Entry Costs and Increasing Trade*

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Abstract

Using confidential microdata from the US Census, we find that the fraction of manufacturing plants that export rose from 21% in 1987 to 39% in 2006. It has been suggested that similar trends in other countries may have been caused by declining costs of entering foreign markets. Our study tests this hypothesis for the first time. Both reduced form and structural estimation approaches find little evidence that the entry costs declined significantly in the US over this period. We instead argue that changes in other factors that determine export status are sufficient to explain these trends.

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1 Introduction

A common feature of the rise in aggregate exports from several countries across the world is a significant expansion in the number of firms that export. A natural explanation that has been suggested by prior authors (e.g., Melitz 2003) is that the up-front costs of entering foreign markets have declined.[1] We test this idea for the first time using plant level data from the United States Census Bureau. We find that the US also saw significant foreign market entry over the period, with the fraction of plants that export rising from 21% in 1987 to 39% in 2006.[2] Across a number of different estimation approaches, however, we find little evidence for the idea that declines in the costs of entering foreign markets played a significant role in driving these trends. We instead argue that changes in other factors that govern export status were of a sufficient magnitude to explain the level of foreign market entry that we see in the data, without the need to appeal to falling entry costs.

Our analysis begins by presenting a number of descriptive statistics that provide new insight into the US experience. We find that the rise in the fraction of plants selling abroad mentioned above was broad-based; it was experienced across a wide range of industries as well as geographic regions. These extensive margin adjustments were matched with strong intensive margin adjustments, with average foreign sales per exporter also increasing substantially. Over time, changes along both of these margins had a large influence on aggregate trade volumes. Finally, at the same time that more plants began to sell abroad, the level of persistence in export market status remained quite stable over time.

We next turn to understanding how much of a role declines in the costs of entering foreign markets played in these trends. As these costs cannot be directly observed with current data sources, we need to use models of firm behavior to estimate their magnitude. Thus, to get a comprehensive perspective we consider both reduced form and structural estimation approaches. Our reduced form analyses provide a tractable way of addressing this question for the US manufacturing sector as a whole and allow for a wide variety of robustness checks. This approach, however, does not allow us to directly estimate the magnitude of changes in these costs. In our estimations, coefficient parameters in the regression specification are directly related to the costs of entering foreign markets. We let these coefficients differ across the earlier and later parts of the sample to look at how the costs compare. Our estimates imply similar magnitudes for these parameters across the two different periods. These findings suggest small changes in the barriers to entry in foreign markets.

We then turn to a set of structural estimations that use the methodology developed by

[1] See also Roberts and Tybout (1997a).

[2] We discuss our data and how these and other figures are calculated in Section 2.

Das, Roberts, and Tybout (2007). This approach allows us to estimate the average level of foreign market entry costs that plants face in a given period. The methodology is attractive in that it provides numerical estimates of how these costs have changed and is flexible in accounting for other factors that determine exporting behavior. Estimations require the use of computationally intensive Bayesian Monte Carlo Markov Chain methods, however. We are thus constrained to focusing our analysis on understanding the experiences of a small set of industries. We estimate these costs across 1987-1997 and 1992-2003 and compare the results for these two time periods. Two of the three industries that we consider experienced roughly similar or rising costs across the two different panels and the third saw a moderate decline. Taken together, the results from the reduced form and structural estimations are evidence that declines in the costs of entering foreign markets have been modest at best. The level of responsiveness of export market participation to changes in the costs of entering foreign markets predicted by recent models of international trade suggests that these changes are unlikely to have played a large role in the changes that we see in the data.

We conclude with an analysis of whether changes in other factors that determine export status were of a sufficient magnitude to explain these trends. Specifically, we investigate whether a calibrated model of plant heterogeneity and international trade akin to that of Chaney (2008) can match the extensive margin adjustments that we see in the data. Keeping other factors such as the costs of entering foreign markets as well as trade-related variable costs stable, we find that growth in foreign income is sufficient to explain the rise in the fraction of exporters. Our accounting exercise demonstrates that a reduction in the costs of entering foreign markets is not needed to account for these trends in a standard model. These calculations lend credibility to our estimation results and point to a significant role for foreign economic growth in explaining the rise of trade.

