ_l and $\tilde{\eta} = \eta\gamma^S_{all}$. If we additionally assume that $\varepsilon^R_{ijt} = \varepsilon^F_{ijt} = \varepsilon^S_{ijt} = 0$ for every i, j, and t, and $\gamma^S_{all} > 0$, then equation (32) defines a lower bound on κ_l as a function of observed determinants of export revenue and the parameter vector $(\tilde{\eta}, \alpha)$:

$$\gamma^S_{all}(\tilde{\eta}^{-1}(r^o_{ij8} - r^o_{ij'8}) + \kappa_l) \geq 0 \quad \longrightarrow \quad \kappa_l \geq \tilde{\eta}^{-1}(r^o_{ij'8} - r^o_{ij8}). \tag{33}$$

Our model however allows ε^R_{ijt}, ε^F_{ijt} and ε^S_{ijt} to differ from zero: equations (7), (10), and (14) impose only that these terms are mean zero conditional on the firm's information set and export decisions. Therefore, deriving bounds on κ_l that do not depend on these expectational errors requires averaging profit differences such as those in equation (32) across firms, destination pairs, and periods selected on the basis of variables that belong to the firm's information set. For each inequality in equation (29), the instrument function $\Psi_k(Z_{ijt}, Z_{ij't})$ selects the observations that the corresponding moment averages over. As $\Psi_k(\cdot)$ is a function of variables included in the firm's information set (see Assumption 3), the average of the expectational errors across the observations that make $\Psi_k(\cdot)$ equal to one will indeed equal zero asymptotically. Thus, the resulting moment will depend only on observed covariates and parameters. How can we guarantee that the moment defined by a function $\Psi_k(\cdot)$ identifies a lower bound on κ_l?

A moment inequality will help identify a lower bound on κ_l if it averages across paths such that, as in Table 3, the firm benefits from extended gravity in language more in the observed path than in the alternative one. An instrument function that satisfies the requirements in equations (26) and (28) and selects observations likely to verify this condition is:

$$\Psi_k(Z_{ijt}, Z_{ij't}) = \mathbb{1}\{s^o_j = s^o_{j'} = \gamma^S_{all}, d_{ijt-1} = d_{ij't-1} = 0, e^o_{ijt} - e^o_{ij't} = \gamma_l\}. \tag{34}$$

This function takes value one if three requirements are satisfied, and zero otherwise. The first requirement is that neither j nor j' share continent, language or similar income per capita with Chile; the second requirement is that firm i is exporting to neither j nor j' in year $t-1$; and, the third requirement is that countries j and j' are identical in every extended gravity covariate other than language, which benefits only the observed destination j.

The function in equation (34) guarantees that, for all observations entering the moment inequality defined by it, $\pi_{ijj't}$ is analogous to that in equation (30). However, it does not guarantee that $\pi_{ijj't+1}$ will equal zero as in equation (31). Imagine that, instead of the path in Table 3, we observe the one in Table 4, in which the firm exports to the United Kingdom also in year 9. In this case, the difference in export profits in year 9 in the United Kingdom is

$$d_{ij9}(\pi_{ij9} - \pi^{j \to j'}_{ij9}) = \gamma^S_{all} - \gamma^E_c - \gamma^E_g + \varepsilon^S_{ij9}, \tag{35}$$

or, in words, the sunk costs of entering the United Kingdom for a firm that only exports to

Table 4: Example of a 1-period Export Event

		$t = 7$	$t = 8$	$t = 9$
Observed	United Kingdom	0	1	1
	Germany	0	0	0
Alternative	United Kingdom	0	0	1
	Germany	0	1	0

Germany in year 8. Therefore, for the example in Table 4, equation (32) becomes

$$\pi_{ijj'8} + \delta\pi_{ijj'9} = \tag{36}$$
$$\gamma^S_{all}(\tilde{\eta}^{-1}(r^o_{ij8} - r^o_{ij'8} + \varepsilon^R_{ij8} - \varepsilon^R_{ij'8}) + \kappa_l + \delta(1 - \kappa_c - \kappa_g)) - \varepsilon^F_{ij8} + \varepsilon^F_{ij'8} - \varepsilon^S_{ij8} + \varepsilon^S_{ij'8} + \delta\varepsilon^S_{ij9}.$$

The examples in Tables 3 and 4 assume that the firm does not export to any country other than the United Kingdom in year 9. More generally, when swapping an observed destination by an alternative one at any period t, one needs to keep track of how this change affects, through extended gravity effects, the sunk costs in any other country to which the firm starts exporting at period $t + 1$. We illustrate this case through an example in Online Appendix F.3.

As a comparison of equations (32) and (36) illustrates, the function $\Psi_k(\cdot)$ in equation (34) does not fully determine the parameter vector on which the corresponding moment $\mathbb{m}_k(\cdot)$ depends: the profit difference in equation (32) does not depend on κ_c and κ_g, while that in equation (36) does. However, all profit differences satisfying the requirements of the instrument function in equation (34) share the feature that their derivative with respect to κ_l is likely positive. Consequently, the resulting moment is increasing in κ_l and, thus, identifies a lower bound on it.[35]

5 Inference

Our parameter vector of interest is κ, defined in equation (23). We treat all other parameters as nuisance parameters. For estimation, we use the inequalities $\{\mathbb{m}_k(\theta) \geq 0, k = 1, \ldots, 10\}$ described in equation (29) and Online Appendix F.2. As the examples in equations (32) and (36) illustrate, and Appendix C.2 proves, we can write these moments as a function of κ, the vector of revenue parameters α, the rescaled elasticity of demand $\tilde{\eta}$, and the sunk cost γ^S_{all}. Furthermore, these moments are homogeneous of degree one in γ^S_{all} and, thus, we can set this parameter to any arbitrary positive constant without affecting the bounds on $(\alpha, \kappa, \tilde{\eta})$.

We estimate bounds on $(\alpha, \kappa, \tilde{\eta})$ in two steps. First, we use data on export revenues and moment equalities to obtain point estimates of α. Second, we use moment inequalities and these estimates of α to obtain confidence sets for $(\kappa, \tilde{\eta})$. This two-step estimator is preferred over an approach that uses only moment inequalities to estimate bounds on $(\alpha, \kappa, \tilde{\eta})$. First, the two-

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[35] If the partial derivative of $\mathbb{m}_k(\cdot)$ with respect to κ_l is positive, then, holding all other parameters constant, $\mathbb{m}_k(\cdot)$ increases with κ_l and, thus, the inequality $\mathbb{m}_k(\theta) \geq 0$ will be violated at low values of κ_l.

step approach uses different sources of variation to identify α and κ: we use data on export revenues conditional on export participation to identify α, and data on foreign market entry and exit to identify κ. If we had estimated all parameters using only our inequalities, then separate identification of α and κ would be exclusively due to the functional form restrictions we impose on the revenue, fixed, and sunk cost functions in equations (6), (9), (12), and (13). Second, if we were to identify α using only inequalities, then it would be set identified (instead of point identified). Finally, due to computational constraints, identifying α using inequalities would force us to limit its dimensionality.[36]

5.1 First Step

We estimate α using data on revenues, r_{ijt}, and its determinants, X^r_{ijt}, for the subsample of firms, countries, and years with positive exports. Specifically, equations (6) and (7) imply that

$$\mathbb{E}_{jt}[r_{ijt} - \exp(\alpha_{jt} + \alpha_i + (X^r_{ijt})'\alpha^r)|X^r_{ijt}, d_{ijt} = 1] = 0.$$

Given this moment condition, we use nonlinear least squares to compute the estimates $\hat{\alpha}$ (see Online Appendix E for additional details). As X^r_{ijt} is observed independently of the value of d_{ijt}, we define a proxy for r_{ijt} for every firm, country, and year as $\hat{r}_{ijt} \equiv \exp(\hat{\alpha}_{jt} + \hat{\alpha}_i + (X^r_{ijt})'\hat{\alpha}^r)$.

5.2 Second Step

Given $\hat{r}_{ijt}$ for every firm, country, and year, we use the sample analogue of the ten moment inequalities described in equation (29) and Online Appendix F.2 to compute a 95% confidence set for the vector $(\kappa, \tilde{\eta})$. We apply the inference procedure described in Section 10.2 of Andrews and Soares (2010) to account for the fact that our moments depend on the preliminary estimate $\hat{\alpha}$. We base our confidence set on the modified method of moments (MMM) statistic; i.e.

$$Q(\hat{\alpha}, \theta_\kappa, \theta_{\tilde{\eta}}) = \sum_{k=1}^{K} \Big(\min \Big\{ \frac{\bar{m}_k(\hat{\alpha}, \theta_\kappa, \theta_{\tilde{\eta}})}{\hat{\sigma}_k(\hat{\alpha}, \theta_\kappa, \theta_{\tilde{\eta}})}, 0 \Big\} \Big)^2, \tag{37}$$

where θ_κ denotes the unknown parameter vector whose true value is κ, and $\theta_{\tilde{\eta}}$ denotes the unknown parameter whose true value is $\tilde{\eta}$. For each moment $k = 1, \ldots, 10$, $\bar{m}_k(\cdot)$ is the sample analogue of the moment in equation (29) after normalizing it by γ^S_{all}, and $\hat{\sigma}_k(\hat{\alpha}, \theta_\kappa, \theta_{\tilde{\eta}})$ is the standard deviation of the observations entering moment k. Given the statistic in equation (37), we apply the Generalized Moment Selection procedure to compute our confidence intervals.[37] In

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[36] See the discussion in footnote 28. A third possible approach is to combine in one step the equalities we use to identify α and the inequalities that identify $(\kappa, \tilde{\eta})$. This approach has the same computational limitations as using only inequalities to estimate $(\alpha, \kappa, \tilde{\eta})$: we would still need to limit the dimensionality of α.

[37] We adjust the variance matrix of the moments to account for their dependency on $\hat{\alpha}$. Section 8 in Andrews and Shi (2013) contains a similar adjustment for the case of a conditional moment inequality estimator. We thank the authors of Andrews et al. (2017) for sharing with us an unpublished version of their work that includes details

Sections 6 and 7, we report confidence sets for linear functions of the elements of κ; we compute these as projections of the 95% confidence set for $(\kappa, \tilde{\eta})$.[38]

6 Results

We present confidence sets for linear combinations of four parameters: the relative reduction in sunk costs due to extended gravity in border, κ_b, continent, κ_c, language, κ_l, and income per capita, κ_g. We assume here that the fixed costs term u_{ic_jt} is common across countries; i.e. $u_{ic_jt} = u_{it}$, for all j.[39] We impose no other restriction on the distribution of u_{it}.

As described in Section 5, our extended gravity estimates depend on prior estimates of the revenue parameters α, which we use to compute a proxy for the potential export revenue of every firm, country and year, $\hat{r}_{ijt}$. Our estimates of α, reported in Table E.1 in Online Appendix E, reveal several patterns: new exporters sell small amounts; firms' exports increase in the size of the destination market and generally decrease in any measure of distance between home and foreign markets; and more productive firms, as proxied either by value added per worker or by domestic sales, export larger amounts. For the purpose of computing confidence sets on extended gravity parameters, the main characteristic of the nine revenue regressions reported in Table E.1 is that, as we show in Table E.2 in Online Appendix E, all generate very similar proxies $\hat{r}_{ijt}$. Our moment inequality estimates are thus robust to different specifications of the export revenue regression. To confirm this, we report here and in Online Appendix F.5 confidence sets for the extended gravity parameters that rely on different specifications of the export revenue regression. No matter which specification we use to construct $\hat{r}_{ijt}$, our confidence sets are very similar.

As we show in Table 5, we estimate the relative reduction in sunk costs due to the extended gravity effect in border to be between approximately 6% and 13%, the reduction due to continent to be between 19% and 29%, that due to language to be between 29% and 36%, and that due to similarity in income per capita to be lower than 29%. Panel A in Figure 2 represents these estimates graphically: except for the case of similarity in income per capita, the bounds of our confidence sets are tight and reject the null that extended gravity effects are zero. One should not conclude from these estimates that linguistic factors matter more than geographic ones. Contiguous countries will also generally share continent and, as shown in Table 6 and Panel A in Figure 2, their joint effect is between 25% and 38%, comparable to the effect of sharing a

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on the implementation of the estimator in Section 8 of Andrews and Shi (2013); we adapt their procedure to our combination of a nonlinear least squares first-step estimator and an unconditional moment inequality second-step estimator. All details are in Online Appendix F.4.

