Gravity and extended gravity: estimating a structural model of export entry

Morales, Eduardo; Sheu, Gloria and Zahler, Andrés
Harvard University

January 2011

Gravity and Extended Gravity: Estimating a Structural Model of Export Entry*

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

[1]Harvard University
[2]U.S. Department of Justice
[3]Harvard University

January 16th, 2011

JOB MARKET PAPER

Abstract

Exporters continuously enter and exit individual foreign markets. Although a given firm's status as an exporter tends to be persistent, the set of destination countries that a firm serves changes frequently. In this paper we empirically examine the determinants of a firm's choice of destination countries and show that their export paths follow systematic patterns. We develop a model of export dynamics where firms decide in each period the countries to which they sell. Our model allows profits from each possible destination country to depend on: (a) how similar it is to the firm's home country (gravity), and (b) how similar it is to other destinations to which the firm has previously exported (extended gravity). Given the enormous number of possible export paths from which firms may choose, conventional estimation approaches based on discrete choice models are unfeasible. Instead, we use a moment inequalities approach. Our inequalities come from applying an analogue of Euler's perturbation method to a discrete choice setting. We show that standard gravity forces have a much larger influence on sunk costs than on fixed costs of exporting and that extended gravity effects can be substantial.

JEL Classifications: F12, C51, L65
Keywords: gravity, extended gravity, export dynamics, moment inequalities

*The views in this paper are not purported to be those of the United States Department of Justice. We would like to thank Pol Antràs, Michael Dickstein, Ricardo Hausmann, Elhanan Helpman, Guido Imbens, Robert Lawrence, Marc Melitz, Julie Mortimer, Ariel Pakes, and Dani Rodrik for helpful comments. Special thanks to Jenny Nuñez, Luis Cerpa, the Chilean Customs Authority, and the Instituto Nacional de Estadísticas for helping us build the database. All errors are our own. Email: emorales@fas.harvard.edu, gloria.sheu@usdoj.gov, andres_zahler@hksphd.harvard.edu

1 Introduction

Exporters continuously enter and exit individual foreign markets. Although a given firm's status as an exporter is persistent, the specific set of countries that a firm serves changes frequently. These export dynamics generate economy-wide productivity fluctuations in the exporting countries through intra-industry resource re-allocations (Pavcnik (2002), Melitz (2003)) and within firm productivity growth coming from learning by exporting (Van Biesebroeck (2005), De Loecker (2007), Lileeva and Trefler (2010)). The entry and exit of firms in foreign markets also has direct welfare implications for importing countries as they affect the range of product varieties available for consumption (Broda and Weinstein (2006)). Besides its welfare implications, the movement of firms in and out of export markets has proved relevant in explaining long-run changes in aggregate trade flows (Evenett and Venables (2002), Bernard et al. (2009), Lawless (2009)), asymmetric responses to temporary and permanent changes in expected export profits (Ruhl (2008)), persistent deviations from purchasing power parity (Ghironi and Melitz (2005)), and variation in stock market returns and earnings yields (Fillat and Garetto (2010)).

This paper analyzes the determinants of firm entry and exit into foreign markets. We allow export dynamics in each potential destination country to depend on: (a) similarity between the importing country and the firm's home country, and (b) similarity between the current importing country and prior destinations of the firm's exports. Therefore, the model borrows from the most recent gravity equation literature the intuition that firms tend to access first markets that are larger and geographically and linguistically closer to the country of origin (e.g. Eaton and Kortum (2002), Helpman et al. (2008)). Besides, we complement this intuition by allowing export decisions of firms in every time period to also depend on their previous exporting history. More precisely, this paper introduces the concept of *extended gravity* as a new determinant of firm entry into export markets. While gravity reflects closeness between home and destination markets, extended gravity depends on similarities between two receiving countries. We quantify how strong gravity and extended gravity effects are in determining firms' country-specific entry and exit decisions.

Extended gravity effects reflect the empirical fact (shown in Section 3) that firms are more likely to enter countries that are similar to other destinations to which they have previously exported. We can think of the startup costs that firms face when entering a new country as adaptation costs. Extended gravity indicates that some firms are better prepared than others to export to certain countries precisely because they have been previously serving similar markets and therefore have already completed part of the costly adaptation process. This process may imply modifications to the offered product in order to customize it to the particular local tastes or legal requirements imposed by national consumer protection laws (e.g. writing instruction manuals and labeling the product in the local language). Additional sources of adaptation costs may be time spent in looking for a distributor, or wages paid to newly-hired workers with specific skills (e.g. language skills). Given that adaptation costs are likely to be higher the more different the destination market is from the home country, extended gravity effects are potentially more significant in countries that are far away and particularly different from the country of origin.

We embed gravity and extended gravity effects in a multi-period, multi-country generalization of Melitz (2003). Firms are monopolistic competitors and face a CES demand function in every market. They take their entry and exit decisions dynamically, and expectational errors are accounted for. In order to incorporate gravity, we allow trade costs to vary depending on whether each of the destinations shares its continent or language, or has similar GDP per capita, with the firm's home country. Extended gravity is assumed to affect only entry costs. This is consistent with the interpretation of extended gravity as related to how costly it is for a firm to adapt itself to a new country. Once a firm is already serving a particular market, all the adaptation costs must have already been incurred and no additional advantage is obtained from exporting to other destination countries. The extended gravity variables included in the model are firm-country-year specific. We use four dummies to reflect common border, continent, or official language, or having similar GDP per capita, with a country to which the firm was exporting in the previous year.

In the estimation of our model, we use a data set that contains information on exports for the Chilean manufacturing sector during the period of 1995 to 2005. We use firm-level matched information both on export flows disaggregated by country and year (provided by the Chilean Customs Agency) and on some characteristics of the production function of the corresponding firm (taken from the Chilean Annual Industrial Survey).

The traditional approach to the structural estimation of models of entry relies on deriving choice probabilities from the theoretical framework, and choosing the parameter values that maximize the likelihood of the entry choices observed in the data (e.g. see 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 set includes 2^N elements), computing the value function corresponding to each of its elements is impossible with currently available computational capabilities. We avoid this complication by using moment inequalities as our estimation method. In our setting, moment inequality estimators require 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 will typically be partial, that is, there may be a set of points satisfying the moment inequalities rather than just a single point.

Our inequalities come from applying an analogue of Euler's perturbation method to our dynamic discrete choice problem. Specifically, we impose only one-period deviations on the observed export path for each firm. Contrary to multiple-period deviations, one-period deviations are compatible with obtaining consistent estimates for the parameters even if expectational errors on the part of the agents are allowed.

We estimate our model for the manufacturing sector of chemicals and chemical products (sector 24 according to 2-digit ISIC rev.3.1). The results show that standard gravity variables have a significant effect on trade costs. The startup 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. Colombia) are estimated to be between $277,303$ USD and $313,216$ USD.[1] These costs increase significantly when the destination country is not located in South America (e.g. the entering costs for Spain are estimated to be between $347,549$ USD and $429,675$ USD). The increase coming from the destination country not having Spanish as official language is smaller (e.g. the estimated interval for Brazil is $283,323$ USD to $421,640$ USD). Finally, when a country differs from Chile in all three gravity variables included in the model, the estimated interval increases further and becomes $387,527$ USD to $538,986$ USD. Concerning the extended gravity variables, language is the only one which is estimated to significantly reduce the cost of accessing a new country: previously serving a market that has the same official language as the destination country reduces country-specific entry costs between 19 and 28 percent.

The spatial dependence in export entry and exit generated by extended gravity effects has important implications for the interpretation of the gravity equation parameters as well as for trade policy.

Since Tinbergen (1962) pioneered the use of gravity equations to study bilateral trade flows, his specification has been widely used. A defining characteristic of the gravity equation introduced by Tinbergen (1962) is that trade flows between two countries are predicted to depend exclusively on some index of their economic size and measures of trade resistance between them. Anderson and van Wincoop (2003) were the first to take into account the effect of third countries and introduce a multilateral resistance term in the specification of an otherwise standard gravity equation. In their model, for a given bilateral barrier between two countries j and j', higher geographical barriers between j' and other countries will raise imports from j. Extended gravity effects work in the opposite direction. Their existence makes it beneficial for firms to direct their export activities towards "hub" markets that share characteristics with a large number of countries. This effect will increase exports to these countries not only from firms already exporting to connected countries but, in general, from every firm. Not controlling for this "hubness" variable is likely to result in an upward bias in the estimates of the effect of bilateral trade barriers.[2]

[1] We report here the point estimates for the extrema of the identified set. Confidence intervals are provided in Section 8. Unless otherwise stated, every quantity included in this paper is evaluated in year 2000 US dollars.

[2] This is due to the fact that the more distinct a country is from the origin country, the more likely it is that firms exporting to it benefit from extended gravity effects. Note that the extended gravity effects generated by

Following the collapse of international trade that began in the last quarter of 2008, gravity equations have become a popular tool to estimate the elasticity of global trade with respect to world GDP.[3] Omitting the "hubness" variables makes these estimates particularly misleading. Even under the assumption that the elasticity of bilateral trade with respect to the trade partner's GDP is identical across any possible pair of countries, extended gravity effects imply that it is important to know how changes in global GDP are distributed across markets. A drop in GDP in a "hub" country, which is connected to many others through extended gravity, will have a much larger effect on aggregate trade than an equivalent change in a "non-hub" country that is isolated.

In addition to the consequences of extended gravity for the interpretation of parameters in gravity equations, the existence of extended gravity connections among the importing countries also has novel policy implications. Our model implies that 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 has important implications for import policies, suggesting that policies in one country will generate externalities for other countries. These externalities unveil a possible rationale for regional integration agreements, which force countries to internalize those cross-country effects when setting their legal barriers to trade. Concerning export policy, whenever there are reasons for export promotion measures, extended gravity points to the convenience of targeting these to hub countries that share characteristics with the largest number of foreign markets.

Our paper is related to several strands of the literature. First, our work relates to papers that structurally estimate fixed and sunk costs of exporting. Das et al. (2007), lacking data on export flows disaggregated by countries, estimate only general fixed and sunk costs of breaking into exporting. In contrast, we provide estimates in dollar values for country-specific fixed and sunk costs of exporting that vary depending on the characteristics of the destination country.

Second, this paper also complements Albornoz et al. (2010), Chaney (2010), and Defever et al. (2010). The first two provide theoretical mechanisms that generate spatial patterns in sequential entry. Albornoz et al. (2010) assume firms have imperfect information about their export profitability, which they discover only after actually engaging in exporting. Assuming that profitability is correlated over time and across destinations, their model predicts that firms that have successfully entered some market are more likely to access countries that are similar to it. In contrast, Chaney (2010) builds a model in which exporters can break into a market only if they have a contact, and assumes that the probability of a given exporter acquiring such a contact in a new country is increasing in the aggregate trade flows between the

a given country are different for different countries of origin. Therefore, the standard practice in the gravity equation literature of introducing country-year dummies is not enough to control for the omitted "hubness" variable.

[3] Recent papers that either compute this elasticity or use estimates of it as motivation are: Amiti and Weinstein (2009), Freund (2009), Grossman and Meissner (2010), and Jacks et al. (2010).

potential destination country and any other country that the exporter was previously serving. Furthermore, Albornoz et al. (2010) and Defever et al. (2010) present reduced form evidence showing that the geographical expansion paths that firms follow depend on their previous destination markets.[4] Our paper contributes to this literature by structurally estimating a trade model that embeds a mechanism generating sequential entry.

Third, from a methodological point of view, our paper fits in the literature applying moment inequalities to the estimation of structural models. Like ours, many of these papers use this method as a way of handling choice sets that are large and complex (e.g. Katz (2007), Ishii (2008), Ho (2009)). The most closely related paper to ours is Holmes (2010), which studies Wal-Mart's store location problem and quantifies the savings in distribution costs afforded by having a dense network. This paper's moment inequality estimator relies on the assumption that Wal-Mart has perfect foresight and employs inequalities based on multiple-period deviations. In contrast, Pakes et al. (2006) and Pakes (forthcoming) discuss the possibility of applying an analogue of Euler's perturbation method to the analysis of single agent dynamic discrete choice models without imposing perfect foresight. Our paper applies this approach. We allow agents to have expectational errors and show that only moment inequalities based on one-period deviations are compatible with consistent estimation in this setting.

The rest of the paper is structured as follows. In Section 2 we describe our data set, which we use in Section 3 to present reduced form evidence of the basic entry patterns we observe. Section 4 derives our model of firm entry into different export destinations, and Section 5 provides information on how we can derive moment inequalities from this model. Sections 6 and 7 describe the methods we use to estimate our parameters. Section 8 presents the baseline results, and Section 9 shows that they are robust to alternative specifications of the moment inequalities used in the estimation. Section 10 concludes.

2 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, allowing us to exploit information on the export destinations of each firm and on their domestic activity.[5]

[4] Albornoz et al. (2010) uses Argentinean data, and the results in Defever et al. (2010) refer to Chinese exporters. Although it is not the main focus of their paper, Eaton et al. (2008) shows additional evidence in the same direction for Colombian exporters.

[5] 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

These firms operate in the 19 different 2-digit ISIC sectors that deal with manufacturing.[6] We restrict our analysis to one sector: the manufacture of chemicals and chemical products (sector 24). This is the second largest export manufacturing sector in Chile.[7] As Table 1 shows, the volume of exports in the chemicals sector increased by approximately 19 percent on average during the sample period, and in 2005 it accounted for 17.5 percent of Chile's manufacturing exports.

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.[8]

An observation in this data is a firm-country-year combination. For each observation we have information on the value of goods sold in US dollars. We obtain sales values in year 2000 terms using the US CPI. Basic summary statistics appear in Table 2. About 68 percent of our firms export at least one year of our sample period. These firms earn average revenues of over 1,390,000 USD per export market every year and have average domestic sales of 44,480,000 USD. In comparison, average domestic sales for nonexporters are 1,940,000 USD. Both distributions are nevertheless very skewed. The 75th percentile is in both cases significantly smaller than the corresponding mean. The average number of export destinations these firms serve per year is close to 6, and the median number is 4.

We complement our customs-ENIA data with a database of country characteristics. We obtain information on the primary official language and the names of bordering countries for each destination market from CEPII.[9] We collect data on real GDP, real GDP per capita, and US dollar nominal exchange rates from the World Bank World Development Indicators. We use the Wholesale Price Index (or the Producer Price Index in those cases in which the Wholesale Price Index was not available) and nominal exchange rate data to build a bilateral real exchange rate index with respect to Chile. The source of the data on price indices is primarily the World Bank World Development Indicators, and the International Financial Statistics of the International Monetary Fund for those country-years for which the data was not available through the World Development Indicators.

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. We lose a number of small firms in the merging process because, as indicated in the main text, ENIA only covers plants with more than 10 workers. Nevertheless, the remaining firms account for around 80 percent of total export value.

[6]ENIA encompasses class D (sectors 15 to 36) of the ISIC rev.3.1 industrial classification.

[7]The largest export manufacturing sector is food and food products. The estimation results for this sector are still unavailable. They will be included in a new draft of this paper, which will be posted soon.

[8]From our sample, we exclude only firms that appear in ENIA less than three years or that appear during two or more discontinuous periods between 1995 and 2005 (i.e. firms that first disappear and later reappear in the sample).

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

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. We use the World Bank classification of countries into GDP per capita groups[10]. The extended gravity variables compare each country to a firm's previous export bundle. We have separate dummies for sharing language, continent, GDP per capita category, and 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 it does not share the corresponding characteristic with Chile (e.g. the destination country does not have Spanish as official language) but it does share this characteristic with some other country to which the firm was exporting in the previous year. As an example, Austria would take value of one for a given firm-year in all the four extended gravity variables if the firm exported to Germany in the previous period. We use dummy variables rather than continuous differences in order to simplify the interpretation of our strategy to build moment inequalities.

3 Preliminary Evidence

In this Section, we provide reduced form evidence that supports the choices made in the specification of the structural model.

First, we consider why it is important to take into account extended gravity alongside the more conventional gravity forces. Table 3 presents transition matrices differentiating by extended gravity. The left panel of this table reports the probability that a firm entered a given country in a given year, conditioned on that firm-country-year observation falling into one of two groups. The first group contains those observations in which the firm was exporting in the previous period to a market that shares the corresponding characteristic (continent, language, GDP per capita group, or border) with the destination country. The second group includes those observations where the firm was exporting last period but not to any market that shares the same characteristic with this country. The right hand side of this table reports the probability that an observation falls into each of these two groups, conditioned on whether or not it entered that country during the given period[11].

[10] 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.

[11] As an example of how to read Table 3, the probability of entering a given country for a firm that was exporting in the previous period to some other country in the same continent is 0.035. This probability decreases to 0.006 if the firm was exporting to countries that do not share continent with that country. At the same time, the probability that a firm entering a given country was exporting in the previous period to some destination in the same continent is 0.598.

