Extended Gravity*

Eduardo Morales[1], Gloria Sheu[2], and Andrés Zahler[3]

[1]Princeton University
[2]U.S. Department of Justice
[3]Universidad Diego Portales

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Abstract

Exporting firms often enter foreign markets that are similar to previous export destinations. We develop a dynamic model in which a firm's exports in each market may depend on how similar it is to its 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 structurally estimate our model. We conclude that extended gravity reduces firms' cost of foreign market entry by 27% to 40%.

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1 Introduction

Exporting firms continuously enter and exit individual foreign markets. This movement of firms into and out of export markets is an important determinant of long-run changes in aggregate trade flows (Eaton et al., 2008). However, reduced-form evidence shows that firms are more likely to enter countries that are similar to their previous export destinations (Lawless, 2009, 2013; Defever et al., 2011; Albornoz et al., 2012; Meinen, 2012).[1] We establish that this spatial correlation in firms' entry patterns is due to entry costs in a market being smaller for firms that have previously exported to similar markets. We define this path dependence in entry costs as *extended gravity*.

Extended gravity has significant implications for trade policy. Reducing trade barriers in a country increases 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. Regarding export policy, whenever there are reasons for export promotion measures, extended gravity encourages aiming these policies toward destination countries that share characteristics with large export markets.

This paper develops and estimates a new model of firm entry into foreign markets. Previous models of firms' export participation have tended to study a simple binary exporting decision (Roberts and Tybout, 1997; Das et al., 2007) or have assumed exporters make independent entry decisions for each destination market (Helpman et al., 2008; Eaton et al., 2011). By contrast, in our model entry costs in a given market depend on how similar it is to other countries to which the firm has previously exported. Our model shares with the gravity equation literature the intuition that firms are more likely to export to markets that are geographically and linguistically close to the country of origin (Bernard et al., 2007). But the model also allows each firm's export decision to depend on its previous export history. While gravity reflects proximity between origin and destination markets, extended gravity depends on proximity between past and potential destinations. We quantify the strength of gravity and extended gravity as determinants of firms' country-specific export decisions.

Extended gravity is consistent with the idea that export entry requires a costly adaptation process: some firms are better prepared than others to export to certain countries because these firms have previously served similar markets and have therefore already completed part of the costly adaptation process. 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 consumer protection laws.[2] Adaptation may also involve searching for a local distributor, or hiring new workers with knowledge of specific markets.[3] Because

[1]Similarly, country level export growth in a destination is enhanced by export experience gained in proximate markets (Evenett and Venables, 2002).

[2]See Chapter 8 in U.S. Commerce Department (2012).

[3]See Chaney (forthcoming, 2013) for a model of firms' exports expansion through distribution networks.

adaptation costs may increase with the distance between origin and destination countries, we allow extended gravity effects to be larger in destinations far from the country of origin.

To measure the importance of gravity and extended gravity, we use a new matched firm-level dataset that includes information on exports by year and destination as well as a broad set of firm characteristics during 1995–2005. These data are provided by the Chilean Customs Agency and the Chilean Annual Industrial Survey, and are therefore comprehensive, including both exporters and non-exporters. Because firms in different industries likely face different export costs, we estimate our model for a single industry to avoid aggregation bias. Specifically, we estimate our model for the chemicals and chemical products manufacturing sector.[4]

In identifying extended gravity effects from firms' observed export choices, we face the standard empirical challenge of separating path dependence from unobserved heterogeneity. Unobservable (to the econometrician) determinants of the decision to export that are specific to each firm-country pair and correlated both over time and across countries can generate export paths similar to those we would observe if extended gravity factors were an important determinant of firms' choices. In order to separately identify the effect of these unobservables from the path dependence generated by extended gravity, we estimate multiple discrete choice models that account for a broad range of spatial and temporal correlation patterns in the unobservable determinants of export choices.[5] Our estimates indicate an important role for extended gravity in explaining firms' export choices. Even after controlling for unobserved heterogeneity, firms are more likely to export to countries sharing a border or continent with countries to which they were exporting in the previous period.

Our mixed logit estimates present evidence of path dependence, but they do not indicate whether this is due to a reduction in export entry costs (i.e. extended gravity), or to some other mechanism.[6] In order to test our hypothesis that extended gravity factors imply a reduction in entry costs, we build a multi-period, multi-country export model and use it to structurally identify entry costs that may depend on both on gravity and extended gravity. We account for gravity by allowing entry costs to depend on whether each potential destination shares its continent, language, or GDP per capita with Chile. By contrast, the extended gravity variables included in the model indicate whether the destination shares a border, continent, language, or GDP per capita with a country to which the firm exported in the previous year, but does not share these characteristics with Chile. If extended gravity factors are indeed

Molina and Muendler (2013) show that new exporters hire away workers from other exporters.

[4]During our sample period, the chemical sector (ISIC rev. 3.1 sector 24) is consistently among the top two manufacturing sectors in Chile by volume of exports. Most firms are small producers, and typical products exported are methanol, iodine, and potassium nitrate.

[5]Specifically, in the reduced form analysis in Section 3, we estimate several dynamic mixed logit models with normally distributed firm-specific random effects that are common to countries their sharing continent, language or GDP per capita. The World Bank classifies countries into four groups based on their GDP per capita. In this paper, two countries share GDP per capita if the World Bank classifies them in the same group.

[6]An alternative mechanism that may increase firm entry in markets that are close to its prior destinations is learning across markets; see Albornoz et al. (2012), Nguyen (2012), Akhmetova and Mitaritonna (2013).

important, firms in our framework decide whether to enter a country taking into account the impact of their decision on future entry costs in other markets.

The traditional approach to the structural estimation of entry models relies on deriving choice probabilities from a theoretical framework, and choosing 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. Writing the choice probabilities involves examining the dynamic implications of every possible combination of export destinations. Given the cardinality of the choice set (for a given number of countries N, the choice or consideration set includes 2^N elements), computing the value function corresponding to each of its elements is impossible with currently available computational capabilities. The impossibility of computing the value function implies that we cannot solve the model and perform counterfactuals. However, using moment inequalities as our estimation method, we can still estimate the structural parameters and, therefore, measure the effect of the extended gravity variables on export entry costs. Our moment inequality estimator requires neither computing the value function of the firm nor artificially reducing the dimensionality of the choice set. A consequence of applying moment inequalities is that identification is partial.

Our inequalities come from applying an analogue of Euler's perturbation method. Specifically, we impose one-period deviations on the observed export path for each firm. Our moment inequalities are robust to different assumptions on: (a) how firms form expectations of the impact of current export choices on future profits; (b) firms' choice sets; and (c) firms' information sets. In addition, our inequalities do not impose any parametric restriction on the distribution of the expectational errors, which may differ flexibly across firms, countries, and time periods.

Our moment inequality estimates show that extended gravity variables have a significant effect on trade costs. Sharing a border significantly reduces the cost of accessing a new country: previously serving a market that shares a border with a destination country that differs from Chile in all three gravity variables considered in this paper reduces entry costs by 22,930 USD to 39,960 USD.[7] By contrast, sharing a continent, language or GDP per capita has no significant impact on the costs of subsequent entry. With respect to standard gravity variables, the export entry costs for a Chilean firm entering a country that is in South America, in which Spanish is predominantly spoken, and that has similar GDP per capita to Chile (e.g. Argentina) is estimated to be between 16,350 USD and 18,970 USD. When a country differs from Chile in continent, language, and GDP per capita (e.g. Germany), the estimated lower bound for the entry costs is 94,860 USD and the upper bound is 101,990 USD. In line the estimates in Das et al. (2007), we also find that fixed costs of exporting are very close to zero. These estimates imply that a firm previously exporting to France will benefit from a 27% to

[7] We report here the point estimates for the extrema of the identified set. Confidence intervals are provided in Section 7. Unless otherwise stated, every dollar value is evaluated in year 2000 USD.

40% reduction in the costs of entering Germany. Conversely, exporting to countries like Spain or Australia does not affect entry costs in Germany.

Our paper is related to several strands of the literature. First, the existence of extended gravity has important implications for the interpretation of the parameters in the gravity equation. A defining characteristic of the gravity equation (as introduced by Tinbergen, 1962) is that trade flows between two countries are predicted to depend exclusively on the size of each country and measures of trade resistance between them. Anderson and van Wincoop (2003) take into account the effect of third countries and introduce multilateral resistance terms in the specification of an otherwise standard gravity equation. In their model, for a given bilateral barrier between two countries, higher geographical barriers between one of them and the rest of the world raises imports from the other one. Extended gravity effects work in the opposite direction. Their existence makes it beneficial for firms to direct their export activities towards markets that share characteristics with a large number of countries. As we show in Section 3, not controlling for extended gravity biases downwards the estimates of the effect of distance on firm export entry. Therefore, ignoring extended gravity controls in the estimation of a gravity equation will result in a downward bias in the elasticity of trade with respect to distance.[8]

Second, our work relates to papers that structurally estimate the fixed and sunk costs of exporting. Das et al. (2007), because they lack data on export flows disaggregated by countries, estimate the fixed and sunk costs of breaking into exporting generally. In contrast, we provide estimates for country-specific fixed and sunk costs of exporting that vary depending on the characteristics of the destination country and the export history of each firm.

Third, our paper relates to previous work showing that firms tend to export to countries similar to their prior destinations: Eaton et al. (2008), Lawless (2009, 2013), Defever et al. (2011), Albornoz et al. (2012), and Meinen (2012). None of these papers structurally estimates a model of forward-looking firms that incorporates a mechanism rationalizing this export entry behavior. We build such a model and precisely state the economic and statistical assumptions that are consistent with our identification strategy. We also expand on this previous literature by estimating extended gravity effects while allowing for persistent firm-country specific unobserved heterogeneity that is correlated across countries.

Fourth, our paper introduces a new moment inequality procedure to solve problems of multiple discreteness. These are situations in which agents violate the single-choice assumption implicit in multinomial discrete choice models. Similar problems of multiple discreteness appear in the store-network choice literature (Jia, 2008; Holmes, 2011; Ellickson et al., 2012), demand estimation literature (Allenby et al., 2002; Dubé, 2004; Allenby et al., 2007), and in

[8]Extended gravity effects generated by previous exports to a given country differ across countries of origin. This implies that introducing destination country-year dummies in the gravity equation is not enough to control for the effects of extended gravity.

the work on the location of facilities for multi-plant firms (Tintelnot, 2012) and on the sourcing decisions of importers (Antràs et al., 2014).[9] In many of these papers, the resulting choice set that accounts for all the different bundles an agent might choose is very large. In contrast to all of these papers (with the only exception being Holmes, 2011), our paper accounts for multiple discreteness in a dynamic setting, and proposes a solution procedure that does not require computing a different value function for each bundle.

Fifth, our paper contributes to a growing literature applying moment inequalities to the estimation of structural models (Katz, 2007; Ishii, 2008; Ho, 2009; Holmes, 2011; Ho and Pakes, 2013; Eizenberg, 2014). The estimation framework in our paper is similar to that in Holmes (2011), but has one important difference: we do not form our inequalities by changing the order in which firms entered different markets; instead, our inequalities are formed by altering the set of countries chosen by a firm at given point in time, independently of the markets accessed by this firm in future periods. Because we do not condition on firms' future choices, our inequalities do not require assuming that firms have perfect foresight and, therefore, generalize the inequalities introduced in Holmes (2011). When deciding whether to access a foreign market, it is well known that exporters face considerable uncertainty (Rauch and Watson, 2003).[10] It is thus particularly important that our estimation framework is able to accommodate exporters' expectational errors.

The rest of the paper is as follows. In Section 2, we present stylized facts that motivate the rest of the paper. Section 3 presents reduced form evidence on firms' entry patterns. Section 4 introduces a model of firm entry into export markets, and Section 5 derives moment inequalities from this framework. Section 6 describes our estimation approach, and Section 7 presents the results. Section 8 concludes.[11]

2 Descriptive Evidence

In this section, we define our extended gravity variables, and provide descriptive evidence that motivates our interest in the impact of these variables on exporters' entry decisions. We also discuss alternative economic mechanisms that could potentially generate export patterns consistent with this evidence.

The extended gravity variables compare each country to the set of countries in a firm's previous export bundle. We define separate dummies for sharing language, continent, GDP per capita (hereafter GDPpc), and a border with at least one country the firm exported to in the previous year, and not with Chile itself. More precisely, an extended gravity dummy (e.g. language) for a given firm-year pair and destination country takes on the value one if

[9] See also Athey and Stern (1998), Hendel (1999), and Fox and Lazzati (2013).

[10] Sources of uncertainty affecting exporters include: trade policy changes and real exchange rate fluctuations.

[11] We include a detailed description of the data and additional details in an appendix.

the country does not share the corresponding characteristic with Chile (e.g. the destination country does not have Spanish as its official language) but it does share this characteristic with some other country to which the firm exported in the previous year. For example, all four extended gravity variables for Austria would take on the value one for a firm that exported to Germany in the previous period.

Table 1 presents probabilities of entry according to each extended gravity variable. For each group of firms, the probability of entry is defined as the number of firms exporting to a given country in year t and not in year $t-1$ divided by the number of non-exporters to this country at $t-1$. The overall probability of entry is only 0.53%. If our extended gravity story holds, we expect this probability to be larger among those firms that were exporting in the previous year to a market that shares some characteristic (continent, language, GDPpc, or a border) with the destination country. This prediction matches the evidence in Table 1. The probability of entry conditional on previously exporting to a market that is connected to the destination country is always larger than the general probability of entry. This increase in probability depends on the particular characteristic shared between both markets: it is approximately three fold if the both markets share GDPpc or language, more than five fold if they are located in the same continent, and thirteen fold if they share a border.[12]

Table 1: Transition Probabilities

	Probability of Entry	Number of Entries
Overall:		
	0.53%	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

Aside from a reduction in entry costs due to extended gravity effects, other economic forces may explain the findings in Table 1. First, suppose that firms rank countries by proximity to Chile and spread out gradually to more distant countries (i.e. export entry is purely determined by standard gravity factors). In this case, the fact that a firm is already exporting to a certain continent would predict an increase in the probability that they will export to more countries on that continent. The relationship would be driven by distance between Chile

[12] Table 1 also shows that entry events in which a firm previously exported to a country that shares some characteristic with the destination market account for the majority of entries in the data (868 from a total of 1,638). The remaining 770 entry events correspond to firms entering countries that were not related to any of their previous destinations.

and that continent, not between countries on that continent. However, it is harder for such a story to rationalize the language and border transition probabilities. The model would have to predict that languages can be ranked by distance from Spanish in such a way that firms would access countries with more distant languages only when they have previously accessed those countries with closer languages. In the same way, the border variable in the model would have to generate a pattern where firms spread outwards from Chile through countries that physically touch each other. Yet, that conjecture then generates an extended gravity relationship, since it depends on borders between countries that do not include Chile. Regardless, this analysis shows the importance of controlling for gravity factors in order to correctly identify extended gravity effects. Both our reduced-form evidence and structural model take this identification issue into account.

Second, the observed higher probability of exporting to a given country for firms previously exporting to similar markets could reflect similarity in firm-specific demand conditions across these markets. Under this interpretation, for example, the higher probability of exporting to a market among those firms previously exporting to a bordering market would not be due to a reduction in entry costs generated by previous export experience, but instead the consequence of similarity in firm-specific preferences among markets that are geographically close to each other. This is an example of the problem of separately identifying heterogeneity from state-dependence. To account for firm heterogeneity in our estimation of extended gravity effects, our reduced form estimation controls for observable and unobservable firm-specific determinants of export entry that are both persistent over time and correlated across countries.

3 Reduced-Form Evidence

In this section, we provide additional evidence suggestive of the importance of extended gravity effects in explaining firms' entry decisions. Consider the two alternative explanations for the transition probabilities in Table 1 mentioned in Section 2: (a) distance of each destination market to the firms' home country (gravity); (b) unobserved demand and supply conditions that make exporters more likely to choose destinations with similar geographical location, language, and/or GDPpc, independently of their previous export experience in those countries (unobserved heterogeneity). We show that, even after controlling for these alternative explanations of spatial correlation in firms' export destinations, firms are still more likely to access countries that are similar to their previous export destinations.