[38] Our projected confidence sets are conservative. Instead of applying the procedure introduced in Bugni et al. (2017) (which has better power properties), we report these projected sets for two reasons. First, they are sufficiently tight to provide economically meaningful information on the effect of extended gravity on sunk costs. Second, as we report confidence sets for many functions of κ, it is computationally more convenient to obtain a single confidence set for $(\kappa, \tilde{\eta})$ and then project it multiple times.

[39] In Section 7, we relax this assumption and allow u_{ic_jt} to vary across countries that differ in the continent of location, official language, or income per capita.

Table 5: Confidence Sets for Individual Extended Gravity Parameters

Border	Continent	Language	GDPpc
[5.71%, 13.33%]	[19.05%, 28.57%]	[28.57%, 36.19%]	[0%, 28.57%]

Notes: This table reports results conditional on the regression results described in column I of Table E.1 in Online Appendix E. The confidence intervals are projections of a confidence set for $(\kappa, \tilde{\eta})$ computed following the procedure described in Online Appendix F.4.1.

Table 6: Confidence Sets for Combinations of Extended Gravity Parameters

Border + Continent	Language + GDPpc	Continent + GDPpc	Continent + GDPpc + Border	Continent + Language	Continent + Language + Border	Continent + Language + GDPpc	All
[24.76%, 38.10%]	[32.38%, 60.95%]	[24.76%, 49.52%]	[34.29%, 57.14%]	[47.62%, 62.86%]	[55.24%, 74.29%]	[57.14%, 81.90%]	[68.57%] 89.52%]

Notes: This table reports bounds on sums of elements of the vector κ defined in equation (23). It uses the regression results described in column I of Table E.1. The confidence intervals reported in this table are projections of a 5-dimensional confidence set for $(\kappa, \tilde{\eta})$ computed following the procedure described in Online Appendix F.4.1.

common language.

Table 6 and Panel B in Figure 2 present bounds on combinations of extended gravity parameters. Firms that have export experience in a country that shares border, continent, language and similar income per capita with a new export destination will pay sunk export costs 69% to 90% smaller than those paid by a firm that has either no prior export experience or experience only in countries unrelated to the new destination. This result calls into question the assumption, standard in the international trade literature, that firms consider each foreign country as an independent export market. Our results suggest that, when two countries are very similar to each other, firms that jump between them face barriers only slightly larger than those they would face when jumping across regions of the same country.

Panel C in Figure 2 illustrates our estimates through the example of a firm that enters the United States. If this firm was previously exporting to Canada, a country that shares border, continent, language, and similar income per capita with the United States, it would pay only between one tenth and one third of the entry costs paid by a firm that was not exporting in the prior year. Similarly, Panel D of Figure 2 shows that the cost of starting to export to Germany for a firm whose only export destinations in the previous year are, for example, China or Argentina will be between four and ten times larger than the corresponding cost for a firm that exported to Austria instead. These results reflect that, once a firm has adapted its products or workforce to successfully export to Austria, the additional cost required to enter Germany is relatively small. Furthermore, firms are forward-looking and, thus, when considering whether to enter a country like Austria, they take into account that the investment required to break into this market will eventually allow them to enter other similar countries such as Germany. Therefore, the decision of whether to enter a foreign country will depend on how similar it is to other markets.

The difference in the entry costs in Germany of previous exporters to Austria and previous exporters to France reflects the role of language in generating extended gravity effects. Once the linguistic connection is not present, the total reduction in entry costs due to extended gravity is at most 57%. If we further omit the income per capita connection and consider the sunk costs for Germany of previous exporters to Poland, then the cost reduction is between 25% and 38%. Finally, sharing only continent (as is the case of Greece and Germany) implies, as discussed above, an approximate reduction in entry costs of 19% to 29%.

Is it easier to enter the United States from Mexico or from the United Kingdom? Mexico shares all geographic factors (border and continent) with the United States, while the United Kingdom shares all non-geographic factors (language and similar income per capita). While we cannot reject that the extended gravity effects enjoyed by a firm previously exporting to Mexico are the same as those experienced by a firm previously exporting to the United Kingdom, most parameter values in our confidence set indicate that the combined effect of language and income per capita is larger than the combined effect of border and continent.

Two features of our estimates are worth noting. First, although we identify κ from firms' discrete export decisions, our estimates do not depend on a normalization by scale. The reason is that κ captures not the absolute but the relative reduction in sunk costs. Second, our estimates show that, even though the confidence interval for a parameter may be large, confidence intervals for linear combinations of this and other parameters can be smaller. For example, the confidence interval for κ_g is nearly 30 percentage points wide; however, the confidence interval for the sum of all extended gravity parameters, $\kappa_b + \kappa_c + \kappa_l + \kappa_g$, is 21 percentage points wide. Combinations of parameters may thus be better identified than each of them by itself; estimates will have this property whenever the covariates that multiply these parameters are positively correlated. Panel (e) in Figure 3 illustrates this: the projection of the confidence set for $(\kappa, \tilde{\eta})$ on the space (κ_c, κ_g) slopes negatively and, thus, includes points that combine high values of κ_c with low values of κ_g and points that combine low values of κ_c with high values of κ_g. The bounds on $\kappa_c + \kappa_g$ are thus narrower than those on κ_g. The reason why the projection of the confidence set for $(\kappa, \tilde{\eta})$ on the space (κ_c, κ_g) slopes negatively is that countries that belong to the same continent tend to have similar income per capita: if a firm enters a country that shares a continent with a prior export destination, this country will also likely share similar income per capita with that destination. In these cases, our estimator cannot determine whether the firm's entry decision is due to extended gravity in continent or in income per capita, but it can determine that the sum of both effects must be large enough to explain the observed export decision.[40]

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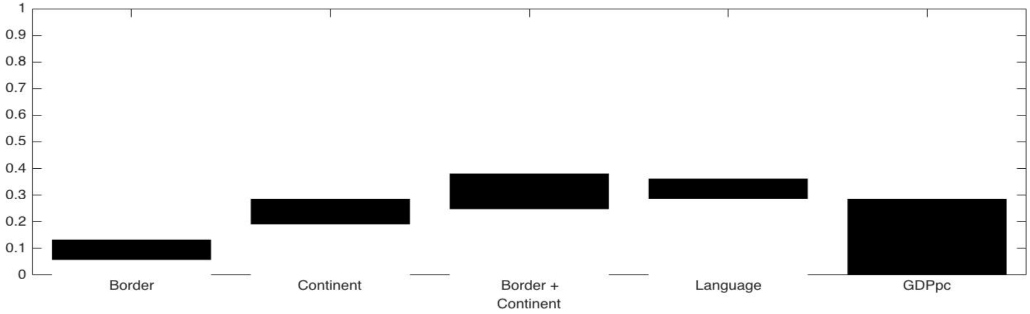
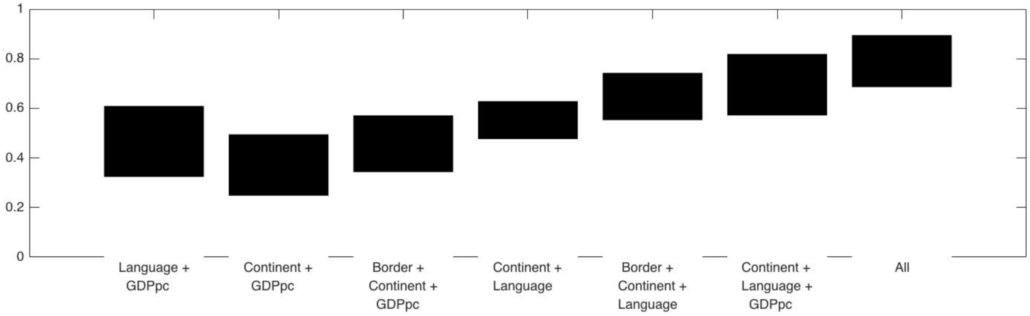
[40] This is a reason why we do not aim to identify the effect of each gravity variable on sunk costs. In the case of Chile, gravity variables are very correlated: most Spanish-speaking countries are located in South America and have similar levels of income per capita. E.g., if we observe firms choosing Argentina over the larger US market, export costs in Argentina must be lower; however, we cannot discern whether this is due to Argentina sharing continent, language or similar income per capita with Chile. We thus estimate extended gravity effects relative to the sunk costs of exporting to a country that differs from Chile in all gravity variables: we identify bounds on

Figure 2: Confidence Sets for Extended Gravity Parameters

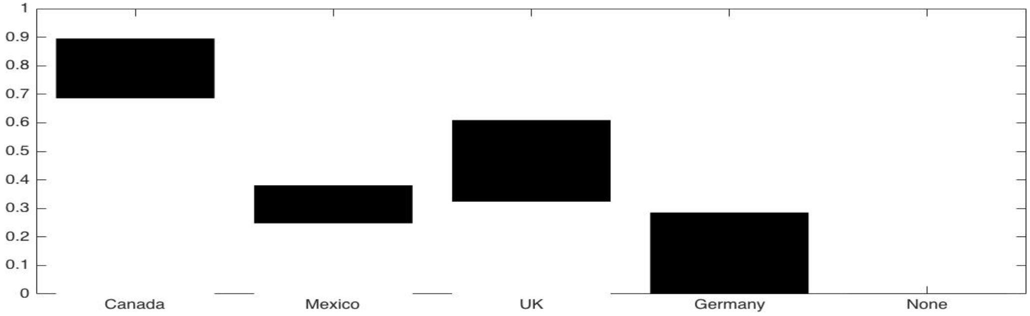
Panel A: Individual Extended Gravity Parameters



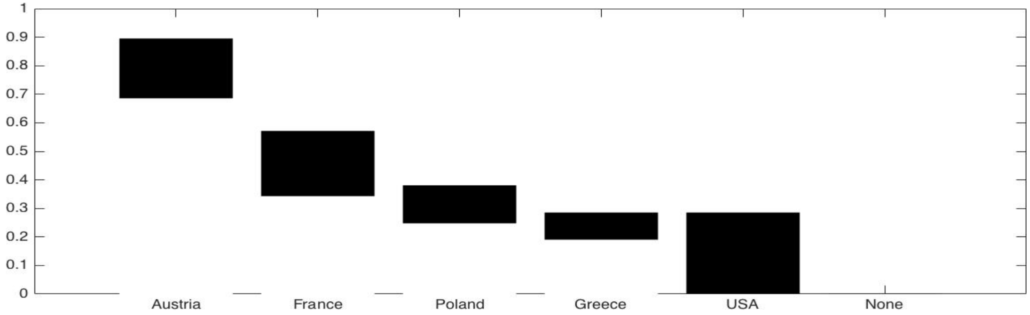
Panel B: Combinations of Extended Gravity Parameters



Panel C: Extended Gravity Effects When Entering the United States



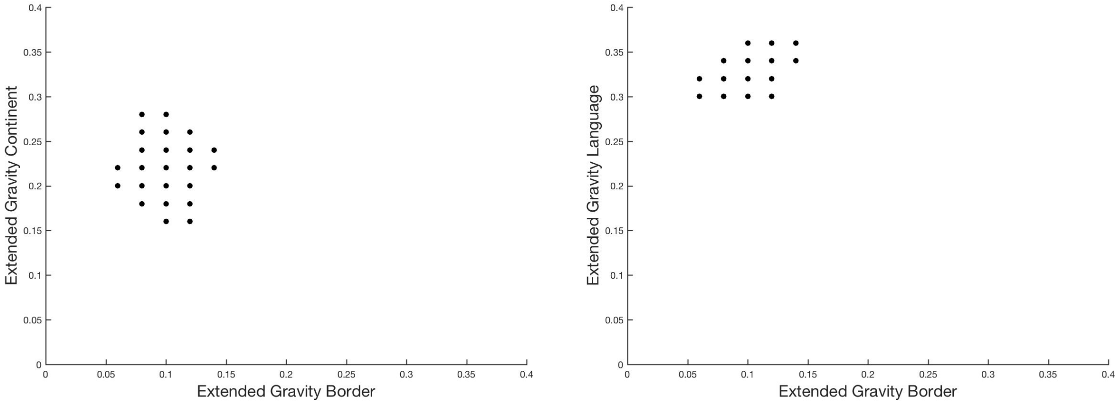
Panel D: Extended Gravity Effects When Entering Germany