Our work addresses an issue that is relevant for a number of other countries in addition to the US. Several other studies have suggested that large-scale foreign market entry was experienced worldwide during this period. Indeed, of the studies that have used plant or firm level data to study the rise in exports from other nations, many have found that entry into foreign markets played a significant role in the expansion of trade. This work includes studies on the experiences of Chile, Colombia, Mexico, and Morocco.[3] Although there is little plant-level evidence on this question outside of these countries, we also see dramatic

[3] These papers include Bergoeing, Micco, and Repetto (2011), Roberts, Sullivan, and Tybout (1995), and Clerides, Lach and Tybout (1996). Roberts and Tybout (1997a) provide a survey of several of these papers. A notable exception here is China; see Amiti and Freund (2010). In the US context, Bernard and Jensen (2004a) have also previously documented a significant increase in the fraction of manufacturing plants that export over the period 1987-1992. Bernard, Jensen, and Schott (2009) additionally report significant extensive margin entry for US firms in goods (agriculture, manufacturing, and mining) sectors across the two years 1993 and 2000.

increases in the number of goods sold across countries in disaggregated industry-level trade data. These results are consistent with substantial foreign market entry by firms in different sectors for a wide range of countries. Papers documenting these trends include Evenett and Venables (2002), Broda and Weinstein (2006), and Harris, Kónya, and Mátyás (2011). Particularly notable is an acceleration in the growth of varieties traded during our sample period of 1987-2006. Taken together, these studies suggest that our estimations address a question of first-order importance for understanding the recent growth of worldwide trade.

Our analysis also fills a significant gap in the international trade literature. A large number of studies have looked at the effect of changes in variable trade costs on export and import patterns. While there has been some work on other factors such as transportation costs, this work has primarily focused on understanding the effects of changes in tariffs. Yet these costs are only one, albeit important, piece of the puzzle. Changes in the barriers to entry in foreign markets also can have significant effects on trade patterns. One reason why these changes have not yet been studied is that methods to estimate their magnitude have only been developed relatively recently. Another is that the data requirements for looking at how they have changed are quite high. This study represents an initial effort to address this issue.

In the next section, we discuss our data sources and document several new stylized facts about US plants' exporting behavior from 1987 to 2006. Section 3 uses a model of export behavior to motivate reduced form estimations on the evolving nature of these costs. In Section 4 we describe the structural model that we use to estimate changes in these costs and the results that we get from our estimations. Section 5 performs an accounting exercise that looks at the contribution of other factors to the rise in export market participation such as increases in foreign income. Section 6 concludes.

2 Data and Stylized Facts

We use data from a number of different sources. Our data on aggregate industry exports come from two sources (i) the United Nations' Commodity Trade Statistics Database (Comtrade) and (ii) data from the US Census Bureau that was concorded to the 1987 US SIC classification system using the approach described in Pierce and Schott (2008). Information on price deflators is obtained from the NBER manufacturing productivity database (Bartelsman and Gray, 1996). The primary microdata for our analyses come from the Annual Survey of Manufactures (ASM) and Census of Manufactures (CMF) from the US Census Bureau.

Both data sets contain information on the operations of US manufacturing plants. The CMF is conducted every year ending in 2 or 7 (e.g. 1987, 1992, etc.) and contains data on the universe of manufacturing establishments. The ASM is a survey of plants that is conducted in each intervening year. The sampling frames for these surveys are chosen two years after the most recent CMF.[4] These establishments are then followed over time for five years until the next ASM sampling frame is implemented. Given the inability to aggregate to the firm level in the ASM, we treat the plant as the unit of analysis. This is consistent with the literature that has used this data as well as a number of other trade-related studies on other countries. Wherever possible, however, we perform robustness checks on our analysis at the level of the firm, finding similar results. We begin our analyses in 1987, the first year that comprehensive data on export revenues were collected.