Define d_{ijt} to be a dummy variable equal to 1 if firm i exports to country j during year t. In order to account for the effect of gravity as a determinant of export entry, we allow d_{ijt} to depend on: (a) potential revenue that i could obtain in j at t if it enters this market (revenue); (b) measures of distance between j and Chile (gravity); (c) previous export experience of i in

j, as captured by d_{ijt-1}; and (d) interactions of d_{ijt-1} with the measures of distance between Chile and j. In order to capture extended gravity effects, we include interactions of d_{ijt-1} with measures of previous export experience of i in markets other than j that share some characteristic with j. Formally,

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

where b_{t-1} identifies the bundle of countries to which i exported at $t-1$, and u_{ijt} denotes factors that affect i's export decision in j at t that are unobserved to the econometrician. As measures of gravity, we include dummy variables that take value one if country j does not share a border, continent, language, GDPpc, or free trade agreements with Chile. As measures of extended gravity, we include dummy variables that take value one if the bundle of countries b_{t-1} to which i was exporting at $t-1$ includes at least one country that shares a border, continent, official language, and GDPpc with j, and that characteristic is not shared by Chile. As an example, the variable "Ext. Grav. Lang." takes value one if the destination country shares official language with at least one country to which the firm exported in the previous year, and that language is not Chile's official language (i.e. Spanish).[13]

In order to account for unobserved heterogeneity, we allow for a flexible correlation structure in u_{ijt}. Specifically, we allow for firm-specific unobserved determinants of profits that are constant over time and across countries that share geographical location, language and/or GDPpc. Formally, $u_{ijt} = u_{ig(j)} + \varepsilon_{ijt}$, where $g(j)$ indicates the group of countries g to which j belongs. The different columns in Table 2 differ in the definition of the groups g. The error terms ε_{ijt} are logistically distributed and independent across firms, countries and time periods; the terms $u_{ig(j)}$ are mean zero normally distributed and independent across firms and groups g; and both error terms are assumed to be independent of each other. This error structure implies

$$cov(u_{ijt}, u_{i'j't'}) = \begin{cases} \sigma_g^2 + \sigma_\varepsilon^2 & \text{if } i = i',\ j = j', \text{ and } t = t', \\ \sigma_g^2 & \text{if } i = i',\ g(j) = g(j'), \text{ and } j \neq j' \text{ or } t' \neq t, \\ 0 & \text{otherwise,} \end{cases}$$

where $\sigma_\varepsilon^2 = var(\varepsilon_{ijt})$ is the variance of the standard logistic distribution (i.e. $\sigma_\varepsilon^2 = \pi^2/3 \approx 3.289$) and $\sigma_g^2 = var(u_{ig(j)})$ is the variance of a normal distribution and estimated jointly with the parameter vector β. The unobserved effects $u_{ig(j)}$ account for the possibility that firms

[13] We denote the gravity dummy variables as "Grav. Border", "Grav. Cont.", "Grav. Lang.", "Grav. GDPpc", and "Grav. FTA". We denote the extended gravity dummy variables as "Ext. Grav. Border", "Ext. Grav. Cont.", "Ext. Grav. Lang.", and "Ext. Grav. GDPpc". Appendix A.1 contains a detailed description of each variable.

might be more likely to access countries that are similar to their previous export destinations because, for reasons exogenous to their export history, they happen to be particularly profitable in this group of countries (e.g. due to correlated demand shocks). In contrast, the term $\beta_5[(1 - d_{ijt-1}) \times \text{ext.gravity}_{ijb_{t-1}t}]$ accounts for the possibility that exporting to some country increases the profitability of entering in the next period countries similar to it. While β_5 measures the strength of path dependence, σ_g^2 accounts for the importance of unobserved individual heterogeneity.

Besides the structural error, u_{ijt}, the only covariate in equation (1) that we do not directly observe in the data is the potential revenue from exporting, revenue_{ijt}. Our dataset provides information on the realized export revenue for those firms, countries and years with positive exports. No information is available on the export revenue that firms could have obtained in markets in which they did not actually export (i.e. we only observe $\text{revenue}_{ijt} \times d_{ijt}$). We deal with this missing data problem by generating a proxy for revenue_{ijt} for every i, j, and t. We build this proxy by projecting the realized export revenues on covariates that are observed for every firm, country and time period. Using different firm and country characteristics as covariates in this projection yields different values for the variable revenue_{ijt}. Table A.2 presents projection estimates for six different sets of covariates. In spite of the differences across these sets, Table A.3 shows that the pairwise correlation coefficients between the export revenues generated by these six specifications are close to one.

Table 2 uses a proxy for revenue_{ijt} consistent with the specification in column I of Table A.2 and presents maximum likelihood estimates of the parameter vector (β, σ_g^2) under seven different definitions of the group index g. These different definitions imply different spatial correlation patterns in u_{ijt}. As an example, column I in Table 2 allows u_{ijt} to be correlated for observations corresponding to the same firm and countries that share continent, language, and GDPpc. Column II defines broader groups and allows u_{ijt} to be correlated for observations corresponding to the same firm and countries that share continent and language, independent of their GDPpc. Columns III to VII allow for other patterns of correlation in u_{ijt} (see the caption of Table 2 for details).[14]

Table 2 shows that both path dependence and unobserved heterogeneity are important in explaining export entry. Qualitatively, Table 2 indicates that: (a) geographic factors (border and continent) are always important determinants of path dependence across countries, meaning that exporting to a country increases the probability of exporting to countries that are geographically close to it; (b) the findings on similarity in language and income per capita

[14] Following Heckman (1981), Table 2 deals with the initial conditions problem by assuming a reduced form specification for the probability of exporting in the initial period. Specifically, we assume that the probability that a firm exports to a given country in the initial period follows a standard normal distribution. The results are invariant to the introduction of year fixed effects. When introducing country and firm effects, the incidental parameters problem makes our estimates inconsistent and, therefore, unstable and dependent on the particular specification of the groups g. Both results with year fixed effects and with either country or firm fixed effects are available upon request.

depend on the assumptions restricting the correlation structure of u_{ijt}.

Quantitatively, the increase in the probability of exporting to j at t caused by exporting at $t-1$ to a country that shares both a border and continent with j is estimated to be between one fifth and one half of the increase in probability that would have been caused by exporting to j itself at $t-1$. As an example, in column I, the sum of the extended gravity effects in border and continent relative to the persistence effect in a country that differs from Chile in continent, language, and GDPpc is equal to 0.462.[15] Across columns II to VII, this number takes on the values 0.4256, 0.3879, 0.3944, 0.1838, 0.4095, and 0.4607. Thus, nothing facilitates exports to a far away country as much as having exported to the same country in the past, but previous exports to geographically close countries also have a statistically and economically important impact on facilitating entry.

The estimates of β are not sensitive to the particular statistical model used to predict the potential export revenue, revenue$_{ijt}$. Table A.4 presents estimates of β in the model with firm-continent-language-GDPpc specific random effects (i.e. that in column I of Table 2) using the six different revenue projections described in Table A.2. The estimates of β are not affected by the specific revenue projection we use.[16]

Independently of the specific vector of observable characteristics that we use to predict the potential export revenue, obtaining consistent estimates of β requires that all the variables affecting export revenues that are not included in the projection are unobserved by the potential exporter when deciding whether to export. Otherwise, the estimates of the revenue projection in Table A.2 are affected by sample selection bias and the estimates of β in Tables 2 and A.4 are inconsistent. In order to avoid this potential source of bias, in Table A.5 we proxy for the potential export revenue, revenue$_{ijt}$, by three variables that are observed for every firm, country and year (independently of the value of d_{ijt}): firms' sales in Chile, and firms' sales in Chile interacted both with distance to the destination market and with aggregate imports in this market. Given that the censored data on export revenue is not used to obtain the estimates of β in Table A.5, these are not affected by sample selection bias. Except for the different proxy for revenue$_{ijt}$, each column in Table A.5 shows estimates for the same model as the corresponding column in Table 2. The estimates of $(\beta_2, \beta_3, \beta_4, \beta_5)$ in both tables are very similar. Therefore, we conclude that, in our setting, using the observed revenue to define a proxy for the potential revenue from exporting for every firm, country, and year (independently of whether they actually exported) does not seem to bias the discrete choice estimates.

[15]This number is computed as the ratio between the sum of the coefficients on "Entry × Ext. Grav. Border" and "Entry × Ext. Grav. Cont." and the sum of the coefficients on "Entry", "Entry × Grav. Border", "Entry × Grav. Cont.", "Entry × Grav. Lang.", and "Entry × Grav. GDPpc": $(0.761 + 1.552)/(2.180 + 0.919 + 1.032 + 0.145 + 0.727) = 0.463$.

[16]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 particular statistical model used to predict the potential revenue from exporting, revenue$_{ijt}$, among those in Table A.2.

Table 2: Logit: Firm-Specific Random Effects

Variables: (β)	I	II	III	IV	V	VI	VII
Revenue	0.014^a	0.013^a	0.015^a	0.013^a	0.015^a	0.017^a	0.016^a
	(5.415)	(5.126)	(6.100)	(5.088)	(5.897)	(6.343)	(6.444)
Grav. Border	-0.315^a	-0.268^a	-0.123	-0.183^b	-0.193^b	-0.057	-0.054
	(-3.188)	(-2.757)	(-1.278)	(-1.918)	(1.936)	(-0.597)	(0.559)
Grav. Cont.	-0.037	-0.050	-0.246^b	-0.263^a	-0.055	-0.334^a	-0.327^a
	(-0.356)	(-0.481)	(-2.513)	(-2.600)	(-0.035)	(-3.488)	(-3.399)
Grav. Lang.	-0.724^a	-0.669^a	-0.651^a	-0.619^a	-0.623^a	-0.578^a	-0.586^a
	(-7.659)	(-7.255)	(-7.611)	(-6.769)	(-7.028)	(-6.851)	(-6.901)
Grav. GDPpc	0.179^b	0.141^c	0.153^b	0.197^a	0.077	0.055	0.052
	(2.338)	(1.933)	(2.145)	(2.719)	(1.055)	(0.773)	(0.727)
Grav. FTA	-0.338^a	-0.259^a	-0.306^a	-0.304^a	-0.319^a	-0.505^a	-0.376^a
	(-4.978)	(-4.288)	(-5.162)	(-5.146)	(-5.349)	(-5.770)	(-6.404)
Entry	-2.180^a	-2.356^a	-2.652^a	-2.940^a	-3.354^a	-2.906^a	-2.608^a
	(-3.877)	(-4.232)	(-4.913)	(-5.416)	(-5.905)	(-5.446)	(-4.962)
Entry × Grav. Dist.	-0.124^c	-0.128^c	-0.075	0.036	0.014	-0.068	-0.091
	(-1.655)	(-1.726)	(-1.049)	(0.497)	(0.187)	(-0.595)	(-1.291)
Entry × Grav. Border	-0.919^a	-0.910^a	-1.097^a	-1.086^a	-1.168^a	-1.153^a	-1.182^a
	(-6.791)	(-6.793)	(-8.243)	(-8.191)	(-8.512)	(-8.722)	(-8.873)
Entry × Grav. Cont.	-1.032^a	-0.864^a	-0.703^a	-1.032^a	0.278^c	-0.734^a	-0.915^a
	(-6.930)	(-5.854)	(-4.898)	(-7.223)	(1.921)	(-5.374)	(-6.629)
Entry × Grav. Lang.	-0.145	-0.165	-0.395^a	-0.173	-0.380^a	0.001	-0.428^a
	(-1.149)	(-1.319)	(-3.313)	(1.404)	(-3.169)	(0.006)	(-3.656)
Entry × Grav. GDPpc	-0.727^a	-0.623^a	-0.567^a	-0.694^b	-0.273^b	-0.388^a	0.019
	(-6.504)	(-5.902)	(-5.158)	(-6.285)	(-2.588)	(-3.766)	(0.171)
Entry × Ext. Grav. Border	0.761^a	0.830^a	0.793^a	0.872^a	0.699^a	0.942^a	0.889^a
	(9.814)	(11.140)	(10.822)	(11.931)	(9.552)	(13.334)	(12.576)
Entry × Ext. Grav. Cont.	1.552^a	1.263^a	1.307^a	1.465^a	0.201^b	1.180^a	1.467^a
	(17.001)	(14.224)	(14.570)	(17.029)	(2.271)	(14.468)	(18.380)
Entry × Ext. Grav. Lang.	0.277^a	0.293^a	0.251^a	0.224^b	-0.130	-0.111	0.236^a
	(2.843)	(3.117)	(2.735)	(2.409)	(-1.353)	(-1.244)	(2.668)
Entry × Ext. Grav. GDPpc	0.708^a	0.657^a	0.573^a	0.576^a	0.229^a	0.429^a	-0.056
	(7.810)	(7.719)	(6.287)	(6.495)	(2.767)	(5.301)	(-0.602)
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)	9.374^a	8.908^a	9.169^a	9.272^a	5.714^a	8.199^a	8.826^a
	(9.227)	(8.762)	(9.022)	(9.133)	(5.620)	(8.033)	(8.665)
Log-likelihood	-0.085	-0.072	-0.070	-0.073	-0.059	-0.060	-0.058
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 dependent variable is a dummy variable for positive exports. The explanatory variable Revenue denotes predicted revenue, as generated by the estimates in Column I of Table A.2. 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 effects.

If firms were assumed not to internalize the effect of their current export choices on future profits (i.e. firms are static optimizers), it would be possible to interpret β_2 as the effect of gravity on fixed costs, and β_4 and β_5 as the effect of, respectively, gravity and extended gravity, on entry costs. Given this interpretation, Table A.6 shows that assuming that there are no extended gravity effects ($\beta_5 = 0$) biases the estimates of the impact of gravity on entry costs. Specifically, consistent with the large positive coefficients on "Entry × Ext. Grav. Cont." and "Entry × Ext. Grav. GDPpc" in Table 2, the coefficients on both "Entry × Grav. Cont." and "Entry × Grav. GDPpc" in Table A.6 become very close to zero.[17]

As Section 4 shows, as long as firms are forward looking and extended gravity effects exist, the decision to export in one country is not independent of the decision to export in another country. In other words, when extended gravity effects are present, independent binary choice models for each possible destination market do not adequately capture the decision problem that forward looking exporters face. It seems reasonable to assume that firms decide on the investments necessary to access foreign markets taking into account their impact on profits at least one year ahead. Consequently, in the following section, we show how to identify both gravity and extended gravity effects while allowing firms to internalize the impact of their current export decisions on their future stream of profits.

4 An Empirical Model of Export Entry

In this section, we present a model of firms' export behavior that will guide the identification of the impact of gravity and extended gravity on the costs that firms face when starting to export to new destination countries. We take the creation and destruction of firms as exogenous and endogenize their supply decision in each foreign market. All firms are located in Chile but may sell in every country. Firms are assumed to make these supply decisions every year. Conceptually, we split firms' decision into two choices: first, a choice over the optimal price (or quantity) in every country in their consideration set; second, a choice over the optimal bundle of export destinations among those in that set. The first choice determines the intensive margin of trade. The second one determines the extensive margin at the firm-country level.

Sections 4.1 and 4.2 describe, respectively, the assumptions imposed on the intensive and extensive margin decisions. Section 4.3 shows how to derive moment inequalities that may be used for estimation and inference on the structural parameters introduced in Section 4.2.

[17] The intuition for the bias in "Entry × Grav. Cont." is the following. Some of the firms entering countries in continents other than South America are actually benefiting from extended gravity effects and facing reduced entry costs. In Table 2, the coefficient on "Entry × Ext. Grav. Cont." captures the entry costs only for those entry events not benefiting from extended gravity effects. If we do not control appropriately for these extended gravity effects, then our estimates of the coefficient on "Entry × Grav. Cont." reflect average entry costs across firms that do and don't benefit from extended gravity effects. Consequently, when we omit the extended gravity covariates, the impact of gravity variables on entry costs is estimated to be too small.

4.1 Intensive Margin

Conditional on exporting to a destination country, a firm's choice over optimal export price (or quantity) will determine revenue in that market. We define gross profits as revenue from exporting minus variable trade costs or, equivalently, as profits before accounting for costs that are independent of the quantity sold in a destination market but are necessary to sell in that market (i.e. fixed and sunk costs). We assume that gross profits are a constant fraction of sales revenue. This is consistent with a model in which monopolistically competitive exporters face constant elasticity of substitution demand functions in every export market.[18]

We use r and v to denote the potential revenue and gross profits from exporting, and assume that

$$r_{ijt} = r^{o}_{ijt} + u^{R}_{ijt}, \tag{2a}$$

$$v_{ijt} = \eta^{-1} r_{ijt}, \tag{2b}$$

with

$$r^{o}_{ijt} = r^{o}_{ijt}(\alpha) = \exp(\alpha x^{R}_{ijt}), \tag{3}$$

and x^{R}_{ijt} is a vector of covariates observed for every firm, country, and year.[19] The term u^{R}_{ijt} captures measurement error in revenue as well as additional determinants of revenue that are unobserved to the econometrician, and η^{-1} denotes the fraction of revenue that is transformed into profits.[20] We can think of the terms entering in the right hand side of equation (3) as capturing either demand conditions in j or the marginal cost for i of supplying to j.

4.2 Extensive Margin

Aside from gross profits, the decision of i to enter j at t will also depend on country-specific fixed and sunk costs. The fixed costs of i in j are faced every year that i is exporting to j and are independent of i's previous exporting history. They are included to account for factors such as the cost of advertising, updating information on the characteristics of the market, and participating in trade fairs. Fixed costs are denoted as f_{ijt} and modeled as $f_{ijt} = f^{o}_{j} + u^{F}_{ijt}$.

