An Anatomy of International Trade: Evidence from French Firms (Preliminary and Incomplete)

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Abstract

Data on the individual export destinations of French firms shed light on the nature of entry barriers to national markets. While firms are very heterogeneous with respect to where they sell and how much they sell, the data reveal some striking regularities: (1) Looking across destinations, the relationship between market size, French market share, and the number of French firms selling there is very tight, with the number of participants rising almost in proportion with respect to market share and with an elasticity of about two-thirds with respect to market size. (2) Looking across firms, most exporters sell to very few markets while a small number sell almost everywhere. Firms that export more widely sell much more within France and have higher value-added per worker. We show that a simple Ricardian model of export behavior with Cournot competition and a fixed cost of entry, calibrated to data on trade shares around the world, can explain these features. A relatively low fixed cost implies a difference in the number of goods supplied to the largest and smallest markets of a factor of nearly 500. But with our assumption about the elasticity of substitution across commodities and our model’s implication that lowest cost suppliers are overrepresented in the smallest markets, the implied welfare advantage is only 1.5.

Key words: International trade, exporting, market penetration

JEL classification: F11; F17; O33
1 Introduction

A new empirical literature has emerged that examines international trade at the level of individual producers. Bernard and Jensen (1995, 1999a), Clerides, Lach, and Tybout (1998), and Aw, Chung, and Roberts (1998) among others, have shown that exporters are typically in the minority; they tend to be more productive and larger; yet they usually export only a small fraction of their output. All of these characteristics suggest that individual producers face substantial hurdles in entering foreign markets.

In response to these empirical studies a new theoretical literature has emerged that tries to model international trade at the producer level. Bernard, Eaton, Jensen, and Kortum (2003) (Henceforth BEJK) develop a Ricardian model of plant-level export behavior while Melitz (2003) provides a model based on monopolistic competition. Essential to either explanation are trade barriers that deter many producers who sell at home from entering foreign markets. In BEJK these barriers take the form of simple “iceberg” transport costs that are proportional to the amount shipped. Melitz, however, assumes a fixed cost of exporting.

This work raises a number of new questions about entry into different national markets. In existing models with a fixed cost of exporting, the cost is independent of the number of export destinations. But a fixed cost might apply to each national market. Fixed costs would then suggest that a threshold level of sales is needed for a new market to be worth entering. Once the fixed cost is overcome, however, with no variable costs a foreign producer should not face any cost disadvantage at the margin. In contrast, with only variable costs, market size should be irrelevant to where a producer decides to sell, although foreign sellers would face a cost disadvantage limiting their market share.

Distinguishing the different forms of entry barriers facing foreign firms requires knowing which countries individual producers enter. Previous empirical work has been restricted by lack of data on individual export destinations. Researchers have known whether a producer exported and how much it sold, but not its ability to penetrate individual national markets.

Our work makes use of an extensive source of data that has not yet been tapped to shed light on the answers to these questions. INSEE has compiled a comprehensive dataset of French firms that incorporates customs data to determine the individual destinations of each firm’s exports. Focusing on manufacturing firms in 1986, these data reveal enormous heterogeneity across both destinations and across firms in the nature of entry into different markets. Nevertheless, we observe some striking regularities.

We show how a simple Ricardian model with firm heterogeneity in efficiency and with both fixed and variable costs can explain these qualitative features of the data. Calibrating the model to data on bilateral trade flows around the world, we explain them quite well quantitatively as well. The fixed costs needed to explain the entry patterns we observe are quite modest, averaging around $7,000 (in U.S. dollars) as of 1986.

The data suggest that the largest markets in the world have over 1000 times more firms selling in them than the smallest ones. Our model suggests that the implied impact on welfare is much more modest. For one thing, an elasticity of substitution between the products of different firms of around 3.9 does a good job in explaining other features of the data. At this value, if all firms had the same variable cost of selling in a market, a 500 hundred-fold difference in the number of goods translates into about an eight-fold welfare difference. Moreover, firm heterogeneity in our model implies that different suppliers have different unit costs of serving different markets. Lower-cost firms, which typically charge lower prices, are relatively more
likely to enter small markets than large ones. Under our parameterization this additional feature of the model lowers the welfare difference to a factor of only 1.5. While the effect is much smaller than the factor of 500 suggested by the number of products, the welfare difference is nevertheless substantial.