If our extended gravity story holds, we expect that membership in the first group, where the firm exports in the previous period to a destination that shares the corresponding characteristic, raises the probability of entry relative to the case where the firm does not export to such a destination. This prediction bears out in all the panels of Table 3, since the top left hand entry is always substantially larger than the entry directly below it. Observations in which the firm previously exported to a country that shares the corresponding characteristic also account for a significant portion of the entry events that appear in the data. They are clearly the majority in all panels except for border and language. This is not surprising given that most countries share borders and official languages with very few other countries.

Although we argue that these tables support the inclusion of extended gravity in our model, there are other possible explanations for these findings. For example, imagine a model where continents are ranked in terms of their proximity to Chile, and firms tend to spread out gradually to more distant continents (i.e. entry is purely determined by standard gravity factors). In this case, the fact that a firm is already exporting to a certain continent would increase the probability that they will soon export to more countries on that continent. But the relationship would be driven by the distance between Chile and that continent, not between countries in that continent. However, it is harder for such a story to rationalize the language and border matrices. The model would have to predict that languages can be ranked by complexity in such a way that firms would access countries whose official language is up in the scale only when they have previously accessed the countries with "easier" 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. This analysis shows how important it is to control for gravity factors in order to correctly identify extended gravity effects. Our structural model takes this identification issue into account.

In the structural model we develop in the next sections, we assume that the state vector of a firm is defined based only on its export status in the previous period. This assumption implies: (1) extended gravity effects last only for one period; (2) every firm that did not export to a country in a given period has to pay full entry costs if it exports to it in the next period; (3) every firm that did not export at all in a given period has to pay the full basic costs of reentering into the export activity if it exports to any country in the next period.

Table 4 shows that the intensity of the extended gravity effects decreases very fast between lags one and two. In particular, the probability of entering a country in period t given that the firm was exporting to some other country that shares a characteristic with it is, on average, divided by 3 when that export event happened in $t-2$ instead of $t-1$. In the same way, the probability of exporting to a country in period t given that the firm was exporting to the same country in period $t-1$ is 0.7745, and it decreases to 0.2173 when we condition on exporting to this country in $t-2$ and not in $t-1$. Finally, the probability of exporting to some country in t for exporters in period $t-1$ is 0.9065 and it decreases to 0.3472 when we condition on exporting in $t-2$ and not in period $t-1$. Therefore, in an extension of the finding in Roberts and Tybout (1997), not only does the general export persistence decay very fast, but the same can be said for persistence of exporting to a given country and extended gravity effects.

4 An Empirical Model of Export Entry

In this section, we present a partial equilibrium model where producers based in Chile and operating in a particular sector choose in every period the set of foreign countries they want to serve, in order to maximize their expected flow of profits. We take the creation and destruction of firms as exogenous and endogenize their supply decision in each foreign market. The following model is assumed to apply to any sector and, in particular, to the sector of chemicals and chemical products considered in the empirical section.

Sections 4.1 and 4.2 describe, respectively, the demand and the supply sides of the model. Given the setting introduced in these two sections, subsection 4.3 then shows how to derive constraints on the observed behavior of firms that can be used for estimation and inference. These constraints are defined through moment inequalities. Specifically, subsection 4.3 describes a general method to derive moment inequalities in a dynamic discrete choice setting in which perfect foresight on the part of the agents is not necessarily imposed.

4.1 Demand

Each country j is populated by a representative consumer who has a constant elasticity of substitution (CES) utility function over the different varieties i available in each sector:

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

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

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

where C_{jt} is the total consumption of country j in the sector to which variety i belongs,[12] and P_{jt} is the sectoral price index in country j:

[12]From now on, all the nominal variables appearing in the model should be understood as expressed in the same unit of currency.

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

4.2 Supply

Each variety is produced monopolistically by a single-product firm. We identify each firm by the same subindex i that identifies varieties. These firms are located in Chile but may sell in every country j. A firm serving market j may face four different types of costs:

(1) marginal cost or cost per unit of output shipped to market j. It includes production costs, transport costs, taxes and tariffs. It is denoted as mc_{ijt} and assumed to be constant.[13] We model the marginal cost that firm i faces in country j at period t (in logs) as:

$$\ln(mc_{ijt}) = \ln(f_{it}) + \ln(g_{jt}^{M}) + \epsilon_{ijt}^{M}$$

where f_{it} denotes the effect of firm characteristics, g_{jt}^{M} captures the effect of destination country characteristics, and ϵ_{ijt}^{M} is an error term. We assume the following functional form for f_{it}:

$$\ln(f_{it}) = \beta_0^M + \beta_{ds}^M \ln(domsales_{it}) + \beta_s^M skill_{it} + \beta_w^M \ln(avgwage_{it}) + \beta_{va}^M \ln(avgvaladd_{it})$$

where β_0^M is a constant, *domsales* is sales revenue in Chile, *skill* indicates the proportion of skilled workers, *avgwage* is the average wage in the firm, and *avgvaladd* denotes the average value added per worker. The four variables are used as proxies for the firm's unit cost function.

Concerning the term g_{jt}^{M} we impose:

$$\ln(g_{jt}^M) = \beta_t^M + \beta_{ar}^M avlrer_j + \beta_{dr}^M dvlrer_{jt} + \beta_l^M law_j + \beta_b^M border_j + \beta_c^M cont_j + \beta_l^M lan_j + \beta_{gpc}^M gdppc_j$$

where β_t^M is a time effect, *avlrer* and *dvlrer* capture, respectively, the sample mean and the corresponding year-to-year deviations of the real exchange rate (in logs), *law* is a measure of the quality of legal framework, and *border*, *cont*, *lan*, and *gdppc* are dummies that indicate, respectively, whether the destination country shares border, continent, official language, or GDP per capita classification with Chile. Most of these variables are standard in the gravity equation literature as proxies for international transport costs and, therefore, we refer to them as *gravity variables*. We allow the long term effect of the real exchange rate (captured by β_{ar}^M) to be different from the short run effect (β_{dr}^M). The GDP per capita dummy is included as proxy for within-country transport costs and quality of judicial institutions.

[13] Constant marginal costs are convenient because, conditional on the firm exporting to a set of countries, they make the supply decision in any of those countries independent of the supply decision in the others.

(2) fixed cost faced by the firm every year it is exporting to market j, independently of the quantity exported and of its previous exporting history in this or in other foreign markets. It encompasses, among other factors, the cost of marketing campaigns, expenditures on updating information on the characteristics of the market, and the cost of participation in fairs. It is denoted as fc_{ijt} and modeled as:

$$fc_{ijt} = g_j^F + \epsilon_{ijt}^F \tag{2}$$

where g_j^F is a term that depends on observable gravity variables and ϵ_{ijt}^F is an error term. The term g_j^F is modeled as:

$$g_j^F = \mu_0^F + \mu_c^F cont_j + \mu_l^F lan_j + \mu_{gpc}^F gdppc_j \tag{3}$$

where *cont*, *lan*, and *gdppc* are the same dummy variables included in the expression for g_{jt}^M.

(3) sunk cost or startup cost faced by firms that were not exporting to country j in the previous period. These sunk costs account, among other factors, for the costs of building distribution networks, hiring workers with specific skills (e.g. knowledge of foreign languages), and acquiring information about country-specific preferences and legal requirements needed to commercialize products in that country. We account in the model for the possibility that these costs are smaller for those firms that have been previously exporting to countries similar to j. The intuition is that these firms might have already gone through a big part of the adaptation process that generates these sunk costs before actually accessing country j. Therefore, we introduce a term that accounts for the effect of the previous exporting history of the firm on sunk costs:

$$sc_{ijb_{t-1}t} = g_j^S - e_{jb_{t-1}}^S + \epsilon_{ijt}^S$$

where g_j^S depends on observable gravity variables, $e_{jb_{t-1}}^S$ depends on *extended gravity* variables, and ϵ_{ijt}^S is an error term. The *extended gravity term* captures the reduction in the sunk cost of exporting to country j for a firm that in the previous period was exporting to the bundle of countries b_{t-1}.[14]

The gravity term in sunk costs is modeled analogously to the one in fixed costs:

$$g_j^S = \mu_0^S + \mu_c^S cont_j + \mu_l^S lan_j + \mu_{gpc}^S gdppc_j \tag{4}$$

while the extended gravity term is specified as:

$$e_{jb_{t-1}}^S = \zeta_b^S border_{jb_{t-1}}^e + \zeta_c^S cont_{jb_{t-1}}^e + \zeta_l^S lan_{jb_{t-1}}^e + \zeta_{gdp}^S gdppc_{jb_{t-1}}^e \tag{5}$$

where $border^e$, $cont^e$, lan^e, and $gdppc^e$ are dummy variables that take value one if the bundle

[14] $b_{t-1} = \emptyset$ denotes that the firm was not exporting in the previous period.

of countries b_{t-1} to which the firm was exporting in the previous period includes at least one country that shares, respectively, border, continent, official language, and GDP per capita group with the destination country j *and that characteristic is not shared by the country of origin of the firm* (i.e. Chile).[15]

Note that the extended gravity term $e^S_{jb_{t-1}}$ will be zero when: (a) firm i did not export in the previous period; (b) firm i exported only to countries that do not share border, continent, official language, nor GDP per capita group with country j; (c) country j shares border with Chile, is in South America, has Spanish as official language, and is classified as an Upper Middle Income country.

(4) basic cost or startup cost that the firm must pay if it was not exporting to any country in the previous period. This fourth type of trade cost is included in the model in order to account for the bureaucratic costs in permits and licenses that a firm must face when starting to export. Note that it is paid only once, no matter to how many countries the firm is starting to export in period t. It is denoted by bc and it is modeled as:

$$bc_{it} = \mu^B_0 + \epsilon^B_{it} \tag{6}$$

where μ^B_0 is a constant, and ϵ^B_{ijt} collects the unobservable factors.

The model described above includes 36 parameters: 23 of them enter the expression for the gross profits from exporting, including 11 time effects (β); 4 enter the expression for fixed costs (μ^F); 8 appear in the expression for sunk costs (μ^S, ζ^S); and 1 in the basic costs (μ^B). We group all these parameters into a single parameter vector $\theta = (\beta, \mu^F, \mu^S, \mu^B, \zeta^S)$. Section 6 specifies all the assumptions on the statistical properties of the error terms (ϵ^M_{ijt}, ϵ^F_{ijt}, ϵ^S_{ijt}, ϵ^B_{it}).

4.3 Firm's Optimization Problem

We use the structure described above to derive moment inequalities. These inequalities arise from firms' optimizing behavior. We can split the optimization problem faced by firms in every period into two sequential problems: (a) first, firms solve a *static* optimization problem and choose an optimal price and quantity in every country *conditional on serving that country*; (b) second, firms solve a *dynamic* optimization problem and choose the bundle of countries to which they will supply a positive amount of output. Subsection 4.3.1 describes the static problem and subsection 4.3.2 analyses the dynamic one. Subsection 4.3.3 maps firms' optimizing behavior into moment inequalities.

[15] E.g. the extended gravity variable lan^e takes value 1 if country j shares official language with at least one country included in the bundle of countries b_{t-1} and that language is not the official language of Chile (i.e. Spanish).

4.3.1 Static Problem of the Firm

We begin by deriving the maximum gross profits that a firm may earn in a country j conditional on operating in it. These are defined as revenue from exporting minus variable trade costs. Given the assumption of constant marginal trade costs, the variable trade costs are just the product of these marginal costs and the quantity exported. Therefore, the *gross profits* are defined as profits before accounting for fixed, sunk, or basic costs.

A continuum of varieties is supplied in every country. Therefore, each supplier sets its price in country j taking the sectoral price index, P_{jt}, as given. Taking into account our demand structure, this means that firms set a fixed multiplicative markup over marginal cost. As a result, the price in market j is:

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

Plugging this price into our demand (see eq.(1)) gives the revenue earned by firm i in country j:

$$r_{ijt} = \left(\frac{\eta}{\eta - 1} \frac{mc_{ijt}}{P_{jt}} \right)^{1-\eta} C_{jt} \tag{7}$$

Fixed markups and constant marginal costs imply that the maximum gross profits for firm i of exporting to country j at period t are proportional to revenue:

$$v_{ijt} = \frac{1}{\eta} r_{ijt} \tag{8}$$

4.3.2 Dynamic Problem of the Firm

As indicated above, in addition to marginal costs, firms may have to pay fixed, sunk, and basic costs when exporting to a set of countries b_t. We define *net profits* from exporting as export profits after accounting for all the possible trade costs. Specifically, we can write the net profits for firm i of exporting to country j at period t given that it exported in the previous period to a bundle of countries b_{t-1} as:

$$\pi_{ijb_{t-1}t} = v_{ijt} - fc_{ijt} - \mathbb{1}\{j \notin b_{t-1}\} sc_{ijb_{t-1}t}$$

where $\mathbb{1}\{j \notin b_{t-1}\}$ is an indicator function for firm i not exporting to country j in $t-1$. Aggregating across countries we obtain the total net profits for the current export bundle b_t:

$$\pi_{ib_tb_{t-1}t} = \sum_{j \in b_t} \pi_{ijb_{t-1}t} - \mathbb{1}\{b_{t-1} = \emptyset\} bc_{it}$$

where $\mathbb{1}\{b_{t-1} = \emptyset\}$ is an indicator function for firm i not exporting at all in $t-1$.

While b_t denotes a generic bundle of countries that a firm might choose in period t, we use o_t to identify the *observed* export bundle in that period t (i.e. the bundle selected by a firm in t). Assumption 1 below indicates how the choice of this bundle is made. While Assumption 1 is compatible with firms being perfectly forward looking and taking in every period the export decision that maximizes the expected value of the sum of discounted profits over an unbounded horizon, it is weaker than this and allows for other decision criteria that firms might have.

Assumption 1 *Let us denote by $o_1^T = \{o_1, o_2, \dots, o_T\}$ the observed sequence of bundles chosen by any given firm i between periods 1 and T. Given a sequence of information sets for firm i at different time periods, $\{\mathcal{J}_{it}, \mathcal{J}_{it+1}, \dots\}$, a sequence of choice sets from which firm i picks its preferred export bundle, $\{\mathcal{B}_{ib_{t-1}t}, \mathcal{B}_{ib_t t+1}, \dots\}$, and a particular conditional expectation function $\mathcal{E}_i[\cdot]$ capturing its subjective expectations:*

$$o_t = \underset{b_t \in \mathcal{B}_{io_{t-1}t}}{\text{argmax}} \; \mathcal{E}_i\big[\Pi_{ib_t o_{t-1}t} | \mathcal{J}_{it}\big] \qquad \forall \;\; t = 1, 2, \dots, T \tag{9}$$

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 of the discount factor, δ, and the static export profits the firm might obtain in periods $t+2$ and after:

$$\omega_{i\mathbf{b}_{t+1}t+2} = \omega_{it+2}(\delta, \pi_{i\mathbf{b}_{t+2}\mathbf{b}_{t+1}t+2}, \pi_{i\mathbf{b}_{t+3}\mathbf{b}_{t+2}t+3}, \dots),$$

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

$$\mathbf{b}_{t+s} = \underset{b_{t+s} \in \mathcal{B}_{ib_{t+s-1}t+s}}{\text{argmax}} \; \mathcal{E}_i\big[\Pi_{ib_{t+s}b_{t+s-1}t+s} | \mathcal{J}_{it+s}\big], \quad \forall s \geq 1.$$

Assumption 1 links the observed export choices made by each firm in each period with the structure described in sections 4.1 and 4.2. It models firm's choice at period t as the outcome of an optimization problem that is defined by four elements: (1) a function $\Pi_{ib_t o_{t-1}t}$; (2) subjective expectations, as captured by a conditional expectation function, $\mathcal{E}_i[\cdot]$; (3) knowledge about the relevant environment included in an information set, $\mathcal{J}_{it}$; and, (4) the set of options taken into account by the firm (i.e. possible combinations of foreign countries to which firm i considers exporting), as defined by a choice or consideration set, $\mathcal{B}_{io_{t-1}t}$.[16]

[16]Note that we allow the consideration set of firm i at period t to depend on the bundle of countries it chose in the previous period. Also note that the bundles $\{\mathbf{b}_{t+s}\}_{s\geq 1}$ are random variables from the perspective of period t. The reason is that the value of $\{\mathbf{b}_{t+s}\}_{s\geq 1}$ depends on the information sets $\{\mathcal{J}_{t+s}\}_{s\geq 1}$, and these one might be unknown to firm i at period t.