[18] Appendix A.5 includes a microfoundation for equations (2) and (3) that follows standard demand and market structure assumptions usually imposed in trade models with heterogeneous firms (Melitz (2003)). For the purposes of this paper, it is irrelevant which model generates these expressions. Their only role is to allow the econometrician to form unbiased predictors of the gross profits that i will obtain if it exports to j at t.

[19] The r_{ijt} is identical to revenue$_{ijt}$ in eq. (1). The term r^{o}_{ijt} is the proxy for revenue$_{ijt}$ discussed in Section 3. As in Table 2, in our moment inequalities, we use the vector x^{R}_{ijt} described in column I of Table A.2.

[20] For any variable x, we use x^{o} to denote the part of x that depends on observable (to the econometrician) covariates and parameters we will estimate. We use u^{X} to denote the component of x that is unobserved to the econometrician. Accordingly, we define $v^{o}_{ijt} = \eta^{-1} r^{o}_{ijt}$ and $u^{V}_{ijt} = \eta^{-1} u^{R}_{ijt}$. For ease of notation, we will eliminate subindices whenever they are not necessary. In particular, note that r and v might depend on the previous set of export destinations of i, b_{t-1}.

The observable component of fixed costs is assumed to depend exclusively on gravity variables:

$$f_j^o(\gamma^F) = g_j^F(\gamma^F) = \gamma_0^F + \gamma_c^F(\text{Grav. Cont.}) + \gamma_l^F(\text{Grav. Lang.}) + \gamma_g^F(\text{Grav. GDPpc}). \quad (4)$$

The sunk costs account for the expenses in building distribution networks, hiring workers with specific skills (e.g. knowledge of foreign languages), and adapting the exported products to country-specific preferences and legal requirements in the destination country. They are independent of the quantity exported by i to j, and i only has to pay them if it was not exporting to j in the previous year. Through the extended gravity term, we account for the possibility that costs are smaller for those firms that have previously exported to countries similar to j: these firms might have already gone through a large part of the adaptation process that generates these sunk costs. Therefore, we model the sunk costs as $s_{ijb_{t-1}t} = s_{jb_{t-1}t}^o + u_{ijt}^S$. The observable part of sunk costs is assumed to depend both on gravity variables and extended gravity variables, $s_{jb_{t-1}t}^o = g_j^S - e_{jb_{t-1}}^S$, where the gravity term is modeled as

$$g^S(\gamma^S) = \gamma_0^S + \gamma_c^S(\text{Grav. Cont.}) + \gamma_l^S(\text{Grav. Lang.}) + \gamma_g^S(\text{Grav. GDPpc}), \quad (5)$$

and the extended gravity term is specified as

$$\begin{aligned} e^S(\gamma^E) = \gamma_b^E(\text{Ext. Grav. Border}) + \gamma_c^E(\text{Ext. Grav. Cont.}) + \gamma_l^E(\text{Ext. Grav. Lang.}) \\ + \gamma_g^E(\text{Ext. Grav. GDPpc}). \end{aligned} \quad (6)$$

We define the potential net static profits of i in j at t, given that the firm exported in the previous period to a bundle of countries b_{t-1}, as:

$$\pi_{ijb_{t-1}t} = v_{ijt} - f_{ijt} - (1 - d_{ijt-1})s_{ijb_{t-1}t}. \quad (7)$$

Aggregating across countries we obtain the total net static profits for the export bundle b_t:

$$\pi_{ib_tb_{t-1}t} = \sum_{j \in b_t} \pi_{ijb_{t-1}t}.$$

We use the vector γ to encompass all the parameters in equations (4), (5), and (6).

4.3 Firm's Optimization

While b_t denotes a generic bundle of countries that a firm might choose at t, o_t denotes the export bundle that is actually chosen. Assumption 1 indicates how this choice is made.

Assumption 1 *Let us denote by $o_1^T = \{o_1, o_2, \ldots, o_T\}$ the observed sequence of bundles chosen by some firm between periods 1 and T. Given a sequence of information sets for i at* *different time periods, $\{\mathcal{J}_{it}, \mathcal{J}_{it+1}, \dots\}$, and a sequence of choice sets from which i picks its preferred export bundle, $\{\mathcal{B}_{it}, \mathcal{B}_{it+1}, \dots\}$, we assume that*

$$o_t = \underset{b_t \in \mathcal{B}_{it}}{\operatorname{argmax}} \mathbb{E}\big[\Pi_{ib_t o_{t-1} t} | \mathcal{J}_{it}\big] \qquad \forall \;\; t = 1, 2, \dots, T \tag{8}$$

where

$$\Pi_{ib_t o_{t-1} t} = \pi_{ib_t o_{t-1} t} + \delta \pi_{i\mathbf{b}_{t+1} b_t t+1} + \omega_{i\mathbf{b}_{t+1} t+2},$$

the term $\omega_{i\mathbf{b}_{t+1} t+2}$ is any arbitrary function that satisfies

$$(\omega_{i\mathbf{b}_{t+1} t+2} \perp b_t) | \mathbf{b}_{t+1}, \tag{9}$$

and the bundle $\mathbf{b}_{t+1}$ is defined as the optimal bundle that would be chosen at period $t+1$ if the bundle b_t was chosen at period t:

$$\mathbf{b}_{t+1} = \underset{b_{t+1} \in \mathcal{B}_{it+1}}{\operatorname{argmax}} \mathbb{E}\big[\Pi_{ib_{t+1} b_t t+s} | \mathcal{J}_{it+1}\big].$$

Assumption 1 models the choice of i at t as the outcome of an optimization problem defined by four elements: (1) a value function, $\Pi_{ib_t o_{t-1} t}$; (2) an information set, $\mathcal{J}_{it}$; (3) a law of motion for this information set, as captured by the conditional expectation function, $\mathbb{E}[\cdot|\mathcal{J}_{it}]$; and, (4) a set of bundles of countries to which i considers exporting, $\mathcal{B}_{it}$.[21]

Assumption 1 imposes that the function $\Pi_{ib_t o_{t-1} t}$ is a discounted sum of: (a) the net profits obtained at t, $\pi_{ib_t o_{t-1} t}$; (b) the profits the firm will obtain at $t+1$ given the choice b_t made at t, $\pi_{i\mathbf{b}_{t+1} b_t t+1}$; and, (c) an arbitrary function that is allowed to vary across firms, time periods and bundles chosen at $t+1$, $\omega_{i\mathbf{b}_{t+1} t+2}$. Equation (9) imposes that, once we control for the bundle b_{t+1}, $\omega_{i\mathbf{b}_{t+1} t+2}$ must not depend on the choice b_t. According to our definition of export profits in equation (7), any firm exporting at t will pay sunk costs of exporting depending only on the export bundle chosen at $t-1$. Consequently, equation (9) is compatible with firms that take into account the effect of their current choices on future profits in any of the three following ways: (a) only one period ahead, $\omega_{i\mathbf{b}_{t+1} t+2} = 0$; (b) any finite number p of periods ahead, $\omega_{i\mathbf{b}_{t+1} t+2} = \delta^2 \pi_{i\mathbf{b}_{t+2} \mathbf{b}_{t+1} t+2} + \cdots + \delta^p \pi_{i\mathbf{b}_{t+p} \mathbf{b}_{t+p-1} t+p}$; or, (c) an infinite number of periods ahead (i.e. perfectly forward looking firms), $\omega_{i\mathbf{b}_{t+1} t+2} = \mathbb{E}\big[\Pi_{i\mathbf{b}_{t+2} \mathbf{b}_{t+1} t} | \mathcal{J}_{it+2}\big]$. In summary, Assumption 1 only imposes two restrictions on firms' value functions: (1) firms take into account the effect of their current choice on static profits at least one period ahead; and, (2) the current choice b_t enters the objective function of the firm only through its effect on

[21] When a firm makes its period t choice, the bundles of countries that will be chosen in future periods, $\{\mathbf{b}_{t+s}\}_{s \geq 1}$, are random variables, as they depend on factors included in future information sets, $\{\mathcal{J}_{t+s}\}_{s \geq 1}$, that might be unknown to the firm at period t. We use the boldface $\mathbf{b}_{t+1}$ to denote the random variable whose realization is the observed bundle b_{t+1}.

the static profits at t and $t+1$, and on the choice $\mathbf{b}_{t+1}$ to be taken at $t+1$.[22]

For our estimation procedure, we do not need to precisely define a consideration set, $\mathcal{B}_{it}$, nor an information set, $\mathcal{J}_{it}$, for every i and t. However, we need to impose necessary conditions on them. These are contained in Assumptions 2 and 3.

Assumption 2 *Let us denote by $\mathcal{B}_{it}$ the consideration set of i at t, and by o_t its optimal export bundle, then*

$$(o_t, \{\bar{o}_{jt}; \forall j\}, \{\tilde{o}_{jj't}; \forall j, j'\}) \in \mathcal{B}_{it},$$

where $\bar{o}_{jt}$ is the bundle that results from modifying the value corresponding to j in o_t, and $\tilde{o}_{jj't}$ is the bundle that results from exchanging elements j and j' in o_t.

In words, Assumption 2 imposes that $\mathcal{B}_{it}$ includes the bundle of countries actually chosen by i at t (i.e. o_t), plus all other possible bundles that could be generated by either adding or dropping one export destination (i.e. $\bar{o}_{jt}$, where j denotes the country added or dropped), or swapping i's export status in any two countries, j and j' (i.e. $\tilde{o}_{jj't}$). As an example, if i is only exporting to j at t, Assumption 2 imposes that the set $\mathcal{B}_{it}$ is such that i could have: (a) not exported to any country; (b) exported to country j and one additional destination; and, (c) exported to some alternative destination j' instead of j. In summary, for each firm and time period, we are assuming consideration sets that include at least the actual observed choice and a small number of variations around it.[23]

Assumption 3 *Let us denote by $\mathcal{J}_{it}$ the information set of i at t, then,*

$$Z_{it} \in \mathcal{J}_{it},$$

where $Z_{it} = \{Z_{ijt}; \forall j \in \mathcal{B}_{it}\}$, and Z_{ijt} includes the indicator d_{ijt-1} plus all the covariates that determine r^o_{ijt-1}, g^F_j, g^S_j and $e^S_{jb_{t-1}}$.

In words, Assumption 3 imposes that, when deciding the optimal set of export destinations at t, i knows: (a) the set of countries it exported to at $t-1$; (b) the fixed and sunk costs of exporting to every country in its consideration set (except for the terms u^F_{ijt} and u^S_{ijt}); and (c) the revenue that it would have obtained at $t-1$ if it had exported to any of those countries (except for the term u^R_{ijt-1}). Assumption 3 is compatible with firms deciding whether to

[22] Restriction (2) would not hold if entry costs were lower for non-exporters that exported two periods ago than for firms that never exported. From a theoretical standpoint, extending our methodology to allow for entry costs at t that depend on export participation at $t-2$ is straightforward. However, this would complicate the computation of our inequalities, and Table 3 in Roberts and Tybout (1997) shows that one cannot reject the null hypothesis that both d_{ijt-2} and d_{ijt-3} have no effect on the probability of exporting at t.

[23] Assumption 2 does not specify the exact content of $\mathcal{B}_{it}$. It only imposes minimal requirements on it. These requirements are satisfied by a consideration set that includes all possible bundles of countries in the world.

export to a country without having perfect information on the revenue they would obtain if they actually enter that country; r_{ijt} might or not belong to $\mathcal{J}_{it}$.

Assumptions 1 to 3 are not enough to determine the optimal export bundle of i at t. The lack of sufficient conditions for optimality implies that a likelihood function is not defined and, accordingly, maximum likelihood estimation is not possible.[24] Nonetheless, as the following section shows, Assumptions 1 to 3 impose necessary conditions that can be used to (partially) identify the parameter vector (α, γ).

4.3.1 Deriving Moment Inequalities: One-period Deviations

We apply an analogue of Euler's perturbation method to derive moment inequalities. We form inequalities by comparing the actual sequence of bundles observed for a given firm with alternative sequences that differ from it in only one period. The vector $o_1^T = \{o_1 \ldots, o_t, \ldots, o_T\}$ denotes the observed sequence of country bundles selected by a particular firm. We define an alternative sequence of bundles that differs from o_1^T at a particular period t, $\{o_1, \ldots, o_t', \ldots, o_T\}$, where o_t' denotes a counterfactual bundle for period t.

Proposition 1 *If Assumption 1 holds, and $o_t' \in \mathcal{B}_{it}$, then:*

$$\mathbb{E}[\pi_{io_t o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o_t t+1} | \mathcal{J}_{it}] \geq \mathbb{E}[\pi_{io_t' o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o_t' t+1} | \mathcal{J}_{it}], \tag{10}$$

with $\mathbf{o}_{t+1} = \text{argmax}_{b_{t+1} \in \mathcal{B}_{it+1}} \mathbb{E}\big[\Pi_{ib_{t+1} o_t t+1} | \mathcal{J}_{it+1}\big]$.

The proof of Proposition 1 is in Appendix A.6. Intuitively, given that the bundle that would be chosen at period $t+1$ conditional on choosing o_t at period t, $\mathbf{o}_{t+1}$, could have been chosen even if o_t' had been picked (instead of o_t), then the sequence $\{o_t', \mathbf{o}_{t+1}'\}$, where $\mathbf{o}_{t+1}'$ is the bundle that the firm would have picked at $t+1$ had the firm exported to o_t' in the previous period, is weakly preferred *at period t* over the sequence $\{o_t', \mathbf{o}_{t+1}\}$. Since o_t was preferred over o_t', then transitivity of preferences insures that the path $\{o_t, \mathbf{o}_{t+1}\}$ was weakly preferred *at period t* over the alternative path $\{o_t', \mathbf{o}_{t+1}\}$. Equation (10) does not rule out the possibility that, *ex post*, the path $\{o_t', o_{t+1}\}$ could have been preferred over the observed $\{o_t, o_{t+1}\}$.[25]

[24] In order to complete the model, we would need to fully specify, for every i and t: the function $\omega_{i\mathbf{b}_{t+1} t+2}$; the information set $\mathcal{J}_{it}$; the consideration set $\mathcal{B}_{it}$; and a law of motion for $\mathcal{J}_{it}$. Given the complexity of the problem, for any reasonable definition of firms' choice sets and planning horizon, it would be computationally infeasible to obtain the maximum likelihood estimator. The reason is that, in the presence of extended gravity effects, for a firm that considers exporting to N countries, the actual choice set includes all the 2^N possible bundles. In a dynamic setting, computing the likelihood function requires computing a different value function for each of these 2^N choices. This becomes a daunting task even for relatively small values of N.

[25] More precisely, Proposition 1 does not imply

$$\mathbb{E}[\pi_{io_t o_{t-1} t} + \delta \pi_{io_{t+1} o_t t+1} | \mathcal{J}_{it}] \geq \mathbb{E}[\pi_{io_t' o_{t-1} t} + \delta \pi_{io_{t+1} o_t' t+1} | \mathcal{J}_{it}],$$

nor

$$\pi_{io_t o_{t-1} t} + \delta \pi_{io_{t+1} o_t t+1} \geq \pi_{io_t' o_{t-1} t} + \delta \pi_{io_{t+1} o_t' t+1},$$

In order to simplify notation, we rewrite the inequality in equation (10) as $\mathbb{E}[\pi_{idt}|\mathcal{J}_{it}] \geq 0$, where $d = (o_t, o'_t)$ denotes a deviation at t.[26] From this conditional inequality and Assumption 3, we derive unconditional moment inequalities:

$$\mathbb{M}_k = \mathbb{E}[g_k(Z_{it})\pi_{idt}] \geq 0, \tag{11}$$

where $g_k(\cdot)$ is a positive valued function and Z_{it} is defined in Assumption 3. In other words, $g_k(\cdot)$ may be a function of any country or firm characteristic as long as it belongs to i's information set at t, $\mathcal{J}_{it}$.

Computationally, the moment inequalities described in equation (11) have two attractive features: (a) they do not require comparing the payoff of the observed choice of i at t with the payoff of every other possible export bundle that it could have chosen at t (i.e. any other bundle included in $\mathcal{B}_{it}$); and (b) they do not require computing the value functions of actual and counterfactual bundles (the difference in these value functions, π_{idt}, depends exclusively on the difference in static profits in two periods, t and $t+1$). Feature (a) allows us to avoid precisely specifying the consideration set of i at t, $\mathcal{B}_{it}$. Feature (b) allows us to avoid imposing any assumption on the planning horizon of firm i.[27]

We may write different moment inequalities of the type in equation (11) by altering the choice of the function $g_k(\cdot)$. Section 5 specifies how we choose the set of functions $\{g_k(\cdot), k = 1, \ldots, K\}$ in order to obtain moment inequalities that identify the parameter vector γ.