Section 2 which follows describes our data. Section 3 presents a model of global competition with fixed costs, while Section 4 describes how we calibrate and simulate our model. Section 5 discusses how the simulated data generated by the calibrated model compares with actual data. Section 6 examines what our model has to say about the extent to which fixed costs put small markets at a disadvantage.

2 The Data

French Customs collect administrative data on how much French firms earn from sales of different products in different destinations (see Biscoup and Kramarz, 2002). The customs data are matched with another administrative dataset of fiscal origin (BRN) which includes most balance-sheet variables (value-added, total assets, labor costs, revenues) as well as employment for almost all French firms.

While the data cover all private sector firms, our focus is on a cross section of manufacturing firms from 1986, yielding a sample of over 200,000. The raw data distinguish among over 200 different national and subnational export destinations. Since we lack other data (in particular, on domestic production) from many of the smaller destinations, we limit ourselves to 113 destination countries (including France). (Since the entities which we eliminated are very small, they constitute a trivial proportion of France’s total export activity.)

As is typically the case, summing across what individual producers report exporting produces a number that is less than what is reported at the aggregate level. In the French case missing exports arise because manufacturing firms sell to nonmanufacturing intermediaries who report the foreign sales, and the connection between producer and destination is lost. Across all destinations, the firm data fail to account for about 20 per cent of total manufacturing exports.\footnote{This figure compares with underreporting of about 40 per cent in the U.S. Census of Manufactures. See Bernard and Jensen (1999a) for a discussion.}

While the raw data themselves are confidential and housed at INSEE, we can construct a rich set of statistics from them. Some of these statistics do not rely on individual export destinations, so can be compared with the analogous statistics from producers located elsewhere (and, in particular, to U.S. producers). Statistics based on individual destinations, however, are to our knowledge unique to these data, providing a new window on the connections between firms and where they sell.

Previous work on the export behavior of individual producers has typically used the plant as the unit of observation. The French data report exports and other features by firm. Obviously differences arise. A firm might own several plants, for example, while a firm might exist that does not own any production unit that corresponds with the definition of a plant. \textit{A priori}, a case can be made for either unit of observation over the other. A firm, for example, might own several plants with very diverse characteristics. Hence firm-level observations might mask a great deal of the variation in the plant-level data. But observations at the plant level may fail to pick up inputs provided by the headquarters which would be picked up at the firm level.
2.1 Deja Vu: Firms and Total Exports

Researchers have so far had to make do with what’s available. A comparison of the French firm data with plant level data from other countries is at least suggestive of what difference the unit of observation makes. In fact, a comparison of a number of characteristics of the French firm data with plant-level data from other countries, particularly from the U.S. Census of Manufactures, suggests that the unit of observation makes little difference to the overall story: On the important dimensions for which comparisons can be made, French firms and U.S. plants appear to be very similar:

1. Just over 40,000 of the 200,000 firms in the sample report exporting anything. Quite remarkably, of the 200,000 manufacturing plants in the 1992 U.S. Census of Manufacturing, 21 per cent report exporting. Hence the participation rates are nearly identical. This apparent similarity might seem surprising given that France has a larger export share. An explanation is that the U.S. Census data are based on a survey in which very small plants are typically not sampled, while the French data are nearly comprehensive. Hence the French data are likely to contain many more small producers who are less likely to export.

2. Figure 1 compares the distribution of export-intensity among French manufacturing firms and U.S. manufacturing plants that actually export. The distributions are similar, with the modal exporter in either country selling less than 10 per cent of its output abroad. The one notable difference is that France has a substantially larger share of firms that export 90 to 100 percent of their output (although the absolute share is still less than 3 per cent).

3. The typical exporting plant in the United States sells 5.6 times more than non-exporting counterpart. It sells 4.8 times as much domestically. The size advantage of exporting firms in France is much greater: The typical exporting firm sells nearly 28 times as much in France as a firm that does not sell anything abroad. (The obvious explanation for the much higher number in France is, again, the exclusion from the U.S. data of very small plants, which are less likely to export and which sell very little at home.)

4. Value added per worker at the average U.S. plant that exports is 33 per cent higher than at the average plant that does not export. The corresponding figure for French firms is a more modest 12.5 percent.

The similar behavior of U.S. plants and French firms (in the dimensions in which they can be compared) suggests that common forces might be behind the patterns exhibited by each, despite the change of country and unit of observation. While we consider an analysis of the export destination of French firms of interest for its own sake, we take the similarities between U.S. plants and French firms as evidence that what we learn from where French firms sell is informative about export patterns more generally.