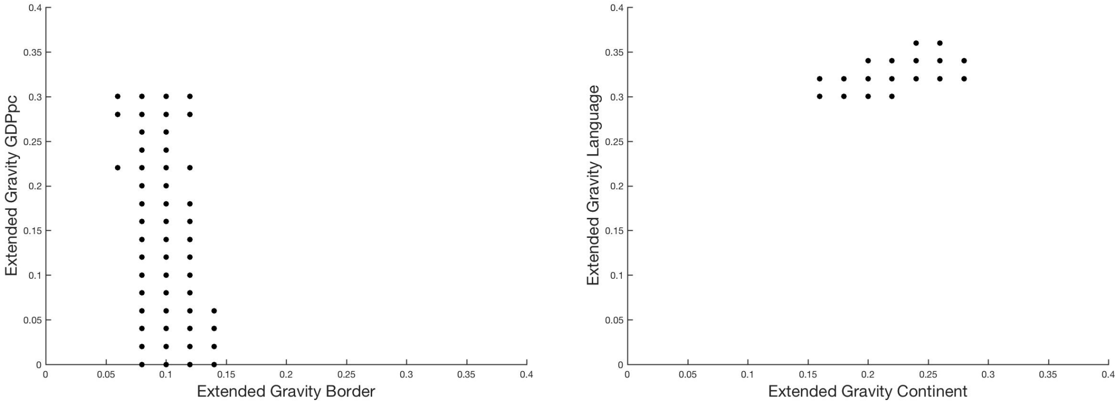
Notes: These figures represent the projected confidence intervals reported in Panel A of tables 5 and 6.

$\kappa_b = \gamma_b^E/\gamma_{all}^S$, but not, for example, on γ_b^E/γ_c^S.

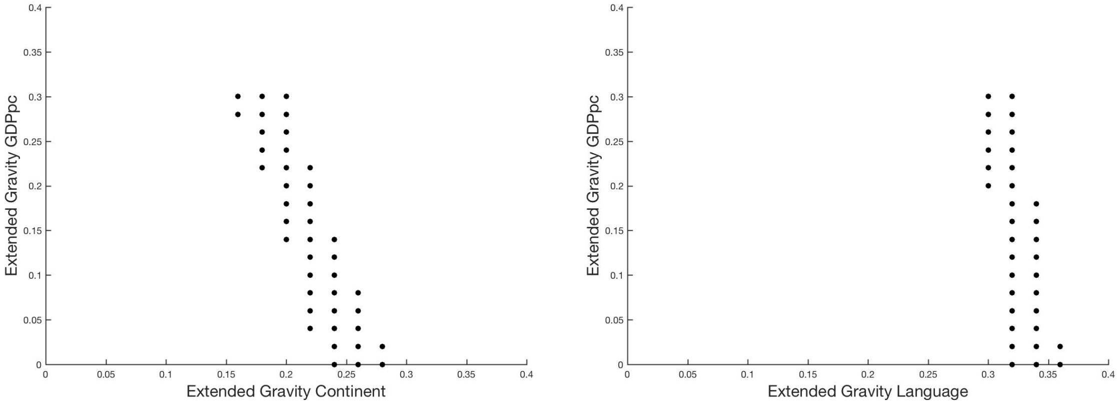
Figure 3: Projected Confidence Set


(a) Border vs. Continent

(b) Border vs. Language


(c) Border vs. GDPpc

(d) Continent vs. Language


(e) Continent vs. GDPpc

(f) Language vs. GDPpc

Notes: These confidence sets are two-dimensional projections of a 5-dimensional confidence set for $(\kappa, \tilde{\eta})$ computed following the procedure described in Online Appendix F.4.1.

7 Robustness

We present here estimates consistent with unobserved heterogeneity in export profits, u_{ic_jt}, varying across groups of countries. We treat u_{ic_jt} as a firm i, year t, and group-of-countries c_j fixed effect, and define the groups c_j by the countries' continent, language, or income per capita. We thus impose no restriction on the distribution of u_{ic_jt} across country groups, firms, and years. This implies that only those inequalities in which we swap an observed export destination for an alternative one belonging to the same country group will be useful to identify κ: any difference in the firm's export decisions in two countries j and j' that do not belong to the same country group, $c_j \neq c_{j'}$, can be explained by specific realizations of u_{ic_jt} and $u_{ic_{j'}t}$. Our approach to build inequalities is thus based on differencing out the unobserved heterogeneity that affects firms' export decisions, and we do so by choosing actual and counterfactual destinations j and j' such that $c_j = c_{j'}$ and, therefore, $u_{ic_jt} - u_{ic_{j'}t} = 0$.

Inequalities that compare export profits in countries that share continent, language, or similar income per capita create challenges for the identification of extended gravity parameters. For example, consider the case in which we treat u_{ic_jt} as a firm-continent-year fixed effect and, thus, build inequalities that compare destinations that belong to the same continent. This complicates the identification of the continent extended gravity parameter, κ_c. A firm that benefits from extended gravity in continent when entering country j in year t would have equally benefited from it if it had entered an alternative destination j' located in the same continent. The difference in static profits in year t, $\pi_{ijj't}$, will thus not depend κ_c. While the difference in static profits in year $t+1$, $\pi_{ijj't+1}$, may still depend on κ_c, inequalities that difference out a firm-continent-year fixed effect will have low identification power for κ_c. However, as long as there is variation in language and income per capita across countries sharing a continent, these inequalities may still be useful to identify extended gravity effects due to language, κ_l, and income per capita, κ_g. Similarly, when we allow for firm-language-year or firm-income-per-capita-group-year fixed effects, our inequalities lose identification power for the corresponding extended gravity parameters.

The results we obtain when we allow u_{ic_jt} to vary across groups of countries, reported in Table 7, are consistent with those we obtain when we assume that this term is common to all countries, reported in Table 5. When we allow u_{ic_jt} to differ across continents, the border extended gravity effect is estimated to be between 10% and 23%, the one due to language to be between 12% and 27%, and the one due to similarity in income per capita to be between 9% and 21%. As expected based on the discussion above, the continent extended gravity effect is not identified in this case. Allowing u_{ic_jt} to vary across countries that differ in their official language yields a border extended gravity effect between 3% and 9%, a continent extended gravity effect between 12% and 24%, and an extended gravity effect due to similarity income per capita between 15% and 34%. Finally, when allowing for firm-income-per-capita-group-year- fixed effects, we obtain a border extended gravity effect between 4% and 7%, and extended gravity effects due to continent

Table 7: Confidence Sets for Individual Extended Gravity Parameters

Panel A: Firm-Year-Continent Fixed Effects

Border	Continent	Language	GDPpc
[10.37%, 22.70%]	[-, -]	[11.85%, 26.67%]	[8.89%, 20.74%]

Panel B: Firm-Year-Language Fixed Effects

Border	Continent	Language	GDPpc
[2.96%, 8.89%]	[11.85%, 23.70%]	[-, -]	[14.81%, 34.07%]

Panel C: Firm-Year-GDP Per Capita Fixed Effects

Border	Continent	Language	GDPpc
[4.10%, 7.18%]	[18.46%, 28.72%]	[18.46%, 28.72%]	[-, -]

Notes: This table reports bounds on the vector κ defined in equation (23). It relies on the regression estimates in column I of Table E.1. The bounds in panels A, B, and C are computed under the assumption that u_{ic_jt} is, respectively, a firm-continent-year, a firm-language-year, and a firm-income-per-capita-group-year fixed effect. The confidence intervals are projections of a confidence set for $(\kappa, \tilde{\eta})$ computed following the procedure described in Online Appendix F.4.1.

and language between 19% and 29%.

Our inequalities do not allow for firm-, year-, and country-specific unobserved heterogeneity in export profits known to the firm when deciding on its optimal set of export destinations. However, as the simulation in Online Appendix G.3 shows, if substantial unobserved heterogeneity impacts the firm's export decisions, the identified set defined by inequalities that ignore such heterogeneity is likely to be empty. We use the model specification tests in Andrews and Soares (2010) and Bugni et al. (2015) to test the null hypothesis that the identified sets defined by the inequalities employed in Tables 5 and 7 are nonempty: the p-values are always larger than 10% (see Online Appendix F.4.2 for details). One should not interpret our results as suggesting that export profits do not differ across firms for unobserved reasons. Such unobserved determinants are accounted for in our model through the terms ε^R_{ijt}, ε^F_{ijt}, and ε^S_{ijt}, defined in equations (6), (8), and (11). However, consistent with equations (7), (10), and (14), our estimates do not contradict the assumption that these terms are also unobserved to the firm when deciding which new destinations to enter.

8 Concluding Remarks

We use moment inequalities to estimate a dynamic model of firm entry into spatially related export markets. The traditional approach assumes that the firm's export decision in a market is independent of the decision taken in any other market. Conversely, our model allows for dynamic complementarities across markets in the firm's export decisions. These decisions are thus potentially very complex, and this complexity makes moment inequalities ideal.

Our results show that extended gravity is an important determinant of firms' entry costs.

A firm that exports to countries that share border, continent, language, and similar income per capita with a market face sunk costs in it that are 69% to 90% smaller than those faced by a firm whose export destinations do not share any of these four characteristics with this market. Among the extended gravity factors we consider, geography and language are the most important. Exporting to a country located in the continent of a subsequent new destination reduces sunk costs by 19% to 29% if both countries do not share border, and by 25% to 38% if they do. This effect is similar to the impact of sharing language, which reduces entry costs by 29% to 36%.

Although our estimator has the advantage of being consistent with a flexible specification of the firm's information and consideration sets and planning horizon, it also has limitations. Our baseline estimates assume away the existence of firm-, year- and country-specific factors that influence firms' entry decisions but are not in our data. If these factors are correlated across countries that share some extended gravity variable, then our extended gravity estimates will not capture only state dependence in trade costs but also the effect of unobserved heterogeneity in export profits. To address this concern, we also present estimates that allow for firm-group-of-countries-year fixed effects. No matter whether we group countries by their continent, language or income per capita, the resulting estimates are consistent with the baseline ones.

As sunk costs are important determinants of firms' exports (Das et al., 2007) and the extensive margin of firms drives much of the variation in aggregate trade across destinations (Bernard et al., 2010), our findings suggest that shocks to export profits in a market will have important effects on neighboring countries and in countries sharing a language with them. For example, our analysis suggests that an increase in trade barriers between the United States and China will impact Chinese exports to Mexico and Canada. Quantifying this impact, however, requires correctly specifying firms' information and consideration sets and planning horizons, as well as solving the resulting combinatorial dynamic discrete choice problem. This requires specifying elements of the model on which we have very little information and dealing with computational challenges still unsolved in the literature. We leave this quantification for future work.

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Appendix

A Reduced-Form Evidence: Details

We complement here the content of Section 2 and present additional reduced-form evidence on the relevance of extended gravity in determining firms' export destinations.

A.1 Transition Probabilities by Firm Size

As discussed in Section 2.2, extended gravity effects are not the only mechanism that can rationalize the transition probabilities in Table 1. An alternative explanation is the joint effect of two forces: (a) most firms either do not export or export to very few destinations, while a small number of firms export widely; (b) the more countries a firm exports to, the more likely it is that a new destination shares some characteristic with a previous destination of the firm. As suggestive evidence that the transition probabilities reported in Table 1 are not entirely due to this alternative explanation, Tables A.1 and A.2 report transition probabilities analogous to those in Table 1 for subgroups of firms that differ in their domestic sales (interpreted here as a proxy for the firm's productivity) and in their total number of export destinations in the previous year, respectively. To facilitate the comparison, the first two columns in both of these tables include the overall numbers reported in Table 1.