Assumption 1 does not impose any restriction on subjective expectations, information sets and consideration sets.[17] However, it assumes that the function $\Pi_{ib_t o_{t-1} t}$, which firms care about when selecting the set of countries to which they export at period t, is a discounted sum of the net profits obtained at t, $\pi_{ib_t o_{t-1} t}$, 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 an arbitrary function that is allowed to change across firms, time periods and bundles chosen at $t+1$, $\omega_{i\mathbf{b}_{t+1} t+2}$. Assumption 1 restricts $\omega_{i\mathbf{b}_{t+1} t+2}$ to be a function of the discount factor and the static profits that the firm might obtain in periods $t+2$ and later.[18]

The introduction of the function $\omega_{i\mathbf{b}_{t+1} t+2}$ makes the optimization defined in equation (9) compatible with firms being forward-looking in many different degrees. Specifically, Assumption 1 is compatible with firms that take into account the effect of their current choices on future profits in any of the three following ways:

1. only one period ahead:
$$\omega_{i\mathbf{b}_{t+1} t+2} = 0;$$

2. any finite number p of periods ahead:
$$\omega_{i\mathbf{b}_{t+1} t+2} = \delta^2 \pi_{i\mathbf{b}_{t+2}\mathbf{b}_{t+1} t+2} + \delta^3 \pi_{i\mathbf{b}_{t+3}\mathbf{b}_{t+2} t+3} + \cdots + \delta^p \pi_{i\mathbf{b}_{t+p}\mathbf{b}_{t+p-1} t+p}$$
with
$$\mathbf{b}_{t+s} = \underset{b_{t+s} \in \mathcal{B}_{ib_{t+s-1} t+s}}{\text{argmax}} \; \mathcal{E}_i\left[\Pi_{ib_{t+s} b_{t+s-1} t+s} | \mathcal{J}_{it+s}\right] \quad \forall s = 2, \ldots, p;$$

3. or an infinite number of future periods ahead (i.e. perfectly forward looking firms):
$$\omega_{i\mathbf{b}_{t+1} t+2} = \mathcal{E}_i\left[\Pi_{i\mathbf{b}_{t+2}\mathbf{b}_{t+1} t} | \mathcal{J}_{it+2}\right]$$
with
$$\mathbf{b}_{t+2} = \underset{b_{t+2} \in \mathcal{B}_{ib_{t+1} t+2}}{\text{argmax}} \; \mathcal{E}_i\left[\Pi_{ib_{t+2} b_{t+1} t+2} | \mathcal{J}_{it+2}\right].$$

In summary, Assumption 1 imposes only three constraints on firms' behavior: (1) firms take into account the effect of their current choice on static profits *at least* one period ahead;

[17] Propositon 1 and Assumption 2 impose some restrictions on these three elements. For details, refer to the discussion contained in Section 4.3.3. Note in particular that Assumptions 1 and 2, and Propositon 1, are consistent with firms having rational expectations.

[18] This characterization of the function $\omega_{i\mathbf{b}_{t+1} t+2}$ is more restrictive than necessary for our estimation method to provide consistent estimates. In order for our moment inequalities to be correctly defined, the function $\omega_{i\mathbf{b}_{t+1} t+2}$ may take any shape as long as it does not depend directly on the set of countries b_t selected at t. Given that any firm i exporting to any given bundle b_{t+s}, for any s, will pay or not sunk and basic costs of exporting depending only on the export bundle b_{t+s-1} (i.e. independently of b_{t+s-2}, b_{t+s-3}, ...), the independence between $\omega_{i\mathbf{b}_{t+1} t+2}$ and b_t, conditional on b_{t+1}, is guaranteed as long as $\omega_{i\mathbf{b}_{t+1} t+2}$ is just a function of the discount factor and the static profits in periods $t+2$ and after: $\omega_{i\mathbf{b}_{t+1} t+2} = \omega_{it+2}(\delta, \pi_{i\mathbf{b}_{t+2}\mathbf{b}_{t+1} t+2}, \pi_{i\mathbf{b}_{t+3}\mathbf{b}_{t+2} t+3}, \ldots)$.

(2) firms internalize in t that the set of countries to which they are going to export to in the next period, $\mathbf{b}_{t+1}$, is a random variable and that it will be determined in $t+1$ by solving an optimization problem analogous to the one they are facing in the current period; (3) the current choice b_t enters the objective function of the firm only through its effect on the static profits in periods t and $t+1$, and on the choice $\mathbf{b}_{t+1}$ to be taken in period $t+1$.

4.3.3 Deriving Moment Inequalities: One-period Deviations

We apply an analogue of Euler's perturbation method to derive moment inequalities. The theoretical possibility of deriving moment inequalities by applying Euler's perturbation method to the analysis of single agent dynamic discrete choice problems appears in Pakes et al. (2006) and Pakes (forthcoming). In adapting the intuition contained in these papers to our setting, we will form inequalities by comparing the actual sequence of bundles observed for a given firm i with alternative sequences that differ from it only in one period. Using the same notation as before, $o_1^T = \{o_1, \ldots, o_t, o_{t+1} \ldots, o_T\}$ 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:

$$\{o_1, \ldots o_{t-1}, o'_t, o_{t+1} \ldots, o_T\},$$

where o'_t denotes a counterfactual bundle for period t. Note that when the firm makes the choice at period t the bundles of countries that will be chosen in future periods are random variables, $\{\mathbf{o}_{t+s}\}_{s\geq 1}$, 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.

Proposition 1 *If $o'_t \in \mathcal{B}_{io_{t-1}t}$ and all the possible realizations of $\mathbf{o}_{t+1}$ are in $\mathcal{B}_{io'_t t+1}$, then:*

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

and

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

The proof of Proposition 1 is contained in Section A.1 in the Appendix.[19] Intuitively, if 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 of countries 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 export path $\{o_t, \mathbf{o}_{t+1}\}$ was weakly preferred *at period* t over the alternative path $\{o'_t, \mathbf{o}_{t+1}\}$.

[19]Note that we use the boldface $\mathbf{o}_{t+1}$ to denote the random variable whose realization is the observed bundle o_{t+1}.

Equation (10) refers to the preferences of the firm at the time it had to choose between the actual and the counterfactual bundle and, therefore, it does not rule out the possibility that, *ex post*, the export path $\{o'_t, o_{t+1}\}$ could have generated higher profits than the observed $\{o_t, o_{t+1}\}$.[20] Assumption 2 below imposes a connection between the preferences of firms at any time period and the actual realization of the differences in profits between two alternative export paths.

Proposition 1 imposes some constraints on the counterfactual bundles we can use to build moment inequalities. It requires in particular that the counterfactual bundle, o'_t, belongs to the consideration or choice set of the firm at period t, and that the firm could have still chosen the bundle indicated by $\mathbf{o}_{t+1}$ even if it picked o'_t at period t. As shown in Section 5, the counterfactuals we use in the estimation diverge from the actual ones in that either they add or subtract one country to the bundle, they switch one export destination for an alternative one, or they exit exporting completely. Therefore we are implicitly assuming choice sets for each firm and time period that include *at least* the actual observed choice and a small number of variations around it.[21]

In order to simplify notation, we rewrite the inequality in equation (10):

$$\mathcal{E}_i[\pi_{id\mathbf{o}_{t+1}t} | \mathcal{J}_{it}] \geq 0 \tag{11}$$

where $d = (o_t, o'_t)$ denotes a particular deviation at period t and:

$$\pi_{id\mathbf{o}_{t+1}t} = (\pi_{io_t o_{t-1}t} - \pi_{io'_t o_{t-1}t}) + \delta(\pi_{i\mathbf{o}_{t+1}o_t t+1} - \pi_{i\mathbf{o}_{t+1}o'_t t+1})$$

Given that the inequality in equation (11) holds for every possible deviation d, we can aggregate across deviations in a single inequality. These deviations might differ in the alternative bundle of countries, o'_t, used to build the deviation d, in the firm, and in the time period in which it is applied. We can therefore build a generic inequality as:

$$\frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}^k} \mathcal{E}_i[\pi_{id\mathbf{o}_{t+1}t} | \mathcal{J}_{it}] \geq 0$$

[20]More precisely, note that Proposition 1 does not imply:

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

nor

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

where o_{t+1} is the bundle to which firm i is observed to export at period $t+1$.

[21]Note that we are not specifying the exact limits of the choice set. We are just imposing some requirements on its minimum size. These requirements are obviously satisfied by a choice set that includes all the possible combinations of all countries existing in the world.

and $D_k = \sum_{i=1}^{I} \sum_{t=1}^{T} D_{it}^k$ is the number of observations used in the inequality.[22]

Finally, in order to derive moment inequalities from these theoretical inequalities, we need to restrict the behavioral expectations of the agents. The following assumption imposes the necessary constraint on the set of conditional expectation functions $\{\mathcal{E}_i[\cdot]\}_{i=1}^{I}$.

Assumption 2 *There is a positive valued function $g_{k_l}(\cdot)$ and an $x_{idt} \in \mathcal{J}_{it}$ such that:*

$$\frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}^k} \mathcal{E}_i[\pi_{id\mathbf{o}_{t+1}t} | \mathcal{J}_{it}] \geq 0 \qquad \Rightarrow \qquad \mathbb{E}\Big[\frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}^k} \pi_{id\mathbf{o}_{t+1}t} g_{k_l}(x_{idt})\Big] \geq 0, \quad (12)$$

and $\mathbb{E}[\cdot]$ denotes the statistical expectation or expectation with respect to the data generation process.

Intuitively, Assumption 2 implies that agents make the right choices on average, where the average is computed across choices made by different firms in multiple periods and with respect to multiple alternatives or counterfactuals. Aggregating across firms, years, and deviations has the advantage of making Assumption 2 robust against expectational errors that are correlated across firms in a single year, or across firms and years in a single country. Assumption 2 does not impose that every firm must have rational expectations (i.e. $\mathcal{E}_i[\cdot] = \mathbb{E}[\cdot]$, $\forall i$) but it is consistent with it. In the same way, Assumption 2 is not violated either if firms are assumed to have perfect foresight.

Assumption 2 does not specify the information set of the agents, $\mathcal{J}_{it}$, but it imposes mild restrictions on it. Specifically, it assumes that the variables used as instruments in the moment inequalities, $g_{k_l}(x_{idt})$, are contained in the information set of the agent at the time it took the decision from which we are deviating in the counterfactual. As can be seen in Section 5, the only instruments we will use are indicator functions that classify firms and countries into groups according to their size. Therefore, the only assumptions imposed on the information set of the agents is that they know their own volume of domestic sales and the GDP of the countries included in their consideration or choice sets.

Assumptions 1 and 2 are not enough to rely on likelihood methods to identify the true vector of parameters θ. In order to derive a likelihood function from the model described in sections 4.1 and 4.2, we would need to specify the function $\omega_{i\mathbf{b}_{t+1}t+2}$ for every i and t, the expectation function $\mathcal{E}_i[\cdot]$ for every i, the information set $\mathcal{J}_{it}$ corresponding to every i and t, and the specific choice set $\mathcal{B}_{ib_{t-1}t}$ that each firm considers in each period.[23] All these are

[22] Abusing notation, we use D_k below to denote both the set of deviations used to build the corresponding inequality and its cardinality.

[23] Specifically, Assumption 1 and 2 are compatible with (but not restrictive to) firms that: (1) are perfectly forward looking and, therefore, select the set of countries they export to by maximizing their future stream of profits over an infinite horizon; (2) have rational expectations; and, (3) consider in every period the profits of exporting to every possible combination of countries in the world (i.e. to 2^N possible choices, where N is the

elements on which we actually have very little information. In contrast, Assumptions 1 and 2 are enough to derive moment inequalities that allow us to identify the parameter θ.

5 Specifying Moments: Bounding Cost Parameters

As it will be shown in Section 6, we use moment inequalities to estimate the parameters affecting fixed, sunk and basic costs[24]. For each of these parameters we build sets of moment inequalities aimed at identifying both an upper and a lower bound. Building moments implies two steps: first, we identify all the possible observations that might provide information on the lower or upper bound for each parameter (i.e. we find the set D^k); second, we aggregate those observations into one or multiple moments for each parameter-bound pair (i.e. we define different functions $g_{k_l}(\cdot)$). We illustrate here our procedure with two examples. Specifically, we examine how we build moments to identify bounds for our baseline fixed cost parameter, μ_0^F, and for the parameter that measures the extended gravity effect of language, ζ_l^S. Additional examples are provided in the Appendix in Section A.2.

5.1 Identifying Observations

5.1.1 Example 1: Bounding μ_0^F

Imagine we observe a firm i with the following stream of gross profits in country j and an associated export trajectory

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

where v_{ijt} denote the potential gross profits that firm i would obtain in country j if it were to export at period t, 1 indicates that the firm is exporting to j and 0 indicates that the firm is not. A possible counterfactual would be

Year	1	2	3	4	5
Actual	0	1	1	0	0
Counterfactual	0	1	1	1	0

number of countries in the world). Given that the cardinality of this choice set is enormous and that computing the value function for each of its elements is unfeasible with currently available computational capabilities, a model that imposes these three restrictive assumptions cannot be estimated either through any method that relies on the specification of a likelihood function. Therefore, even if these three additional assumptions were imposed, we would still need to use moment inequalities to identify the different parameters of the model.

[24]There are a total of 13 parameters entering either fixed, sunk or basic costs: (μ_0^F, μ_c^F, μ_l^F, μ_{gdp}^F, μ_0^S, μ_c^S, μ_l^S, μ_{gdp}^S, ζ_b^S, ζ_c^S, ζ_l^S, ζ_{gdp}^S, μ_0^B).

where we delay the exit period by one year. Assume for simplicity that country j shares the same continent, language, and GDP per capita group with Chile, meaning that the gravity variables for these characteristics appearing in the fixed cost term take a value of 0. Then our counterfactual generates the following difference in profits

$$\pi_{ido_5 4} = -v_{ij4} + \mu_0^F + \epsilon_{ij4}^F,$$

which generates an observation for moment inequality that identifies the lower bound for μ_0^F.

In order to get an observation that helps to identify the upper bound for μ_0^F we simply flip the counterfactual and advance exit by one period,

Year	1	2	3	4	5
Actual	0	1	1	0	0
Counterfactual	0	1	0	0	0

This gives the difference in profits

$$\pi_{ido_4 3} = v_{ij3} - \mu_0^F - \epsilon_{ij3}^F$$

Thus, we have an observation for the moment inequality that identifies the upper bound of μ_0^F.

In most cases the parameter of interest will not be the only unknown to appear in an observation. Following the previous example, if country j had not been in the same continent as Chile, the two observations described above would have been:

$$\pi_{ido_5 4} = -v_{ij4} + \mu_0^F + \mu_c^F + \epsilon_{ij4}^F,$$

and

$$\pi_{ido_4 3} = v_{ij3} - \mu_0^F - \mu_c^F - \epsilon_{ij3}^F$$

It is possible that parameters affecting fixed and sunk costs appear both in the same inequality. Again modifying the original example, return to the case where country j is assumed to share the same continent, language, and GDP per capita group with Chile (i.e. all the gravity and extended gravity variables entering fixed and sunk costs are going to take a value of 0) and imagine that firm i had reentered country j in period 5 in the actual strategy. In this case the different in profits that contributes to identify the upper bound for μ_0^F would not be affected but the one that identifies the lower bound would now be:

$$\pi_{ido_5 4} = -v_{ij4} + \mu_0^F + \epsilon_{ij4}^F - \delta\mu_0^S - \delta\epsilon_{ij5}^S$$

5.1.2 Example 2: Bounding ζ_l^S

Imagine that the same firm i is exporting in year 7 to only one country. This country only shares official language with some country j and it shares nothing with some other country j'. The stream of profits and actual export strategies implemented in each country j and j' are:

	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 would be:

	Year	7	8	9
Actual	Country j	0	1	0
	Country j'	0	0	0
Counterfactual	Country j	0	0	0
	Country j'	0	1	0

where firm i enters country j' instead of country j. Assume for simplicity that country j and j' take the same value of the standard gravity variables and that firm i does not export to any country in year 9. Then our counterfactual generates the following difference in profits:

$$\pi_{ido_98} = v_{ij8} - v_{ij'8} + \zeta_l^S - \epsilon_{ij8}^F + \epsilon_{ij'8}^F - \epsilon_{ij8}^S + \epsilon_{ij'8}^S \tag{13}$$

which generates an observation for the moment inequality identifying the lower bound for ζ_l^S. Once we impose that ζ_l^S must take a nonnegative value, this observation might be uninformative if firm i would have preferred country j over country j' even if the extended gravity effect of language was zero.

As indicated above in the example for μ_0^F, other parameters will appear in this inequality if, for example, country j and j' take different values of the gravity variables, firm i is observed to continue exporting to country j at period 9, etc.

If we are looking for an upper bound, then we need to find a year for which there was a country that benefited from extended gravity effects in language in which firm i did not enter and another country that did not benefit from these effects in which firm i actually entered. By building a counterfactual that switches the export strategies in those two countries we find an observation that helps us identify the upper bound for ζ_l^S.

The procedure to identify bounds for the parameters measuring the extended gravity effects of border, continent and GDP per capita is completely analogous to the one described above for language. We just need to find a pair of countries j and j' that diverge in the particular dimension we are interested in, and follow the same steps indicated above.

5.2 Aggregating Observations into Moments

Once we have searched over all firms, countries, and time periods in our sample for actual strategies and possible counterfactuals that help us identify the upper or lower bound for our parameters of interest, we need to decide how to aggregate those observations into inequalities. Assumption 2 imposes that each moment inequality should be an average across firms, years, and counterfactual countries but allows for some freedom in the deviations to include in each of the averages. With the aim of getting the tightest possible bounds, we work with four possible aggregation strategies (i.e. four possible moments) for each bound-parameter pair: (1) selection of firms (2) selection of countries; (3) no selection; (4) selection of firms and countries.