Since the French data report individual export destinations, they provide insight into both: (1) how firm participation in exporting varies from market to market and (2) how the choice of markets varies from firm to firm. We look at each in turn.
2.2 Destination Facts

Our data allow us to break French exports across destinations into the number of French firms selling there and how much each firm sells. Standard data allow a different breakdown of French exports into market share and market size. Hence, denoting total French exports of manufactures to destination $n$ by $X_{nF}$, we can write:

$$X_{nF} = N_{nF} \bar{x}_{nF} = \lambda_{nF} X_n$$

where $N_{nF}$ denotes the number of French firms selling in country $n$ and $\bar{x}_{nF}$ their average sales there, while $\lambda_{nF}$ is France’s market share in $n$ and $X_n$ total absorption of manufactures in destination $n$.

1. Figure 2 plots the number of French entrants $N_{nF}$ against market size $X_n$ (both magnitudes in logarithms). Note that there is a positive association, although the relationship is not a tight one. However, as Figure 3 demonstrates, dividing the number of French entrants $N_{nF}$ by French market share in the destination ($\lambda_{nF}$) delivers a tighter relationship. The number of firms varies nearly in proportion with market share, given market size, and, given market share, rises with market size. The slope of the relationship is around two-thirds. Hence if two destinations have the same French market share but one is twice as large as another, the larger market attracts around 65 percent more French exporters.\(^2\) In other words, the number of exporters increases with total French exports. To the extent that variation in total exports arises from French market share, the elasticity is nearly one. To the extent it is due to variation in market size, the elasticity is 0.65.\(^3\)

2. Behind the tight relationship between French market share, market size, and the number of French exporters is an enormous diversity in the amounts that individual firms sell. Figure 4 portrays the sales across different market sizes of French firms according to their percentile in French sales to that market. Firms in the 99th percentile sell more than 10,000 times those in the first percentile. In all categories sales tend to rise with market size (since, as explained above, the elasticity of the number of firms with respect to market size is less than one).

2.3 Firm Facts

We can also cut the French firm data by looking at differences in exporting patterns across firms.

\(^2\)Figure 3 identifies destinations according to their quartile in French market share. Note that the tight relationship between the number of French firms that export to a country relative to French market share and market size holds across these quartiles.

\(^3\)Another way to present this relationship is in terms of a regression of $\ln N_{nF}$ on $\ln X_n$ and $\ln \lambda_{nF}$. The coefficient on $\ln X_{nF}$ is 0.65 (standard deviation .023) while the coefficient on $\ln \lambda_{nF}$ is 0.86 (standard deviation .037). The $R^2$ is 0.892. (Of course, because of the identity connecting the variables, a regression of $\ln \bar{x}_{nF}$ on $\ln \lambda_{nF}$ and $\ln X_n$ yields coefficients of 1 minus the ones above.) The implication is that a higher French market share in a destination typically reflects 86 percent more firms selling there and 16 percent more sales per firm. Given market share, larger sales to a larger market typically reflect 65 percent more firms and 35 percent more sales per firm.
1. Figure 5 shows the frequency of the number of destinations of French exporters. Most exporters sell to only one country, and the frequency of selling to a larger number declines quite systematically with the number of destinations. But there are firms that sell almost everywhere.

2. Destinations also vary according to their popularity. If a French firm exports at all it is most likely to sell in Belgium. Firms that sell to less popular destinations tend to sell to a wider range of destinations, to be larger, and to have higher value added per worker.

3. The productivity and size advantage of exporters over nonexporters extends within exporters to a productivity and size advantage of firms that sell more widely. Figure 6 shows that value added per worker rises consistently with the number of export destinations. Figure 7 shows that the value of sales in France rises dramatically with the number of export destinations served.

3 A Model of Global Competition

Our goal is to formulate a model that is consistent with these various facts, to quantify it, and to use it to measure the gains from various types of market integration. The model developed in BEJK (2003) provides a qualitative explanation for the features of overall exports described in Section 2.1 above. Their approach posits that (unobserved) producer efficiency is the single dimension of heterogeneity across units. Firms that are more efficient are, on average: (1) more likely to beat out their rivals in more markets, so export more, (2) more likely to beat out their competition in each market by a wider margin, so could charge a higher mark-up, (and, hence, display higher value added per worker), and (3) more likely to charge a lower price, so sell more.