Table A.1: Transition Probabilities By Firm Size

	Overall		Large Firms		Small Firms	
	Prob. of Entry	Num. of Entries	Prob. of Entry	Num. of Entries	Prob. of Entry	Num. of Entries
Overall:	0.66%	1638	1.03%	1264	0.30%	374
Extended Gravity:						
If Ext. Grav. Border = 1	6.74%	397	6.78%	321	5.94%	76
If Ext. Grav. Cont. = 1	2.79%	525	2.86%	391	2.88%	134
If Ext. Grav. Lang. = 1	1.59%	205	1.46%	145	1.83%	60
If Ext. Grav. GDPpc = 1	1.53%	588	1.59%	453	1.52%	135
If All Ext. Grav. = 0	0.31%	770	0.69%	585	0.16%	185

Notes: *Large Firms* have domestic sales above the median; *Small Firms* have domestic sales below the median. The median domestic sales in our sample equals approximately 1.8 million dollars.

Table A.2: Transition Probabilities By Number of Export Destinations

	Overall		Many Destinations		Few Destinations	
	Prob. of Entry	Num. of Entries	Prob. of Entry	Num. of Entries	Prob. of Entry	Num. of Entries
Overall:	0.66%	1638	1.97%	871	0.38%	767
Extended Gravity:						
If Ext. Grav. Border = 1	6.74%	397	7.22%	361	1.21%	36
If Ext. Grav. Cont. = 1	2.79%	525	3.23%	497	0.95%	28
If Ext. Grav. Lang. = 1	1.59%	205	1.87%	196	0.34%	9
If Ext. Grav. GDPpc = 1	1.53%	588	2.31%	498	0.57%	90
If All Ext. Grav. = 0	0.31%	770	0.99%	134	0.33%	636

Notes: *Many Destinations* firms are firms with more than the median number of destinations; *Few Destinations* firms are firms with less than the median number of destinations. The median number of destination in our sample is four.

The first row in Tables A.1 and A.2 shows that the overall probability of entry is larger for large firms and for firms already exporting to a large number of destinations. The remaining rows in these tables show that, for all the four subgroups of firms we consider in them, the general finding that firms are more likely to enter a country when previously exporting to similar destinations survives. For example, the relative increase in the entry probability associated to previously exporting to a bordering country is: approximately thirteen when considering all firms; seven when considering firms with large domestic sales; close to twenty when considering firms with low domestic sales; and slightly below four no matter whether we look at firms with above or below the median number of export destinations in the year prior to entry. As the remaining rows in Tables A.1 and A.2 illustrate, similar patterns hold for the relative increase in export entry probabilities associated with previously exporting to countries located in the same continent, sharing the same official language, or having similar income per capita as the potential new export destination.

A.2 Binary Logit Model

As discussed in Section 2.2, an alternative explanation for the transition probabilities reported in Table 1 is the importance of gravity variables in determining the entry behavior of potential exporters. If firms rank countries by proximity to Chile and spread out gradually to more distant markets, then a firm already exporting to a continent would be more likely to start exporting to other countries in the same continent. Similarly, if Chilean firms enter destinations with languages more similar to Spanish before entering those with more distinct languages (e.g. French speaking countries are prioritized over German speaking ones), the fact that we observe firms successively entering countries that share a language would be exclusively due to their ranking in terms of linguistic distance to the country of origin (gravity) and not due to their linguistic distance to prior destinations of the firm (extended gravity). We show in Table A.3 how reduced-form entry probabilities depend on extended gravity variables while simultaneously controlling for standard gravity covariates. Specifically, we present in Table A.3 estimates of several binary logit models of the probability that a firm exports a positive amount to a destination in a given year. These binary logit models correspond to a restricted version of the model in equation (1); specifically, these logit models impose that $u_{ic_j} = 0$ for every firm i and every cluster of countries c_j.

Besides accounting for the impact of the extended gravity covariates of interest, the baseline specification (column I of Table A.3) allows the probability that a firm exports to a potential destination to depend on: (a) measures of distance between the potential destination and Chile (gravity); (b) measures of previous export experience of the firm in this potential destination; and (c) interactions of the measures in (a) and (b). The covariates in (a) account for gravity; those in (b) account for persistence in export status; and those in (c) account for heterogeneity in this persistence across potential destinations.

The results in column I of Table A.3 show that: (a) the most important determinant of export participation is prior export participation (as indicated by the large negative coefficient on “Entry”); (b) all statistically significant measures of distance between destination and origin countries have a negative impact on the probability that the firm exports to that destination; (c) the persistence in export status is stronger in destinations that are further away (in the gravity sense) from the country of origin of the firms (as indicated by the negative coefficients on the interactions of “Entry” with the different gravity variables); (d) all extended gravity variables have a large and statistically significant positive impact on export participation; (e) for a destination j that does not share border, nor continent, nor language nor similar income per capita with Chile, the increase in the probability of exporting at t to country j caused by exporting at $t-1$ to a country that shares a border, continent, language or similar income per capita with country j relative to the probability increase caused by exporting to j itself at period $t-1$ is 18%, 27%, 4%, and 15%, respectively (the relative impact of previously exporting to a country that shares all four extended gravity variables with a destination is 63%).

A shortcoming of the specification in column I of Table A.3 is that it does not directly account for the heterogeneity in export probabilities across firms of different size documented in Table A.1 in Appendix A.1. This heterogeneity is likely to capture an underlying heterogeneity in supply (e.g. productivity) and demand (e.g. quality) factors that impact firms' export probabilities by affecting their potential export revenues; i.e. the revenues they would obtain if they were to export. In columns II to IV of Table A.3, we account for this impact by adding to the set of covariates in column I a proxy for this potential export revenue. Specifically, we include either domestic sales as an additional control (in column II) or a measure of potential export revenues that we construct by projecting the observed export revenues (of those firms, countries and years with positive exports) on a set of firm and country characteristics that we observe for every firm, country and year (in columns III and IV).[41]

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[41] Specifically, column III in Table A.3 uses a revenue proxy consistent with the specification in column I of Table E.1 (which projects export revenues on a large set of firm and country characteristics) and column IV in Table A.3 uses a proxy

Table A.3: Logit

Variables: (β)	I	II	III	IV	V	VI	VII	VIII
Domestic Sales		0.002^b				0.002^b		
		(2.225)				(2.327)		
Revenue			1.769^a	2.735^a			1.857^a	3.118^a
			(7.131)	(12.433)			(7.436)	(14.059)
Grav. Border	0.012	-0.008	-0.022	-0.039				
	(0.137)	(-0.085)	(-0.236)	(-0.419)				
Grav. Cont.	-0.287^a	-0.266^a	-0.288^a	-0.258^a	-0.547^a	-0.537^a	-0.549^a	-0.483^a
	(-3.050)	(-2.793)	(-3.040)	(-2.679)	(-6.366)	(-6.754)	(-6.949)	(-6.015)
Grav. Lang.	-0.430^a	-0.450^a	-0.582^a	-0.612^a	-0.457^a	-0.480^a	-0.616^a	-0.648^a
	(-5.874)	(-6.013)	(-7.845)	(-8.068)	(-6.366)	(-6.532)	(-8.447)	(-8.693)
Grav. GDPpc	0.008	-0.017	0.033	0.034	-0.019	-0.045	0.011	0.016
	(0.116)	(-0.246)	(0.484)	(0.495)	(-0.294)	(-0.659)	(0.156)	(0.233)
Grav. FTA	-0.412^a	-0.413^a	-0.386^a	-0.375^a				
	(-7.257)	(-7.076)	(-6.730)	(-6.418)				
Entry	-3.471^a	-3.383^a	-3.352^a	-3.881^a	-4.821^a	-4.805^a	-4.768^a	-4.743^a
	(-6.738)	(-6.493)	(-6.509)	(-7.389)	(-70.567)	(-69.808)	(-68.918)	(-68.579)
Entry × Grav. Dist.	-0.104	-0.115^c	-0.116^c	-0.044				
	(-1.519)	(-1.657)	(-1.695)	(-0.637)				
Entry × Grav. Border	-0.938^a	-0.919^a	-0.894^a	-0.906^a				
	(-7.368)	(-7.182)	(-7.004)	(-7.043)				
Entry × Grav. Cont.	-0.901^a	-0.923^a	-0.890^a	-0.907^a	-1.305^a	-1.328^a	-1.295^a	-1.316^a
	(-6.693)	(-6.778)	(-6.662)	(-7.043)	(-11.976)	(-12.022)	(-11.813)	(-11.863)
Entry × Grav. Lang.	-0.506^a	-0.493^a	-0.355^a	-0.449^a	-0.701^a	-0.694^a	-0.545^a	-0.596^a
	(-4.702)	(-4.497)	(-3.274)	(-4.078)	(-7.221)	(-6.999)	(-5.555)	(-5.979)
Entry × Grav. GDPpc	-0.569^a	-0.553^a	-0.589^a	-0.570^a	-0.580^a	-0.565^a	-0.606^a	-0.588^a
	(-5.731)	(-5.497)	(-5.907)	(-5.654)	(-5.871)	(-5.643)	(-6.097)	(-5.864)
Ext. Grav. Border	1.129^a	1.170^a	1.138^a	1.088^a	0.960^a	0.991^a	0.968^a	0.918^a
	(15.636)	(15.811)	(15.758)	(14.561)	(14.152)	(14.283)	(12.509)	(13.055)
Ext. Grav. Cont.	1.695^a	1.653^a	1.682^a	1.649^a	1.809^a	1.773^a	1.794^a	1.755^a
	(20.094)	(19.099)	(19.923)	(18.902)	(22.137)	(21.161)	(21.917)	(20.705)
Ext. Grav. Lang.	0.240^a	0.219^b	0.227^b	0.176^c	0.297^a	0.282^a	0.286^a	0.227^b
	(2.660)	(2.329)	(2.516)	(1.842)	(3.343)	(3.035)	(3.210)	(2.393)
Ext. Grav. GDPpc	0.974^a	1.012^a	0.967^a	0.992^a	0.911^a	0.943^a	0.905^a	0.933^a
	(11.762)	(12.014)	(11.667)	(11.709)	(11.173)	(11.368)	(11.085)	(11.163)
Num. Obs.	234,896	234,896	234,896	234,896	234,896	234,896	234,896	234,896

Notes: *a* denotes 1% significance, *b* denotes 5% significance, *c* denotes 10% significance. Estimates are obtained by MLE, and t-statistics are in parentheses. The dependent variable is a dummy variable for positive exports. All specifications include year fixed effects. "Domestic Sales" and "Revenue" are measured in tens of millions of year 2000 US dollars; "Grav. Dist" is in logs. The variable "Revenue" in columns III and VII corresponds to the specification in column I of Table E.1; the variable "Revenue" in columns IV and VIII corresponds to the specification in column VI of Table E.1. Table E.1 is reported in Online Appendix E. All other covariates are dummy variables.

The specifications in columns V to VII differ from those in columns I to IV only in that they exclude those gravity measures that we will also be excluding from the specification of the fixed and sunk export costs in our structural model: "Grav. Border", "Grav. FTA", and "Grav. Dist". As the results in Table A.3 show, eliminating

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consistent with the specification in column VI of Table E.1 (which projects export revenues on a small set of characteristics). Consistently with the high correlations in Table E.2, the estimates in columns III and IV of Table A.3 are very similar to each other. Tables E.1 and E.2 are reported in Online Appendix E.

these covariates from the logit model reduces the coefficient on "Entry", "Grav. Cont", and "Grav. Lang" but has nearly no impact on the four extended gravity coefficients.

A.3 Mixed Logit Model

In Appendix A.3.1, we describe the likelihood function whose maximizers we report in Table 2. In Appendix A.3.2, we present estimates of specifications that differ from those in Table 2 in the measure of potential export revenues that we use as our covariate "revenue" in equation (1). In Appendix A.3.3, we present estimates of specifications that differ from those in Table 2 in that they do not control for gravity variables.