How do we select firms for cases (1) and (4)? We know from a regression of observed export revenue on exporter and destination country characteristics (see Table A.1) that higher domestic sales are correlated with higher predicted revenue from exporting in every country and time period. Therefore, as an example, when looking for a lower bound for the parameter μ_0^F, we obtain a higher lower bound if we build an inequality that averages only across the observations coming from large firms (and the opposite for the case in which we are looking for an upper bound). We define firms as big if their domestic sales in the first year of the sample (i.e. 1995) were above the median (and vice versa). Given that larger firms have higher export profits in every country, the selection of firms is irrelevant in those moments that compare profits between two countries (e.g. moments that identify bounds for ζ_l^S, see Section 5.1.2).

How do we select countries for cases (2) and (4)? Table A.1 shows that higher GDP in the destination country is correlated with higher predicted revenue from exporting for every firm and time period. Therefore, keeping the same example as before, when looking for a lower bound for parameter μ_0^F we build an inequality that, for each firm, uses observations that come from large countries (and the opposite when looking for an upper bound). When looking for a lower bound for the parameter ζ_l^S we use counterfactuals that make the firm enter those countries that are large among the ones that the firm did not enter and that did not benefit from a nonzero extended gravity effect in language. On the contrary, when looking for an upper bound for this parameter, we use counterfactuals that introduce the firm in countries that are relatively big among those in which the firm did not enter and that benefited from a nonzero extended gravity effect in language. We define countries as big if their GDP at the beginning of the sample period is above the median for the group of countries that could be used as counterfactuals in each case.

Not all these moments will be used in the estimation. Some of these aggregations for some of the bounds end up including very few observations. Even if Assumption 2 imposes only an asymptotic requirement on the moments used in the estimation, inequalities that use very few observations may have very large error components and can lead to very misleading results. We are explicit in Section 8 about the moments used to find our estimates.

Besides the different restrictions on the parameter space coming from the moment inequalities described above, we impose the following additional constraints on the possible values the parameters may take: (1) all the parameters must take non-negative values; (2) the parameters measuring extended gravity effects cannot take values such that the sunk cost of entering some country j for a firm exporting in the previous period to some other country j' becomes negative. The difference between these constraints in the parameter space and those coming from moment inequalities is that the former are deterministic and, therefore, are imposed in every random sample.

6 Estimation Method

Once we have specified the different moment inequalities that identify the parameters entering the fixed, sunk, and basic costs, it remains to explain how these moments are going to be used to estimate those parameters. Section 6.1 lays out the linear moment inequality framework in general terms. Section 6.2 specifies how this framework maps to our setting and we explain in detail our estimation method.

6.1 The Linear Moment Inequality Framework

We focus here on identification and estimation of the extreme or boundary points of the identified set, while we leave for Section 7 the discussion about inference and how to build confidence intervals in the linear moment inequality framework. We follow the approach to estimation in models in which parameters are defined by moment inequalities contained in Pakes et al. (2006).

Let there be S linear moment inequalities, with each inequality indexed by s:

$$m_s(\theta) = \mathbb{E}\Big[\frac{1}{N}\sum_{i=n}^{N}(z_{0n} + z_{1n}\theta + \epsilon_n)g(z_{2n})\Big] \geq 0 \qquad s = 1, 2, \ldots, S \tag{14}$$

where N is the number of observations in the moment inequality, θ is the parameter vector to estimate, (z_0, z_1, z_2) is a vector of observable variables, and ϵ is an unobservable term. This set of moment inequalities will usually come from restrictions on the data generation process derived from a structural model. Given this set of moments, the identified set Θ is defined as the subset of points satisfying the S linear constraints in equation (14). This identified set can be written as the set of values θ such that:

$$0 = \sum_{s=1}^{S} \big(\min\{0, m_s(\theta)\}\big)^2$$

We define an analog estimate $\hat{\Theta}$ of the identified set Θ as the set of values of θ that minimize the objective function:

$$\sum_{s=1}^{S} \big(\min\{0, \tilde{m}_s(\theta)\}\big)^2 \tag{15}$$

where $\tilde{m}_s(\cdot)$ is the sample analog of the corresponding moment inequality $m_s(\cdot)$[25]:

$$\tilde{m}_s(\theta) = \frac{1}{N}\sum_{i=n}^{N}(z_{0n} + z_{1n}\theta)g(z_{2n})$$

As it is shown in Pakes et al. (2006), the bounds of $\hat{\Theta}$ are consistent estimates of the corresponding bounds of Θ as long as the sample moments are uniformly consistent estimates of the population moments:

$$\sup_{\theta} ||\tilde{m}_s(\theta) - m_s(\theta)|| \xrightarrow{N\to\infty} 0$$

Given the specification of the linear moment inequalities in equation (14), the uniform consistency of the sample moments is guaranteed as long as:

$$\frac{1}{N}\sum_{n=1}^{N} \epsilon_n g(z_{2n}) \xrightarrow{N\to\infty} 0$$

6.2 Mapping the Framework to our Model

As a result of Assumption 2, our model provides a set of S moment inequalities where each moment inequality s is indexed by the pair (k, l):

$$m_s(\theta) = \mathbb{E}\Big[\frac{1}{D_k}\sum_{i=1}^{I}\sum_{t=1}^{T}\sum_{d=1}^{D_{it}^k} \pi_{id\mathbf{o}_{t+1}t}(\theta)g_{k_l}(x_{idt})\Big] \geq 0 \tag{17}$$

[25] The objective function in equation (15) is a special case of more general Modified Method of Moments (MMM) test function defined in Andrews and Soares (2010):

$$\sum_{s=1}^{S} \big(\min\{0, \frac{1}{\sigma_s(\theta)} m_s(\theta)\}\big)^2, \tag{16}$$

where $\sigma_s^2(\theta)$ is the variance of $m_s(\theta)$. Equations (15) and (16) are both going to generate the same identified set. Furthermore, their sample analogs are going to generate also the same estimated set as long as there exists a parameter θ that makes any of the two functions equal to 0 in the particular random sample under study (this is going to be the case in our setting, see Section 8).

where $\theta = (\beta,\ \mu^F,\ \mu^S,\ \mu^B,\ \zeta^S)$ is the finite dimensional parameter vector that we want to estimate.

The empirical model described in Section 4 parameterizes the difference in profits as:

$$\pi_{id\mathbf{o}_{t+1}t}(\beta, \mu^F, \mu^S, \mu^B, \zeta^S) = v_{idt}(\beta) - g^F_d(\mu^F) - \big(g^S_{d\mathbf{o}_{t+1}}(\mu^S) - e^S_{d\mathbf{o}_{t+1}}(\zeta^S)\big) - bc_{d\mathbf{o}_{t+1}}(\mu^B) + \varepsilon_{2d}$$

where each of its terms is defined as:

$$\begin{aligned}
v_{idt} &= \sum_{j\in o_t} v_{ijt} - \sum_{j\in o'_t} v_{ijt}\\
g^F_d &= \sum_{j\in o_t} g^F_j - \sum_{j\in o'_t} g^F_j\\
g^S_{d\mathbf{o}_{t+1}} &= \Big(\sum_{j\in o_t} \mathbb{1}\{j\notin o_{t-1}\} g^S_j - \sum_{j\in o'_t} \mathbb{1}\{j\notin o_{t-1}\} g^S_j\Big) + \delta \sum_{j\in \mathbf{o}_{t+1}} \big(\mathbb{1}\{j\notin o_t\} - \mathbb{1}\{j\notin o'_t\}\big) g^S_j\\
e^S_{d\mathbf{o}_{t+1}} &= \sum_{j\in o_t} \mathbb{1}\{j\notin o_{t-1}\} e^S_{jo_{t-1}} - \sum_{j\in o'_t} \mathbb{1}\{j\notin o_{t-1}\} e^S_{jo_{t-1}} + \delta \sum_{j\in \mathbf{o}_{t+1}} \big(\mathbb{1}\{j\notin o_t\} e^S_{jo_t}\\
&\quad - \mathbb{1}\{j\notin o'_t\} e^S_{jo'_t}\big)\\
bc_{d\mathbf{o}_{t+1}} &= \Big(\mathbb{1}\{o_t\neq\emptyset, o_{t-1}=\emptyset\} - \mathbb{1}\{o'_t\neq\emptyset, o_{t-1}=\emptyset\}\Big) bc + \delta\Big(\mathbb{1}\{\mathbf{o}_{t+1}\neq\emptyset, o_t=\emptyset\}\\
&\quad - \mathbb{1}\{\mathbf{o}_{t+1}\neq\emptyset, o'_t=\emptyset\}\Big) bc\\
\varepsilon_{2d} &= \sum_{j\in o_t} \epsilon^F_{ijt} - \sum_{j\in o'_t} \epsilon^F_{ijt} + \Big(\sum_{j\in o_t} \mathbb{1}\{j\notin o_{t-1}\}\epsilon^S_{ijt} - \sum_{j\in o'_t} \mathbb{1}\{j\notin o_{t-1}\}\epsilon^S_{ijt}\Big) + \delta \sum_{j\in \mathbf{o}_{t+1}} \big(\mathbb{1}\{j\notin o_t\}\\
&\quad - 1\{j\notin o'_t\}\big)\epsilon^S_{ijt+1} + \Big(\mathbb{1}\{o_t\neq\emptyset, o_{t-1}=\emptyset\} - \mathbb{1}\{o'_t\neq\emptyset, o_{t-1}=\emptyset\}\Big)\epsilon^B_{ijt}\\
&\quad + \delta\Big(\mathbb{1}\{\mathbf{o}_{t+1}\neq\emptyset, o_t=\emptyset\} - \mathbb{1}\{\mathbf{o}_{t+1}\neq\emptyset, o'_t=\emptyset\}\Big)\epsilon^B_{ijt+1}
\end{aligned}$$

and the definition of v_{ijt}, g^F_j, g^S_j, $e^S_{jo_{t-1}}$, bc, ϵ^F_{ijt}, ϵ^S_{ijt}, and ϵ^B_{ijt} is given in equations (2), (3), (4), (5), (6), and (8).

A comparison of equation (17) and equation (14) shows that our moment inequalities do not map exactly to the linear moment inequality framework described in Section 6.1 because $v(\cdot)$ is a loglinear function of β. However, $g^F(\cdot)$, $g^S(\cdot)$, $e^S(\cdot)$ and $bc(\cdot)$ are linear functions of the corresponding parameter vectors. We will therefore estimate θ in two stages. In the first stage, we apply linear panel data estimation techniques to obtain point estimates of β that are independent of the value estimated for (μ^F, μ^S, μ^B, ζ^S). In the second stage, we use the linear moment inequality framework in order to obtain set estimates for (μ^F, μ^S, μ^B, ζ^S) conditional on the first stage estimates $\hat{\beta}$.

6.2.1 First Stage Estimation

All the parameters entering the expression for the gross profits from exporting $v(\cdot)$ appear also in the expression for the potential revenue from exporting $r(\cdot)$ (see equations (7) and (8)). Using data on observed export revenues for firms, countries and years with positive exports, we obtain point estimates for the parameter vector β. In order to obtain these estimates in the simplest possible way, we exploit the fact that the equilibrium equation for revenue from exporting that arises from solving the static problem of the firm is loglinear (see equation (7)). Therefore we estimate β applying a fixed effects estimator on the equation:

$$\ln(r_{ijt}) = \beta Z_{ijt} + (1-\eta)\epsilon^{M}_{ijt} \tag{18}$$

where Z_{ijt} includes all the observable variables[26] appearing in equation (7) and ϵ^{M}_{ijt} is assumed to be independent of Z_{ijt}. Once we have obtained our estimates $\hat{\beta}$, we define an approximation to the potential gross profits from exporting for firm i in country j at time t as:

$$\hat{v}_{ijt} = v_{ijt}(\hat{\beta}) = \frac{1}{\eta}\hat{r}_{ijt} = \frac{1}{\eta}\hat{\alpha}\exp(\hat{\beta}Z_{ijt})$$

where $\hat{\alpha}$ is defined as the OLS estimate of the only coefficient in a regression of r_{ijt} on $\exp(\hat{\beta}Z_{ijt})$ that does not include a constant. The elasticity of substitution η is not uniquely identified from the reduced form expression for export revenues. Therefore, we borrow the value of η for from Broda et al. (2006)[27]. Given our approximation to gross profits $\hat{v}_{ijt}$ we define the first stage error as:

$$\varepsilon_{1ijt} = v_{ijt} - \hat{v}_{ijt}$$

and

$$\varepsilon_{1d} = \sum_{j\in o_t}\epsilon_{1ijt} - \sum_{j\in o'_t}\epsilon_{1ijt}$$

6.2.2 Second Stage Estimation

Using the results from the first stage estimation, we can rewrite each of our moment inequalities as:

$$m_s(\theta_2) = \mathbb{E}\Big[\frac{1}{D_k}\sum_{i=1}^{I}\sum_{t=1}^{T}\sum_{d=1}^{D^k_{it}}\big(\hat{v}_{idt} - g^F_d(\mu^F) - g^S_{d\mathbf{o}_{t+1}}(\mu^S) + e^S_{d\mathbf{o}_{t+1}}(\zeta^S) - bc_{d\mathbf{o}_{t+1}}(\mu^B) + \varepsilon_d\big)g_{k_l}(x_{idt})\Big] \geq 0$$

[26]We proxy the term $C_{jt}P^{\eta-1}_{jt}$ with a power function of the GDP of country j at period t.

[27]Specifically, we use a value of 5.75 for the elasticity of substitution across varieties in the chemicals and chemical products sector.

where $\theta_2 = (\mu^F, \mu^S, \mu^B, \zeta^S)$, and $\varepsilon_d = \varepsilon_d^1 + \varepsilon_d^2$. Note that now our moments are linear in parameters. The sample analogues of these moment inequalities are:

$$\tilde{m}_s(\theta_2) = \frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d=1}^{D_{it}^k} \big(\hat{v}_{idt} - g_d^F(\mu^F) - g_{do_{t+1}}^S(\mu^S) + e_{do_{t+1}}^S(\zeta^S) - bc_{do_{t+1}}(\mu^B)\big) g_{k_l}(x_{idt}) \geq 0$$

where o_{t+1} is the realization of the random variable $\mathbf{o}_{t+1}$ (i.e. it is the observed bundle of countries for firm i at period $t+1$).

Applying the results in Pakes et al. (2006) summarized in section 6.1, the estimated set $\hat{\Theta}_2$ defined as:

$$\hat{\Theta}_2 = \underset{\theta_2}{\text{argmin}} \sum_{s=1}^{S} \big(\min\{0, \tilde{m}_s(\theta_2)\}\big)^2$$

will be a consistent estimate for the corresponding identified set Θ_2 that is obtained from fixing β at its true value and solving for

$$\min_{\theta_2} \sum_{s=1}^{S} \big(\min\{0, m_s(\theta_2)\}\big)^2$$

as long as the following assumption holds

Assumption 3 *For every moment inequality $s = 1, \ldots, S$, it holds that:*

$$\frac{1}{D_k} \sum_{i=1}^{I} \sum_{t=1}^{T} \sum_{d_t=1}^{D_{it}^k} \varepsilon_d g_{k_l}(x_{idt}) \xrightarrow{D^k \to \infty} 0$$

and $D_k = \sum_{i=1}^{I} \sum_{t=1}^{T} D_{it}^k$.

Assumption 3 imposes that the sum of the first and second stage errors is asymptotically orthogonal to any variable that we are using as instrument in our moment inequalities. Given that Assumption 2 imposes that x_{idt} belongs to the information set of the agent at the time it takes the decision from which we deviate, a sufficient condition for Assumption 3 to hold is that there is no unobservable variable affecting differently the net profits of the actual strategy and its counterfactual that is known by the firm when taking its decision and not accounted by us in the model. On the contrary, any unobservable variable that affects identically the net profits of following the actual or the counterfactual export strategies is differenced out in our moment inequalities. Assumption 3 may be understood as a no-selection bias assumption: the decision of firms to serve some country and not others at any period of time must be based exclusively on observable characteristics of the firm's environment that the model is taking into account.

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 the firm at the time of taking its entry and exit decisions. This is an example of the typical identification problem, present in many applications, between heterogeneity and state-dependence.

Concerning the implications of Assumption 3 for the structural errors included in the model, note that *sufficient* conditions for Assumption 3 to hold are: (a) ϵ^M_{ijt} is independently distributed of Z_{ijt} and identically distributed for every i, j, and t (see equation (18)); (b) (ϵ^F_{ijt}, ϵ^S_{ijt}, ϵ^B_{it}) is mean independent of any variable included in the information set of the agent $\mathcal{J}_{it}$.