But Destination Fact 1, above, presents a challenge to this model. BEJK predict that the number of sellers should vary in proportion with market share, a result roughly born out in the French data. But it also predicts that, given market share, variation in French exports arising from variation in market size would be reflected totally in sales per firm. But in fact it is variation in the number of French exporters that is doing two-thirds of the work in this dimension as well. One explanation is that there is a fixed cost of entering a national market. Larger markets thus have room for more sellers. This approach is the one that we pursue.

Our approach generalizes the assumptions about the distribution of costs made in EK (2002) and BEJK (2003). We consider a world in which there are a continuum of $J$ products, indexed by $j \in [0, J]$. There are $N$ countries each with a number of potential producers of any of the continuum of goods.

3.1 Countries as Sources of Production

The $k$th lowest cost producer of commodity $j$ in each country $i = 1, ..., N$ has the ability to deliver a unit of good $j$ to destination $n = 1, ..., N$ at marginal cost:

$$c_{ni}^{(k)}(j) = w_i d_{ni} \left[ u_i^{(k)}(j)/T_i \right]^{1/\theta}$$

Here $w_i$ denotes the cost of a bundle of inputs in country $i$, $T_i$ reflects the overall efficiency in country $i$, and $d_{ni}$ represents the “iceberg” transport cost between $i$ and $n$, i.e., number of
units of good $j$ that the producer needs to make in order to deliver one unit to country $n$. The term $u^{(k)}_i$ is the realization of a random variable $U^{(k)}_i$ drawn from the following parameterless distributions:

$$\Pr[U^{(1)}_i(j) \leq u] = 1 - e^{-u}$$
$$\Pr[U^{(k+1)}_i(j) \leq u|U^{(k)}_i(j) = u^k] = 1 - e^{-(u-u^k)}.$$  \hspace{1cm} (2)

The parameter $\theta$ governs the extent to which variability in $u$ translates into variability in unit cost.

Note that:

1. The terms $w_i$ and $T_i$ depend on $i$ but not $n$, $j$, or $k$. Hence factor costs and economy-wide efficiency affect all products originating from country $i$ regardless of destination, commodity, or individual producer.

2. The term $d_{ni}$ depends on $i$ and $n$ together but not $j$ or $k$. Hence we are imposing the restriction that all commodities and producers face the same geographic hurdles.

3. The value of $u^{(k)}_i$ affects the unit cost across all destinations in proportion.

4. The distribution of $u^{(k)}_i$ and the parameter $\theta$ are independent of source, commodity, and producer. Hence we introduce a common level of variability in efficiency across potential producers in different countries.

For our purposes here, we can aggregate all sources of cost in delivering products from $i$ to $n$ that are systematic across commodities and producers into a single term $\lambda_{ni} = T_i / (w_i d_{ni})^{-\theta}$, writing (1) as:

$$c^{(k)}_{ni}(j) = [u^{(k)}_i(j) / \lambda_{ni}]^{1/\theta}.$$  \hspace{1cm} (3)

### 3.2 Countries as Market Destinations

Each destination $n$ spends a total amount $X_n$ on manufactures. The share that it spends on commodity $j$ is:

$$X_n(j) = \alpha(j) X_n \left[ \frac{p_n(j)}{p_n} \right]^{1-\sigma}$$  \hspace{1cm} (3)

where $p(j)$ is the price of commodity $j$ there, $p_n$ is the CES price index there given by:

$$p_n = \left[ \int_0^J \delta_{[L_n(j) > 0]} \alpha(j) p_n(j)^{1-\sigma} dj \right]^{1/(1-\sigma)}$$  \hspace{1cm} (4)

and $\sigma$ is the elasticity of substitution. The term $\alpha(j)$ is the weight good $j$ receives in preferences, which we treat as common across destinations $n$. The term $L_n(j)$ denotes the number of individual producers supplying good $j$ to market $n$.

Potential suppliers of good $j$ to market $n$ have costs $c^{(1)}_n(j) < c^{(2)}_n(j) < c^{(3)}_n(j) < \ldots$. In order to deliver anything at all to market $n$ a producer must also incur a fixed cost $F_n(j)$, which may differ across destinations and by product, but is common across suppliers of good $j$ to that destination.
3.3 Linking Source to Destination Cost Heterogeneity

We derive the $c_{ni}^{(l)}(j)$ above from the $c_{ni}^{(k)}(j)$ in Section 3.1 by reordering, so that:

$$c_{ni}^{(l)}(j) = \min_{k=1, \ldots, l; i=1, \ldots, N} \left\{ c_{ni}^{(k)}(j) \right\}.$$  

To link source and destination countries we need to keep track of the national identity of the $l$th lowest cost supplier of good $j$ to market $n$, denoted $i_{ni}^{(l)}(j)$.