A.3.1 Likelihood Function

The log-likelihood function of the mixed logit models whose estimates are presented in Table 2 is

$$(NC)^{-1}\sum_{i=1}^{N}\sum_{c=1}^{C}\log\left[\int_{u_{ic}} L_{ic}(u_{ic})(1/\sigma_c)\phi(u_{ic}/\sigma_c)du_{ic}\right], \tag{A.1}$$

with

$$L_{ic}(u_{ic}) \equiv \prod_{\substack{j=1,\\ c=c_j}}^{J}\Big\{\prod_{s=1}^{T_i}\{\mathcal{L}(d_{ijs}|\{d_{ij's-1};j'=1,\ldots,J\},x_{ijs},u_{ic};\beta)\}\mathcal{L}_0(d_{ij0}|x_{ij0},u_{ic};\mu)\Big\}, \tag{A.2}$$

where $\prod_{j=1,c=c_j}^{J}$ denotes the product over all countries j included in the cluster c; the vector x_{ijt} includes the observed measures of "revenue", "gravity", and "ext.gravity"; $\beta' \equiv (\beta_1,\beta_2',\beta_3,\beta_4',\beta_5')$; μ is a vector of reduced-form parameters; and $\phi(\cdot)$ denotes the standard normal density. The variable N denotes the total number of firms that appear at least one year in the sample, the variable C denotes the total number of clusters of countries that we allow for, and T_i denotes the total number of periods that firm i appears in the sample. The models presented in the different columns of Table 2 differ only in the definition of the cluster of countries $c=1,\ldots,C$. The index s indicates the number of periods the firm has been in the sample.

The individual likelihood function $\mathcal{L}(\cdot)$ equals

$$\begin{aligned}&\mathcal{L}(d_{ijt}|\{d_{ij't-1};j'=1,\ldots,J\},x_{ijt},u_{ic};\beta) = \\ &\big(P(d_{ijt}=1|\{d_{ij't-1};j'=1,\ldots,J\},x_{ijt},u_{ic};\beta)\big)^{d_{ijt}}\big(1-P(d_{ijt}=1|\{d_{ij't-1};j'=1,\ldots,J\},x_{ijt},u_{ic};\beta)\big)^{1-d_{ijt}},\end{aligned} \tag{A.3}$$

with

$$\begin{aligned}&P(d_{ijt}=1|\{d_{ij't-1};j'=1,\ldots,J\},x_{ijt},u_{ic};\beta) = \\ &\frac{\exp(\beta_1\,\text{revenue}_{ijt}+\beta_2\,\text{gravity}_j+\beta_3(1-d_{ijt-1})+\beta_4[(1-d_{ijt-1})\times\text{gravity}_j]+\beta_5\text{ext.gravity}_{ijt}+u_{ic_j})}{1+\exp(\beta_1\,\text{revenue}_{ijt}+\beta_2\,\text{gravity}_j+\beta_3(1-d_{ijt-1})+\beta_4[(1-d_{ijt-1})\times\text{gravity}_j]+\beta_5\text{ext.gravity}_{ijt}+u_{ic_j})}.\end{aligned} \tag{A.4}$$

The individual likelihood function $\mathcal{L}_0(\cdot)$ equals

$$\mathcal{L}_0(d_{ij0}|x_{ij0},u_{ic};\mu) = \big(P_0(d_{ij0}=1|x_{ij0},u_{ic};\mu)\big)^{d_{ij0}}\big(1-P_0(d_{ij0}=1|x_{ij0},u_{ic};\mu)\big)^{1-d_{ij0}}, \tag{A.5}$$

for some unknown probability function $P_0(\cdot)$. Our model does not have a prediction for the functional form of the function $P_0(\cdot)$. This function determines the probability of the initial conditions $\{d_{ij0};i=1,\ldots,N,\ j=1,\ldots,J\}$ as a function of the exogenous covariates included in the vector $\{x_{ij0};i=1,\ldots,N,\ j=1,\ldots,J\}$ and the firm- and group-of-countries-specific effects $\{u_{ic_j};i=1,\ldots,N,\ j=1,\ldots,J\}$. Following Heckman (1981), we approximate $P_0(\cdot)$ through a reduced-form function of the exogenous variables included in the vector x_{ijt} and the unobserved effect u_{ic_j}; specifically, we assume that

$$P_0(d_{ij0}=1|x_{ij0},u_{ic};\mu) = \frac{\exp(\mu_1\,\text{revenue}_{ij0}+\mu_2\,\text{gravity}_j+u_{ic_j})}{1+\exp(\mu_1\,\text{revenue}_{ij0}+\mu_2\,\text{gravity}_j+u_{ic_j})}. \tag{A.6}$$

An alternative approach to model $P_0(\cdot)$ is to assume that all firms are in steady state in the first year of our sample (e.g. Card and Sullivan, 1998). Not only is this assumption unrealistic in our setting but, additionally, computing the steady state export probability of each firm in each destination country is particularly complicated in our case due to the presence of the extended gravity effects.

For any given value of the parameter vector (β, σ_c, μ), computing the log-likelihood function in equations (A.1) to (A.6) requires numerically computing the integral

$$\int_{u_{ic}} L_{ic}(u_{ic})(1/\sigma_c)\phi(u_{ic}/\sigma_c)du_{ic}, \tag{A.7}$$

for every firm i in the sample and every cluster c in which we partition the J possible export destinations. To compute this integral, we use the Gauss-Hermite quadrature (e.g. Butler and Moffitt, 1982) and, thus, approximate it as

$$\int_{u_{ic}} f_{ic}(u_{ic})(1/\sigma_g)\phi(u_{ic}/\sigma_g)du_{ic} \approx \pi^{-\frac{1}{2}} \sum_{l=1}^{n} \tilde{w}_l f_{ic}(\sqrt{2}\sigma_g \tilde{u}_l), \tag{A.8}$$

where $\tilde{w}_l$ and $\tilde{u}_l$ are the Gauss-Hermite quadrature weights and nodes. In our approximation, we fix $n = 10$ and use the weights and nodes reported in Table 7.4 in Judd (1998).

A.3.2 Estimates under Alternative Revenue Proxies

As discussed in Section 2.3, a challenge in the estimation of the model in equation (1) is that we do not directly observe in the data the potential revenue from exporting for every firm-country-year triplet. We observe however actual export revenues for those firms, countries, and years with positive exports. We construct our proxy for firms' potential export revenues, "revenue," by regressing the observed export revenues (whenever these ones are positive) on a set of covariates that we observe for every firm, destination, and year, independently of the export status of the firm in this destination market and time period.

The baseline estimates in Table 2 rely on a proxy for the firm's potential export revenue constructed using the specification in column I of Table E.1 in Online Appendix E. This specification uses a very large set of covariates to generate predicted export revenues. Specifically, it uses several determinants of firms' marginal production costs and multiple gravity and extended gravity covariates as basis to construct a proxy of potential export revenues for each firm-destination-year triplet.

To explore the robustness of our extended gravity estimates, we present in Table A.4 estimates of a mixed logit model that differs from that reported in column I of Table 2 exclusively in the measure of potential export revenues that it exploits. Specifically, each of the six columns in Table A.4 uses the measure of potential export revenues generated by the specification described in the corresponding column of Table E.1 in Online Appendix E (the estimates in column I of Table 2 are thus identical to the estimates in column I of Table A.4). These specifications differ significantly in the sets of covariates that they include. For example, the specification in column I includes twenty-eight covariates, while that in column VI includes only three.

The differences in the estimates across the different columns of Table A.4 are very small. Table A.4 thus shows that the estimates of the specification in column I of Table 2 are robust to alternative specifications of the proxy for potential export revenues. For each of the specifications in columns II to VII of Table 2, tables analogous to Table A.4 are available upon request. They all show that the mixed logit estimates are not affected by the specific model used to construct our revenue proxy.

As discussed in Section 2.3, the estimates presented in Table 2 and Table A.4 are potentially affected by a sample selection bias problem. If the firms that select themselves into exporting in a particular market and year do so on the basis of variables that affect their export revenues and that we do not explicitly control for in the revenue projection that we use as basis to construct our export revenue proxy, then the estimates of the revenue projection parameters will be biased (even in large samples) and, as a consequence, the proxies for potential export revenues computed using these estimates will not adequately capture such potential export revenues.

To test the robustness of our baseline extended gravity estimates, we present in Table A.5 estimates of mixed logit specifications identical to those in Table 2 except for the fact that we proxy for the potential export revenue of a firm using a covariate that is observed for every firm, country, and year: the firm's domestic sales. The estimates of the parameters measuring the impact of the extended gravity covariates on firms' export decisions are very similar in both tables. This suggests that the potential sample selection bias affecting the estimates in Table 2 does not seem to be an important concern in our empirical application.[42]

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[42] A similar conclusion can be reached by comparing the estimates of the extended gravity parameters in columns I, II, V, and VI of Table A.3 in Appendix A.2 (which do not depend on the revenue regressions in Table E.1 in Online Appendix E) with those in columns III, IV, VII, and VIII of the same table (which rely on export revenue proxies constructed using the revenue regression estimates in Table E.1). The estimates of the extended gravity parameters are very similar across both sets of columns.

Table A.4: Mixed Logit With Alternative Proxy for Export Revenue

Variables: (β)	I	II	III	IV	V	VI
Revenue	1.366^a	1.400^a	1.184^a	1.788^a	2.648^a	2.290^a
	(5.414)	(4.437)	(4.969)	(6.021)	(11.684)	(9.000)
Grav. Border	-0.315^a	-0.317^a	-0.310^a	-0.319^a	-0.311^a	-0.244^b
	(-3.187)	(-3.207)	(-3.138)	(-3.224)	(-3.156)	(-2.468)
Grav. Cont.	-0.037	-0.056	-0.033	-0.036	-0.054	-0.032
	(-0.354)	(-0.524)	(-0.317)	(-0.341)	(-0.512)	(-0.305)
Grav. Lang.	-0.725^a	-0.714^a	-0.719^a	-0.751^a	-0.759^a	-0.746^a
	(-7.664)	(-7.482)	(-7.565)	(-7.937)	(-8.206)	(-7.918)
Grav. GDPpc	0.179^b	0.148^c	0.175^b	0.182^b	0.177^b	0.179^b
	(2.343)	(1.911)	(2.288)	(2.388)	(2.324)	(2.312)
Grav. FTA	-0.302^a	-0.300^a	-0.308^a	-0.302^a	-0.284^a	-0.321^a
	(-4.979)	(-4.809)	(-5.079)	(-4.982)	(-4.657)	(-5.195)
Entry	-2.183^a	-2.201^a	-2.168^a	-2.163^a	-2.166^a	-2.781^a
	(-3.881)	(-3.895)	(-3.853)	(-3.849)	(-3.860)	(-4.885)
Entry × Grav. Dist.	-0.124^c (-1.651)	-0.121 (-1.609)	-0.126^c (-1.685)	-0.127^c (-1.690)	-0.128^c (-1.709)	-0.049 (-0.637)
Entry × Grav. Border	-0.919^a (-6.793)	-0.934^a (-6.882)	-0.917^a (-6.775)	-0.909^a (-6.710)	-0.926^a (-6.842)	-0.926^a (-6.794)
Entry × Grav. Cont.	-1.031^a (-6.927)	-1.035^a (-6.907)	-1.034^a (-6.939)	-1.029^a (-6.910)	-0.971^a (-6.531)	-1.076^a (-7.186)
Entry × Grav. Lang.	-0.146 (-1.151)	-0.160 (-1.247)	-0.151 (-1.186)	-0.120 (-0.952)	-0.180 (-1.450)	-0.235^c (-1.866)
Entry × Grav. GDPpc	-0.727^a (-6.509)	-0.717^a (-6.334)	-0.721^a (-6.457)	-0.728^a (-6.516)	-0.705^a (-6.305)	-0.705^a (-6.231)
Ext. Grav. Border	0.761^a	0.791^a	0.749^a	0.765^a	0.697^a	0.739^a
	(9.814)	(10.002)	(9.656)	(9.863)	(8.958)	(9.329)
Ext. Grav. Cont.	1.551^a	1.516^a	1.559^a	1.548^a	1.523^a	1.509^a
	(16.990)	(16.345)	(17.079)	(16.960)	(16.618)	(16.159)
Ext. Grav. Lang.	0.279^a	0.273^a	0.286^a	0.277^a	0.222^b	0.227^b
	(2.864)	(2.707)	(2.936)	(2.842)	(2.244)	(2.222)
Ext. Grav. GDPpc	0.708^a	0.750^a	0.709^a	0.706^a	0.704^a	0.731^a
	(7.809)	(8.166)	(7.817)	(7.784)	(7.723)	(7.919)
Firm RE	Yes	Yes	Yes	Yes	Yes	Yes
Continent RE	Yes	Yes	Yes	Yes	Yes	Yes
Language RE	Yes	Yes	Yes	Yes	Yes	Yes
GDPpc RE	Yes	Yes	Yes	Yes	Yes	Yes
Std. Dev. RE: (σ_g)	9.373^a	9.380^a	9.372^a	9.366^a	9.349^a	9.376^a
	(63.291)	(64.516)	(62.893)	(63.291)	(63.979)	(65.107)
Num. Obs.	234,896	234,896	234,896	234,896	234,896	234,896

Notes: *a* denotes 1% significance, *b* denotes 5% significance, *c* denotes 10% significance. Estimates are obtained by MLE, and t-statistics are in parentheses. For each column, "Revenue" denotes predicted revenue, as generated by the estimates in the corresponding column of Table E.1 in Online Appendix E. The variable "Entry" is a dummy variable that takes value one if the firm did not export to the corresponding destination in the previous year; i.e. "Entry" $= 1 - d_{ijt-1}$. All columns include firm-continent-language-GDPpc group-specific random effects.