5 Specifying Moments: Bounding Cost Parameters

We build inequalities by modifying the entry behavior of firms in different markets. We may group our inequalities into two categories. The first category uses an alternative export bundle, o'_t, that differs from the actual bundle, o_t, in that it either adds or drops one entry event: firm i at t is forced to add or drop an export destination to which it was not exporting at $t-1$.

where o_{t+1} is the bundle effectively chosen by i at $t+1$ (i.e. the realization of the random variable $\mathbf{o}_{t+1}$). In words, Proposition 1 implies that, at any t, the expected discounted sum of profits generated by the actual choice, o_{t+1}, should be larger than that generated by any counterfactual choice, o'_{t+1}. However, it does not imply that the *ex post* realized profits must larger along the actual path than along the counterfactual one.

[26] For any variable x, we define x_{idt} as the difference in x between the actual path, $\{o_1, \ldots, o_{t-1}, o_t, o_{t+1} \ldots, o_T\}$, and the counterfactual one, $\{o_1, \ldots o_{t-1}, o'_t, o_{t+1} \ldots, o_T\}$, at t and $t+1$. As an example, $\pi_{idt} = (\pi_{io_t o_{t-1} t} - \pi_{io'_t o_{t-1} t}) + \delta(\pi_{i\mathbf{o}_{t+1} o_t t+1} - \pi_{i\mathbf{o}_{t+1} o'_t t+1})$.

[27] The difference in value functions between actual and counterfactual paths, π_{idt}, only depends on the static profits in two time periods, t and $t+1$. This is a consequence of the assumption, implicit in Sections 4.1 and 4.2, that, *conditional on its export destinations at t and $t-1$*, the static profits of i at t do not depend on export destinations in periods previous to $t-1$. Therefore, when we alter the export choice made by i at t (o_t vs. o'_t), *conditional on keeping the rest of the export path constant*, this perturbation will only affect i's static profits at t and $t+1$. It is straightforward to extend our identification strategy to cases in which the choice at t directly affects payoffs in periods t, $t+1$, ..., $t+t^*$ (e.g. assuming a firm only pays sunk costs in a country if it did not export to it during the last t^* periods). For identification, the only restriction that we need to impose on t^* is that it should be smaller than the total number of periods in our sample.

The second category uses an alternative export bundle that switches the observed entry event in some country j to some other country j': firm i at t is forced to enter export destination j' instead of j.[28] While the first group of inequalities modifies the number of export destinations firms are exporting to, the second one alters the particular set of destinations while holding its number constant.

5.1 Adding or Dropping Export Destinations

Imagine we observe firm i with the stream of observed gross profits and export trajectory in country j described in Table 3, where 1 indicates that i is exporting to j and 0 indicates that it is not. For simplicity, assume that j shares continent, language, and GDPpc with Chile.

Table 3: Example of a 1-period Export Event

Year	1	2	3	4	5	6
Profits	v_{ij1}	v_{ij2}	v_{ij3}	v_{ij4}	v_{ij5}	v_{ij6}
Exports	0	0	0	1	0	0

A natural counterfactual to the path in Table 3 is to impose that i does not export to j during period 4. In this case, the realized difference in profits between actual and counterfactual strategies would be

$$\pi_{id4} = v_{ij4} - f_{ij4} - s_{ijb_34} = v^o_{ij4} - \gamma^F_0 - \gamma^S_0 + u_{id4},$$

where $u_{id4} = u^V_{ij4} - u^F_{ij4} - u^S_{ij4}$. In order to form inequalities using revealed preference arguments, it is not the realized difference in profits that matters, but i's expectation of this difference at the time it chooses its export destinations for period 4. Given the implicit assumption that i's expectations are rational, we compute our inequality as

$$\mathbb{E}[\pi_{id4}|\mathcal{J}_{i4}] \geq 0, \qquad \longrightarrow \qquad \mathbb{E}[v^o_{ij4} - \gamma^F_0 - \gamma^S_0 + u_{id4}|\mathcal{J}_{i4}] \geq 0,$$

where $\mathbb{E}[\cdot|\mathcal{J}_{i4}]$ denotes the expectation with respect to the data generating process conditional on i's information set when deciding the export destinations in period 4. This inequality will identify an upper bound for the sum $\gamma^F_0 + \gamma^S_0$:

$$\gamma^F_0 + \gamma^S_0 \leq \mathbb{E}[v^o_{ij4} + u_{id4}|\mathcal{J}_{i4}]. \tag{12}$$

The particular form of this inequality depends on the fact that i does not export to j in period 5. In many occasions, as in Table 4, we observe export paths where export events last for

[28] Using the notation introduced in Assumption 2, the first category corresponds to an alternative bundle o'_t such that $o'_t = \bar{o}_{jt}$, for some j such that $d_{ijt-1} = 0$. The second category corresponds to an alternative bundle o'_t such that $o'_t = \tilde{o}_{jj't}$, for some j and j' such that $d_{ijt-1} = d_{ij't-1} = 0$.

more than one period.

Table 4: Example of a 2-period Export Event

Year	1	2	3	4	5	6
Profits	v_{ij1}	v_{ij2}	v_{ij3}	v_{ij4}	v_{ij5}	v_{ij6}
Exports	0	0	0	1	1	0

In this case, the counterfactual that imposes that i does not export to j at period 4 yields the following inequality

$$\gamma_0^F + (1-\delta)\gamma_0^S \leq \mathbb{E}[v_{ij4}^o + u_{id4}|\mathcal{J}_{i4}], \tag{13}$$

where $u_{id4} = u_{ij4}^V - u_{ij4}^F - u_{ij4}^S + \delta u_{ij5}^S$.

We construct our inequalities by averaging out across many perturbations of the kind described in inequalities (12) and (13). The general inequality that encompasses these two particular examples is

$$\mathbb{E}[(\gamma_0^F + \gamma_0^S - \delta d_{ijt+1}\gamma_0^S)g_k(Z_{it})] \leq \mathbb{E}[(v_{ijt}^o + u_{idt})g_k(Z_{it})], \tag{14}$$

with $u_{idt} = u_{ijt}^V - u_{ijt}^F - u_{ijt}^S + \delta d_{ijt+1}u_{ijt+1}^S$, and

$$g_k(Z_{it}) = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0,$$
$$d_{ijt} = 1, (\text{Ext. Grav. Border})_j = 0, (\text{Ext. Grav. Cont.})_j = 0, (\text{Ext. Grav. Lang.})_j = 0,$$
$$\text{Ext. Grav. GDPpc})_j = 0\}. \tag{15}$$

The inequality in equation (14) is constructed using counterfactual bundles that reduce the number of i's export destinations and, accordingly, identifies an upper bound on both γ_0^F and γ_0^S. In order to define inequalities that identify a lower bound for these parameters, we need to use counterfactuals that increase the number of countries firms enter. As an example, consider a counterfactual to the actual export path in Table 3 in which i exports to j at period 2. In this case, the resulting inequality will identify a lower bound for the sum $\gamma_0^F + \gamma_0^S$:

$$\gamma_0^F + \gamma_0^S \geq \mathbb{E}[v_{ij2}^o + u_{id2}|\mathcal{J}_{i2}].$$

with $u_{id2} = u_{ij2}^V - u_{ij2}^F - u_{ij2}^S$. The general inequality that helps identify lower bounds on γ_0^F and γ_0^S is:

$$\mathbb{E}[(\gamma_0^F + \gamma_0^S - \delta d_{ijt+1}\gamma_0^S)g_k(Z_{it})] \geq \mathbb{E}[(v_{ijt}^o + u_{idt})g_k(Z_{it})], \tag{16}$$

with $u_{idt} = u_{ijt}^V - u_{ijt}^F - u_{ijt}^S + \delta d_{ijt+1}u_{ijt+1}^S$ and $g_k(Z_{it})$ equal to that in equation (15) except that d_{ijt} is set to 0 (instead of imposing $d_{ijt} = 1$).

The inequalities in equations (14) and (16) do not depend on the parameters capturing the impact of gravity variables in either fixed or sunk costs. However, by switching the values of the dummy variables "Grav. Cont.", "Grav. Lang.", and "Grav. GDPpc" to be equal to 1 in the function $g_k(Z_{it})$ we can derive inequalities of the same kind as those in equations (14) and (16) that depend on those gravity parameters. Analogously, depending on whether $g_k(Z_{it})$ conditions on particular values of the extended gravity variables, the resulting moment inequalities might also incorporate elements of the vector capturing the effect of extended gravity effects on export entry costs.

5.2 Swapping Export Destinations

Imagine that we observe i following the export path described in Table 5, where j and j' differ in that j is located in Europe and j' is located in South America. Assume also that both j and j' have Spanish as their official language and are in the same GDPpc group as Chile.

Table 5: Example of a 1-period Export Event

	Year	7	8	9
Country j	Profits	v_{ij7}	v_{ij8}	v_{ij9}
	Exports	0	1	0
Country j'	Profits	$v_{ij'7}$	$v_{ij'8}$	$v_{ij'9}$
	Exports	0	0	0

A possible counterfactual is one in which i enters j' instead of j. In order to avoid having to deal with extended gravity variables, assume that i does not export to any country in years 7 and 9. Then, our counterfactual generates the following difference in profits:

$$\pi_{id8} = v_{ij8} - f_{ij8} - s_{ij8} - (v_{ij'8} - f_{ij'8} - s_{ij'8}) = v^o_{ij8} - v^o_{ij'8} - \gamma^F_c - \gamma^S_c + u_{id8}$$

where $u_{id8} = u^V_{ij8} - u^V_{ij'8} - u^F_{ij8} - u^S_{ij8} + u^F_{ij'8} + u^S_{ij'8}$. Therefore, we can form the inequality

$$\mathbb{E}[\pi_{id8}|\mathcal{J}_{i8}] \geq 0 \quad \longrightarrow \quad \gamma^F_c + \gamma^S_c \leq \mathbb{E}[v^o_{ij8} - v^o_{ij'8} + u_{id8}|\mathcal{J}_{i8}], \tag{17}$$

which identifies an upper bound bound for $\gamma^F_c + \gamma^S_c$. Intuitively, the difference in the expected extra gross profits of exporting to j instead of j' should be large enough to compensate for the extra fixed and sunk costs needed to access a market that is not in South America.

As indicated above, it is typical to observe export events that last more than one period. In particular, imagine that the observed path had been as described in Table 6.

If we build a counterfactual in which i exports to j' at 8 (instead of j), the resulting

Table 6: Example of a 2-period Export Event

	Year	7	8	9
Country j	Profits	v_{ij7}	v_{ij8}	v_{ij9}
	Exports	0	1	1
Country j'	Profits	$v_{ij'7}$	$v_{ij'8}$	$v_{ij'9}$
	Exports	0	0	0

moment inequality is:

$$\gamma_c^F + \gamma_c^S - \delta(\gamma_0^S + \gamma_c^S) \leq \mathbb{E}[v_{ij8}^o - v_{ij'8}^o + u_{id8}|\mathcal{J}_{i8}], \tag{18}$$

with $u_{id8} = u_{ij8}^V - u_{ij'8}^V - u_{ij8}^F - u_{ij8}^S + u_{ij'8}^F + u_{ij'8}^S + \delta u_{ij9}^S$. We can write the general inequality that encompasses the cases represented in equations (17) and (18) as

$$\mathbb{E}[(\gamma_c^F + \gamma_c^S - \delta d_{ijt+1}(\gamma_0^S + \gamma_c^S))g_k(Z_{it})] \leq \mathbb{E}[(v_{ijt}^o - v_{ij't}^o + u_{idt})g_k(Z_{it})]. \tag{19}$$

with $u_{idt} = u_{ijt}^V - u_{ij't}^V - u_{ijt}^F - u_{ijt}^S + u_{ij't}^F + u_{ij't}^S + \delta d_{ijt+1} u_{ijt+1}^S$ and

$$\begin{aligned} g_k(Z_{it}) = \mathbb{1}\{&(\text{Grav. Cont.})_j = 0, (\text{Grav. Cont.})_{j'} = 1, (\text{Grav. Lang.})_j = 0, (\text{Grav. Lang.})_{j'} = 0, \\ &(\text{Grav. GDPpc})_j = 0, (\text{Grav. GDPpc})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0, \\ &(\text{Ext. Grav. Border})_j = 0, (\text{Ext. Grav. Border})_{j'} = 0, (\text{Ext. Grav. Cont.})_j = 0, \\ &(\text{Ext. Grav. Cont.})_{j'} = 0, (\text{Ext. Grav. Lang.})_j = 0, (\text{Ext. Grav. Lang.})_{j'} = 0, \\ &(\text{Ext. Grav. GDPpc})_j = 0, (\text{Ext. Grav. GDPpc})_{j'} = 0\}. \end{aligned} \tag{20}$$

In order to obtain an inequality that identifies a lower bound for a linear combination of the parameters γ_c^F and γ_c^S, we have to impose $d_{ijt} = 0$ and $d_{ij't} = 1$ (instead of $d_{ijt} = 1$ and $d_{ij't} = 0$) in the function $g_k(Z_{it})$. Analogously, we can derive inequalities that exclusively depend on extended gravity parameters, or on combinations of gravity and extended gravity parameters by setting to one the corresponding dummy variables that are included as arguments of the function $g_k(Z_{it})$ described in equation (20).

6 Estimation

Once we have specified the different moment inequalities that identify the parameters entering fixed and sunk costs, it remains to explain how these inequalities are used to estimate these parameters. In order to make explicit the dependency of the general population moment inequality in equation (11) on the parameter vector (α, γ), we rewrite it as:

$$\mathbb{M}_k(\alpha^*, \gamma^*) = \mathbb{E}[g_k(Z_{it})(\pi^o_{idt}(\alpha^*, \gamma^*) + u_{idt})] \geq 0, \tag{21}$$

where (α^*, γ^*) denotes the true value of the parameter vector (α, γ), $\pi^o_{idt}(\alpha, \gamma) = \nu^o_{idt}(\alpha) - f^o_{idt}(\gamma^F) - s^o_{idt}(\gamma^S, \gamma^E)$, and $u_{idt} = u^V_{idt} - u^F_{idt} - u^S_{idt}$. While $\pi^o_{idt}(\alpha, \gamma)$ is a function of observed covariates and parameters, u_{idt} groups all the terms that are unobserved to the econometrician. Substituting the expectation operator with its sample counterpart and keeping only the part of π_{idt} that depends on observable variables and parameters, we obtain a sample inequality:

$$\mathbb{m}_k(\alpha, \gamma) = \frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}} g_k(Z_{it}) \pi^o_{idt}(\alpha, \gamma) \geq 0, \tag{22}$$

where $D_k = \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}} g_k(Z_{it})$, I is the number of firms, and D_{it} is the set of all possible deviations from the bundle chosen by i at t that are consistent with Assumption 2.[29]

We estimate the vector (α, γ) in two stages. In the first stage, we use nonlinear least squares on longitudinal data to obtain point estimates of α. In the second stage, we use moment inequalities to obtain set estimates of γ conditional on the first stage estimates, $\hat{\alpha}$. This two-step estimator is preferred over an alternative approach that uses moment inequalities to estimate both α and γ. First, it allows us to use different sources of variation to identify α and γ. In particular, we use the information on the continuous variable capturing export revenue, r_{ijt}, to identify α, and the discrete variable capturing the entry decision, d_{ijt}, to identify γ. If we had estimated both α and γ through moment inequalities, then both parameters would be identified by the binary decision capturing entry. Second, using different sources of data to identify α and γ implies that the ability to separately identify these two parameter vectors is not exclusively due to functional form assumptions.[30] Finally, if we were to identify α using moment inequalities, then it would also be set identified (instead of point identified). Therefore, ignoring the information on export revenue and using moment inequalities to identify both α and γ implies a loss of identification power.

6.1 First Stage Estimation

We use data on observed export revenues for firms, countries, and years with positive exports to estimate α. We base our estimation of α on the following orthogonality condition:

[29] The function $g_k(\cdot)$ will take value 0 for many of these deviations. Therefore, each moment inequality k is formed by summing over a subset of all the possible deviations that are consistent with Assumption 2.

[30] If we had estimated both α and γ through moment inequalities, then both parameters would be separately identified only through the assumptions imposed on the functions $v^o_{idt}(\cdot)$, $f^o_{idt}(\cdot)$ and $s^o_{idt}(\cdot)$: linearity of $f^o_{idt}(\cdot)$ and $s^o_{idt}(\cdot)$ vs. log-linearity of $v^o_{idt}(\cdot)$.

$$\mathbb{E}[r_{ijt} - r^o_{ijt}(\alpha)|x^R_{ijt}, d_{ijt} = 1] = 0, \tag{23}$$

where both $r^o_{ijt}(\alpha)$ and x^R_{ijt} are defined in Section 4.1. We use our estimates of α, $\hat{\alpha}$, to define an approximation to the potential gross profits from exporting for i in j at t as $v^o_{ijt} = \eta^{-1} r^o_{ijt}(\hat{\alpha})$, where the value of η is borrowed from Broda et al. (2006).[31] We denote the approximation error as $\hat{u}^V_{ijt}(\alpha) = u^V_{ijt} + \eta^{-1}(r^o_{ijt}(\alpha) - r^o_{ijt}(\hat{\alpha}))$, with u^V_{ijt} defined in Section 4.1.