From the underlying heterogeneity in the $u_i^{(k)}(j)$'s, along with the $\lambda_{ni}$'s, we can derive the implied distribution of costs in each destination:

We first define $\pi_{ni} = \lambda_{ni}/\lambda_n$, where $\lambda_n = \sum_{i=1}^{N} \lambda_{ni}$. Using expression (1), we can define:

$$v_{ni}^{(k)}(j) = u_i^{(k)}/\pi_{ni} = \lambda_n \left[ c_{ni}^{(k)}(j) \right]^\theta \quad (5)$$

and:

$$v_n^{(l)}(j) = \min_{k=1, \ldots, l; i=1, \ldots, N} \left\{ v_{ni}^{(k)}(j) \right\} = \lambda_n \left[ c_n^{(l)}(j) \right]^\theta.$$  

The distribution of costs $c_n^{(l)}(j)$ in destination $n$, then, can be linked to the parameters $\theta$ and $\lambda_n$, and the distribution of $v_n^{(l)}(j)$. What makes this result useful is:

**Result 1:** The term $v_n^{(l)}$ is the realization of a random variable $V_n^{(l)}$ drawn from the following distribution:

$$\Pr[V_n^{(l)}(j) \leq v] = 1 - e^{-v} \quad \Pr[V_n^{(l+1)}(j) \leq v|V_n^{(l)}(j) = v'] = 1 - e^{-(v-v')}.$$  

Hence the term $\lambda_n = \sum \lambda_{ni} = \sum T_i(u_i d_{ni})^{-\theta}$ summarizes all that is specific to destination $n$ in the distribution of costs there. The parameters $\lambda_n$ and $\theta$ thus provide a complete characterization of the distribution of costs in destination $n$.

An implication is that under any market structure in which prices are determined “anonymously,” i.e., solely on the basis of the costs of suppliers there, regardless of their origin, the parameters $\lambda_n$ and $\theta$ characterize the distribution of prices in destination $n$. Knowing $n$’s sources of supply provides no additional information.

Moreover, the probability that country $i$ is the $l$th lowest cost source in destination $n$ is independent of $l$. Specifically:

**Result 2:** $\Pr[j_{ni}^{l}(j) = i] = \pi_{ni}$ independent of the realizations of $V_n^{(l)}(j)$, $l = 1, 2, \ldots$.  

Hence, conditional on entering a market, the distribution of a supplier’s cost is independent of source.

We can link both the distribution of costs in destination $n$ and sales in $n$ to sources in $i$ with data on trade shares through:

**Result 3:** The share of purchases from source $i$ in destination $n$ is given by $\pi_{ni}$.
This result follows from fact that the distributions of sales and prices in any destination depend only on the underlying distribution of costs there. The probability that source $i$ is the $l$th lowest cost source is $\pi_{ni}$ regardless of $l$. Conditional on its being the $l$th lowest cost source its cost is independent of $i$. It thus follows that $\pi_{ni}$ is $i$’s share in $n$’s purchases. Hence we can infer the parameter $\pi_{ni}$ from $i$’s share in $n$’s purchases.

An important consequence of Results 2 and 3 is that, as long as market structure is such that prices are determined anonymously (that is, purely on the basis of the costs of potential suppliers and not their origins), we can infer the total number of firms selling in market $n$, $N_n$, from the number of French firms selling there $N_{nF}$, and French market share $\pi_{nF}$, as $N_n = N_{nF}/\pi_{nF}$. We can interpret the vertical axis of Figure 3 as depicting the total number of firms selling in each of our 113 destinations. The data thus indicate a very tight relationship between $N_n$ and $X_n$, with the elasticity of $N_n$ with respect to $X_n$ of .65.

### 3.4 Market Structure

To complete the characterization of equilibrium we need to make specific assumptions about market structure. While most specifications of market structure obey the anonymity property required for Results 2 and 3, they have different implications for the relationship between market share, market size, and the number of firms selling to a market.

EK (2002) assume perfect competition, implying that $p_n(j) = c_n^{(1)}(j)$. Perfect competition does not make any specific prediction about the number of individual firms entering a market. As pointed out by BEJK (2003), perfect competition is inconsistent with the observed heterogeneity of productivity observed across U.S. manufacturing plants.