7 Confidence Intervals

There are a variety of different approaches to inference with moment inequalities. Some of them aim at finding a confidence interval for the true parameter, others for the identified set, and finally others for extremum points of this set. Papers that provide methods to compute confidence intervals for the true parameters are: Imbens and Manski (2004), Romano and Shaikh (2008), Andrews and Guggenberger (2009), and Andrews and Soares (2010). On the contrary, papers that focus on confidence intervals for the identified set are Chernozhukov et al. (2007), Rosen (2008), and Romano and Shaikh (2010). Finally, Pakes et al. (2006) proposes valid confidence intervals for the boundaries of the identified set. Our estimates of the confidence interval fit in this later category.[28]

This section relies heavily on Holmes (2010). Holmes (2010) modifies the approach in Pakes et al. (2006) in order to take into account that there is correlation in the second stage error terms across deviations when two deviations involve the same country.

Let us denote by $\hat{\mu}$ the vector that stacks the sample average of all the variables included in any of the moment inequalities used in the estimation[29]. Our moments are averages across deviations and different moments might include different number of deviations. We denote by D^s the total number of observations used in moment s. Let's use $\hat{\Sigma}_1$ to denote the variance-covariance matrix of the sample mean $\hat{\mu}$ under the assumption that $\hat{\mu}$ is an average of independent and identically distributed observations.

Computing the limit distribution of the estimator of the extreme points of the identified set requires knowing *ex ante* the binding moments. This is information that the researcher will

[28]Note that by taking the appropriate limits of confidence intervals that are valid for the extreme values, we can construct conservative confidence intervals for the identified set and for the true value of the parameter vector.

[29]Given that the moment inequalities are sample average themselves, note that building $\hat{\mu}$ implies simply stacking in a column vector all the terms that appear in the moments.

generally not have and that we certainly don't have[30]. Pakes et al. (2006) provide inferential procedures that do not depend on prior knowledge of which moments bind. This procedure allows to simulate asymptotically conservative confidence intervals for each extreme point of the identified set[31]. These confidence intervals are based on a set of simulation draws r=1, ..., R of the moment inequality exercise. Each of these simulations uses a draw from a normal distribution with mean $\hat{\mu}$ and covariance $\hat{\Sigma}_1$. By plugging each of the components of the vector drawn r into its corresponding place in its moment inequality we obtain the set of inequalities:

$$\tilde{m}_s^r(\theta_2) \geq 0 \qquad s = 1, \dots, S.$$

We explain here the procedure to obtain an asymptotically conservative confidence interval for the upper and lower bound of a particular linear combination of the elements of the parameter vector θ_2. We denote this linear combination as τ:

$$\tau = f \cdot \theta_2$$

where f is an arbitrary constant vector of the same dimension as θ_2. Specifically, we are looking for a confidence interval for

$$\overline{\tau} = f \cdot \overline{\theta}_2$$

and

$$\underline{\tau} = f \cdot \underline{\theta}_2$$

with $\overline{\theta}_2$ and $\underline{\theta}_2$ defined as:

$$\overline{\theta}_2 = \underset{\theta_2}{\text{argmax}}\, \tau \qquad \text{s.t.} \qquad \theta_2 \in \underset{\theta_2}{\text{argmin}} \sum_{s=1}^{S} \big(\min\{0, m_s(\theta_2)\}\big)^2$$

$$\underline{\theta}_2 = \underset{\theta_2}{\text{argmin}}\, \tau \qquad \text{s.t.} \qquad \theta_2 \in \underset{\theta_2}{\text{argmin}} \sum_{s=1}^{S} \big(\min\{0, m_s(\theta_2)\}\big)^2$$

Using the insights in Section 6.1, we know that we can obtain consistent estimates for $\overline{\tau}$ and $\underline{\tau}$ by computing the corresponding bounds of the set $\hat{\Theta}_2$ (see Section 6.1). Let's denote these bounds $\hat{\overline{\tau}}$ and $\hat{\underline{\tau}}$:

$$\hat{\overline{\tau}} = f \cdot \hat{\overline{\theta}}_2$$

$$\hat{\underline{\tau}} = f \cdot \hat{\underline{\theta}}_2$$

[30] Most of the parameters identified in this paper through moment inequalities appear simultaneously in most of our moments, making it impossible to know which moments bind and, therefore, define the identified set.

[31] This method assumes identical number of observations per moment, independent observations within moments, and no first-stage error.

with $\hat{\bar{\theta}}_2$ and $\hat{\underline{\theta}}_2$ defined as:

$$\hat{\bar{\theta}}_2 = \underset{\theta_2}{\operatorname{argmax}}\, \tau \qquad \text{s.t.} \qquad \theta_2 \in \underset{\theta_2}{\operatorname{argmin}} \sum_{s=1}^{S} \big(\min\{0, \tilde{m}_s(\theta_2)\}\big)^2$$

$$\hat{\underline{\theta}}_2 = \underset{\theta_2}{\operatorname{argmin}}\, \tau \qquad \text{s.t.} \qquad \theta_2 \in \underset{\theta_2}{\operatorname{argmin}} \sum_{s=1}^{S} \big(\min\{0, \tilde{m}_s(\theta_2)\}\big)^2$$

The first step to build our confidence intervals is to compute two $S \times 1$ vectors of shifters that measure the degree of slackness of each moment inequality in the actual sample:

$$\hat{\bar{\gamma}}^s \equiv \max\big\{0, \tilde{m}_s(\hat{\bar{\theta}}_2)\big\}$$

$$\hat{\underline{\gamma}}^s \equiv \max\big\{0, \tilde{m}_s(\hat{\underline{\theta}}_2)\big\}$$

We are going to obtain confidence intervals for $\bar{\tau}$ and $\underline{\tau}$ through simulation. Specifically, using these shifters, the set of moment inequalities linked to the draw r, and the number of observations per moment in the sample, we are going to obtain a draw from the distribution from which we derive our confidence intervals. We denote these draws as $\hat{\bar{\tau}}^r$ and $\hat{\underline{\tau}}^r$ and compute them as:

$$\hat{\bar{\tau}}^r = f \cdot \hat{\bar{\theta}}_2^r$$

$$\hat{\underline{\tau}}^r = f \cdot \hat{\underline{\theta}}_2^r$$

with $\bar{\theta}_2^r$ and $\underline{\theta}_2^r$ defined as:

$$\bar{\theta}_2^r = \underset{\theta_2}{\operatorname{argmax}}\, \tau \qquad \text{s.t.} \qquad \theta_2 \in \underset{\theta_2}{\operatorname{argmin}} \sum_{s=1}^{S} \Big(\min\{0, \tilde{m}_s^r(\theta_2) + \frac{1}{\sqrt{2\ln(\ln(D^s))}}\bar{\gamma}^s\}\Big)^2$$

$$\underline{\theta}_2^r = \underset{\theta_2}{\operatorname{argmin}}\, \tau \qquad \text{s.t.} \qquad \theta_2 \in \underset{\theta_2}{\operatorname{argmin}} \sum_{s=1}^{S} \Big(\min\{0, \tilde{m}_s^r(\theta_2) + \frac{1}{\sqrt{2\ln(\ln(D^s))}}\underline{\gamma}^s\}\Big)^2$$

Iterating this procedure for each r, we obtain R realizations of the vector $(\underline{\tau}^r,\bar{\tau}^r)$. Taking the $\alpha/2$ percentile of the realizations for the lower bound and the $1-\alpha/2$ percentile of the ones for the upper bound, we compute the $1-\alpha$ confidence intervals.

The method described above does not account for correlation among observations included in the same moment inequality. This type of correlation structure might appear in our model given that different deviations involve the same set of countries. In order to account for this type of correlation structure we follow Holmes (2010) and use subsampling methods to compute a new covariance matrix for the vector $\hat{\mu}$. Each subsample is generated in the following way. Given a set of N countries existing in our database, we chose a random subsample of destinations of size N_b. We define a deviation subsample as the set of deviations for which both the actual and the counterfactual country belong to the random subsample of destinations. For each of these subsamples, we compute a sample mean $\hat{\mu}_b$ of each variable included in each moment inequality. The vector $\hat{\mu}_b$ averages only across deviations included in the deviation subsample. Iterating this subsampling process B times and using the set of B sample averages $\hat{\mu}_b$ computed in this way, we compute an estimator $\hat{\Sigma}_2$ for the covariance matrix associated with $\hat{\mu}$ that accounts for correlation in the observations:

$$\hat{\Sigma}_2 = \frac{N_b}{N}\hat{\Sigma}_b$$

where

$$\hat{\Sigma}_b = \frac{1}{B}\sum_{b=1}^{B}(\hat{\mu}_b - \hat{\mu})(\hat{\mu}_b - \hat{\mu})'$$

Substituting $\hat{\Sigma}_2$ for $\hat{\Sigma}_1$ and following the same simulation procedure described above provides with an estimate of a confidence interval for $\bar{\tau}$ and $\underline{\tau}$ that account for correlation in the observations.

8 Baseline Results

This section presents the baseline estimates for the different parameters affecting fixed, sunk and basic costs of exporting for firms operating in the chemical sector[32]. These results use only one moment inequality per bound-parameter pair. Concerning the moments included in the estimation, the tighter set of moments among the ones described in Section 5.2 are used. Specifically, we only use big firms and big countries to identify lower bounds and the set of all firms and small countries to identify upper bounds[33]. Table 5 presents a summary of the 26 moment inequalities used in the estimation of the results presented in this section. We denote this set of moments as the *narrow* version. In Section 9 we present results for alternative combinations of moment inequalities.

The first two columns of Table 6 contain the lower and upper bound estimates for each parameter. These numbers indicate the minimum and maximum values that are consistent

[32]The first stage estimation results are contained in Table A.1. We use this first stage result as a reduced form approximation to gross profits from exporting. They predict the counterfactual profits from actions firms did not implement but that we introduce in our moment inequalities. Table A.1 shows the first stage estimates for three different cases: no censorship in the revenue equation (1st column); we drop the export revenues below 1,000 USD (2nd column); we drop the export revenues below 5,000 USD (3rd column). We use the results in column one in the second stage. Columns two and three present coefficients that are very similar to those in column one. This shows that our predicted gross profits are not driven by many small export flows that could be thought of as samples or pure experimentation.

[33]The definition of big and small countries as well as big and small firms is given in Section 5.2. We could not use only small firms to identify upper bounds because there are very few small exporting firms and, in consequence, the different inequalities ended up having very few observations.

with the sample moment inequalities. The compute these bounds or extreme points without imposing any restriction on the values that the other parameters may take.

The lower bound is equal to zero for many of the parameters. The reason for this is that each of the variables that we are including in the specification of fixed and sunk costs tends to be very correlated with a subgroup of the remaining variables. Therefore, whenever we observe a particular entry or exit of any given firm in any given country, it is possible to load the explanation of that behavior on any of the effects that are concurrent in it. If the same effects appear in similar magnitude for different observations, then it is going to be impossible to reject the possibility that each of those factors has a zero effect[34]. The correlation between the different explanatory variables can be observed in Table 5. Note that the four extended gravity variables tend to take the same sign in every moment. The same can be said for the standard gravity variables entering sunk costs and the ones affecting fixed costs.

Having a lower bound of zero for each of the parameters separately does not imply that the estimated set includes a point where all the parameters are simultaneously zero. Specifically, the identified set is not the Cartersian product of the intervals presented in Table 6. Given the impossibility of computing the extreme values of the identified set in every possible dimension, Table 7 shows the predicted costs of exporting to a selected group of countries. This table contains the upfront cost a firm must pay in order to export to a given country (indicated in the first column) depending on the country to which the firm was exporting in the previous period (indicated in the second column)[35]. This upfront cost can be decomposed into fixed, sunk and basic costs of exporting. This decomposition is done in Table 8 for the midpoint of each of the intervals shown in Table 7[36]

The estimates show that exporting to any country, no matter how similar this one is to

[34] The reason for the strong correlation in gravity effects is that most of the countries that have Spanish as official language are located in South America and have levels of GDP per capita similar to Chile.

[35] Each country represents a particular linear combination of the parameters included in the vector θ_2. Therefore, the bounds shown in Table 7 are just extremum estimators of the identified set in dimensions different from the ones shown in Table 6. Our model yields different upfront costs for two countries j and j' only if they have different values for at least one of the variables included in fixed or sunk costs. Therefore, the reader can substitute any of the countries in Table 7 for any other one that has the same gravity and extended gravity characteristics and the indicated upfront costs are going to be equally applicable. For example, the estimated fixed cost of exporting to Germany is the same as the one estimated for the US and the sunk cost of entering Germany for a firm that is previously exporting to Austria is estimated to be the same as the one of entering the US for a firm previously exporting to Canada.

[36] The decomposition is *ad hoc*. While the estimated intervals in Table 7 come directly from the model and the linear inequalities implied by it, the numbers in Table 8 impose additional assumptions. Firstly, they are built using only the midpoint of the intervals in Table 7. Secondly, the sunk costs are computed as the difference between the corresponding midpoints for the upfront costs borne by firms that were not exporting to the destination country in the previous year and the one faced by firms that were exporting to it. Taking differences between the sunk costs yields the extended gravity effect. Finally, the basic costs are computed as the difference in the upfront costs' midpoint for the firms that were not exporting at all in the previous period and those that were exporting to some country that implies no extended gravity effect with the destination country. It is this *ad hoc* procedure what explains that, for example, Table 8 indicates different numbers for the basic costs depending on the destination country (even though they are assumed in the model to be independent of the set of countries to which a firm is exporting).

Chile, implies high fixed costs. Gravity forces modify these fixed costs in relatively small magnitudes. While the fixed costs of exporting to the US are estimated to lie between 223,708 USD and 242,627 USD, the corresponding ones for Colombia are estimated to take a value between 215,785 USD and 235,578 USD. Table 7 shows that the estimated mean gross export profits for the firms that exported a positive quantity to each of these countries are nearly two times the estimated fixed costs in the case of the US, and nearly 50% higher than those fixed costs in the case of Colombia. Country specific sunk costs of exporting are estimated to be in general lower than fixed costs but they are much more affected by gravity. In particular, the sunk cost of exporting to the US for a firm that does not profit from any extended gravity effect is estimated to be between 3 and 4 times larger than the sunk costs of exporting to Colombia. By comparing the approximated sunk cost of exporting to the US (230,089 USD) with the one of exporting to Spain (162,440 USD) and the one of exporting to Brazil (118,589 USD) with the corresponding one for Colombia (69,578 USD), we see that linguistic factors have a big effect on sunk costs. In the same way, the comparison of the corresponding numbers for the US and Brazil shows that the joint effect of changes in continent and GDP per capita group also push up the sunk costs of exporting significantly.

Concerning the extended gravity effects, the estimates in Tables 7 and 8 show that having exported to a country that has the same language as the one the firm is trying to access has a significant effect in reducing the entry costs. In particular, having exported to the UK reduces the sunk costs of entering the US by 18.86% (43,385 USD) while having export experience in a portuguese speaking country decreases the entry costs in Brazil by an estimated 27.97% (33,169 USD). On the contrary, geographic factors don't seem to generate any significant extended gravity effect. For example, having exported to Canada implies no advantage with respect to having exported to the UK for accessing the US market and the sunk costs of exporting to Spain for a firm that was previously exporting to France are estimated to be the same as those for a firm that was only exporting to Colombia.

9 Robustness

This section replicates the estimation exercise using different moments from the ones employed to obtain the results in Section 8. We explore in particular two different variants.

First, we analyze the influence of the moment aimed at identifying the lower bound of the parameter measuring the basic costs of exporting, μ_0^B, on our estimates. This bound is identified out of firms that are entering into exporting: firms that at some period $t-1$ were not exporting to any country, but that are exporting at period t. There are only 86 entry events of this type in the sample (see last column corresponding to moment 6 in Table 5) and, therefore, the corresponding moment will be an average of only 86 observations. As it can be seen in Table 5, all the moments included in the estimation use a number of observations that is 5 times larger and in most of the cases it is actually 10 times larger. Therefore, by not including this moment we want to avoid estimates that are might be driven only by very few observations. A comparison of Table A.2 and Table 6 shows that the estimated set is not affected at all by the inclusion or not of this particular moment. In other terms, this moment happens to be non-binding in the original set of results. Therefore, Tables 7 and 8 remain invariant no matter whether we include or not this extra moment. Furthermore, the confidence intervals for the different parameters remain very similar except for the upper bound of the parameter μ_0^B itself.

Second, we redo the estimation exercise using moments that do not select firms nor counterfactual countries. We still use only one moment inequality per parameter-bound pair but, instead of selecting deviations based on the counterfactual countries and firms involved, we aggregate across all the possible deviations that identify the corresponding bound. We denote this set of moments as the *wide* version. They are summarized in Table A.3. Tables A.4, A.5, and A.6 are the analogous of 6, 7, and 8 for the case of the *wide* version of moments. Comparing both sets of tables, we can observe that, as expected, the wide version of moments generates larger intervals for each parameter than the narrow version. Nevertheless, the main conclusions outlined in Section 8 still hold: (1) the fixed costs vary much less with gravity variables than the sunk costs; (2) the sunk costs increase as the destination country differentiates from Chile in continent, language and GDP per capita; (3) the main extended gravity effect is generated by a firm exporting in the previous period to a country that shares official language with the destination country.