6.2 Second Stage Estimation

Using the results from the first stage estimation, we rewrite our sample moments as:

$$\mathbb{m}_k(\hat{\alpha}, \gamma) = \frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}} g_k(Z_{it}) \pi^o_{idt}(\hat{\alpha}, \gamma) \geq 0, \tag{24}$$

Using a set of inequalities $\{\mathbb{m}_k(\hat{\alpha}, \gamma); k = 1, \ldots, K\}$, we estimate an identified set for γ as

$$\hat{\Theta}_\gamma = \underset{\gamma}{\text{argmin}} \sum_{k=1}^{K} \big(\min\{0, \mathbb{m}_k(\hat{\alpha}, \gamma)\} \big)^2.$$

We define Θ_γ as the identified set to which the estimated set $\hat{\Theta}_\gamma$ converges as the number of observations used in each moment inequality k, D_k, converges to infinity. This will happen if either the number of firms in the sample or the number of sample periods goes to infinity.

6.3 Properties of the Identified Set

Equation (21) shows that the population moments $\{\mathbb{M}_k(\alpha, \gamma); k = 1, \ldots, K\}$ hold at the true value of the parameter vector, (α^*, γ^*). If the expectations of the sample moments $\{\mathbb{m}_k(\alpha, \gamma); k = 1, \ldots, K\}$ also hold for $(\alpha, \gamma) = (\alpha^*, \gamma^*)$, then the set Θ_γ will contain the true value of the parameters. For every $k = 1, \ldots, K$, the difference between the population inequality and the expectation of the sample inequality evaluated at (α^*, γ^*) is

$$\mathbb{M}_k(\alpha^*, \gamma^*) - \mathbb{E}[\mathbb{m}_k(\alpha^*, \gamma^*)] = \mathbb{E}[g_k(Z_{it})(\hat{u}^V_{idt}(\alpha^*) + u^F_{idt} + u^S_{idt})].$$

Therefore, if

[31] Under the microfoundation in Appendix A.5, η is the elasticity of substitution across varieties. For the chemical products sector, Broda et al. (2006) estimate η to be equal to 5.75. This implies that an exporter's profit margin (gross of fixed and sunk costs) is approximately 20%. The value assumed for η affects the scale of our estimates of γ; however, it does not affect the relative magnitudes of the different γ parameters.

$$\mathbb{E}[g_k(Z_{it})(\hat{u}^V_{idt}(\alpha^*) + u^F_{idt} + u^S_{idt})] \leq 0 \tag{25}$$

then $\mathbb{E}[\mathbb{m}_k(\alpha^*, \gamma^*)] \geq \mathbb{M}_k(\alpha^*, \gamma^*) \geq 0$. In words, as long as equation (25) holds, equation (21) implies that, for any k, $\mathbb{E}[\mathbb{m}_k(\alpha^*, \gamma^*)] \geq 0$. Consequently, if the first stage yields a consistent estimator of α, then the inequality in equation (25) is necessary and sufficient for Θ_γ to contain the true value of γ. Assumptions 4 and 5 below impose restrictions on the distribution of the error terms u^R_{ijt}, u^F_{ijt}, and u^S_{ijt}, that are sufficient (but not necessary) for equation (25) to hold.

Assumption 4 *The error term u^R_{ijt} is such that $\mathbb{E}[u^R_{ijt}|x^R_{ijt}, \mathcal{J}_{it}] = 0$.*

Note that $u^R_{ijt} = r_{ijt} - r^o_{ijt}(\alpha^*)$. Assumption 4 does not impose any restriction on the relationship between i's information set, $\mathcal{J}_{it}$, and the observable determinants of the potential revenue from exporting included in the function r^o_{ijt}, x^R_{ijt}.[32] However, Assumption 4 imposes that the unobserved term u^R_{ijt} is mean independent of the information set, $\mathcal{J}_{it}$, and observed determinants of export revenue, x^R_{ijt}. That is, u^R_{ijt} does not account for variables that are unobserved to the econometrician but observed by firms when taking their export decisions. Assumption 4 is consistent with u^R_{ijt} capturing measurement error and i's expectational error on exports revenue, r_{ijt}.[33] Under Assumption 4, the orthogonality restriction in equation (23) identifies the true value of α, α^*.

Assumption 5 *The error terms (u^F_{ijt}, u^S_{ijt}) are such that $\mathbb{E}[u^F_{ijt}, u^S_{ijt}|\mathcal{J}_{it}] = 0$.*

Similarly to Assumption 4, Assumption 5 allows firms to have imperfect information about fixed and sunk costs, but it does not allow them to have information about these costs that is not known by the econometrician.

Assumptions 4 and 5 do not impose any parametric restriction on the distribution of the error terms $(u^R_{ijt}, u^F_{ijt}, u^S_{ijt})$. They do not impose restrictions on their second and higher order moments. Consequently, our estimation procedure will yield consistent estimates of all structural parameters while allowing these unobserved components of export costs to be

[32] A stricter version of Assumption 4 would be to impose that, for every i, j and t, $x^R_{ijt} \in \mathcal{J}_{it}$ and $\mathbb{E}[u^R_{ijt}|\mathcal{J}_{it}] = 0$. This would imply that, at the time of deciding its export destinations for year t, i knows as much as the econometrician observes *ex post*. Assumption 4 is weaker because it allows for the possibility that firms take decisions without knowing some determinants of export revenue that are revealed *ex post* (e.g. the demand level in j, as measured by the total aggregate imports in j at t; whether they will face unexpected disruptions in their production process, as measured by the value added per worker at the end of the year).

[33] Ideally, we would like to include a broader set of fixed effects in the expression for r^o_{ijt}. However, there are multiple countries that receive exports from only a handful of firms during our sample period. Therefore, both country and firm-year fixed effects are very imprecisely estimated, affected by outliers, and may have a large impact on our estimates of predicted revenue, $r^o_{ijt}(\hat{\alpha})$. For this reason, we prefer to not include country nor firm-year specific fixed effects in the expression for r^o_{ijt}.

correlated across firms and countries and to follow different distributions for different firms in different countries and time periods.

While Assumptions 4 and 5 are very flexible in terms of the statistical properties of firms' expectational errors and data measurement error, they are more restrictive in terms of structural errors or variables that are in firms' information sets and are unobserved to the econometrician. Assumptions 4 and 5 impose that there is no variable affecting the net profits from exporting that is known by the firm when making its export decision and not included in our set of observed covariates: the entry decision of firms into different countries must be exclusively based on characteristics of the firm's environment that the model takes into account.[34]

Our extended gravity estimates might be particularly affected if there are unobservable firm-country effects that happen to be correlated across countries that are connected through any of the extended gravity variables (e.g. across countries that have the same official language), and that are known to a firm at the time of its entry decisions. At this juncture, the literature on moment inequalities does not allow us to account for such structural errors.[35] Nevertheless, we deal with the absence of structural errors in our moment inequalities in two different ways. First, we construct our inequalities by building counterfactuals that only affect the export entry behavior of firms. This implies that our inequalities only use information on firms' decisions in countries for which they do not have recent export experience. Therefore, if firms were to acquire private information about their export costs in a country only by exporting to it, this would not affect our estimates. Second, our reduced form results in Table 2 show that the evidence in favor of extended gravity effects is robust to accounting for unobservable firm-country determinants of export profits that are correlated across countries that share continent, language, and GDPpc.

[34] In our model, if extended gravity effects were assumed to be zero, firms would take independent export entry decisions in each foreign country. In this case, one could apply the methodology in Das et al. (2007) to estimate country-specific fixed and sunk costs of exporting. Das et al. (2007) assumes that the vector $(u^R_{ijt}, u^F_{ijt}, u^S_{ijt})$ belongs to the information set of the firm, $\mathcal{J}_{it}$, and imposes parametric restrictions on its distribution. If we were to use moment inequalities à la Holmes (2011), instead of Assumptions 4 and 5, we would have to assume that $\mathbb{E}[u^R_{ijt}|x^R_{ijt}, \mathcal{J}_{i1}, \ldots, \mathcal{J}_{it}, \ldots, \mathcal{J}_{iT}] = 0$ and $\mathbb{E}[u^F_{ijt}, u^S_{ijt}|\mathcal{J}_{i1}, \ldots, \mathcal{J}_{it}, \ldots, \mathcal{J}_{iT}] = 0$. While the inequalities à la Holmes (2011) are only consistent with an interpretation of $(u^R_{ijt}, u^F_{ijt}, u^S_{ijt})$ as capturing pure measurement error, our inequalities are consistent with this vector capturing either pure measurement error or agents' expectational error.

[35] To the best of our knowledge, the only papers that consider moment inequality estimators with choice-specific expectational and structural errors are Pakes et al. (2011), Eizenberg (2014), and Dickstein and Morales (2013). Pakes et al. (2011) only allows for choice-specific structural errors in the case of ordered choice models. Eizenberg (2014) proposes a methodology that, applied to our setting, would imply assuming that the support of the sum of sunk and fixed costs is contained within the support of the expected change in variable export profits resulting from adding or dropping one destination. There is no economic reason to think that this support restriction holds in our setting. Finally, Dickstein and Morales (2013) only contains results for binary choice problems, while the problem faced by exporters involves choosing among a very large choice set.

7 Results

This section presents our moment inequality estimates for the bounds on the different fixed and sunk costs parameters. We estimate bounds on twelve parameters: a constant, γ_0^F, and three gravity parameters, $(\gamma_c^F, \gamma_l^F, \gamma_g^F)$, for fixed costs; a constant, γ_0^S, and three gravity parameters, $(\gamma_c^S, \gamma_l^S, \gamma_g^S)$, for sunk costs; and four extended gravity parameters, $(\gamma_b^E, \gamma_c^E, \gamma_l^E, \gamma_g^E)$.

In our moment inequalities, we generate a proxy for the potential gross profits, v_{ijt}^o, using the estimates of predicted revenue, $r_{ijt}^o(\hat{\alpha})$, described in column I of Table A.2. These estimates show that: (a) new exporters export small amounts (consistent with Eaton et al., 2008; Ruhl and Willis, 2008; Arkolakis, 2013); (b) firms' exports increase in the size of the destination market (consistent with Eaton et al., 2011) and generally decrease in the different measures of distance between home and destination markets included in the regression; (c) more productive firms, as measured by value added per worker, export larger amounts.

Based on the analysis in Section 3, we expect the estimates of the bounds of fixed and sunk costs parameters to be robust to alternative specifications of the revenue function $r_{ijt}^o(\alpha)$. Specifically, Tables A.3 and A.4 indicate that, as long as the vector of observable covariates used to predict revenue, x_{ijt}^R, includes measures of firm size, destination market size, and its distance to Chile, the specific vector x_{ijt}^R employed to predict revenue is unlikely to affect the set estimated by our moment inequalities. Furthermore, the similarity of the estimates in Tables 2 and A.5 suggests that the potential sample selection bias that would arise if Assumption 4 were not to hold is unlikely to affect the estimates of the bounds of γ.

Table 7 shows estimates of bounds for each of the parameters entering fixed and sunk costs.[36] The fixed costs parameters are all bounded above by relatively low numbers. The upper bound on the fixed costs of exporting to a country that is similar to Chile in terms of geographic location, language, and GDP per capita (e.g. Argentina) is 1,810 USD. The corresponding upper bound for a country like China is 10,800 USD (i.e. the sum of the upper bounds on the terms γ_0^F, γ_c^F, γ_l^F and γ_g^F). Concerning the sunk costs estimates, the results show that the constant term, γ_0^S, and the gravity term due to language, γ_l^S, have lower bounds different from zero. In particular, the entry costs in countries like Argentina, Uruguay, or Colombia are estimated to be between 14,500 and 19,430 USD. In countries that differ from Chile in some or all gravity variables, these sunk costs are significantly larger. Specifically, for a firm that has never exported, the entry costs in countries like China, the UK, or the US is estimated to be between 82,980 and 134,920 USD.

Having a lower bound of zero for a subset of the parameters does not imply that the estimated set, $\hat{\Theta}_\gamma$, includes a point where all these parameters are simultaneously zero. In Table 7, the lack of separate identification for each of the parameters is responsible for the

[36]A detailed description of the specific moment inequalities used to compute the bounds presented in this section is provided in Appendix A.7.

Table 7: Moment Inequality Estimates

Fixed Costs:		Sunk Costs:		Ext. Gravity:	
γ_0^F	[0, 1810]	γ_0^S	[14500, 19430]	γ_b^E	[0, 40370]
γ_c^F	[0, 2290]	γ_c^S	[0, 12690]	γ_c^E	[0, 10590]
γ_g^F	[0, 3460]	γ_g^S	[0, 12440]	γ_g^E	[0, 1570]
γ_l^F	[0, 3240]	γ_l^S	[68480, 90360]	γ_l^E	[0, 12050]

Notes: For each interval $[N_1, N_2]$, N_1 denotes the lower bound and N_2 denotes the upper bound. Values are in year 2000 USD. This table uses data on all foreign countries.

large estimated bounds. This lack of separate identification is due to the fact that the gravity variables that we are including in the specification of fixed and sunk costs are highly correlated with each other. Whenever we observe a particular firm deciding to enter some country j instead of an alternative country j', j and j' will usually differ in more than one of the gravity variables. Therefore, it is possible to load the explanation of the preference for j over j' onto any one of these variables. The strong correlation in the gravity variables is due to the fact that most of the countries that have Spanish as their official language are also located in South America and have levels of GDPpc similar to Chile. As an example, if we observe a Chilean firm entering Argentina instead of the larger U.S. market, our model will conclude that this must be due to exporting costs being lower in Argentina. However, it is impossible to discern whether the difference in trade costs between the U.S. and Argentina is due to Argentina sharing a continent with Chile, sharing language, or having similar GDPpc.

Given that the particular geographic location of Chile complicates the separate identification of the different gravity parameters in our inequalities, in Table 8 we focus on identifying fixed and sunk costs of exporting for countries that differ in either none or all the three gravity variables included in the analysis. In this case, the only fixed and sunk costs parameters whose bounds are identified are: (a) the constant terms, γ_0^F and γ_0^S; and (b) the sum of the gravity terms due to continent, language, and GDPpc, $\gamma_c^F + \gamma_g^F + \gamma_l^F$ and $\gamma_c^S + \gamma_g^S + \gamma_l^S$. As column I in Table 8 shows, the resulting bounds on fixed and sunk costs parameters are tighter that in Table 7. Specifically, exporting to a country like Argentina implies fixed costs lower than 770 USD and sunk costs between 15,810 and 18,970 USD. If a firm has not previously exported to any country sharing border, continent, language, or GDPpc, the entry costs into a country like China are estimated to be between 94,320 and 102,710 USD. Concerning the extended gravity effects, we estimate a reduction in entry costs between 22,930 and 39,960 USD when exporting to a country that shares a border with a previous export destination of the firm. All the other extended gravity effects considered in the analysis are precisely estimated to be very close to zero (i.e. their upper bounds are small numbers). Column II in Table 8 sets to 0 those parameters whose upper bound in column I is very low. The estimated bounds for the three remaining parameters remain basically unchanged.[37]

Table 8: Moment Inequality Estimates

Specifications	I	II
Fixed Costs:		
γ_0^F	[0, 770]	0
$\gamma_c^F + \gamma_g^F + \gamma_l^F$	[0, 1150]	0
Sunk Costs:		
γ_0^S	[15810, 18970]	[16350, 18970]
$\gamma_c^S + \gamma_g^S + \gamma_l^S$	[78510, 83740]	[78510, 83020]
Extended Gravity:		
γ_b^E	[22930, 39960]	[22930, 39960]
γ_c^E	[0, 3720]	0
γ_g^E	[0, 550]	0
γ_l^E	[0, 4040]	0

Notes: For each interval $[N_1, N_2]$, N_1 denotes the lower bound and N_2 denotes the upper bound. Values are in year 2000 USD. All columns only use data on countries that are not in South America, do not have Spanish as their official language, and do not belong to the upper-middle GDPpc group based on the World Bank classification. Columns II sets $\gamma_0^F = \gamma_c^F + \gamma_g^F + \gamma_l^F = \gamma_c^E = \gamma_g^E = \gamma_l^E = 0$.