BEJK (2003) assume Bertrand competition. As with perfect competition only the lowest cost supplier enters, but with $p_n(j) = \max\{c_n^{(2)}(j), \bar{m}_n^{(1)}(j)\}$, where $\bar{m} = \sigma/(\sigma - 1)$ for $\sigma > 1$ (for $\sigma \leq 1$ we can set $\bar{m} \to \infty$). While this model succeeded in explaining the U.S. and French facts about producer export behavior in general, it fails to account for the strongly positive association between market size and the number of entrants exhibited in the French data.

Here we assume Cournot competition. If there are $L_n(j)$ suppliers competing to sell good $j$ in market $n$, with costs $c_n^{(1)}(j), c_n^{(2)}(j), c_n^{(3)}(j), \ldots, c_n^{L_n(j)}$, the Cournot price is:

$$p_n(j) = \frac{\sigma}{\sigma L_n(j) - 1} \sum_{l=1}^{L_n(j)} c_n^{(l)}(j). \quad (7)$$

The profit of seller $l$ with cost $c_n^{(l)}(j)$ is:

$$\Pi_n(j) = \sigma \left[ 1 - \frac{c_n^{(l)}(j)}{p_n(j)} \right]^{2} x_n \left[ \frac{p_n(j)}{p_n} \right]^{1-\sigma} - F_n(j) \geq 0$$

In a Nash-Cournot equilibrium all active sellers are earning nonnegative profits while any potential supplier could not earn a nonnegative profit given the set of active suppliers.

There can be multiple Cournot equilibria. We follow Berry (1992) in considering the equilibrium that emerges if potential suppliers consider entry sequentially in reverse order of cost. We first consider the outcome in which supplier with cost $c_n^{(1)}(j)$ enters as a monopolist. If this supplier cannot earn variable profit sufficient to cover $F_n(j)$ we conclude that good $j$ will not be supplied to market $n$ (since obviously if the supplier with lowest cost can’t make
it in this market neither can any supplier with a higher cost). If this supplier can make it we consider the outcome in which suppliers with costs $c^{(1)}_n(j)$ and $c^{(2)}_n(j)$ serve the market as Cournot duopolists. If the supplier with cost $c^{(2)}_n(j)$ cannot earn variable profit sufficient to cover $F_n(j)$ we conclude that the supplier with cost $c^{(1)}_n(j)$ will supply the good as a monopolist. If there is room for a second supplier we then go on to ask if the market can sustain the three suppliers with costs $c^{(1)}_n(j)$, $c^{(2)}_n(j)$, and $c^{(3)}_n(j)$, and so forth. We continue the process until we find supplier $L_n(j)$ such that suppliers $1, ... L_n(j)$ can earn nonnegative profits on their own while, if supplier $L_n(j) + 1$ entered it would lose money.\footnote{Other possible equilibria could involve less efficient suppliers blocking entry by more efficient ones, or mixed strategies of entry. We focus on the equilibrium in which the most efficient suppliers enter because we it is more likely to reflect the outcome a dynamic process in which more efficient suppliers would drive out the less efficient. The choice of equilibrium makes little difference for any of our results.}

Note that in Cournot equilibrium (and under most other forms of competition), prices are homogeneous of degree one in costs. Since the distribution of the cost parameters $v$ is the same in all markets, by inverting (5) we can infer that the price index in any destination is proportional to $\lambda_n^{-1/\theta}$.

### 4 Fitting the Model to Data

We take the model to data in three steps. We first simulate the equilibrium across destinations to see how well we can match the number of French firms selling in each location. This simulation allows us to infer the price level in each country. This simulation does not identify the individual French firms supplying different markets. We then simulate the costs of potential suppliers in different source countries and relate them to their costs of supplying different markets. We finally solve for the world equilibrium, connecting simulated French firms with their sales in different destinations.

#### 4.1 Simulation across Destinations

Result 2 above allows us to simulate the equilibrium in any destination $n$ without needing to know where different suppliers are selling. Given Result 1 and data on aggregate bilateral trade shares to identify the $\pi_{ni}$, the only parameters we need are $\theta$, $\sigma$, $F_n(j)$ and $\alpha(j)$. (We choose $J$ in order for the total number of French export-destination pairs in our simulation to equal the actual number.). At this stage we treat $F_n(j) = F(j)$ as constant across destinations. Furthermore, we treat $F(j)$ and $\alpha(j)$ as the realization of lognormally-distributed random variables (possibly correlated). That is, log $F_n(j)$ and log $\alpha(j)$, are normally distributed with means $\mu_F$, $\mu_\alpha$ and variances $\sigma_F, \sigma_\alpha$, and correlation $\rho_{F\alpha}$.