10 Concluding Remarks

This paper applies the moment inequalities approach to the estimation of a structural model of international trade. In recent years, new rich databases for the study of trade flows have become available. Such data sets contain information for several years on the specific output volume each firm exports to each possible destination country in the world[37]. 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 and exit decisions into individual countries becomes a crucial element of any structural model that tries to examine trade flows at the firm level.

Concurrently with the upsurge in the availability of firm-level destination specific export data, great interest has arisen in the study of the interactions between destination markets. We

[37]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 (2009)), Argentina (Albornoz et al. (2010)), China (Defever et al. (2010)), France (Eaton, Kortum, and Kramarz (2010), Buono et al. (2008)), Colombia (Eaton et al. (2008)), Ireland (Lawless (2009)), Peru (Martincus and Carballo (2008)), Denmark (Munch and Nguyen (2009)), Portugal (Bastos and Silva (2010)).

introduce the concept of *extended gravity* in order to denote these interactions. Trade theory had traditionally attempted to explain trade flows by focusing exclusively on the characteristics of each exporting-importing country pair. Papers like Albornoz et al. (2010) and Chaney (2010) introduce theoretical mechanisms that point out the need to account for the full export history of each firm when trying to predict firm-level trade behavior in any given country at any moment of time.

Models that allow for country-specific entry costs and extended gravity effects imply that firms' decision to enter (or exit) each country is intrinsically dynamic[38] and cannot be analyzed separately of the corresponding decision for the other countries[39]. This makes the choice set of firms extremely complex. It is precisely this complexity that makes moment inequalities ideal to study the export decision problem of the firm. Furthermore, the moment inequality approach implemented in this paper has the additional advantage of allowing for the identification and estimation of parameters of interest with a minimum number of structural assumptions. Specifically, this approach does not require a full specification of firms' expectations, information sets, and consideration sets, at the time of choosing their export destinations.

We estimate trade costs of exporting using firm-level export data for an unbalanced panel of Chilean manufacturing firms operating in the chemicals sector. The results show that both the traditional gravity and the extended gravity forces are important determinants of firms' decision to access different export markets. In particular, our estimates show that the startup costs of accessing a new country are significantly determined by the differences between the characteristics of the new country and those of both the home country and of the countries to which a firm had previously exported. On the contrary, the fixed costs that a firm must pay in every continuation year of exporting depend much less on country characteristics.

Although the analysis is rich in many dimensions -notably in its flexibility concerning the choice set firms face and in the multiple characteristics of destination countries that it takes into account- it has limitations. The structural model considered places all the extended gravity effects into sunk costs. In particular, it assumes that the variable costs of exporting do not depend on the exporting history of the firm. This is done mainly for computational reasons. Allowing the variable costs of exporting to depend on extended gravity effects would imply that the potential gross profits from exporting to any given country cannot be computed independently of the set of countries to which the firm is effectively exporting. Therefore, the solution of the model would be more complicated.

[38]Due to the existence of country-specific entry costs, the decision to export to a given country in a given period affects the following period's export profits in the same country. Therefore, this entry decision cannot be analyzed as a static optimization problem.

[39]Due to the existence of extended gravity effects, the decision to export to a given country in a given period may affect the net profits of exporting to any other country with whom it shares an extended gravity effect. Therefore, the decision to export to a given country cannot be analyzed independently of the decision to serve other countries that are related to it through some extended gravity variable.

Another limitation of the model is the absence of structural errors. Although this paper is the first one to allow for expectational errors in the analysis of dynamic discrete choice problems through moment inequalities, it still has the limitation that it leaves out structural errors. In particular, it does not consider firm-country specific factors that influence entry and exit decisions but are not in the data. If these unobservable factors tend to be correlated across countries that are connected in our setting through some extended gravity variable, then our estimates might not be capturing state dependence in trade costs but rather the effect of unobserved heterogeneity in country specific potential export profits[40].

Finally, this paper brings up the question of how important extended gravity effects are in the determination of aggregate trade flows. On the one hand, previous studies have shown that there is a great deal of dynamics in firms' export relations that washes out at a more aggregate level (see Buono et al. (2008)). Yet, on the other hand, Eaton et al. (2008) show that entry and exit into exporting has an important effect on aggregate trade flows in the long term, with successful entrants accounting for almost half of total export expansion during their first ten years of exporting. Determining the effect of extended gravity variables on aggregate trade flows therefore boils down to analyzing to what extent firms that benefit from these effects are likely to succeed in their export activity.

[40] Morales (2010) studies the identification problem of state dependence vs. heterogeneity in this setting and allows for a particular set of structural errors in the estimation of trade costs.

Appendix

A.1 Proof of Proposition 1

The proof of Proposition 1 comes directly from Assumption 1. From equation (9) we know that:

$$\mathcal{E}_i[\pi_{io_to_{t-1}t} + \delta\pi_{i\mathbf{o}_{t+1}o_tt+1} + \omega_{i\mathbf{o}_{t+1}t+2}|\mathcal{J}_{it}] \geq \mathcal{E}_i[\pi_{io'_to_{t-1}t} + \delta\pi_{i\mathbf{o}'_{t+1}o'_tt+1} + \omega_{i\mathbf{o}'_{t+1}t+2}|\mathcal{J}_{it}],$$

with

$$\mathbf{o}_{t+1} = \underset{b_{t+1}\in\mathcal{B}_{io_tt+1}}{\text{argmax}} \ \mathcal{E}_i\left[\Pi_{ib_{t+1}o_tt+1}|\mathcal{J}_{it+1}\right],$$

and

$$\mathbf{o}'_{t+1} = \underset{b_{t+1}\in\mathcal{B}_{io'_tt+1}}{\text{argmax}} \ \mathcal{E}_i\left[\Pi_{ib_{t+1}o'_tt+1}|\mathcal{J}_{it+1}\right].$$

By transitivity of preferences,

$$\mathcal{E}_i[\pi_{io_to_{t-1}t} + \delta\pi_{i\mathbf{o}_{t+1}o_tt+1} + \omega_{i\mathbf{o}_{t+1}t+2}|\mathcal{J}_{it}] \geq \mathcal{E}_i[\pi_{io'_to_{t-1}t} + \delta\pi_{i\mathbf{o}_{t+1}o'_tt+1} + \omega_{i\mathbf{o}_{t+1}t+2}|\mathcal{J}_{it}],$$

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

$$\mathcal{E}_i[\pi_{io_to_{t-1}t} + \delta\pi_{i\mathbf{o}_{t+1}o_tt+1}|\mathcal{J}_{it}] \geq \mathcal{E}_i[\pi_{io'_to_{t-1}t} + \delta\pi_{i\mathbf{o}_{t+1}o'_tt+1}|\mathcal{J}_{it}]. \quad \text{Q.E.D.}$$

A.2 Identifying Observations: Additional Examples

Here we present additional examples of how to build inequalities that identify the bounds of each of our parameters. We focus on the parameters μ_0^S (constant term in the country-specific sunk costs of exporting), μ_l^F (gravity term corresponding to language entering the fixed costs of exporting), and μ_l^S (gravity term corresponding to language entering the sunk costs of exporting).

A.2.1 Additional Example 1: Bounding μ_0^S

Imagine we observe firm i with the following stream of gross profits in country j and an associated export trajectory

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

A counterfactual that is going to help us identify an upper bound for μ_0^S is:

Year	1	2	3	4	5
Actual	0	1	0	0	0
Counterfactual	0	0	0	0	0

where we eliminate the entry event. Assume for simplicity that country j shares the same continent, language, and GDP per capita group with Chile, meaning that the gravity variables for these characteristics appearing in the fixed and sunk cost terms take a value of 0. Then, as long as firm i was exporting to some other country j' in periods 1 or 2 and to no country in periods 3 and later, our counterfactual generates the following difference in profits:

$$\pi_{ido_3 2} = v_{ij2} - \mu_0^F - \mu_0^S - \epsilon_{ij2}^F - \epsilon_{ij2}^S$$

which immediately generates an observation for the upper bound of the sum of μ_0^F and μ_0^S. This example shows that, while the parameter μ_0^F might appear in some moments independently of μ_0^S (see Section 5.1.1), μ_0^S will never appear without μ_0^F. Therefore, the identification of bounds for μ_0^S relies on additional moments like the ones described in Section 5.1.1. As an example:

$$\mu_0^F + \mu_0^S \leq v_{ij2} - \epsilon_{ij2}^F - \epsilon_{ij2}^S$$
$$\mu_0^F \geq v_{i'j'4} - \epsilon_{i'j'4}^F$$

jointly imply:

$$\mu_0^S \leq v_{ij2} - \epsilon_{ij2}^F - \epsilon_{ij2}^S - (v_{i'j'4} - \epsilon_{i'j'4}^F)$$

which gives an observation for the upper bound of μ_0^S. Note that i' might be different from i, j' might be different from j, or both.

The procedure to identify a lower bound for μ_0^S is analogous. It is obtained by combining a lower bound on the sum of μ_0^S and μ_0^F with an upper bound on μ_0^F.

The examples shown here so far, as well as the ones presented in Section 5, are simple cases compared to those that might appear in the data. In general, multiple parameters will appear in the same moment (see Tables 5 and A.3). We progressively complicate the example above to show how more parameters might appear in the same moment inequality:

- Complication 1: add the assumption that firm i is not exporting to any other country other than j at period 1 nor at period 2. In this case, firm i needs to pay the basic costs of exporting when exporting to j at period 2.

$$\pi_{ido_3 2} = v_{ij2} - \mu_0^F - \mu_0^S - \mu_0^B - \epsilon_{ij2}^F - \epsilon_{ij2}^S - \epsilon_{i2}^B$$

- Complication 2: add to complication 1 the assumption that country j does not share continent, official language nor GDP per capita group with Chile.

$$\pi_{ido_3 2} = v_{ij2} - \mu_0^F - \mu_c^F - \mu_l^F - \mu_{gdp}^F - \mu_0^S - \mu_c^S - \mu_l^S - \mu_{gdp}^S - \mu_0^B - \epsilon_{ij2}^F - \epsilon_{ij2}^S - \epsilon_{i2}^B$$

- Complication 3: add to complications 1 and 2 the assumption that firm i was actually exporting to country j at periods 2 and 3 (i.e. not only at period 2). In this case, actual and counterfactual strategies become:

Year	1	2	3	4	5
Actual	0	1	1	0	0
Counterfactual	0	0	1	0	0

and the resulting moment difference in profits is:

$$\pi_{ido_3 2} = v_{ij2} - \mu_0^F - \mu_c^F - \mu_l^F - \mu_{gdp}^F - (1-\delta)(\mu_0^S + \mu_c^S + \mu_l^S + \mu_{gdp}^S + \mu_0^B) - \epsilon_{ij2}^F - \epsilon_{ij2}^S + \delta\epsilon_{ij3}^S - \epsilon_{i2}^B + \delta\epsilon_{i3}^B$$

- Complication 4: add to complications 1, 2, and 3 the assumption that firm i starts exporting at period 3 to some other foreign country j' that shares continent, and language with country j. The final difference in profits is:

$$\pi_{ido_3 2} = v_{ij2} - \mu_0^F - \mu_c^F - \mu_l^F - \mu_{gdp}^F - (1-\delta)(\mu_0^S + \mu_c^S + \mu_l^S + \mu_{gdp}^S) + \delta(\zeta_c^S + \zeta_l^S) - \epsilon_{ij2}^F - \epsilon_{ij2}^S + \delta\epsilon_{ij3}^S - \epsilon_{i2}^B + \delta\epsilon_{i3}^B$$

A.2.2 Additional Example 2: Bounding μ_l^F

Consider a situation in which firm i is exporting in year 7 to countries j and j'. While country j has Spanish as official language, country j' does not. However, neither country j nor j' are located in South America or belong to the same GDP per capita group as Chile. Firm i exits country j in period 8 while it keeps exporting to country j' for, at least, two additional years. Specifically, assume the stream of profits and actual export strategies implemented in each country j and j' are:

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

A possible counterfactual that implements one-period deviations would be:

	Year	7	8	9
Actual	Country j	1	1	1
	Country j'	1	0	0
Counterfactual	Country j	1	0	1
	Country j'	1	1	0

Assuming that firm i does not export to any other country at periods 8 and 9, the difference in profits linked to this particular deviation at period 8 is:

$$\pi_{ido_98} = v_{ij8} - v_{ij'8} + \mu_l^F + \delta(\mu_0^S + \mu_c^S + \mu_{gdp}^S) - (\epsilon_{ij8}^F - \epsilon_{ij'8}^F) + \delta\epsilon_{ij9}^S$$

Note that the counterfactual strategy implies that firm i needs to reenter country j at period 9 and, therefore, pay the corresponding sunk cost of exporting. If the actual strategy implied firm i exiting country j at period 9 (i.e. firm i exports to country j only in years 7 and 8), then the inequality simplifies to:

$$\pi_{ido_98} = v_{ij8} - v_{ij'8} + \mu_l^F - (\epsilon_{ij8}^F - \epsilon_{ij'8}^F)$$

The same intuition outlined here applies when we are looking for observations that identify bounds for μ_c^F and μ_{gdp}^F.

A.2.3 Additional Example 3: Bounding μ_l^S

Assume the same countries j and j' from the example above for μ_l^F. However, instead of the previous strategies, we assume that firm i applies the following export strategies in these two countries:

	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

The deviation that we implement yields:

	Year	7	8	9
Actual	Country j	0	1	0
	Country j'	0	0	0
Counterfactual	Country j	0	0	0
	Country j'	0	1	0

Assuming that neither country j nor country j' benefit from extended gravity effects at period 8 and that firm i does not export to any country at period 9, we obtain the following difference in profits:

$$\pi_{ido_9 8} = v_{ij'8} - v_{ij8} - \mu_l^F - \mu_l^S + \epsilon_{ij8}^F - \epsilon_{ij'8}^F + \epsilon_{ij8}^S - \epsilon_{ij'8}^S$$

Applying the same logic indicated above for μ_0^S, we need to combine this inequality with a upper bound on μ_l^F in order to really obtain a lower bound for μ_l^S.

References

Albornoz, Facundo, Héctor F. Calvo Pardo, Gregory Corcos, and Emanuel Ornelas, "Sequential Exporting," *mimeo*, February 2010. [4, 5, 34, 35]

Alvarez, Roberto, H. Faruq, and Ricardo A. López, "New Products in Export Markets: Learning From Experience and Learning from Others," *mimeo*, 2008. [34]

Amiti, Mary and David E. Weinstein, "Exports and Financial Shocks," *mimeo*, December 2009. [4]

Anderson, James E. and Eric van Wincoop, "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review*, 2003, *93* (1), 170–192. [3]

Andrews, Donald W.K. and Gustavo Soares, "Inference for Parameters Defined by Moment Inequalities Using Generalized Moment Selection," *Econometrica*, 2010, *78*, 119–157. [24, 28]

_ **and Patrik Guggenberger**, "Validity of Subsampling and Plug-in Asymptotic Inference for Parameters Defined by Moment Inequalities," *Econometric Theory*, 2009, *25*, 669–709. [28]

Arkolakis, Costas and Marc-Andreas Muendler, "The Extensive Margin of Exporting Goods: A Firm-level Analysis," *mimeo*, February 2009. [34]

Bastos, Paulo and Joana Silva, "The Quality of a Firm's Exports: Where you Export Matters," *Journal of International Economics*, 2010. [34]

Bernard, Andrew B., J. Bradford Jensen, Stephen J. Redding, and Peter K. Schott, "The Margins of US Trade," *American Economic Review*, 2010, *99*, 487–493. [1]

Biesebroeck, Johannes Van, "Exporting Rises Productivity in Sub-Saharan African Manufacturing Firms," *Journal of International Economics*, 2005, *67*, 373–391. [1]

Broda, Christian and David E. Weinstein, "Globalization and the Gains from Variety," *Quarterly Journal of Economics*, 2006, *121* (2), 541–585. [1]

_ **, Joshua Greenfield, and David E. Weinstein**, "From Groundnuts to Globalization: A Structural Estimate of Trade and Growth," *NBER Working Paper*, September 2006, *No. 12512.* [26]

Buono, Ines, Harald Fadinger, and Stefan Berger, "The Micro Dynamics of Exporting-Evidence from French Firms," *mimeo*, December 2008. [34, 36]

Chaney, Thomas, "The Network Structure of International Trade," *mimeo*, June 2010. [4, 35]

Chernozhukov, Victor, Han Hong, and Elie Tamer, "Estimation and Confidence Regions for Parameter Sets in Econometric Models," *Econometrica*, 2007, *75*, 1243–1284. [28]

Das, Sanghamitra, Mark J. Roberts, and James R. Tybout, "Market Entry Costs, Producer Heterogeneity, and Export Dynamics," *Econometrica*, 2007, *75* (3), 837–873. [2, 4]

Defever, Fabrice, Bendikt Heid, and Mario Larch, "Spatial Exporter Dynamics," *mimeo*, January 2010. [4, 5, 34]

Eaton, Jonathan and Samuel Kortum, "Technology, Geography, and Trade," *Econometrica*, 2002, *70* (5), 1741–1779. [1]