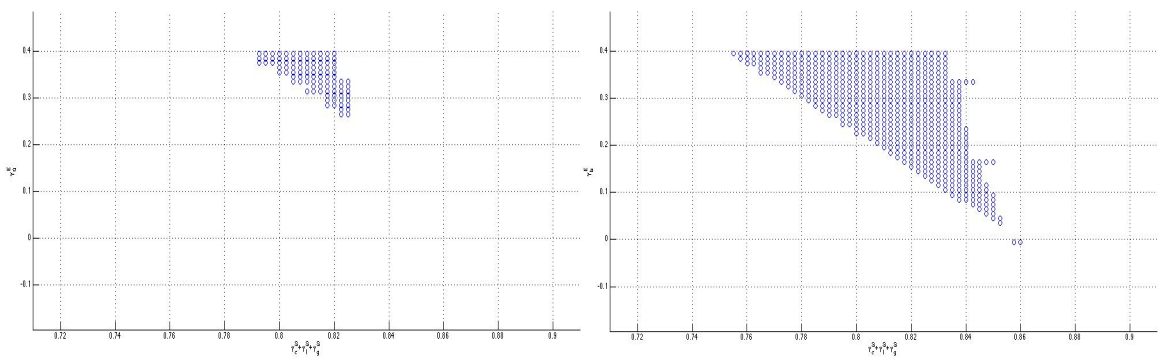
As in every discrete choice model, the scale of the estimates in Tables 7 and 8 is not identified. In our case, this scale is determined by the particular value of η borrowed from Broda et al. (2006). However, the ratio of the extended gravity due to border, γ_b^E, to the sunk cost that a firm faces when exporting to a country that differs from Chile in all three gravity variables, $\gamma_0^S + \gamma_c^S + \gamma_g^S + \gamma_l^S$ is not affected by this scale parameter. Table 8 bounds this ratio to be between 27% and 40%. This implies that, for a firm located in Chile, the cost of starting to export in the US will be between 27% and 40% smaller if the firm was exporting to Canada in the previous year. Therefore, the results in Table 8 show that extended gravity effects due to border are economically significant. We can interpret these results as indicating that geography generates extended gravity effects, but only at very short distances. However, we cannot rule out the hypothesis that the dummy variable for sharing a border is operating as a proxy for factors –other than language and GDPpc– that happen to be common across countries that are geographically close to each other. As an example, one source of entry costs may be the need to find an adequate distributor in the destination country. As long as

[37]Our estimates are broadly consistent with those computed in Das et al. (2007) for the chemical sector in Colombia. As Das et al. (2007) lacks data on export flows disaggregated by countries, the exact comparison of both sets of estimates is complicated. However, a clear conclusion emerges in both papers: fixed costs are estimated to be very close to zero and significantly smaller than the sunk costs.

these distributors operate in multiple countries that are geographically close to each other, firms that have already done business with a distributor will face lower entry costs in those neighboring countries in which the same distributor operates.

As an additional example, an important fraction of these sunk costs may be accounted for by the need to adapt the exported products to the specific legal requirements and idiosyncratic preferences in each destination market. As long as these legal requirements and preferences are relatively similar across countries that are geographically close to each other, firms that have already bought the specific capital equipment necessary to produce goods that are marketable in one particular country will be able to access neighboring countries without having to acquire new machines or introduce additional innovations into their product designs.

Figure 1: Two-Dimensional Plots



(a) Identified Set (b) Confidence Interval

The bounds in Table 8 indicate the limits of the smallest rectangular polygon that encloses the estimated set. However, the boundaries of this set may not form right angles. For the specification in column II of Table 8, Figure 1 shows the projection of both the estimated set and confidence set on the space formed by the parameter $\gamma_c^S + \gamma_l^S + \gamma_g^S$ (on the x axis) and the parameter γ_b^E (on the y axis). Figure 1b shows a confidence interval for for the true parameter, as in Imbens and Manski (2004). It is based on the inversion of the modified method of moments (MMM) statistic (statistic $S_1(\cdot)$ in Andrews and Soares, 2010) and uses the so-called “moment selection t-test” procedure: at each point in the parameter space, those moments that are larger than $(2\ln(\ln(2)))^{1/2}$ are ignored when computing the critical value of the test at that point (see Andrews and Soares, 2010, for more details).[38] The confidence set is significantly larger than the estimated set. In particular, there are multiple relatively low values of γ_b^E and $\gamma_c^S + \gamma_l^S + \gamma_g^S$ that are included in the confidence set and not in the estimated set. In contrast, the upper bound on γ_b^E does not change significantly between both

[38]The confidence set computed using the “mean-shift” approach described in Andrews and Soares (2010) is virtually identical to that in Figure 1b. Three dimensional representations of estimated and confidence sets are available upon request.

sets. The reason for this is that the upper bound on γ_b^E is determined by sample moments that compute averages over very large number of observations. Consequently, the standard error of these moments is very small and this boundary of the estimated set is very similar to the corresponding boundary of the confidence set.

8 Concluding Remarks

This paper uses moment inequalities to structurally estimate a dynamic model of firm entry into spatially related export markets. In recent years, longitudinal data containing information on the output volume that individual firms export to each destination country in the world has become available.[39] A common feature of these datasets is that, no matter how narrowly we define the group of firms we want to examine, there is always variation across them in the destination countries they choose to serve. Therefore, modeling firms' entry decisions into individual countries becomes a crucial element of any structural model that tries to examine trade flows at the firm level.

Concurrent with the increased availability of firm-level destination-specific export data, interest in the structural estimation of models of export entry has grown. We focus on the study of the interactions between destination markets and introduce the concept of *extended gravity* in order to denote such interactions. Trade theory had traditionally attempted to explain trade flows by focusing exclusively on the characteristics of each exporting-importing country pair. In these models, the entry decision in each country is independent of the decision taken in any other market. Models that allow for country-specific entry costs and extended gravity effects imply that firms' decisions to enter each country are intrinsically dynamic and cannot be analyzed separately from the corresponding decisions for the other countries. This makes the decision of firms extremely complex. It is precisely this complexity that makes moment inequalities ideal.

Although our moment inequality analysis has the advantage of allowing for a very flexible specification of firms' expectations, information sets, and consideration sets, and for a non-parametric treatment of expectational and measurement errors, it also has limitations. In particular, it assumes away the existence of firm-country specific factors that influence entry decisions but are not in the data. If these unobservable factors are correlated across countries that are connected through some extended gravity variable, then our moment inequality estimates might not be capturing state dependence in trade costs but rather the effect of unobserved heterogeneity in country specific potential export profits. While we cannot control

[39]This data is collected by national customs agencies. A nonexhaustive list of countries that have made their data available for research are: Chile (Alvarez et al., 2008), Brazil (Arkolakis and Muendler, 2011), Argentina (Albornoz et al., 2012), China (Defever et al., 2011), France (Eaton et al., 2011; Buono and Fadinger, 2012), Colombia (Eaton et al., 2008), Ireland (Lawless, 2009), Peru (Martincus and Carballo, 2008), Denmark (Munch and Nguyen, 2010), and Portugal (Bastos and Silva, 2010).

for the existence of structural errors in our moment inequality estimation, we present reduced form evidence that accounts for such errors. In particular, we estimate a large set of binary mixed logit specifications that allow for normally distributed firm-country specific random effects with different spatial correlation patterns. All these specifications show that firms are more likely to enter countries that share a border with one of their previous destinations.

In conclusion, our results indicate that both gravity and extended gravity forces are important determinants of firms' entry costs. In particular, our estimates show that extended gravity effects based on border are both statistically and economically significant.

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Appendix

A.1 Data Description

Our data come from two separate sources. The first is an extract of the Chilean customs database, which covers the universe of exports of Chilean firms from 1995 to 2005. The second is the Chilean Annual Industrial Survey (*Encuesta Nacional Industrial Anual*, or ENIA), which includes all manufacturing plants with at least 10 workers for the same years. We merge these two data sets using firm identifiers.[40] We restrict our analysis to firms in sector 24 of the ISIC rev.3.1 industrial classification: chemicals and chemical products.

Our data set includes both exporters and non-exporters. Furthermore, in order to minimize the risk of selection bias in our estimates, we use an unbalanced panel that includes not only those firms that appear in ENIA in every year between 1995 and 2005 but also those that were created or disappeared during this period.[41]

An observation is a firm-country-year combination. In the chemical sector, the per-year average number of firm-country pairs with positive exports is approximately 650, out of which around 150 events correspond to firms that were not exporting to this country in the previous period, and around 125 of them correspond to firms that do not continue exporting to the same country in the following year. These export events are generated by, on average, 110 different firms exporting to around 70 countries in total. For each observation we have information on the value of goods sold in USD. We obtain sales in 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 and names of bordering countries for each destination market from CEPII.[42] We collect data on real GDP and real GDP per capita from the World Bank World Development Indicators.[43] We construct our gravity and extended gravity variables from these country characteristics. The gravity measures compare Chile with each export destination. We create individual dummies that indicate if these export destinations share Chile's language, continent, GDP per capita category, or borders.

The following table describes the variables that appear in at least one of the tables presented in the paper. The first column contains the symbol used in these tables to refer to each variable. The second column indicates the dimensions on which each variable may vary: i denotes firm, j denotes country, and t denotes time. For example, it denotes a variable that might vary across firm-year pairs (and that, therefore, is invariant across countries for the same firm and year); ijt denotes a variable that might vary across firm-country-year triplets. The third column contains the description of the corresponding variable.

[40] We aggregate the information from ENIA across plants in order to obtain firm-level information that matches the customs data. There are some cases in which firms are identified as exporters in ENIA but do not have any exports listed with customs. In these cases, we assume that the customs database is more accurate in this respect and thus label these firms as non-exporters.

[41] From our sample, we exclude only firms that appear in ENIA less than three consecutive years.

[42] Available at http://www.cepii.fr/anglaisgraph/bdd/distances.htm. Mayer and Zignago (2006) provide a detailed explanation of the content of this database.

[43] The World Bank classifies countries into four groups (low, lower middle, upper middle and high income) based on their GDP per capita. The World Bank built these classifications using 2002 income per capita. Low income is 735 USD or less, lower middle income is 736 USD to 2,935 USD, upper middle income is 2,936 USD to 9,075 USD and high income is 9,076 USD or more. Chile belongs to the upper middle income group.

Table A.1: Variables

Symbol	Variation	Description
Emp.	it	Total number of workers.
Chile	j	Dummy for destination market being Chile.
Sk. Emp.	it	Total number of skilled workers.
Unsk. Emp.	it	Total number of unskilled workers.
Avg. Sk. Wage	it	Average wage of skilled workers.
Avg. Unsk. Wage	it	Average wage of unskilled workers.
VA/Emp	it	Value added per worker.
Domestic Revenue	it	Total sales in Chile.
Grav. Dist	j	Number of kilometers between the capital of country j and Santiago de Chile (in logs).
Grav. Border	j	Dummy for j *not* sharing a border with Chile.
Grav. Cont.	j	Dummy for j *not* being located in South America.
Grav. Lang.	j	Dummy for Spanish *not* being official language in j.
Grav. GDPpc	j	Dummy for j *not* being in the upper-middle GDPpc group.
Grav. FTA	jt	Dummy for j *not* having a FTA with Chile at t.
Landlocked	j	Dummy for j being landlocked.
Agg. Imports	jt	Total sectoral imports by j from countries other than Chile (in logs).
GDPpc	jt	GDP per capita in j at t.
Ext. Grav. Border	ijt	Dummy for j sharing a border with at least one export destination of firm i in the previous year.
Ext. Grav. Cont.	ijt	Dummy for j sharing continent with at least one export destination of firm i in the previous year.
Ext. Grav. Lang.	ijt	Dummy for j sharing language with at least one export destination of firm i in the previous year.
Ext. Grav. GDPpc	ijt	Dummy for j sharing GDPpc with at least one export destination of firm i in the previous year.
Entry	ijt	Dummy for firm i not exporting to country j at period $t-1$.

A.2 Revenue Regression

The following table contains the NLLS estimates from the projection of observed revenue from exporting on a nonlinear function of firm, country, and year characteristics. Formally, the point estimates in Table A.2 are computed as the solution to the following minimization problem

$$\underset{\hat{\alpha}}{\operatorname{argmin}} \sum_{i,j,t} \Big[d_{ijt} \times \big(\text{revenue}_{ijt} - \exp(\hat{\alpha} x^R_{ijt})^2 \big) \Big]. \tag{26}$$

The estimate $\hat{\alpha}$ will be consistent for the true parameter vector α if and only if

$$\mathbb{E}[\text{revenue}_{ijt} - \exp(\alpha x^R_{ijt}) | x^R_{ijt}, d_{ijt} = 1] = 0.$$

Each of the six different specifications in Table A.2 corresponds to a different vector x^R_{ijt}.

Table A.2: Revenue Regressions

Variables: (β)	I	II	III	IV	V	VI
log(Domestic Revenue)	-	0.386^a (29.186)	-	-	-	0.328^a (20.892)
Emp. × Chile	0.444^a (13.476)	0.142^a (7.201)	0.380^a (11.504)	-	0.184^a (5.301)	-
Sk. Emp.	0.057^b (2.184)	-	0.103^a (4.413)	0.258^a (14.207)	0.236^a (9.775)	-
Unsk. Emp.	-0.002 (-0.145)	-	0.015 (1.339)	0.078^a (8.128)	0.091^a (8.182)	-
Avg. Sk. Wage	0.643^a (4.736)	-	0.816^a (5.591)	0.069^a (5.146)	0.063^a (4.386)	-
Avg. Unsk. Wage	0.009^a (2.751)	-	0.004^c (1.286)	-0.003 (-0.978)	-0.008^a (-2.411)	-
VA/Emp.	0.369^a (24.400)	-	0.341^a (22.632)	0.333^a (22.244)	0.307^a (19.589)	-
Grav. Dist.	-0.638^a (-8.100)	-0.526^a (-6.461)	-0.538^a (-8.096)	-0.617^a (-7.768)	-0.596^a (-8.285)	-1.337^a (-46.453)
Grav. Border	1.206^a (11.504)	1.157^a (10.722)	0.839^a (9.221)	1.195^a (11.219)	0.978^a (10.044)	-
Grav. Cont.	-0.079 (-0.706)	-0.089 (-0.795)	-0.421^a (-4.047)	-0.208^b (-1.827)	-0.531^a (-4.788)	-
Grav. Lang.	-0.084^c (-1.614)	-0.311^a (-6.188)	0.122^a (2.493)	-0.059 (-1.118)	-0.030 (-0.567)	-
Grav. GDPpc	-1.013^a (-3.352)	-1.388^a (-2.968)	-0.143^b (-1.839)	-0.999^a (-2.925)	-0.170^b (-2.110)	-
Grav. FTA	0.202^a (4.439)	-0.182^a (-4.101)	0.237^a (5.241)	0.200^a (4.332)	0.199^a (4.274)	-
Landlocked	-1.234^c (-1.447)	-1.289^b (-1.856)	-0.991^c (-1.334)	-1.127^c (-1.494)	-1.267 (-1.247)	-
Agg. Imports	0.857^a (30.755)	0.871^a (31.649)	-0.782^a (29.503)	0.849^a (30.241)	0.833^b (29.788)	1.107^a (41.867)
GDPpc	-0.067^a (-3.440)	-0.109^a (-5.616)	-0.055^a (-2.899)	-0.067^a (-3.449)	-0.523^a (-2.488)	-
Ext. Grav. Border	-0.205^a (-6.259)	-0.282^a (-8.125)	-	-0.202^a (-6.111)	-	-
Ext. Grav. Cont.	-0.449^a (-9.590)	-0.501^a (-8.671)	-	-0.346^a (-7.136)	-	-
Ext. Grav. Lang.	0.029 (0.883)	0.395^a (10.863)	-	0.033 (0.967)	-	-
Ext. Grav. GDPpc	0.966^a (3.289)	1.617^a (3.492)	-	0.954^a (2.853)	-	-
Entry	-11.028^a (-3.309)	-5.299 (-0.708)	-15.916^a (-6.956)	-10.237^a (-3.095)	-	-
Entry × Grav. Dist.	1.464^a (3.116)	0.593 (0.566)	2.147^a (6.817)	1.387^a (2.997)	-	-

Table A.2: Revenue Regressions (cont.)

Variables: (β)	I	II	III	IV	V	VI
Entry × Grav. Border	-2.296[b] (-1.933)	-0.610 (-0.377)	-3.318[a] (-2.777)	-2.493[b] (-2.044)	-	-
Entry × Grav. Cont.	-1.695[c] (-1.371)	-1.028 (-0.793)	-1.451 (-1.153)	-1.251 (-0.993)	-	-
Entry × Grav. Lang.	-1.055[a] (-4.053)	-1.452[a] (-3.146)	-1.097[a] (-4.083)	-1.075[a] (-4.030)	-	-
Entry × Grav. GDPpc	0.770 (1.159)	2.296[b] (2.242)	-0.045 (-0.083)	0.984[c] (1.368)	-	-
Entry × Ext. Grav. Border	-1.000[a] (-2.997)	-0.409 (-0.769)	-	-0.954[a] (-2.752)	-	-
Entry × Ext. Grav. Cont.	1.264[a] (4.172)	1.267[c] (1.507)	-	0.782[a] (2.635)	-	-
Entry × Ext. Grav. Lang.	0.394[c] (1.307)	-0.975 (-0.884)	-	0.357 (1.144)	-	-
Entry × Ext. Grav. GDPpc	-0.734[b] (-2.018)	-2.385[a] (-2.633)	-	-0.824[b] (-2.073)	-	-
Adj. R^2	0.8715	0.8876	0.8632	0.8633	0.8496	0.8216
Num. Obs.	8219	8219	8219	8219	8219	8219

Notes: *a* denotes 1% significance, *b* denotes 5% significance, *c* denotes 10% significance. Heteroskedasticity-robust t-statistics are in parentheses. The dependent variable is firm-country-year level observed revenue (conditional on being positive). Year and firm dummies are included. Interaction terms between year dummies and a dummy for selling in Chile are also included.