Our computer algorithm for simulating the model for each destination $n$ works conceptually as follows: For an arbitrary good $j$, we draw: (i) a single demand weight $\alpha(j)$ (that applies across all destinations) and (ii) a fixed cost $F(j)$ from a bivariate lognormal distribution with parameters $\mu_F, \mu_\alpha, \sigma_F, \sigma_\alpha, \rho_{F\alpha}$. We then draw for that same good $j$ a set of normalized destination costs $V^{(1)}_n(j), V^{(2)}_n(j), V^{(3)}_n(j), ...$ from the distribution (6) based on Result 1. With these normalized costs and an initial conjecture about the value of the price index $P_n$, we use (5) to solve for actual costs, and solve for the Cournot equilibrium. We repeat this process
across many goods $j$. Having done so, we use the resulting prices to obtain a new estimate of $P_n$. We iterate until our conjecture about $P_n$ is consistent with our estimate of $P_n$.

When we have reached this fixed point, we save our results about the number of firms that supply country $n$, which is the product of the number of goods $j$ we sampled and the average number of entrants, the average of the $L_n(j)$. Multiplying the number of firms supplying country $n$ in our simulation by the actual French market share in country $n$ gives us an estimate of the number of French firms selling in $n$ (up to a scaling factor common across destinations equal to our estimate of $J$ divided by the number of products that we sample).

From the simulated data set we can calculate, in each destination, the number of French firms selling there and the sales of each firm. We can then compare moments of this simulated data set with the actual data on the sales of French firms to that market.

4.2 Simulating and Matching Source Producers to Destination Markets

The first simulation tells us about the number of suppliers of different goods and prices across destinations, but nothing about the nationality of those suppliers and where else they sell. A second simulation connects suppliers in different source countries to costs in different destination countries. For an arbitrary good $j$, we draw a set of normalized source costs $U_i^{(1)}(j), U_i^{(2)}(j), U_i^{(3)}(j),...$ from the distribution (2) in each source country $i$. Since $V_{ni}^{(k)}(j) = U_i^{(k)}(j)/\pi_{ni} = \lambda_n \left[C^{(k)}_{ni}(j)\right]^\theta$, we can use data on bilateral trade shares $\pi_{ni}$ to calculate, for each realized cost $U_i^{(k)}$ in each origin $i$, a corresponding $V_{ni}^{(k)}$ in each destination $n$. This procedure yields a set of realized normalized costs in each destination $n$ that are connected to individual suppliers. We then order these costs in each destination $n$ to determine the ordered normalized destination costs $V_{ni}^{(1)}(j), V_{ni}^{(2)}(j), V_{ni}^{(3)}(j),...$.

We repeat this process for a large number of goods $j$, thinking of each draw as representing a particular good. The consequent data set gives us the cost distribution of ordered normalized costs in each destination with each cost tied to an individual supplier in some source across a range of products determined by the number $J$. Creating this simulated data set requires the use of data on bilateral trade among the 113 countries in our sample, but none of the parameter values of the model ($\theta, \sigma, F$).

4.3 Simulating Firm Exporter Facts

From the matched normalized source and destination costs from the second simulation, imposing a particular value of $\theta$, we can calculate actual costs in each destination. For particular values of $\sigma$ and $F$, we can then calculate, as in simulation 1, the Cournot equilibrium for each product $j$ in each destination, and the price index $P_n$ in each destination.

5 Predictions

Our simulations use values of $\theta = 3.6$ and $\sigma = 3.9$ taken from BEJK (2003). We find that we can replicate the elasticity of the number of entrants with respect to market size quite well with $\sigma_F = 1$, $\sigma_\alpha = 2$, $\rho_{F\alpha} = .5$ and a value of $\mu_F$ that implies a mean fixed cost of $7,300. The implied range of goods $J$ is 614,419. (We normalize $\mu_\alpha = 1$, since it has no implications for the model’s predictions.)
5.1 Destination Facts

We can simulate entry across destinations solely on the basis of the first simulation. Figure 8 illustrates how well our predictions about the number of entrants match the actual numbers across the 113 export destinations of French firms. Figure 9 shows how well our simulated data capture the relationship between number of entrants, market share, and market size shown in Figure 3. Note that we replicate the slope quite well.