Eaton, Jonathan, Marcela Eslava, Maurice Kugler, and James R. Tybout, "The Margins of Entry into Export Markets: Evidence from Colombia," in Elhanan Helpman, Dalia Marin, and Thierry Verdier, eds., *The Organization of Firms in a Global Economy*, Cambridge: Harvard University Press, 2008. [5, 34, 36]

Eaton, Jonathan, Samuel Kortum, and Francis Kramarz, "An Anatomy of International Trade: Evidence from French Firms," *mimeo*, February 2010. [34]

Evenett, Simon J. and Anthony J. Venables, "Export Growth in Developing Countries: Market Entry and Bilateral Trade Flows," *mimeo*, June 2002. [1]

Fillat, José L. and Stefania Garetto, "Risk, Returns, and Multinational Production," *mimeo*, October 2010. [1]

Freund, Caroline, "The Trade Response to Global Downturns: Historical Evidence," *mimeo*, August 2009. [4]

Ghironi, Fabio and Marc J. Melitz, "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *Quarterly Journal of Economics*, 2005, *120*, 865–915. [1]

Grossman, Richard S. and Christopher M. Meissner, "International Aspects of the Great Depression and the Crisis of 2007: Similarities, Differences, and Lessons," *mimeo*, August 2010. [4]

Helpman, Elhanan, Marc Melitz, and Yona Rubinstein, "Estimating Trade Flows: Trading Partners and Trading Volumes," *Quarterly Journal of Economics*, 2008, *123* (2), 441–487. [1]

Ho, Katherine, "Insurer-Provider Networks in the Medical Care Market," *American Economic Review*, 2009, *99* (1), 393–430. [5]

Holmes, Thomas J., "The Diffusion of Wal-Mart and Economies of Density," *Econometrica*, 2010, *forthcoming.* [5, 28, 30]

Imbens, Guido and Charles Manski, "Confidence Intervals for Partially Identified Parameters," *Econometrica*, 2004, *72*, 1845–1857. [28]

Ishii, Joy, "Compatibility, Competition, and Investment in Network Industries: ATM Networks in the Banking Industry," *mimeo*, 2008. [5]

Jacks, David S., Christopher M. Meissner, and Dennis Novy, "Trade Booms, Trade Busts, and Trade Costs," *mimeo*, February 2010. [4]

Katz, Michael, "Supermarkets and Zoning Laws," *Unpublished PhD Dissertation*, 2007, *Harvard University.* [5]

Lawless, Martina, "Firm Export Dynamics and the Geography of Trade," *Journal of International Economics*, 2009, *77* (2), 245–254. [1, 34]

Lileeva, Alla and Daniel Trefler, "Improve Access to Foreign Markets Raises Plant-level Productivity...for Some Plants," *Quarterly Journal of Economics*, 2010, *125* (3), 1055–1099. [1]

Loecker, Jan De, "Do Exports Generate Higher Productivity? Evidence from Slovenia," *Journal of International Economics*, 2007, *73*, 69–98. [1]

Martincus, Christian V. and Jerónimo Carballo, "Is Export Promotion Effective in Developing Countries? Firm-level Evidence on the Intensive and the Extensive Margins of Exports," *Journal of International Economics*, 2008, *76* (1), 89–106. [34]

Mayer, Thierry and Soledad Zignago, "Notes on CEPII's Distances Measures," *mimeo*, May 2006. [6]

Melitz, Marc, "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 2003, *71*, 1695–1725. [1, 2]

Morales, Eduardo, "How Flexible do we Need to be? Allowing for Expectational and Structural Errors in the Estimation of Trade Costs.," *mimeo*, 2010. [36]

Munch, Jakob R. and Daniel X. Nguyen, "Decomposing Firm-level Sales Variation," *mimeo*, June 2009. [34]

Pakes, Ariel, "Alternative Models for Moment Inequalities," *Econometrica*, forthcoming. [5, 16]

_ , Jack R. Porter, Katherine Ho, and Joy Ishii, "Moment Inequalities and their Application," *mimeo*, November 2006. [5, 16, 23, 24, 27, 28, 29]

Pavcnik, Nina, "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants," *The Review of Economic Studies*, 2002, *69*, 245–276. [1]

Roberts, Mark J. and James R. Tybout, "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs," *American Economic Review*, 1997, *87* (4), 545–564. [9]

Romano, Joseph P. and Azeem M. Shaikh, "Inference for Identifiable Parameters in Partially Identified Econometric Models," *Journal of Statistical Planning and Inference*, 2008, *138* (9), 2786–2807. [28]

_ and _ , "Inference for the Identified Set in Partially Identified Econometric Models," *Econometrica*, 2010, *78*, 169–211. [28]

Rosen, Adam M., "Confidence Sets for Partially Identfied Parameters that Satisfy a Finite Number of Moment Inequalities," *Journal of Econometrics*, 2008, *146*, 107–117. [28]

Ruhl, Kim J., "The International Elasticity Puzzle," *mimeo*, March 2008. [1]

Tinbergen, Jan, *Shaping the World Economy*, New York: The Twentieth Century Fund, 1962. [3]

Figures and Tables

Table 1: Export volumes

Year	Export Volume	Export Growth	Prop. Exports
	S.24	S.24	S.24
1996	435	0.0	6.8
1997	653	50.1	9.6
1998	561	28.9	8.4
1999	636	46.2	8.9
2000	1,042	139.6	13.1
2001	1,154	165.0	14.5
2002	1,114	155.9	13.7
2003	1,538	253.3	16.4
2004	1,825	319.2	15.5
2005	2,421	456.3	17.5

Notes: Export volumes are in millions of current US dollars. Export growth shows percentage change in export volumes with respect to year 1996. The proportion of exports is the percentage of aggregate manufacturing exports.

Table 2: Summary statistics (Sector 24)

		N	Mean	S.D.	Min	p25	p50	p75	Max
Dom. sales (exp)	F-Y	1420	44.48	256.95	0.03	1.98	6.01	17.86	6792.19
Dom. sales (nonexp)	F-Y	670	1.94	2.82	0.02	0.46	0.90	2.29	21.05
Value exported	F-Y-C	6253	1.39	8.02	0.00	0.02	0.07	0.41	272.89
Value exported	F-Y	1031	8.43	43.53	0.00	0.04	0.27	1.88	608.42
Value exported	F	142	61.22	303.83	0.00	0.06	1.06	8.71	2761.67
N. countries served	F-Y	1031	6.06	6.47	1	2	4	8	35
N. countries served	F	142	9.96	10.26	1	2	7	14	56
N. entries (countries)	F-Y	1425	1.38	1.65	0	0	1	2	13
N. entries (exporting)	F	95	0.67	0.74	0	0	1	1	3
N. exists (countries)	F-Y	1042	1.01	1.50	0	0	0	2	10
N. exists (exporting)	F	82	0.58	0.81	0	0	0	1	3

Notes: Export volumes and domestic sales are in millions of year 2000 US dollars. The distribution of the different variables is computed across firms that export at least once during the sample period. *F* stands for firm; *Y* stands for year; and *C* stands for country.

Table 3: Transition matrices for extended gravity variables (Sector 24)

		Conditional on $t-1$		Conditional on t	
		Action in t			
All Countries but South American		Entry	No Entry	Entry	No Entry
Options Relative	Shares Continent	0.035	0.965	0.598	0.186
to $t-1$ Bundle	Does Not	0.006	0.994	0.402	0.814
All Countries but Spanish Speaking		Entry	No Entry	Entry	No Entry
Options Relative	Shares Language	0.024	0.976	0.368	0.203
to $t-1$ Bundle	Does Not	0.009	0.991	0.634	0.797
All Countries but Up Mid. Income		Entry	No Entry	Entry	No Entry
Options Relative	Shares Income Group	0.021	0.979	0.759	0.480
to $t-1$ Bundle	Does Not	0.005	0.995	0.241	0.520
All Countries but Bordering Chile		Entry	No Entry	Entry	No Entry
Options Relative	Shares Border	0.075	0.925	0.474	0.009
to $t-1$ Bundle	Does Not	0.009	0.991	0.526	0.991

Notes: All the firms considered in this table were exporting in period $t-1$. The rows differentiate between firms exporting to some country that shares the corresponding characteristic with the destination country and the remaining exporting firms. The columns differentiate between computing probabilities conditional on the state in period $t-1$ (left panel) or conditional on the behavior in period t (right panel).

Table 4: Transition matrices for extended gravity variables (Sector 24)

		Conditional on $t-2$		Conditional on t	
		Action in t			
All Countries but South American		Entry	No Entry	Entry	No Entry
Options Relative	Shares Continent	0.010	0.990	0.126	0.006
to $t-2$ Bundle	Does Not	0.005	0.995	0.874	0.994
All Countries but Spanish Speaking		Entry	No Entry	Entry	No Entry
Options Relative	Shares Language	0.010	0.990	0.082	0.068
to $t-2$ Bundle	Does Not	0.008	0.992	0.918	0.934
All Countries but Up Mid. Income		Entry	No Entry	Entry	No Entry
Options Relative	Shares Income Group	0.006	0.994	0.202	0.150
to $t-2$ Bundle	Does Not	0.004	0.996	0.898	0.850
All Countries but Bordering Chile		Entry	No Entry	Entry	No Entry
Options Relative	Shares Border	0.032	0.968	0.117	0.028
to $t-2$ Bundle	Does Not	0.007	0.993	0.883	0.972

Notes: All the firms considered in this table were exporting in period $t-2$ and are not exporting to a country that shares the corresponding characteristic with the destination country in period $t-1$. The rows differentiate between firms exporting in $t-2$ to some country that shares the corresponding characteristic with the destination country and the remaining exporting firms. The columns differentiate between computing probabilities conditional on the state in period $t-2$ (left panel) or conditional on the behavior in period t (right panel).

Table 5: Summary Statistics of Deviations by Moment

(Sector 24 - narrow version)

Group	Bound	$\Delta\pi$	$\Delta\mu_0^F$	$\Delta\mu_0^S$	$\Delta\mu_0^B$	$\Delta\mu_c^F$	$\Delta\mu_l^F$	$\Delta\mu_g^F$	$\Delta\mu_c^S$	$\Delta\mu_l^S$	$\Delta\mu_g^S$	$\Delta\zeta_b^S$	$\Delta\zeta_c^S$	$\Delta\zeta_l^S$	$\Delta\zeta_g^S$	Obs.
1	LB:μ_0^F	−1.96	-1	0.20	0.03	−0.60	−0.47	−0.61	0.11	0.08	0.11	−0.02	−0.03	−0.01	−0.04	1129
2	UB:μ_0^F	1.74	1	−0.84	−0.03	0.27	0.05	0.56	−0.21	−0.04	−0.47	0.34	0.18	0.02	0.38	2144
3	LB:μ_0^S	−1.62	-1	−0.98	−0.18	−0.78	−0.92	−0.89	0.01	0.01	0.01	0.06	0.61	0.02	0.85	38566
4	UB:μ_0^S	2.30	1	0.54	0.01	0.61	0.45	0.58	−0.25	−0.16	−0.24	0.11	0.11	0.02	0.13	1284
5	LB:μ_0^B	−5.08	-10	−9.98	−0.93	-9	-9	-9	−8.99	−8.99	−8.99	0.02	0.01	0.00	0.04	821
(6)	UB:μ_0^B	5.9	1.7	0.94	0.46	0.86	0.54	0.52	0.30	0.52	0.30	−0.13	−0.08	−0.06	−0.14	86
7	LB:μ_c^F	0.11	0	−0.68	0	-1	−0.79	−0.49	0.21	0.12	−0.15	0.47	−0.01	−0.03	0.21	1867
8	UB:μ_c^F	−0.74	0	−0.35	0	1	0.36	0.39	−0.70	−0.33	−0.36	0.06	0.45	0.12	0.30	614
9	LB:μ_l^F	−0.50	0	−0.66	0	−0.65	-1	−0.42	−0.04	0.21	−0.19	0.48	0.18	−0.04	0.25	2192
10	UB:μ_l^F	0.91	0	−0.41	0	0.24	1	0.25	−0.44	−0.77	−0.37	0.15	0.25	0.28	0.31	871
11	LB:μ_{gdp}^F	0.06	0	−0.66	0	−0.74	−0.81	-1	−0.00	0.08	0.20	0.48	0.17	−0.02	−0.11	1366
12	UB:μ_{gdp}^F	−0.77	0	−0.47	0	0.17	−0.02	1	−0.27	−0.16	−0.78	0.21	0.17	0.10	0.68	794
13	LB:μ_c^S	0.23	0	−0.50	0	-1	−0.89	−0.58	−0.99	−0.90	−0.69	0.02	0.06	0.02	0.14	6041
14	UB:μ_c^S	0.22	0	−0.33	0	1	0.50	0.38	0.60	0.23	0.07	0.06	0.03	−0.01	0.21	844
15	LB:μ_l^S	−0.10	0	−0.49	0	−0.73	-1	−0.49	−0.84	−0.99	−0.63	0.01	0.05	0.02	0.16	6832
16	UB:μ_l^S	0.53	0	−0.29	0	0.35	1	0.38	0.09	0.64	0.11	0.14	0.09	−0.03	0.17	879
17	LB:μ_{gdp}^S	0.39	0	−0.50	0	−0.83	−0.87	-1	−0.90	−0.89	−0.99	0.01	0.01	0.04	0.19	4513
18	UB:μ_{gdp}^S	−0.08	0	−0.34	0	−0.00	−0.05	1	−0.24	−0.26	0.63	0.06	0.06	−0.01	0.01	1648
19	LB:ζ_b^S	0.21	0	−0.34	0	0	0	0	−0.34	−0.33	−0.33	−0.81	0.11	−0.18	0.27	2233
20	UB:ζ_b^S	0.17	0	−0.28	0	0	0	0	−0.25	−0.24	−0.24	1.03	0.40	0.16	0.30	1009
21	LB:ζ_c^S	−0.33	0	−0.28	0	0	0	0	−0.28	−0.27	−0.27	−0.38	−0.81	−0.03	0.14	1774
22	UB:ζ_c^S	0.86	0	−0.36	0	0	0	0	−0.36	−0.36	−0.36	0.23	1.11	0.02	0.44	1157
23	LB:ζ_l^S	−0.30	0	−0.34	0	0	0	0	−0.34	−0.33	−0.34	−0.17	0.24	−0.75	0.33	1946
24	UB:ζ_l^S	0.77	0	−0.30	0	0	0	0	−0.30	−0.30	−0.30	0.02	0.16	0.99	0.29	1438
25	LB:ζ_{gdp}^S	0.16	0	−0.39	0	0	0	0	−0.39	−0.39	−0.38	−0.08	0.12	−0.05	−0.61	949
26	UB:ζ_{gdp}^S	0.11	0	−0.32	0	0	0	0	−0.32	−0.32	−0.32	0.03	0.14	0.04	0.93	1183

Notes: The differences in profits are expressed in millions of 2000 USD dollars. Besides the restrictions deriving from the 26 inequalities above, we additionally impose the constraints that all the parameters should be non-negative and that the extended gravity effects cannot be large enough to make the sunk costs of exporting to some countries negative.

Table 6: Estimated set and confidence intervals for single parameters

(Sector 24 - narrow version)
(Including moment inequality 6 in Table 5)

Parameter	Estimate		PPHI		Correlation	
	Lower	Upper	Lower	Upper	Lower	Upper
μ_0^E	0	199,046	0	748,310	0	393,870
μ_0^S	57,218	77,688	0	121,550	292	190,330
μ_0^F	215,785	235,577	2,185	264,230	173,070	266,550
μ_c^F	0	11,506	0	37,999	0	61,867
μ_l^F	0	24,505	0	69,567	0	93,786
μ_{gdp}^F	0	12,105	0	39,578	0	58,292
μ_c^S	6,902	68,695	0	133,010	0	200,070
μ_l^S	0	109,978	0	153,540	0	181,690
μ_{gdp}^S	35,540	87,339	0	140,070	0	167,190
ζ_c^S	0	24,741	0	131,040	0	171,970
ζ_l^S	0	171,929	0	213,730	0	210,300
ζ_{gdp}^S	0	18,320	0	103,040	0	112,810
ζ_b^S	0	20,558	0	89,670	0	80,504

Notes: Values are in year 2000 USD. For each parameter, the first row contains the inner confidence interval and the second one the outer confidence interval. In both cases, they are 90% intervals computed with 1,000 simulations. The confidence intervals that account for correlation across observations have been computed using 1,000 subsamples.