We use the estimates of α, reported in Table A.2, to predict the revenue that each firm i would obtain from exporting to market j at period t as

$$\widehat{\text{revenue}}_{ijt} = \hat{\alpha} x^R_{ijt}.$$

Table A.3 contains the pairwise correlation coefficient across the six different vectors $\{\widehat{\text{revenue}}_{ijt}, \forall\ i, j, t\}$ generated from the six different specifications included in Table A.2. As this table shows, independently of the specific vector x^R_{ijt} on which we project the observed revenues, the predicted revenues are always very similar.

Table A.3: Revenue - Correlation Matrix

Specification	I	II	III	IV	V	VI
I	1.000					
II	0.938	1.000				
III	0.994	0.956	1.000			
IV	0.908	0.951	0.943	1.000		
V	0.982	0.948	0.986	0.934	1.000	
VI	0.787	0.900	0.832	0.930	0.847	1.000

A.3 Reduced-Form Evidence: Robustness

The six columns in Table A.4 re-estimate the specification in column I of Table 2 using the six different vectors of predicted revenues generated by the six specifications presented in Table A.2. The high pairwise correlation shown in Table A.3 implies that the estimates of the logit model do not vary significantly, independently of the revenue model that we impose.

Table A.4: Logit: Firm-Specific Random Effects

Variables: (β)	I	II	III	IV	V	VI
Revenue	0.014^a	0.014^a	0.012^a	0.018^a	0.027^a	0.022^a
	(5.415)	(4.439)	(4.970)	(6.021)	(11.701)	(9.001)
Grav. Border	-0.315^a	-0.317^a	-0.310^a	-0.318^a	-0.313^a	-0.245^a
	(-3.184)	(-3.207)	(-3.136)	(-3.219)	(-3.169)	(-2.479)
Grav. Cont.	-0.037	-0.057	-0.033	-0.036	-0.050	-0.029
	(-0.356)	(-0.535)	(-0.317)	(-0.342)	(-0.479)	(-0.272)
Grav. Lang.	-0.724^a	-0.713^a	-0.719^a	-0.749^a	-0.762^a	-0.748^a
	(-7.660)	(-7.477)	(-7.567)	(-7.931)	(-8.237)	(-7.948)
Grav. GDPpc	0.179^a	0.148^b	0.174^b	0.181^a	0.177^a	0.179^a
	(2.334)	(1.910)	(2.284)	(2.375)	(2.325)	(2.320)
Grav. FTA	-0.302^a	-0.299^a	-0.308^a	-0.302^a	-0.284^a	-0.321^a
	(-4.978)	(-4.801)	(-5.075)	(-4.982)	(-4.665)	(-5.200)
Entry	-2.179^a	-2.205^a	-2.165^a	-2.160^a	-2.164^a	-2.780^a
	(-3.875)	(-3.901)	(-3.847)	(-3.844)	(-3.858)	(-4.883)
Entry ×	-0.124^b	-0.121^c	-0.127^b	-0.127^b	-0.128^b	-0.049
Grav. Dist.	(-1.657)	(-1.603)	(-1.691)	(-1.695)	(-1.713)	(-0.639)
Entry ×	-0.919^a	-0.934^a	-0.917^a	-0.909^a	-0.924^a	-0.925^a
Grav. Border	(-6.794)	(-6.883)	(-6.776)	(-6.715)	(-6.828)	(-6.785)
Entry ×	-1.032^a	-1.036^a	-1.034^a	-1.029^a	-0.975^a	-1.080^a
Grav. Cont.	(-6.930)	(-6.913)	(-4.898)	(-6.912)	(-6.557)	(-7.213)
Entry ×	-0.145	-0.160	-0.149	-0.121	-0.177^c	-0.231^b
Grav. Lang.	(-1.149)	(-1.244)	(-1.174)	(-0.951)	(-1.428)	(-1.832)
Entry ×	-0.726^a	-0.717^a	-0.722^a	-0.727^a	-0.715^a	-0.707^a
Grav. GDPpc	(-6.498)	(-6.341)	(-6.458)	(-6.504)	(-6.188)	(-6.246)
Entry ×	0.761^a	0.791^a	0.749^a	0.765^a	0.696^a	0.739^a
Ext. Grav. Border	(9.814)	(10.001)	(9.657)	(9.865)	(8.950)	(9.328)
Entry ×	1.552^a	1.517^a	1.560^a	1.495^a	1.523^b	1.508^a
Ext. Grav. Cont.	(17.003)	(16.345)	(17.091)	(16.969)	(16.621)	(16.159)
Entry ×	0.277^a	0.269^a	0.284^a	0.275^a	0.224^b	0.226^b
Ext. Grav. Lang.	(2.847)	(2.669)	(2.914)	(2.828)	(2.266)	(2.218)
Entry ×	0.708^a	0.751^a	0.709^a	0.706^a	0.701^a	0.732^a
Ext. Grav. GDPpc	(7.810)	(8.177)	(7.826)	(7.782)	(7.704)	(7.932)
Std. Dev. RE: (σ_g)	9.374^a	9.380^a	9.372^a	9.365^a	9.346^a	9.375^a
	(9.227)	(9.236)	(9.224)	(9.218)	(9.202)	(9.232)
Log-likelihood	-0.085	-0.072	-0.070	-0.073	-0.059	-0.059

Each of the seven columns in Table A.5 presents estimates for a model that only differs from that in the corresponding column in Table 2 in that the covariate revenue$_{ijt}$ is substituted by the vector [Domestic Revenue, Domestic Revenue × Grav. Dist., Domestic Revenue ×

Agg. Imports]. The estimates of the vector $(\beta_2, \beta_3, \beta_4, \beta_5)$ in Table A.5 are very similar to those in Table 2.

Table A.5: Logit: Firm-Specific Random Effects

Variables: (β)	I	II	III	IV	V	VI	VII
Domestic Revenue	-0.707^a	-0.671^a	0.289	0.648^a	-0.375^c	0.545^a	-1.119^a
	(-3.177)	(-3.135)	(1.111)	(3.244)	(-1.336)	(3.004)	(-4.737)
Domestic Revenue × Grav. Dist.	-0.014	-0.014	-0.111^a	-0.133^a	-0.119^a	-0.142^a	-0.128^a
	(-0.542)	(-0.545)	(-4.263)	(-4.524)	(-4.199)	(-4.398)	(-4.490)
Domestic Revenue × Agg. Imports	0.052^a	0.050^a	0.051^a	0.038^a	0.089^a	0.049^a	0.135^a
	(3.322)	(3.329)	(3.124)	(2.373)	(5.046)	(3.139)	(7.163)
Grav. Border	-0.307^a	-0.256^a	-0.128^c	-0.196^b	-0.178^b	-0.058	-0.411^a
	(-3.107)	(-2.631)	(-1.328)	(-2.046)	(1.788)	(-0.603)	(-3.927)
Grav. Cont.	-0.044	-0.050	-0.228^b	-0.209^b	-0.051	-0.302^a	-0.944^a
	(-0.413)	(-0.479)	(-2.303)	(-2.045)	(-0.494)	(-3.124)	(-8.596)
Grav. Lang.	-0.634^a	-0.605^a	-0.533^a	-0.541^a	-0.539^a	-0.457^a	-1.055^a
	(-6.713)	(-6.533)	(-6.231)	(-5.872)	(-6.087)	(-5.431)	(-10.824)
Grav. GDPpc	0.153^b	0.105^c	0.107^c	0.149^b	0.043	0.011	0.775^a
	(1.977)	(1.423)	(1.481)	(2.026)	(0.587)	(0.152)	(8.286)
Grav. FTA	-0.293^a	-0.254^a	-0.305^a	-0.301^a	-0.272^a	-0.329^a	-0.329^a
	(-4.701)	(-4.088)	(-4.985)	(-4.961)	(-4.404)	(-5.464)	(-4.975)
Entry	-2.199^a	-2.357^a	-2.791^a	-3.011^a	-3.525^a	-3.086^a	-1.784^a
	(-3.873)	(-4.191)	(-5.092)	(-5.482)	(-6.104)	(-5.692)	(-3.205)
Entry × Grav. Dist.	-0.121^c	-0.128^b	-0.056	0.025	0.036	-0.042	-0.195^a
	(-1.606)	(-1.708)	(-0.774)	(0.344)	(0.464)	(-0.577)	(-2.640)
Entry × Grav. Border	-0.938^a	-0.937^a	-1.111^a	-1.081^a	-1.188^a	-1.176^a	-0.833^a
	(-6.912)	(-6.970)	(-8.294)	(-8.111)	(-8.631)	(-8.837)	(-5.829)
Entry × Grav. Cont.	-1.059^a	-0.904^a	-0.753^a	-1.096^a	0.182	-0.801^a	-0.411^a
	(-7.031)	(-6.045)	(-5.186)	(-7.585)	(1.243)	(-5.792)	(-2.699)
Entry × Grav. Lang.	-0.253^b	-0.243^b	-0.533^a	-0.282^b	-0.461^a	-0.137	-0.269^b
	(-1.988)	(-1.930)	(-4.445)	(-2.271)	(-3.817)	(-1.147)	(-2.105)
Entry × Grav. GDPpc	-0.721^a	-0.588^a	-0.551^a	-0.674^a	-0.246^b	-0.347^a	-0.411^a
	(-6.354)	(-5.492)	(-4.936)	(-6.003)	(-2.303)	(-3.310)	(-2.698)
Entry × Ext. Grav. Border	0.775^a	0.848^a	0.797^a	0.875^a	0.704^a	0.941^a	0.451^a
	(9.771)	(11.108)	(10.594)	(11.730)	(9.353)	(13.023)	(5.925)
Entry × Ext. Grav. Cont.	1.538^a	1.256^a	1.289^a	1.474^a	0.196^b	1.174^a	0.898^a
	(16.488)	(13.747)	(14.098)	(16.785)	(2.139)	(14.036)	(10.178)
Entry × Ext. Grav. Lang.	0.293^a	0.298^a	0.249^a	0.223^b	-0.102	-0.112	-0.101
	(2.872)	(3.024)	(2.604)	(2.298)	(-1.032)	(-1.278)	(-1.054)
Entry × Ext. Grav. GDPpc	0.743^a	0.676^a	0.615^a	0.593^a	0.269^a	0.434^a	-0.171
	(8.078)	(7.782)	(6.601)	(6.554)	(3.163)	(5.261)	(-1.650)
Std. Dev. RE: (σ_g)	9.383^a	8.881^a	9.079^a	9.265^a	5.723^a	8.089^a	3.512^a
	(9.238)	(8.736)	(8.933)	(9.127)	(5.600)	(7.926)	(3.465)
Log-likelihood	-0.085	-0.072	-0.070	-0.072	-0.058	-0.059	-0.059

A.4 Effect of Omitting Extended Gravity Terms

Table A.6 differs from Table 2 only in that the specifications estimated in the former assume that $\beta_5 = 0$.

Table A.6: Logit: Firm-Specific Random Effects

Variables: (β)	I	II	III	IV	V	VI	VII
Revenue	0.017^a	0.015^a	0.018^a	0.015^a	0.015^a	0.016^a	0.020^a
	(5.704)	(5.499)	(6.491)	(5.343)	(5.775)	(5.650)	(6.499)
Grav. Border	-0.330^a	-0.291^a	-0.159	-0.197^b	-0.268^a	-0.198^b	-0.489^a
	(-3.328)	(-2.976)	(-1.328)	(-2.049)	(-2.625)	(-1.925)	(-4.621)
Grav. Cont.	0.033	0.022	-0.158	-0.195^b	0.067	-0.398^a	-1.166^a
	(0.309)	(0.214)	(-1.579)	(-1.905)	(0.644)	(-4.014)	(-10.459)
Grav. Lang.	-0.853^a	-0.752^a	-0.718^a	-0.651^a	-0.651^a	-0.281^a	-1.095^a
	(-8.878)	(-7.941)	(-8.236)	(-7.013)	(-7.211)	(-3.169)	(-9.699)
Grav. GDPpc	0.175^b	0.147^b	0.209^a	0.223^b	0.106	0.117	0.374^a
	(2.271)	(2.003)	(2.871)	(3.043)	(1.413)	(1.564)	(3.677)
Grav. FTA	-0.377^a	-0.266^a	-0.359^a	-0.407^a	-0.306^a	-0.462^a	-0.424^a
	(-5.966)	(-4.273)	(-5.733)	(-6.673)	(-4.828)	(-7.524)	(-6.536)
Entry	-1.767^a	-2.462^a	-2.393^a	-2.743^a	-3.791^a	-3.742^a	-1.973^a
	(-3.208)	(-4.382)	(-4.356)	(-5.104)	(-6.627)	(-7.002)	(-3.618)
Entry ×	-0.181^b	-0.111	-0.107	-0.060	0.081	0.064	-0.172^b
Grav. Dist.	(-2.481)	(-1.481)	(-1.473)	(-0.833)	(1.059)	(0.907)	(-2.378)
Entry ×	-0.639^a	-0.645^a	-0.836^a	-0.807^a	-0.967^a	-0.867^a	-0.614^a
Grav. Border	(-4.787)	(-4.916)	(-6.302)	(-6.181)	(-7.086)	(-6.456)	(-4.375)
Entry ×	-0.325^b	-0.149	-0.025	-0.538^a	0.305^b	-0.551^a	0.087
Grav. Cont.	(-2.226)	(-1.030)	(-0.171)	(-3.935)	(2.228)	(-4.125)	(0.600)
Entry ×	-0.428^b	-0.442^a	-0.622^a	-0.329^a	-0.479^a	0.098	-0.281^b
Grav. Lang.	(-3.329)	(-3.503)	(-5.026)	(-2.698)	(-4.041)	(0.819)	(-2.094)
Entry ×	-0.245^b	-0.293^a	-0.121^a	-0.299^a	-0.197^b	-0.321^a	-0.188^b
Grav. GDPpc	(-2.461)	(-3.088)	(-1.249)	(-3.073)	(-2.064)	(-3.358)	(-1.875)
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)	8.913^a	8.191^a	8.273^a	9.855^a	5.447^a	6.514^a	3.721^a
	(8.773)	(8.745)	(8.115)	(8.714)	(5.343)	(6.363)	(3.666)
Log-likelihood	-0.088	-0.074	-0.072	-0.075	-0.058	-0.059	-0.060
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 dependent variable is a dummy variable for positive exports. The explanatory variable Revenue denotes predicted revenue, as generated by the estimates in Column I of Table A.2. 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 effects.

A comparison of Tables A.6 and 2 show that the main effects of assuming $\beta_5 = 0$ on the estimates of $(\beta_1, \beta_2, \beta_3, \beta_4)$ are large increases in the coefficients on "Entry × Grav. Cont." and "Entry × Grav. GDPpc".

A.5 Microfoundation of Revenue and Gross Profits Functions

This section provides a microfoundation for equation (2). This microfoundation is based on specifying: (a) a demand function in j for products supplied by i; (b) a marginal cost function for i of selling products in j; and (c) a particular market structure in j.

Demand. Each country j is populated by a representative consumer who has a constant elasticity of substitution (CES) utility function over different varieties i:

$$Q_{jt} = \Big[\int_{i \in A_{jt}} q_{ijt}^{\frac{\eta-1}{\eta}} \, di \Big]^{\frac{\eta}{\eta-1}}, \qquad \eta > 1,$$

where A_{jt} represents the set of available varieties, η is the elasticity of substitution between varieties, and q_{ijt} is the consumption of variety i in country j at t. Given this utility function, the resulting demand for each variety is

$$q_{ijt} = q_{jt}(p_{ijt}) = \frac{p_{ijt}^{-\eta}}{P_{jt}^{1-\eta}} C_{jt},$$

where $q_{jt}(\cdot)$ is the demand function, C_{jt} is the total consumption of country j in the sector to which variety i belongs, and P_{jt} is the sectoral price index in country j:

$$P_{jt} = \Big[\int_{i \in A_{jt}} p_{ijt}^{1-\eta} di \Big]^{\frac{1}{1-\eta}}.$$

Supply. Firms face a constant marginal cost per unit of output shipped to market j.[44] It includes production costs, transport costs, taxes and tariffs, and it is denoted as mc_{ijt}.

Market structure. Each variety is sold monopolistically in each destination country by a single-product firm. We identify each firm by the same subindex i that identifies varieties.