We can also use the simulated data to examine our model’s predictions about the total number of firms selling each good across destinations. We find that, even with the low fixed cost assumed here, no more than three firms are ever competing to sell the same good to the same country, with one firm the modal number selling any good that turns out to be supplied to a country. Most goods are supplied to the largest markets while, for the smallest ones, most goods are not supplied. Hence a small fixed cost goes a long way towards reducing supply to smaller markets.

5.2 Firm Facts

Together the three simulations generate a dataset of simulated French firms. Figures 10 through 12 compare some moments of our simulated data with moments of the actual data.

Figure 10 looks at how well we pick up how much French exporters sell abroad. We predict too few selling very small amounts and too many exporting 20 to 30 percent of output. We do capture the drop-off but not the long tail of very export-intensive firms.

Figures 11 and 12 concern export destinations. Figure 11 shows that we pick up the frequency of multiple export destinations quite well. We capture the slope of the relationship between number of destinations and domestic sales very well, as shown in Figure 12, but we consistently understate the size advantage of exporting firms.

6 The Welfare Effects of Entry Barriers

A fixed cost of entering a national market implies that consumers in smaller markets are at a disadvantage. Fewer firms will compete in supplying various products and many may not be available at all. In our simulations most of the variation across countries occurs at the margin of initial entry. In the largest market (the United States) around 88 per cent of the goods are provided (with about 25 percent having more than a single supplier). In the smallest economy (Sierra Leone), only .00192 of the goods are available, always provided by a monopolist. Hence even a relatively small fixed cost can create differences in the availability of goods of a factor of nearly 500.

Of course, with an elasticity of substitution of 3.9, the welfare effects of these differences in availability are less drastic. If all the goods that were actually supplied had the same price in each market, as in the Dixit-Stiglitz (1977) framework, the differences in availability of this magnitude imply a price index around 8 times more in the smallest market relative to the largest. In fact, we estimate that the lower availability of goods in Sierra Leone implies a price index there that is only a little over 40 per cent higher than the U.S. price index. The explanation is the selection of sellers into small markets. A small market attracts only very low cost suppliers while the marginal firm supplying a large market may have relatively high cost. For this reason focussing only on the availability of goods exaggerates the welfare cost of smallness. Nevertheless, the welfare cost remains substantial.
Figure 13 plots market size against differences in the price level that emerge because of entry. Note that most of the variation is at the low end.
References


Figure 1: Export Intensity Distributions

- France
- US

Percentage of exporters vs. percentage of output exported.
Figure 2: French Exporters by Market

The graph shows the relationship between market size (in millions of dollars) and the number of French firms selling to that market. The data points are scattered across the range, indicating a varied number of firms for different market sizes.
Figure 3: Entrants per Market, by Quartile of French Market Share
Figure 5: Frequency of French Firms Exporting to Multiple Countries
Figure 6: Exporting and Productivity

The figure shows the relationship between the number of export destinations and value added per worker (in thousands of Francs). It indicates that as the number of export destinations increases, the value added per worker also increases.

- 0 destinations: Value added per worker is around 150,000 Francs.
- 1 destination: Value added per worker increases to around 200,000 Francs.
- 2 destinations: Value added per worker rises to around 250,000 Francs.
- 3 to 5 destinations: Value added per worker continues to rise to around 300,000 Francs.
- 6 to 10 destinations: Value added per worker increases significantly to around 350,000 Francs.
- 11 to 20 destinations: Value added per worker further increases to around 400,000 Francs.
- 21 to 50 destinations: Value added per worker reaches around 450,000 Francs.
- 50 on up destinations: Value added per worker is the highest, around 500,000 Francs.
Figure 7: The Size Advantage of Exporters
Figure 8: Market Entry of French Firms (Model and Data)
Figure 9: Entrants per Market

- **x-axis**: Market size
- **y-axis**: # French exporters/french mkt. share

Data and model are represented by different markers.

- **Data**: Blue diamonds
- **Model**: Pink squares
Figure 10: Distribution of Export Intensity (Model)
Figure 11: Exporters to Multiple Countries (Model and Data)
Figure 12: Size Advantage of Exporters (Model and Data)

The figure shows the mean sales in France divided by the mean for non-exporters across different ranges of export destinations. The data is compared with the model predictions.

- The x-axis represents the number of export destinations, categorized into groups: 1, 2, 3 to 5, 6 to 10, 11 to 20, 21 to 40, 41 to 112.
- The y-axis represents the mean sales ratio, ranging from 0 to 1,000.

The bars indicate the data points, with the model predictions shown in different colors for comparison.
Figure 13: Price Effect of Fixed Costs (Model)