Table 7: Estimates of Trade Costs

(Sector 24 - narrow version)

(Including moment inequality 6 in Table 5)

If the firm at t exports to...	If the firm at t-1 exported to...	Estimates		Percentile of profits		Mean profits/ Cost		Median profits/ Cost	
		Lower	Upper	Exporters	All	Exporters	All	Exporters	All
US	US	223,708	242,627	48	81	1.95	0.72	1.02	0.39
	Canada	319,578	520,165	71	93	1.08	0.40	0.56	0.21
	Mexico	379,653	538,986	75	94	0.99	0.36	0.52	0.20
	UK	319,578	520,165	71	93	1.08	0.40	0.56	0.21
	Colombia	387,527	538,986	75	94	0.98	0.36	0.51	0.19
	Chile	387,527	650,634	78	95	0.88	0.32	0.46	0.17
Spain	Spain	216,767	235,577	72	95	0.78	0.34	0.53	0.19
	France	347,490	429,675	93	98	0.45	0.20	0.31	0.11
	Colombia	347,549	429,675	93	98	0.45	0.20	0.31	0.11
	Chile	347,549	561,449	94	98	0.39	0.17	0.26	0.09
Brazil	Brazil	219,751	242,528	51	79	1.47	0.75	0.99	0.41
	Argentina	277,823	421,634	69	89	0.97	0.49	0.65	0.27
	Portugal	223,374	409,745	66	87	1.07	0.55	0.72	0.30
	Ecuador	283,323	421,640	69	90	0.96	0.49	0.65	0.27
	Chile	283,323	570,953	75	93	0.79	0.41	0.53	0.22
Colombia	Colombia	215,785	235,578	51	82	1.42	0.68	1.00	0.37
	Venezuela	264,520	313,216	62	86	1.11	0.53	0.78	0.29
	Argentina	277,303	313,216	62	89	1.08	0.52	0.76	0.28
	Chile	277,303	481,768	70	92	0.84	0.41	0.59	0.22

Notes: Values are in year 2000 USD. The estimates shown in this table correspond to a model that does not censor exports at any lower bound. Columns 3 to 8 are computed using the predicted profits from the first stage for the corresponding destination country and the midpoints for the constant costs arising from the intervals whose lower and upper bound are shown in columns 1 and 4.

Table 8: Decomposing Trade Costs

(Sector 24 - narrow version)
(Including moment inequality 6 in Table 5)

If the firm at t exports to...	If the firm at t-1 exported to...	Basic	Fixed	Sunk	Ext.Grav.	% Ext.Grav.
US	US	0	233,168	0	0	0
	Canada	0	233,168	186,704	43,385	18.86
	Mexico	0	233,168	226,152	3,937	1.72
	UK	0	233,168	186,704	43,385	18.86
	Colombia	0	233,168	230,089	0	0
	Chile	55,824	233,168	230,089	0	0
Spain	Spain	0	226,172	0	0	0
	France	0	226,172	162,411	0	0
	Colombia	0	226,172	162,440	0	0
	Chile	65,916	226,172	162,440	0	0
Brazil	Brazil	0	231,140	0	0	0
	Argentina	0	231,140	118,589	2,381	1.93
	Portugal	0	231,140	85,420	35,920	29.61
	Ecuador	0	231,140	121,340	0	0
	Chile	74,658	231,140	121,340	0	0
Colombia	Colombia	0	225,682	0	0	0
	Venezuela	0	225,682	63,187	6,391	9.19
	Argentina	0	225,682	69,578	0	0
	Chile	84,276	225,682	69,578	0	0

Notes: Values are in year 2000 USD. The estimates shown in this table correspond to a model that does not censor exports at any lower bound. Columns 3 to 8 are computed using the predicted profits from the first stage for the corresponding destination country and the midpoints for the constant costs arising from the intervals whose lower and upper bound are shown in columns 1 and 4.

Additional Figures and Tables

Table A.1: First Stage Regression

	Sector 24 Noncens.	Sector 24 $\geq 1,000$	Sector 24 $\geq 5,000$
		$lrev_{ijt}$	
$ldomsales_{it}$	0.431***	0.418***	0.362***
	(0.040)	(0.039)	(0.033)
$propskill_{it}$	−0.427***	−0.249*	0.156
	(0.150)	(0.142)	(0.131)
$lavgwage_{it}$	0.322***	0.306***	0.315***
	(0.077)	(0.074)	(0.066)
$lavgvalueadd_{it}$	−0.140***	−0.120***	−0.134***
	(0.057)	(0.054)	(0.042)
$border_{jt}$	0.409***	0.368***	0.342***
	(0.084)	(0.081)	(0.075)
$cont_{jt}$	0.134	0.127	0.119
	(0.084)	(0.079)	(0.074)
$lang_{jt}$	−0.198*	−0.198**	−0.071
	(0.103)	(0.098)	(0.095)
$gdppc_{jt}$	0.179***	0.142***	−0.001
	(0.068)	(0.064)	(0.061)
$lgdp_{jt}$	0.250***	0.264***	0.312***
	(0.022)	(0.021)	(0.020)
$avglrer_j$	−0.103***	−0.095***	−0.078***
	(0.012)	(0.011)	(0.011)
$devlrer_{jt}$	0.610***	0.562***	0.245
	(0.259)	(0.245)	(0.229)
$legal_j$	−0.069***	−0.059***	−0.039***
	(0.020)	(0.019)	(0.017)
Obs.	6,253	6,098	5,575

Notes: * denotes 10% significance, ** denotes 5% significance, *** denotes 1% significance. Robust standard errors are in parentheses. The dependent variable is log revenue. Year fixed effects are included. Columns 2 and 3 only consider observations with export revenues above $1,000$ USD and $5,000$ USD, respectively.

Table A.2: Estimated set and confidence intervals for single parameters

(Sector 24 - narrow version)
(Not including moment inequality 6 in Table 5)

Parameter	Estimate		PPHI		Correlation	
	Lower	Upper	Lower	Upper	Lower	Upper
μ_0^E	0	199,046	0	1,236,000	0	1,213,600
μ_0^S	57,218	77,688	31,417	137,990	292	191,050
μ_0^F	215,785	235,577	186,960	271,610	173,070	269,600
μ_c^F	0	11,506	0	43,406	0	61,867
μ_l^F	0	24,505	0	70,869	0	93,786
μ_{gdp}^F	0	12,105	0	44,887	0	58,292
μ_c^S	6,902	68,695	0	148,970	0	181,690
μ_l^S	0	109,978	0	165,400	0	184,741
μ_{gdp}^S	35,540	87,339	0	163,580	0	184,340
ζ_c^S	0	24,741	0	154,120	0	171,970
ζ_l^S	0	171,929	0	232,060	0	220,340
ζ_{gdp}^S	0	18,320	0	103,040	0	112,810
ζ_b^S	0	20,558	0	100,430	0	80,502

Notes: Values are in year 2000 USD. For each parameter, the first row contains the inner confidence interval and the second one the outer confidence interval. In both cases, they are 90% intervals computed with 1,000 simulations. The confidence intervals that account for correlation across observations have been computed using 1,000 subsamples.

Table A.3: Summary Statistics of Deviations by Moment

(Sector 24 - wide version)

Group	Bound	$\Delta\pi$	$\Delta\mu_0^F$	$\Delta\mu_0^S$	$\Delta\mu_0^B$	$\Delta\mu_c^F$	$\Delta\mu_l^F$	$\Delta\mu_g^F$	$\Delta\mu_c^S$	$\Delta\mu_l^S$	$\Delta\mu_g^S$	$\Delta\zeta_b^S$	$\Delta\zeta_c^S$	$\Delta\zeta_l^S$	$\Delta\zeta_g^S$	Obs.
1	LB:μ_0^F	−1.96	-1	0.20	0.03	−0.60	−0.47	−0.61	0.11	0.08	0.11	−0.02	−0.03	−0.01	−0.04	1129
2	UB:μ_0^F	2.17	1	−0.83	−0.02	0.38	0.25	0.50	−0.29	−0.19	−0.40	0.35	0.21	0.07	0.33	3888
3	LB:μ_0^S	−0.78	-1	−0.99	−0.44	−0.91	−0.83	−0.77	0.00	0.00	0.00	0.02	0.19	0.01	0.26	148648
4	UB:μ_0^S	2.29	1	0.54	0.01	0.61	0.45	0.58	−0.25	−0.16	−0.24	0.11	0.11	0.02	0.13	1284
5	LB:μ_0^B	−5.08	-10	−9.98	−0.93	-9	-9	-9	−8.99	−8.99	−8.99	0.02	0.01	0.00	0.04	821
(6)	UB:μ_0^B	5.91	1.70	0.94	0.46	0.53	0.86	0.51	0.30	0.30	0.52	−0.13	−0.09	−0.06	−0.14	86
7	LB:μ_c^F	0.55	0	−0.67	0	-1	−0.62	−0.45	0.21	0.07	−0.14	0.45	−0.09	−0.04	0.18	3174
8	UB:μ_c^F	−0.74	0	−0.35	0	1	0.36	0.39	−0.70	−0.33	−0.36	0.06	0.45	0.12	0.30	614
9	LB:μ_l^F	−0.17	0	−0.68	0	−0.62	-1	−0.42	−0.08	0.20	−0.21	0.49	0.17	−0.06	0.25	3186
10	UB:μ_l^F	0.92	0	−0.41	0	0.24	1	0.25	−0.44	−0.77	−0.37	0.15	0.25	0.28	0.31	871
11	LB:μ_{gdp}^F	0.46	0	−0.63	0	−0.60	−0.55	-1	−0.05	0.23	−0.01	0.40	0.11	0.00	−0.16	2673
12	UB:μ_{gdp}^F	−0.16	0	−0.50	0	0.05	0.07	1	−0.30	−0.79	−0.22	0.25	0.20	0.10	0.70	1360
13	LB:μ_c^S	0.62	0	−0.47	0	-1	−0.84	−0.51	−0.99	−0.85	−0.62	0.01	0.05	0.02	0.09	16884
14	UB:μ_c^S	0.22	0	−0.33	0	1	0.38	0.50	0.60	0.07	0.23	0.06	0.03	−0.01	0.21	844
15	LB:μ_l^S	0.36	0	−0.47	0	−0.75	-1	−0.48	−0.85	−0.99	−0.61	0.00	0.05	0.02	0.11	18879
16	UB:μ_l^S	1.29	0	−0.32	0	0.19	1	0.31	−0.10	0.63	0.03	0.09	0.16	−0.03	0.18	1765
17	LB:μ_{gdp}^S	0.66	0	−0.48	0	−0.78	−0.81	-1	−0.85	−0.84	−0.99	0.01	0.03	0.03	0.11	11995
18	UB:μ_{gdp}^S	0.64	0	−0.35	0	−0.12	−0.05	1	−0.36	−0.26	0.63	0.04	0.09	−0.01	0.01	3381
19	LB:ζ_b^S	0.67	0	−0.37	0	0	0	0	−0.36	−0.35	−0.36	−0.79	0.09	−0.08	0.13	5153
20	UB:ζ_b^S	0.40	0	−0.30	0	0	0	0	−0.25	−0.23	−0.24	1.03	0.39	0.09	0.22	1629
21	LB:ζ_c^S	0.40	0	−0.30	0	0	0	0	−0.30	−0.29	−0.30	−0.38	−0.81	0.04	−0.14	4021
22	UB:ζ_c^S	1.18	0	−0.37	0	0	0	0	−0.37	−0.37	−0.36	0.16	1.12	−0.06	0.34	2077
23	LB:ζ_l^S	0.23	0	−0.38	0	0	0	0	−0.38	−0.38	−0.37	−0.21	0.21	−0.70	0.19	4176
24	UB:ζ_l^S	1.10	0	−0.32	0	0	0	0	−0.32	−0.32	−0.32	−0.08	0.03	1.00	0.09	2712
25	LB:ζ_{gdp}^S	1.05	0	−0.39	0	0	0	0	−0.39	−0.39	−0.38	−0.14	−0.01	0.14	−0.62	4115
26	UB:ζ_{gdp}^S	0.37	0	−0.32	0	0	0	0	−0.32	−0.32	−0.32	0.02	0.16	0.04	0.95	1943

Notes: The differences in profits are expressed in millions of 2000 USD dollars. Besides the restrictions deriving from the 26 inequalities above, we additionally impose the constraints that all the parameters should be non-negative and that the extended gravity effects cannot be large enough to make the sunk costs of exporting to some countries negative.

Table A.4: Estimated set and confidence intervals for single parameters

(Sector 24 - wide version)
(Including moment inequality 6 in Table A.3)

Parameter	Estimate		PPHI		Correlation	
	Lower	Upper	Lower	Upper	Lower	Upper
μ_0^E	0	274,410	0	1,425,600	0	490,620
μ_0^S	9,703	88,320	0	151,560	0	163,790
μ_0^F	203,390	273,340	0	309,100	145,500	300,040
μ_c^F	0	27,706	0	55,022	0	85,955
μ_l^F	0	61,210	0	121,920	0	162,610
μ_{gdp}^F	0	50,705	0	101,730	0	136,630
μ_c^S	0	69,133	0	134,020	0	202,910
μ_l^S	0	199,820	0	318,960	0	348,230
μ_{gdp}^S	0	195,950	0	334,310	0	255,600
ζ_c^S	0	112,040	0	189,860	0	242,590
ζ_l^S	0	242,450	0	365,620	0	277,490
ζ_{gdp}^S	0	95,989	0	187,110	0	227,300
ζ_b^S	0	81,067	0	125,160	0	89,982

Notes: Values are in year 2000 USD. For each parameter, the first row contains the inner confidence interval and the second one the outer confidence interval. In both cases, they are 90% intervals computed with 1,000 simulations. The confidence intervals that account for correlation across observations have been computed using 1,000 subsamples.

Table A.5: Estimates of Trade Costs

(Sector 24 - wide version)

(Including moment inequality 6 in Table A.3)

If the firm at t exports to...	If the firm at t-1 exported to...	Estimates Lower	Estimates Upper	Percentile of profits Exporters	Percentile of profits All	Mean profits/ Cost Exporters	Mean profits/ Cost All	Median profits/ Cost Exporters	Median profits/ Cost All
US	US	221,400	273,340	51	82	1.84	0.66	0.96	0.36
	Canada	288,580	619,510	74	93	1.01	0.36	0.52	0.20
	Mexico	329,750	646,930	77	95	0.93	0.34	0.49	0.18
	UK	298,170	625,640	75	94	0.99	0.36	0.51	0.20
	Colombia	366,420	646,930	78	95	0.90	0.33	0.47	0.18
	Chile	366,420	694,130	80	96	0.86	0.32	0.45	0.17
Spain	Spain	208,010	273,340	76	95	0.73	0.32	0.50	0.17
	France	279,710	575,720	94	98	0.41	0.18	0.28	0.10
	Colombia	284,160	577,290	94	98	0.41	0.18	0.28	0.10
	Chile	284,160	671,940	94	98	0.37	0.16	0.25	0.09
Brazil	Brazil	203,390	273,340	52	80	1.42	0.73	0.96	0.40
	Argentina	212,450	523,500	70	90	0.92	0.47	0.62	0.26
	Portugal	210,450	522,000	70	90	0.93	0.47	0.62	0.26
	Ecuador	239,590	523,500	71	91	0.89	0.45	0.60	0.25
	Chile	239,590	674,100	77	94	0.74	0.38	0.50	0.21
Colombia	Colombia	203,390	273,340	53	83	1.35	0.65	0.94	0.36
	Venezuela	210,190	331,460	60	87	1.18	0.57	0.83	0.31
	Argentina	232,250	331,460	61	88	1.14	0.55	0.80	0.30
	Chile	232,250	553,360	73	93	0.82	0.39	0.57	0.21

Notes: Values are in year 2000 USD. The estimates shown in this table correspond to a model that does not censor exports at any lower bound. Columns 3 to 8 are computed using the predicted profits from the first stage for the corresponding destination country and the midpoints for the constant costs arising from the intervals whose lower and upper bound are shown in columns 1 and 4.

Table A.6: Decomposing Trade Costs

(Sector 24 - wide version)
(Including moment inequality 6 in Table 5)

If the firm at t exports to...	If the firm at t-1 exported to...	Basic	Fixed	Sunk	Ext.Grav.	% Ext.Grav.
US	US	0	247,370	0	0	0
	Canada	0	247,370	206,675	52,630	20.31
	Mexico	0	247,370	240,970	18,335	7.07
	UK	0	247,370	214,535	43,385	17.27
	Colombia	0	247,370	259,305	0	0
	Chile	23,600	247,370	259,305	0	0
Spain	Spain	0	240,675	0	0	0
	France	0	240,675	187,040	3,010	1.58
	Colombia	0	240,675	190,050	0	0
	Chile	47,325	240,675	190,050	0	0
Brazil	Brazil	0	238,365	0	0	0
	Argentina	0	238,365	129,610	13,570	9.48
	Portugal	0	238,365	127,860	15,320	10.70
	Ecuador	0	238,365	143,180	0	0
	Chile	75,300	238,365	143,180	0	0
Colombia	Colombia	0	238,365	0	0	0
	Venezuela	0	238,365	32,460	11,030	25.36
	Argentina	0	238,365	43,490	0	0
	Chile	110,950	238,365	43,490	0	0

Notes: Values are in year 2000 USD. The estimates shown in this table correspond to a model that does not censor exports at any lower bound. Columns 3 to 8 are computed using the predicted profits from the first stage for the corresponding destination country and the midpoints for the constant costs arising from the intervals whose lower and upper bound are shown in columns 1 and 4.