Table A.5: Mixed Logit with Domestic Revenue as Proxy for Export Revenue

Variables: (β)	I	II	III	IV	V	VI	VII
Domestic Revenue	0.001	-0.001	0.001	0.011^a	0.004^a	0.011^a	0.020^a
	(0.042)	(-1.188)	(0.981)	(10.103)	(2.725)	(12.710)	(20.580)
Grav. Border	-0.307^a	-0.259^a	-0.098	-0.193^b	-0.182^c	-0.044	-0.055
	(-3.109)	(-2.656)	(-1.015)	(-2.011)	(-1.819)	(-0.461)	(0.570)
Grav. Cont.	-0.028	-0.039	-0.248^b	-0.264^a	-0.058	-0.350^a	-0.347^a
	(-0.267)	(-0.374)	(-2.542)	(-2.602)	(-0.576)	(-3.673)	(-3.630)
Grav. Lang.	-0.600^a	-0.567^a	-0.528^a	-0.519^a	-0.502^a	-0.435^a	-0.438^a
	(-6.487)	(-6.262)	(-6.354)	(-5.752)	(-5.808)	(-5.296)	(-5.315)
Grav. GDPpc	0.175^b	0.131^c	0.140^c	0.187^b	0.057	0.027	0.034
	(2.284)	(1.787)	(1.958)	(2.570)	(0.776)	(0.377)	(0.473)
Grav. FTA	-0.316^a	-0.276^a	-0.324^a	-0.322^a	-0.331^a	-0.358^a	-0.402^a
	(-5.210)	(-4.568)	(-5.480)	(-5.437)	(-5.551)	(-6.120)	(-6.847)
Entry	-2.249^a	-2.363^a	-2.694^a	-2.947^a	-3.493^a	-2.942^a	-2.601^a
	(-3.990)	(-4.243)	(-4.984)	(-5.482)	(-6.122)	(-5.480)	(-4.938)
Entry × Grav. Dist.	-0.115	-0.127^c	-0.070	-0.033	0.033	-0.062	-0.089
	(-1.529)	(-1.714)	(-0.974)	(-0.450)	(0.429)	(-0.870)	(-1.269)
Entry × Grav. Border	-0.941^a	-0.932^a	-1.137^a	-1.097^a	-1.202^a	-1.189^a	-1.202^a
	(-6.952)	(-6.949)	(-8.541)	(-8.248)	(-8.740)	(-8.971)	(-8.993)
Entry × Grav. Cont.	-1.051^a	-0.871^a	-0.700^a	-1.030^a	0.255^c	-0.712^a	-0.889^a
	(-7.038)	(-5.885)	(-4.872)	(-7.184)	(1.762)	(-5.213)	(-6.434)
Entry × Grav. Lang.	-0.266^b	-0.262^b	-0.516^a	-0.287^b	-0.507^a	-0.145	-0.585^a
	(-2.121)	(-2.119)	(-4.389)	(-2.351)	(-4.282)	(-1.123)	(-5.601)
Entry × Grav. GDPpc	-0.740^a	-0.622^a	-0.569^a	-0.693^a	-0.253^b	-0.357^a	0.094
	(-6.604)	(-5.876)	(-5.177)	(-6.245)	(-2.396)	(-3.449)	(0.816)
Ext. Grav. Border	0.756^a	0.834^a	0.793^a	0.860^a	0.684^a	0.926^a	0.868^a
	(9.696)	(11.152)	(10.772)	(11.715)	(9.936)	(13.087)	(12.232)
Ext. Grav. Cont.	1.551^a	1.256^a	1.296^a	1.448^a	0.199^b	1.156^a	1.436^a
	(16.943)	(14.080)	(14.477)	(16.787)	(2.248)	(14.132)	(17.918)
Ext. Grav. Lang.	0.301^a	0.309^a	0.268^a	0.226^b	-0.120	-0.111	0.238^a
	(3.070)	(3.272)	(2.913)	(2.416)	(-1.241)	(-1.235)	(2.674)
Ext. Grav. GDPpc	0.726^a	0.665^a	0.590^a	0.575^a	0.226^a	0.411^a	-0.118
	(7.995)	(7.787)	(6.453)	(6.468)	(2.722)	(5.084)	(-1.261)
Firm RE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Continent RE	Yes	Yes	Yes	No	Yes	No	No
Language RE	Yes	Yes	No	Yes	No	Yes	No
GDPpc RE	Yes	No	Yes	Yes	No	No	Yes
Std. Dev. RE: (σ_g)	9.405^a	8.913^a	9.175^a	9.178^a	5.699^a	8.080^a	8.631^a
	(62.500)	(60.670)	(61.785)	(66.540)	(46.880)	(49.006)	(54.410)
Num. Obs.	234,896	234,896	234,896	234,896	234,896	234,896	234,896

Notes: *a* denotes 1% significance, *b* denotes 5% significance, *c* denotes 10% significance. Estimates are obtained by MLE, and t-statistics are in parentheses. The variable "Entry" is a dummy variable that takes value one if the firm did not export to the corresponding destination in the previous year; i.e. "Entry" $= 1 - d_{ijt-1}$. Each column allows for a set of random effects identical to those in the corresponding column of Table 2.

A.3.3 Estimates without Gravity Controls

The estimates in each column of Table A.6 correspond to a model analogous to that in the corresponding column of Table 2 except for the fact that we set to zero the parameters on all covariates including some gravity measure. Specifically, the estimates in each column of Table A.6 are estimates of a restricted-version of the mixed logit model in equation (1) in which all elements of the parameter vectors β_2 and β_4 are assumed to equal zero.

A comparison of the estimates in Table A.6 to those in Table 2 shows that controlling for gravity is crucial for an adequate measurement of the impact of extended gravity covariates on the firm's export decisions. When we do not control for gravity, the estimates of the parameter on the covariate capturing the extended gravity in border are biased upwards, while the estimates of the parameters on all other extended gravity variables included in the specification are biased downwards.

Table A.6: Mixed Logit without Gravity Controls

Variables: (β)	I	II	III	IV	V	VI	VII
Revenue	0.748^a	0.760^a	0.895^a	0.629^a	0.916^a	1.358^a	1.124^a
	(3.367)	(3.380)	(4.107)	(2.857)	(4.027)	(4.913)	(4.673)
Entry	-5.481^a	-5.100^a	-5.255^a	-5.542^a	-4.345^a	-4.954^a	-5.456^a
	(-108.084)	(-87.977)	(-93.637)	(-108.162)	(-5.984)	(-89.697)	(-101.946)
Ext. Grav. Border	1.381^a	1.120^a	1.260^a	1.520^a	0.690^a	1.269^a	1.561^a
	(17.283)	(13.969)	(15.730)	(11.928)	(9.909)	(18.211)	(22.640)
Ext. Grav. Cont.	0.862^a	0.505^a	0.421^a	0.594^a	-0.241^a	0.249^a	0.542^a
	(10.355)	(6.366)	(5.512)	(7.735)	(-3.688)	(3.748)	(8.111)
Ext. Grav. Lang.	-0.140	-0.145	-0.207^b	-0.244^a	-0.542^a	-0.687^a	-0.205^b
	(-1.534)	(-1.594)	(-2.404)	(-2.792)	(-5.878)	(-8.483)	(-2.496)
Ext. Grav. GDPpc	0.223^a	0.201^a	0.176^b	0.154^b	0.043	-0.022	-0.376^a
	(3.014)	(2.911)	(2.446)	(2.223)	(0.666)	(-0.367)	(-6.231)
Firm RE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Continent RE	Yes	Yes	Yes	No	Yes	No	No
Language RE	Yes	Yes	No	Yes	No	Yes	No
GDPpc group RE	Yes	No	Yes	Yes	No	No	Yes
Std. Dev. RE: (σ_c)	9.063^a	7.429^a	8.232^a	8.966^a	5.510^a	6.794^a	8.410^a
	(62.870)	(43.778)	(48.850)	(63.501)	(54.743)	(39.608)	(51.822)
Num. Obs.	234,896	234,896	234,896	234,896	234,896	234,896	234,896
Num. Obs. per (i, c_j)	23	40	46	40	133	93	232

Notes: *a* denotes 1% significance, *b* denotes 5% significance, *c* denotes 10% significance. Estimates are obtained by MLE, and t-statistics are in parentheses. The dependent variable is a dummy variable for positive exports. The explanatory variable "Revenue" denotes predicted export revenue (in tens of millions of year 2000 USD), as generated by the estimates in Column I of Table E.1 in Online Appendix E. The variable "Entry" is a dummy variable that takes value one if the firm did not export to the corresponding destination in the previous year; i.e. "Entry" $= 1 - d_{ijt-1}$. Column I includes firm-continent-language-GDPpc specific random effects. Column II includes firm-continent-language specific random effects. Column III includes firm-continent-GDPpc specific random effects. Column IV includes firm-language-GDPpc specific random effects. Column V includes firm-continent specific random effects. Column VI includes firm-language specific random effects. Column VII includes firm-GDPpc specific random effects.

B Export Revenue Equation: Details

In this section, we show that the assumptions on demand, variable trade, and production costs, and market structure introduced in Section 3.1 imply equations (6) and (7).