Revenue function. Given this demand, marginal cost, and market structure, firms optimally set their price in j as a constant markup over marginal cost:

$$p_{ijt} = \frac{\eta}{\eta - 1} mc_{ijt}.$$

Plugging this price into the demand function, $q_{jt}(\cdot)$, we obtain the true potential export revenue of i in j:

$$r^*_{ijt} = \Big(\frac{\eta}{\eta - 1} \frac{mc_{ijt}}{P_{jt}} \Big)^{1-\eta} C_{jt}. \tag{27}$$

We assume that we can write the export revenue of i in j at t that would be observed if i were to export to j at t as:

$$r_{ijt} = r^o_{ijt} + u^R_{ijt}, \tag{28}$$

[44] Constant marginal costs are convenient because, conditional on a firm exporting a positive amount to a set of countries, the supply decision in any of these countries is independent of the supply decision in the others.

where u^R_{ijt} accounts both for measurement error in revenues and for elements r^*_{ijt} that are unobserved to the econometrician.

Gross profits function. Fixed markups and constant marginal costs imply that the maximum gross profits for i in j at t are proportional to revenue:

$$v_{ijt} = \eta^{-1} r_{ijt}, \tag{29}$$

yielding an expression identical to equation (2b).

A.6 Proof of Proposition 1

The proof of Proposition 1 comes directly from Assumption 1. From equation (8) we know that:

$$\mathbb{E}[\pi_{io_t o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o_t t+1} + \omega_{i\mathbf{o}_{t+1} t+2} | \mathcal{J}_{it}] \geq \mathbb{E}[\pi_{io'_t o_{t-1} t} + \delta \pi_{i\mathbf{o}'_{t+1} o'_t t+1} + \omega_{i\mathbf{o}'_{t+1} t+2} | \mathcal{J}_{it}],$$

with

$$\mathbf{o}_{t+1} = \underset{b_{t+1} \in \mathcal{B}_{it+1}}{\text{argmax}} \; \mathbb{E}\big[\Pi_{ib_{t+1} o_t t+1} | \mathcal{J}_{it+1}\big],$$

and

$$\mathbf{o}'_{t+1} = \underset{b_{t+1} \in \mathcal{B}_{it+1}}{\text{argmax}} \; \mathbb{E}\big[\Pi_{ib_{t+1} o'_t t+1} | \mathcal{J}_{it+1}\big].$$

By transitivity of preferences,

$$\mathbb{E}[\pi_{io_t o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o_t t+1} + \omega_{i\mathbf{o}_{t+1} t+2} | \mathcal{J}_{it}] \geq \mathbb{E}[\pi_{io'_t o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o'_t t+1} + \omega_{i\mathbf{o}_{t+1} t+2} | \mathcal{J}_{it}],$$

where $\mathbf{o}_{t+1}$ is a random variable whose realization is still unknown in period t. Canceling terms on both sides:

$$\mathbb{E}[\pi_{io_t o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o_t t+1} | \mathcal{J}_{it}] \geq \mathbb{E}[\pi_{io'_t o_{t-1} t} + \delta \pi_{i\mathbf{o}_{t+1} o'_t t+1} | \mathcal{J}_{it}]. \quad \text{Q.E.D.}$$

A.7 Specifying Moments: Details

In Section 7, we show results for three different estimated sets: $\hat{\Theta}^1_\gamma$, in Table 7; $\hat{\Theta}^2_\gamma$, in column I of Table 8; and $\hat{\Theta}^3_\gamma$ in column II of Table 8. We denote the sets of moment inequalities that define these three estimated sets as $\mathcal{K}_1$, $\mathcal{K}_2$, and $\mathcal{K}_3$, respectively. Following the notation in the main text, we use k to index each individual moment and K_n to denote the total number of moments included in the set of inequalities $\mathcal{K}_n$, for $n = 1, 2, 3$.

Each moment k is identified by an instrument function $g_k(Z_{it})$. This function is the outcome of multiplying two components:

$$g_k(Z_{it}) = w_{s(k)}(Z_{it}) \times \iota_{l(k)}(Z_{it}),$$

where $w(Z_{it})$ is a *weight function* taking strictly positive values for every Z_{it} and $\iota(Z_{it})$ is an *indicator function*. We index the weight functions by s, $s = 1, \ldots, S$, where $s(k)$ denotes the weight function employed in moment inequality k. Analogously, we index the indicator functions by l, $l = 1, \ldots, L$, where $l(k)$ denotes the indicator function employed in moment inequality k.

The indicator function $\iota_{l(k)}(Z_{it})$ assigns a value of one to those observations it and counterfactual deviations that are included in moment k (equations (15) and (20) are two examples of such indicator functions). Following Section 5, we split the set of L indicator functions into those that define counterfactuals based on adding or dropping destinations, $l = 1, \ldots, L^a$, and those that define counterfactuals based on swapping export destinations, $l = L^a + 1, \ldots, L$.

The weight function $w_{s(k)}(Z_{it})$ assigns different relative weights to those observations it and counterfactual deviations included in moment k. In other words, while the indicator function $\iota_{l(k)}(Z_{it})$ selects the set of it observations and counterfactuals that are included in k, the weight function $w_{s(k)}(Z_{it})$ assigns different weights to each of these selected observations. For the sake of simplicity in exposition, all the examples in Section 5 assume a constant weight function $w_{s(k)}(Z_{it}) = 1$. In generating the estimated sets $\hat{\Theta}^1_\gamma$, $\hat{\Theta}^2_\gamma$, and $\hat{\Theta}^3_\gamma$, we have explored the implications of using different weight functions. The only restriction that Assumption 3 imposes on the argument of the weight function $w_{s(k)}(Z_{it})$ is that it should belong to firm i's information set at period t. Specifically, for each observation it, we have explored weighting this observation by different functions of: (a) firm i's valued added in $t-1$; and (b) both aggregate imports at $t-1$ and geographic distance to Chile of the destination countries in which firm i's export status in period t differs between actual and counterfactual bundles. The estimated sets $\hat{\Theta}^1_\gamma$, $\hat{\Theta}^2_\gamma$, and $\hat{\Theta}^3_\gamma$ are robust to different specifications of these weight functions.

The sets of moments $\mathcal{K}_1$, $\mathcal{K}_2$, and $\mathcal{K}_3$ differ crucially in the indicator functions used to define the corresponding moments. The reason for the difference is that each of these sets aims to identify bounds for a different parameter vector.

Indicator Functions for the Set of Moments $\mathcal{K}_1$

The set of moments $\mathcal{K}_1$ aims to separately identify each of the twelve parameters entering our fixed and sunk costs functions:

$$(\gamma^F_0, \gamma^F_c, \gamma^F_g, \gamma^F_l, \gamma^S_0, \gamma^S_c, \gamma^S_g, \gamma^S_l, \gamma^E_b, \gamma^E_c, \gamma^E_g, \gamma^E_l).$$

Consequently, the set $\mathcal{K}_1$ includes moments that allow us to separately identify the effect of continent, language, and GDPpc differences on both fixed and sunk costs. These moments modify firms' strategies in countries that differ from Chile exclusively in one of these three gravity dimensions. As an example, we try to identify the effect of differences in language on sunk export costs by modifying firms' export entry strategies in countries that differ from Chile in their official language. Analogously, we try to identify the effect of differences in language on fixed export costs by modifying the firms' exit strategies in destinations whose official language is not Spanish.

The set of indicator functions $\{\iota_l(Z_{it}), l = 1, \ldots, L^a\}$ aims to identify upper and lower bounds for the constant terms in fixed and sunk costs (i.e. γ^F_0 and γ^S_0):

$$\iota_1 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 1, d_{ijt} = 0\},$$
$$\iota_2 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 1, d_{ijt} = 1\},$$
$$\iota_3 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 0\},$$
$$\iota_4 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 1\}.$$

The indicator functions that the alter the export bundle of firm i at period t by switching the export participation decision in some country j to some other country j', $\{\iota_l(Z_{it}), l =$

$L^a+1,\ldots,L\}$, are:

$$\iota_5 = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, (\text{Grav. Cont.})_{j'} = 0, d_{ijt-1} = 1, d_{ijt} = 1, d_{ij't-1} = 1, d_{ij't} = 0\},$$
$$\iota_6 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Cont.})_{j'} = 1, d_{ijt-1} = 1, d_{ijt} = 1, d_{ij't-1} = 1, d_{ij't} = 0\},$$
$$\iota_7 = \mathbb{1}\{(\text{Grav. Lang.})_j = 1, (\text{Grav. Lang.})_{j'} = 0, d_{ijt-1} = 1, d_{ijt} = 1, d_{ij't-1} = 1, d_{ij't} = 0\},$$
$$\iota_8 = \mathbb{1}\{(\text{Grav. Lang.})_j = 0, (\text{Grav. Lang.})_{j'} = 1, d_{ijt-1} = 1, d_{ijt} = 1, d_{ij't-1} = 1, d_{ij't} = 0\},$$
$$\iota_9 = \mathbb{1}\{(\text{Grav. GDPpc})_j = 1, (\text{Grav. GDPpc})_{j'} = 0, d_{ijt-1} = 1, d_{ijt} = 1, d_{ij't-1} = 1, d_{ij't} = 0\},$$
$$\iota_{10} = \mathbb{1}\{(\text{Grav. GDPpc})_j = 0, (\text{Grav. GDPpc})_{j'} = 1, d_{ijt-1} = 1, d_{ijt} = 1, d_{ij't-1} = 1, d_{ij't} = 0\},$$
$$\iota_{11} = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, (\text{Grav. Cont.})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{12} = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Cont.})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{13} = \mathbb{1}\{(\text{Grav. Lang.})_j = 1, (\text{Grav. Lang.})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{14} = \mathbb{1}\{(\text{Grav. Lang.})_j = 0, (\text{Grav. Lang.})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{15} = \mathbb{1}\{(\text{Grav. GDPpc})_j = 1, (\text{Grav. GDPpc})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{16} = \mathbb{1}\{(\text{Grav. GDPpc})_j = 0, (\text{Grav. GDPpc})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{17} = \mathbb{1}\{(\text{Ext. Grav. Border})_j = 1, (\text{Ext. Grav. Border})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{18} = \mathbb{1}\{(\text{Ext. Grav. Border})_j = 0, (\text{Ext. Grav. Border})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{19} = \mathbb{1}\{(\text{Ext. Grav. Cont.})_j = 1, (\text{Ext. Grav. Cont.})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{20} = \mathbb{1}\{(\text{Ext. Grav. Cont.})_j = 0, (\text{Ext. Grav. Cont.})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{21} = \mathbb{1}\{(\text{Ext. Grav. Lang.})_j = 1, (\text{Ext. Grav. Lang.})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{22} = \mathbb{1}\{(\text{Ext. Grav. Lang.})_j = 0, (\text{Ext. Grav. Lang.})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{23} = \mathbb{1}\{(\text{Ext. Grav. GDPpc})_j = 1, (\text{Ext. Grav. GDPpc})_{j'} = 0, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_{24} = \mathbb{1}\{(\text{Ext. Grav. GDPpc})_j = 0, (\text{Ext. Grav. GDPpc})_{j'} = 1, d_{ijt-1} = 0, d_{ijt} = 1, d_{ij't-1} = 0, d_{ij't} = 0\}.$$

Indicator Functions for the Set of Moments $\mathcal{K}_2$

In contrast with the set of moments $\mathcal{K}_1$, the set of moments $\mathcal{K}_2$ does not aim to separately identify the effect of sharing continent, language, and GDPpc with Chile on both sunk and fixed costs. The set $\mathcal{K}_2$ aims to identify the joint effect that differences in these three gravity variables have on both entry and fixed export costs. Specifically, the parameter vector identified by the set of moments $\mathcal{K}_2$ is:

$$(\gamma_0^F, \gamma_c^F + \gamma_g^F + \gamma_l^F, \gamma_0^S, \gamma_c^S + \gamma_g^S + \gamma_l^S, \gamma_b^E, \gamma_c^E, \gamma_g^E, \gamma_l^E).$$

Therefore, instead of using moment inequalities that alter firms' strategies in countries that differ from Chile exclusively in one of the three gravity dimensions incorporated in our moment inequality estimation, the set $\mathcal{K}_2$ introduces moments that modify firms' export decisions in destinations that differ from Chile simultaneously in continent, language, and GDPpc group. Given that both sets of moments $\mathcal{K}_1$ and $\mathcal{K}_2$ identify bounds for γ_0^F and γ_0^S, the first four indicator functions used to define the set of moments $\mathcal{K}_2$ are identical to the first four indicators used to define $\mathcal{K}_1$:

$$\begin{aligned}
\iota_1 &= \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 1, d_{ijt} = 0\}, \\
\iota_2 &= \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 1, d_{ijt} = 1\}, \\
\iota_3 &= \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 0\}, \\
\iota_4 &= \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 1\}.
\end{aligned}$$

The remaining indicator functions differ between sets $\mathcal{K}_1$ and $\mathcal{K}_2$. Specifically, the set of indicator functions $\{\iota_l(Z_{it}), l = L^a + 1, \ldots, L\}$ only contains twelve elements:

$$\begin{aligned}
\iota_5 = \mathbb{1}\{&(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 1, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 0, \text{Grav. Lang.})_{j'} = 0, (\text{Grav. GDPpc})_{j'} = 0, d_{ij't-1} = 1, d_{ij't} = 0\}, \\
\iota_6 = \mathbb{1}\{&(\text{Grav. Cont.})_j = 0, \text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 1, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 1, d_{ij't} = 0\}, \\
\iota_7 = \mathbb{1}\{&(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 0, \text{Grav. Lang.})_{j'} = 0, (\text{Grav. GDPpc})_{j'} = 0, d_{ij't-1} = 0, d_{ij't} = 0\}, \\
\iota_8 = \mathbb{1}\{&(\text{Grav. Cont.})_j = 0, \text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0\}, \\
\iota_9 = \mathbb{1}\{&(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0, \\
&(\text{Ext. Grav. Border})_j = 1, (\text{Ext. Grav. Border})_{j'} = 0\}, \\
\iota_{10} = \mathbb{1}\{&(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0, \\
&(\text{Ext. Grav. Border})_j = 0, (\text{Ext. Grav. Border})_{j'} = 1\}, \\
\iota_{11} = \mathbb{1}\{&(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0, \\
&(\text{Ext. Grav. Cont.})_j = 1, (\text{Ext. Grav. Cont.})_{j'} = 0\}, \\
\iota_{12} = \mathbb{1}\{&(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1, \\
&(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0, \\
&(\text{Ext. Grav. Cont.})_j = 0, (\text{Ext. Grav. Cont.})_{j'} = 1\},
\end{aligned}$$

$$\iota_{13} = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0,$$
$$(\text{Ext. Grav. Lang.})_j = 1, (\text{Ext. Grav. Lang.})_{j'} = 0\},$$
$$\iota_{14} = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0,$$
$$(\text{Ext. Grav. Lang.})_j = 0, (\text{Ext. Grav. Lang.})_{j'} = 1\},$$
$$\iota_{15} = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0,$$
$$(\text{Ext. Grav. GDPpc})_j = 1, (\text{Ext. Grav. GDPpc})_{j'} = 0\},$$
$$\iota_{16} = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0,$$
$$(\text{Ext. Grav. GDPpc})_j = 0, (\text{Ext. Grav. GDPpc})_{j'} = 1\}.$$

Indicator Functions for the Set of Moments $\mathcal{K}_3$

The set of moments $\mathcal{K}_3$ differs from $\mathcal{K}_2$ in that it does not aim to identify any fixed costs parameters, nor extended gravity parameters due to continent, GDPpc, or language. Specifically, $\mathcal{K}_3$ defines upper and lower bounds for the following parameters:

$$(\gamma_0^S, \gamma_c^S + \gamma_g^S + \gamma_l^S, \gamma_b^E).$$

Given that the set $\mathcal{K}_3$ does not attempt to identify the constant term of fixed costs, the set of indicator functions that imply adding to or dropping a country from the observed bundle of destinations of firm i in year t, $\{\iota_l(Z_{it}), l = 1, \ldots, L^a\}$, only contains two elements:

$$\iota_1 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 0\},$$
$$\iota_2 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, (\text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 1\}.$$

The set of indicator functions that implies swapping export destinations, $\{\iota_l(Z_{it}), l = L^a + 1, \ldots, L^a\}$, is

$$\iota_3 = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 0, \text{Grav. Lang.})_{j'} = 0, (\text{Grav. GDPpc})_{j'} = 0, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_4 = \mathbb{1}\{(\text{Grav. Cont.})_j = 0, \text{Grav. Lang.})_j = 0, (\text{Grav. GDPpc})_j = 0, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0\},$$
$$\iota_5 = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0,$$
$$(\text{Ext. Grav. Border})_j = 1, (\text{Ext. Grav. Border})_{j'} = 0\},$$
$$\iota_6 = \mathbb{1}\{(\text{Grav. Cont.})_j = 1, \text{Grav. Lang.})_j = 1, (\text{Grav. GDPpc})_j = 1, d_{ijt-1} = 0, d_{ijt} = 1,$$
$$(\text{Grav. Cont.})_{j'} = 1, \text{Grav. Lang.})_{j'} = 1, (\text{Grav. GDPpc})_{j'} = 1, d_{ij't-1} = 0, d_{ij't} = 0,$$
$$(\text{Ext. Grav. Border})_j = 0, (\text{Ext. Grav. Border})_{j'} = 1\},$$