Given the constant elasticity of substitution demand function $q_{ijt} = p_{ijt}^{-\eta} P_{jt}^{\eta-1} Y_{jt}$, the constant marginal production cost w_{it}, the constant variable trade costs τ_{ijt}, and the monopolistic competition assumption, we can write the potential revenue that firm i would obtain in market j at period t as indicated in equation (3); i.e.

$$r_{ijt} = \left[\frac{\eta}{\eta - 1}\frac{\tau_{ijt}w_{it}}{P_{jt}}\right]^{1-\eta} Y_{jt}.$$

Assuming that trade costs in h are common across firms, $\tau_{iht} = \tau_{ht}$, we can similarly write the potential revenue that firm i will obtain in the home market at period t as

$$r_{iht} = \left[\frac{\eta}{\eta - 1}\frac{\tau_{ht}w_{it}}{P_{ht}}\right]^{1-\eta} Y_{ht}. \tag{B.1}$$

Using these two expressions, we can express the potential export revenues of firm i in market j and period t as

$$r_{ijt} = \left[\frac{\tau_{ijt}}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta} \frac{Y_{jt}}{Y_{ht}} r_{iht}. \tag{B.2}$$

Plugging the expression for τ_{ijt} in equation (4) into equation (B.2), we can further write

$$r_{ijt} = r^o_{ijt} + \varepsilon^R_{ijt}, \tag{B.3}$$

with the observed component of revenue being equal to,

$$r^o_{ijt} = \exp(\xi'_{jt} + \xi_i + (X^\tau_{ijt})'\xi^\tau + \ln(r_{iht})), \tag{B.4}$$

$$\xi'_{jt} = \xi_{jt} + \ln\left(\left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta} \frac{Y_{jt}}{Y_{ht}}\right), \tag{B.5}$$

and the unobserved component being equal to

$$\varepsilon^R_{ijt} = \varepsilon^\tau_{ijt}\left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta} \frac{Y_{jt}}{Y_{ht}} r_{iht}. \tag{B.6}$$

As discussed in Section 3.1, X^τ_{ijt} is a vector that includes the firm's lagged export status in market j, d_{ijt-1}, the firm's (log) marginal production costs, $\ln(w_{it})$, and the four extended gravity variables. Specifically, $(X^\tau_{ijt})' \equiv (d_{ijt-1}, (X^e_{ijt})', \ln(w_{it}))$ with

$$(X^e_{ijt})' \equiv ((\text{Ext. Grav. Border})_{ijt}, (\text{Ext. Grav. Cont.})_{ijt}, (\text{Ext. Grav. Lang.})_{ijt}, (\text{Ext. Grav. GDPpc})_{ijt}),$$

and with each of these four extended gravity covariates defined as in footnote 10. Therefore, defining the parameter vector $\xi^\tau \equiv (\xi_d, (\xi_e)', \xi_c)'$, with ξ_d and ξ_c as scalars and ξ_e a 4×1 column vector, we can further rewrite the term $(X^\tau_{ijt})'\xi^\tau$ in equation (B.4) as

$$(X^\tau_{ijt})'\xi^\tau = d_{ijt-1}\xi_d + (X^e_{ijt})'\xi_e + \ln(w_{it})\xi_c. \tag{B.7}$$

The expression for the firm's potential export revenue r_{ijt} in equations (B.4) to (B.7) is not useful as a basis for constructing a proxy for potential export revenues for every firm, country and year because it depends on the firm's marginal production costs, w_{it}, which are unobserved. However, using the expression for the firm's domestic sales in equation (B.1), we can rewrite the firm's marginal production costs as a function of the firm's domestic sales r_{iht} (which are observed for every firm and year in our sample) and a year-specific term; i.e.

$$w_{it} = \left[\frac{r_{iht}}{Y_{ht}}\right]^{\frac{1}{1-\eta}} \frac{\eta - 1}{\eta}\frac{P_{ht}}{\tau_{ht}}. \tag{B.8}$$

Combining this expression with those in equations (B.4), (B.5), and (B.7), we obtain the expression for potential export revenues in equation (6), and we can thus conclude that the assumptions on demand, variable production and trade costs and market structure described in Section 3.1 are indeed compatible with the characterization of the firm's potential export revenues in equation (6).

To make the equivalence between the characterization of potential export revenues r_{ijt} in equations (B.3) to (B.8) and that in equation (6) more clear, note that, once we plug equation (B.8) into equation (B.4), the observable component of export revenue becomes

$$r^o_{ijt} = \exp(\alpha_{jt} + \alpha_i + (X^r_{ijt})'\alpha^r), \tag{B.9}$$

with the country- and year-specific effect defined as

$$\alpha_{jt} = \xi'_{jt} + \ln\left(\left[Y_{ht}^{-\frac{1}{1-\eta}} \frac{\eta - 1}{\eta} \frac{P_{ht}}{\tau_{ht}}\right]^{\xi_a}\right),$$

the firm-specific effect defined as

$$\alpha_i = \xi_i,$$

and

$$(X^r_{ijt})'\alpha^r = d_{ijt-1}\alpha_d + (X^e_{ijt})'\alpha_e + \ln(r_{iht})\alpha_c, \tag{B.10}$$

with

$$\alpha_d = \xi_d, \qquad \alpha_e = \xi_e, \qquad \text{and} \qquad \alpha_c = \frac{\xi_c + 1 - \eta}{1 - \eta}.$$

Finally, concerning the unobservable component of export revenues, ε^R_{ijt}, the following derivation shows that, given its definition in equation (B.6) and the mean independence condition in equation (5), the variable ε^R_{ijt} must satisfy the mean independence condition in equation (7):

$$\begin{aligned}
\mathbb{E}_{jt}[\varepsilon^R_{ijt}|X^r_{ijt}, d_{ijt}, \mathcal{J}_{it}] &= \mathbb{E}_{jt}[\varepsilon^R_{ijt}|d_{ijt-1}, X^e_{ijt}, r_{iht}, d_{ijt}, \mathcal{J}_{it}] \\
&= \mathbb{E}_{jt}\left[\varepsilon^\tau_{ijt}\left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta}\frac{Y_{jt}}{Y_{ht}} r_{iht}\middle| d_{ijt-1}, X^e_{ijt}, r_{iht}, d_{ijt}, \mathcal{J}_{it}\right] \\
&= \mathbb{E}_{jt}[\varepsilon^\tau_{ijt}|d_{ijt-1}, X^e_{ijt}, r_{iht}, d_{ijt}, \mathcal{J}_{it}] \times \left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta}\frac{Y_{jt}}{Y_{ht}} r_{iht} \\
&= \mathbb{E}_{jt}[\varepsilon^\tau_{ijt}|d_{ijt-1}, X^e_{ijt}, w_{it}, d_{ijt}, \mathcal{J}_{it}] \times \left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta}\frac{Y_{jt}}{Y_{ht}} r_{iht} \\
&= \mathbb{E}_{jt}[\varepsilon^\tau_{ijt}|X^\tau_{ijt}, d_{ijt}, \mathcal{J}_{it}] \times \left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta}\frac{Y_{jt}}{Y_{ht}} r_{iht} \\
&= 0 \times \left[\frac{1}{\tau_{ht}}\frac{P_{ht}}{P_{jt}}\right]^{1-\eta}\frac{Y_{jt}}{Y_{ht}} r_{iht} = 0,
\end{aligned}$$

where the first equality uses the definition of X^r_{ijt}, the second equality uses equation (B.6), the third equality takes into account that price indices and market sizes are constant conditional on a country-year pair, the fourth equality takes into account that r_{iht} is a deterministic function of w_{it} and variables that vary only at the country-year pair level, the fifth equality uses the definition of X^τ_{ijt}, and the last equality applies the mean independence restriction in equation (5).

Summing up, this appendix section shows that the description of potential export revenues in equations (6) to (7) is a consequence of the assumptions imposed in Section 3.1.

C Moment Inequalities: Details

C.1 Proof of Proposition 1

Equation (17) implies

$$\mathbb{E}\Big[\Pi_{io_{it}t,L_{it}}\Big|\mathcal{J}_{it}\Big] \geq \mathbb{E}\Big[\Pi_{io^{j\to j'}_{it}t,L_{it}}\Big|\mathcal{J}_{it}\Big].$$

Thus, given the definition of $\Pi_{ibt,L_{it}}$ for any bundle b in equation (18), we know that

$$\mathbb{E}\Big[\pi_{io_{it}t} + \sum_{l=1}^{L_{it}}\delta^l \pi_{io_{it+l}(o_{it})t+l}\Big|\mathcal{J}_{it}\Big] \geq \mathbb{E}\Big[\pi_{io^{j\to j'}_{it}t} + \sum_{l=1}^{L_{it}}\delta^l \pi^{j\to j'}_{io_{it+l}(o^{j\to j'}_{it})t+l}\Big|\mathcal{J}_{it}\Big], \tag{C.1}$$

where

$$\pi^{j\to j'}_{io_{it+l}(o^{j\to j'}_{it})t+l}$$

denotes the static profits at period $t+l$ of a firm that chose $o_{it}^{j\to j'}$ at period t but that selected optimally its set of export destinations in every subsequent period. Specifically, $o_{it+l}(o_{it}^{j\to j'})$ denotes the optimal export bundle at period $t+l$ conditional on having exported to bundle $o_{it}^{j\to j'}$ at period t. Similarly,

$$\mathbb{E}\Big[\pi_{io_{it}^{j\to j'}t} + \sum_{l=1}^{L_{it}} \delta^l \pi^{j\to j'}_{io_{it+l}(o_{it}^{j\to j'})t+l} \Big| \mathcal{J}_{it}\Big] \geq \mathbb{E}\Big[\pi_{io_{it}^{j\to j'}t} + \sum_{l=1}^{L_{it}} \delta^l \pi^{j\to j'}_{io_{it+l}(o_{it})t+l} \Big| \mathcal{J}_{it}\Big], \tag{C.2}$$

where

$$\pi^{j\to j'}_{io_{it+l}(o_{it})t+l},$$

denotes the static profits at period $t+l$ of a firm that chose $o_{it}^{j\to j'}$ at period t but that, in every subsequent period, selected the export bundle that would have been optimal if it had exported to o_{it} at period t instead; specifically, $o_{it+l}(o_{it})$ denotes the optimal export bundle at period $t+l$ conditional on having exported to bundle o_{it} at t.

Combining the inequalities in equations (C.1) and (C.2), we can derive the inequality

$$\mathbb{E}\Big[\pi_{io_{it}t} + \sum_{l=1}^{L_{it}} \delta^l \pi_{io_{it+l}(o_{it})t+l} \Big| \mathcal{J}_{it}\Big] \geq \mathbb{E}\Big[\pi_{io_{it}^{j\to j'}t} + \sum_{l=1}^{L_{it}} \delta^l \pi^{j\to j'}_{io_{it+l}(o_{it})t+l} \Big| \mathcal{J}_{it}\Big].$$

The one-period state dependence of realized profits in our model (see Section 3.3) implies that we can rewrite this inequality as a sum over the differences in static profits at periods t and $t+1$ only,

$$\mathbb{E}\Big[\pi_{io_{it}t} + \delta \pi_{io_{it+1}(o_{it})t+1} \Big| \mathcal{J}_{it}\Big] \geq \mathbb{E}\Big[\pi_{io_{it}^{j\to j'}t} + \delta \pi^{j\to j'}_{io_{it+1}(o_{it})t+1} \Big| \mathcal{J}_{it}\Big].$$

According to the definition of the static profits π_{ibt} in equation (16), we can rewrite this expression as

$$\mathbb{E}\Big[\sum_{j''\in o_{it}} \pi_{ij''t} + \delta \sum_{j''=1}^{J} d_{ij''t+1}\pi_{ij''t+1} \Big| \mathcal{J}_{it}\Big] \geq \mathbb{E}\Big[\sum_{j''\in o_{it}^{j\to j'}} \pi_{ij''t} + \delta \sum_{j''=1}^{J} d_{ij''t+1}\pi^{j\to j'}_{ij''t+1} \Big| \mathcal{J}_{it}\Big],$$

where, as indicated in Section 4.1,

$$\pi^{j\to j'}_{ij''t+1}$$

denotes the static profits of exporting to destination j'' at period $t+1$ for a firm that exported to the bundle $o_{it}^{j\to j'}$ at period t. Reorganizing terms in the prior inequality, we obtain

$$\mathbb{E}\Big[\sum_{j''\in o_{it}} \pi_{ij''t} - \sum_{j''\in o_{it}^{j\to j'}} \pi_{ij''t} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi^{j\to j'}_{ij''t+1}) \Big| \mathcal{J}_{it}\Big] \geq 0,$$

and, taking into account that the bundles o_{it} and $o_{it}^{j\to j'}$ differ only in that destination j is swapped by destination j', this inequality simplifies to

$$\mathbb{E}\Big[\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi^{j\to j'}_{ij''t+1}) \Big| d_{ijt}(1-d_{ij't}) = 1, \mathcal{J}_{it}\Big] \geq 0.$$

According to Assumption 3, $Z_{it} \subseteq \mathcal{J}_{it}$, and, thus, applying the Law of Iterated Expectations, we can derive the following inequality

$$\mathbb{E}\Big[\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi^{j\to j'}_{ij''t+1}) \Big| d_{ijt}(1-d_{ij't}) = 1, Z_{it}\Big] \geq 0,$$

which is identical to that in equation (25) with $\pi_{ijj't} \equiv \pi_{ijt} - \pi_{ij't}$ and

$$\pi_{ijj't+1} \equiv \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi^{j\to j'}_{ij''t+1}). \quad \blacksquare$$

C.2 Proof of Proposition 3

From the expression in equation (15), we can rewrite the difference in static profits at periods t and $t+1$ as:

$$\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi_{ij''t+1}^{j\to j'}) =$$
$$\eta^{-1} r_{ijt} - f_{ijt} - (1 - d_{ijt-1}) s_{ijt} - \eta^{-1} r_{ij't} + f_{ij't} + (1 - d_{ij't-1}) s_{ij't} +$$
$$\delta d_{ijt+1} s_{ijt+1}^{j\to j'} - \delta d_{ij't+1} s_{ij't+1} - \delta \sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(s_{ij''t+1} - s_{ij''t+1}^{j\to j'}),$$

where $s_{ij''t+1}^{j\to j'}$ denotes the potential sunk costs of exporting to country j'' at period $t+1$ for firm i if this one were to swap destination j by destination j' at period t. Given the expressions for export revenues and fixed and sunk export costs in equations (6), (8), and (11), we can rewrite the difference in static profits at periods t and $t+1$ as:

$$\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi_{ij''t+1}^{j\to j'}) =$$
$$\eta^{-1} r_{ijt}^{o} + \eta^{-1} \varepsilon_{ijt}^{R} - f_{j}^{o} - u_{ic_j t} - \varepsilon_{ijt}^{F} - (1 - d_{ijt-1})(s_{j}^{o} - e_{ijt} + \varepsilon_{ijt}^{S}) -$$
$$\eta^{-1} r_{ij't}^{o} - \eta^{-1} \varepsilon_{ij't}^{R} + f_{j'}^{o} + u_{ic_{j'} t} + \varepsilon_{ij't}^{F} + (1 - d_{ij't-1})(s_{j'}^{o} - e_{ij't} + \varepsilon_{ij't}^{S}) +$$
$$\delta d_{ijt+1}(s_{j}^{o} - e_{ijt+1}^{o,j\to j'} + \varepsilon_{ijt+1}^{S}) - \delta d_{ij't+1}(s_{j'}^{o} - e_{ij't+1}^{o} + \varepsilon_{ij't+1}^{S}) -$$
$$\delta \sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(s_{j''}^{o} - e_{ij''t+1}^{o} + \varepsilon_{ij''t+1}^{S} - s_{j''}^{o} + e_{ij''t+1}^{o,j\to j'} - \varepsilon_{ij''t+1}^{S}),$$

and, canceling terms, we obtain

$$\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi_{ij''t+1}^{j\to j'}) =$$
$$\eta^{-1} r_{ijt}^{o} + \eta^{-1} \varepsilon_{ijt}^{R} - f_{j}^{o} - u_{ic_j t} - \varepsilon_{ijt}^{F} - (1 - d_{ijt-1})(s_{j}^{o} - e_{ijt}^{o} + \varepsilon_{ijt}^{S}) -$$
$$\eta^{-1} r_{ij't}^{o} - \eta^{-1} \varepsilon_{ij't}^{R} + f_{j'}^{o} + u_{ic_{j'} t} + \varepsilon_{ij't}^{F} + (1 - d_{ij't-1})(s_{j'}^{o} - e_{ij't}^{o} + \varepsilon_{ij't}^{S}) +$$
$$\delta\Big(d_{ijt+1}(s_{j}^{o} - e_{ijt+1}^{o,j\to j'} + \varepsilon_{ijt+1}^{S}) - d_{ij't+1}(s_{j'}^{o} - e_{ij't+1}^{o} + \varepsilon_{ij't+1}^{S}) + \sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(e_{ij''t+1}^{o} - e_{ij''t+1}^{o,j\to j'})\Big).$$

In order to derive this expression, we have not imposed yet any of the restrictions in Proposition 3. We impose first the restriction that the alternative destination j' must belong to the set $\mathcal{A}_{ijt}$ defined in equation (20b). If we select the counterfactual destination j' in this way, the difference in periods t and $t+1$ static profits simplifies to

$$\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi_{ij''t+1}^{j\to j'}) =$$
$$\eta^{-1} r_{ijt}^{o} + \eta^{-1} \varepsilon_{ijt}^{R} - \varepsilon_{ijt}^{F} - (1 - d_{ijt-1})(s_{j}^{o} - e_{ijt}^{o} + \varepsilon_{ijt}^{S}) -$$
$$\eta^{-1} r_{ij't}^{o} - \eta^{-1} \varepsilon_{ij't}^{R} + \varepsilon_{ij't}^{F} + (1 - d_{ij't-1})(s_{j'}^{o} - e_{ij't}^{o} + \varepsilon_{ij't}^{S}) +$$
$$\delta\Big(d_{ijt+1}(s_{j}^{o} - e_{ijt+1}^{o,j\to j'} + \varepsilon_{ijt+1}^{S}) - d_{ij't+1}(s_{j'}^{o} - e_{ij't+1}^{o} + \varepsilon_{ij't+1}^{S}) + \sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(e_{ij''t+1}^{o} - e_{ij''t+1}^{o,j\to j'})\Big).$$

Therefore, the restriction that destination j' must belong to the set $\mathcal{A}_{ijt}$ defined in equation (20b) implies that the resulting difference in static profits will depend neither on the observable parts of fixed export costs, f_{j}^{o} and $f_{j'}^{o}$, nor on the unobserved fixed cost components $u_{ic_j t}$ and $u_{ic_{j'} t}$. If we additionally impose the restriction that destinations j and j' must share neither continent, nor language, nor similar income per capita with Chile (i.e. $s_{j}^{o} = s_{j'}^{o} = \gamma_{all}^{S}$, as imposed in equation (28)), the expression for the difference in periods t and $t+1$ static profits simplifies to

$$\begin{gathered}
\pi_{ijt} - \pi_{ij't} + \delta \sum_{j''=1}^{J} d_{ij''t+1}(\pi_{ij''t+1} - \pi_{ij''t+1}^{j\to j'}) = \\
\eta^{-1} r_{ijt}^{o} + \eta^{-1}\varepsilon_{ijt}^{R} - \varepsilon_{ijt}^{F} - (1 - d_{ijt-1})(\gamma_{all}^{S} - e_{ijt}^{o} + \varepsilon_{ijt}^{S}) - \\
\eta^{-1} r_{ij't}^{o} - \eta^{-1}\varepsilon_{ij't}^{R} + \varepsilon_{ij't}^{F} + (1 - d_{ij't-1})(\gamma_{all}^{S} - e_{ij't}^{o} + \varepsilon_{ij't}^{S}) + \\
\delta\Big(d_{ijt+1}(\gamma_{all}^{S} - e_{ijt+1}^{o,j\to j'} + \varepsilon_{ijt+1}^{S}) - d_{ij't+1}(\gamma_{all}^{S} - e_{ij't+1}^{o} - \varepsilon_{ij't+1}^{S}) + \sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(e_{ij''t+1}^{o} - e_{ij''t+1}^{o,j\to j'})\Big).
\end{gathered}$$

Therefore, the restriction in equation (28) implies that the resulting difference in static profits depends on the parameter vector $(\gamma_0^S, \gamma_c^S, \gamma_l^S, \gamma_g^S)$ only through the function $\gamma_{all}^S \equiv \gamma_0^S + \gamma_c^S + \gamma_l^S + \gamma_g^S$ introduced in equation (23).

Given the last expression for the difference in periods t and $t+1$ static profits and the following mean independence restriction

$$\mathbb{E}\left[\Psi(Z_{ijt}, Z_{ij't}) d_{ijt}(1 - d_{ij't}) \quad \times \quad \begin{pmatrix} \eta^{-1}\varepsilon_{ijt}^{R} \\ \eta^{-1}\varepsilon_{ij't}^{R} \\ \varepsilon_{ijt}^{F} \\ \varepsilon_{ij't}^{F} \\ (1 - d_{ijt-1})\varepsilon_{ijt}^{S} \\ (1 - d_{ij't-1})\varepsilon_{ij't}^{S} \\ d_{ijt+1}\varepsilon_{ijt+1}^{S} \\ d_{ij't+1}\varepsilon_{ij't+1}^{S} \end{pmatrix}\right] = 0, \tag{C.3}$$

we can rewrite the moment in equation (27) as

$$\begin{aligned}
\mathbb{E}\Bigg[\sum_{j=1}^{J} \sum_{j'\in\mathcal{A}_{ijt}} \Psi(Z_{ijt}, Z_{ij't}) d_{ijt}(1 - d_{ij't})\Big(\eta^{-1}(r_{ijt}^{o} - r_{ij't}^{o}) - (1 - d_{ijt-1})(\gamma_{all}^{S} - e_{ijt}^{o}) + (1 - d_{ij't-1})(\gamma_{all}^{S} - e_{ij't}^{o}) \\
+\delta(d_{ijt+1}(\gamma_{all}^{S} - e_{ijt+1}^{o,j\to j'}) - d_{ij't+1}(\gamma_{all}^{S} - e_{ij't+1}^{o})) + \delta\Big(\sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(e_{ij''t+1}^{o} - e_{ij''t+1}^{o,j\to j'})\Big)\Big)\Bigg].
\end{aligned} \tag{C.4}$$

The mean independence conditions in equation (C.3) are implied by Assumptions 1 and 3, the definition of Z_{ijt} in equation (19b), and the mean independence conditions in equations (7), (10), and (14). Equation (C.4) is still not expressed as a function of the parameter vector $(\alpha, \kappa, \tilde{\eta}, \gamma_{all}^S)$. To do so, one has to realize that, according to equation (13), for any firm, country, and time period, the function e_{ijt}^o is linear in the parameter vector $(\gamma_b^E, \gamma_c^E, \gamma_l^E, \gamma_g^E)$ and, therefore, we can define a function

$$\tilde{e}_{ijt}^{o} \equiv \frac{1}{\gamma_{all}^{S}} e_{ijt}^{o}, \tag{C.5}$$

that is linear in the parameter vector κ defined in equation (23). In words, $\tilde{e}_{ijt}^o$ denotes the extended gravity component e_{ijt}^o normalized by the sunk cost of exporting to a country that shares neither continent, nor language, nor similar income per capita with the firm's home market, γ_{all}^S. Using the equality in equation (C.5), we can rewrite the moment in equation (C.4) as

$$\begin{aligned}
\mathbb{E}\Bigg[\sum_{j=1}^{J} \sum_{j'\in\mathcal{A}_{ijt}} \Psi(Z_{ijt}, Z_{ij't}) d_{ijt}(1 - d_{ij't})\gamma_{all}^{S}\Big(\tilde{\eta}^{-1}(r_{ijt}^{o} - r_{ij't}^{o}) - (1 - d_{ijt-1})(1 - \tilde{e}_{ijt}^{o}) + (1 - d_{ij't-1})(1 - \tilde{e}_{ij't}^{o}) \\
+\delta(d_{ijt+1}(1 - \tilde{e}_{ijt+1}^{o,j\to j'}) - d_{ij't+1}(1 - \tilde{e}_{ij't+1}^{o})) + \delta\Big(\sum_{\substack{j''\neq j,\\ j''\neq j'}} d_{ij''t+1}(1 - d_{ij''t})(\tilde{e}_{ij''t+1}^{o} - \tilde{e}_{ij''t+1}^{o,j\to j'})\Big)\Big)\Bigg],
\end{aligned} \tag{C.6}$$

where $\tilde{\eta} \equiv \eta\gamma_{all}^S$. As indicated in Proposition 3, this moment is a function of the parameter vector α (through r_{ijt}^o and $r_{ij't}^o$), the parameter vector κ (through $\tilde{e}_{ijt}^o$, $\tilde{e}_{ij't}^o$, $\tilde{e}_{ijt+1}^{o,j\to j'}$, $\tilde{e}_{ij't+1}^o$ and, for every j'' distinct from j and j', $\tilde{e}_{ij''t+1}^o$ and $\tilde{e}_{ij''t+1}^{o,j\to j'}$) and the scalar parameters $\tilde{\eta}$ and γ_{all}^S. Furthermore, it is multiplicative in γ_{all}^S. ■