The sample designs of these data sets impose some structure on our analysis. The ASM includes large plants with certainty but samples smaller plants according to their contribution to output. Due to the loss of non-certainty cases across different ASM panels, we limit our sample for panel analyses to plants with 250 or more employees. This avoids a number of challenges involved in following smaller plants over time and allows for comparability with previous studies that have used a similar approach. Despite this restriction, however, our data covers a significant portion of economic activity and the great majority of export volume.[5] Arkolakis (2010) has also suggested that export market entry behavior might be different for small firms, making the assumptions undergirding our analyses more appropriate for large producers.

With these data we develop a number of new stylized facts regarding the pace and character of trade growth since 1987. Figure 1 plots the percentage of plants with 20 or more employees that export in each year from 1987 to 2003.[6] The overall upward trend is unmistakable; 21% of plants exported in 1987 and 35% exported in 2003. Although we focus our analysis on the 1987-2003 period, this percentage rises steadily after 2003 to 39% in 2006. A number of different aspects of these trends are of note. First, we can get a sense of how much of these trends were due to adjustments in exporting status by existing establishments. Amongst plants that had 20 or more employees in both the 1987 and 2002

[4] Over the period 1987-1998 plants with more than 250 employees were sampled with certainty in the ASM. In the 1999-2003 ASM this threshold was increased to 500 employees and was further raised to 1000 in the 2004-2008 ASM. As the sampling probability is inversely related to a plant's contribution to output, plants between 250 and 500 employees are still sampled with a high degree of certainty in 1999-2003, however. In our estimations that span these years, we reweight the plants accordingly.

[5] Bernard and Jensen (2004a) use a similar sample and note that it accounts for 41% of employment, 52% of shipments, and 70% of exports in 1987.

[6] Similar to several other studies, we focus on plants with 20 or more employees. In all of our analyses we drop administrative records, which are essentially imputed data for small employers and new businesses. Due to disclosure concerns, estimates for 1987 and 1992 are from Bernard and Jensen (2004b).

Census of Manufactures, 29% export in 1987 and 39% export in 2002. These figures suggest that a large part of these trends were due to adjustments by plants that were in operation in 1987 but only sold domestically. Secondly, taking the 21% participation rate from 1987 as a baseline, new plants that entered the sample and remained in business until 2002 were somewhat more apt to sell abroad. Those that exited were only slightly less likely to be exporters. The difference between these two figures consequently added to the overall trend but was not the sole determining factor. These trends and foreign market entry by existing plants both contributed. Finally, the rise in the fraction of plants that exported over the period 1987-2003 was due to a 34% increase in the raw number of exporting plants and a 20% decline in the total number of plants. Since exiting plants included a large number of exporters, these declines in the total number of plants would have lowered the number of exporters if there had not been substantial foreign market entry.

Figures 2 and 3 look at the sectoral and geographic dimensions of the rise in export market participation. Figure 2 plots the percentage of plants that export in each industry in 1987 and 2003. While some industries saw larger changes than others, there has been a significant expansion in foreign market participation across nearly all sectors of the economy. Figure 3 demonstrates that the results in Figure 1 were experienced broadly across different regions of the US. These results hold generally across states as well. We find similar results for Figures 1-3 if we instead limit the analysis to plants with 10 or more employees or 250 or more employees. In Tables 1 and 2 we document the time path of these sectoral and geographic trends across 5-6 year intervals, mostly using the CMF. While we find similar patterns to the overall trend by region, there is more heterogeneity in the timing and magnitude of foreign market entry across industries. The fact that the expansion in the fraction of plants that export has been pervasive across these two dimensions suggests that these trends were not driven by idiosyncratic factors such as the rise of high-tech industries.

In a similar vein, we also looked at how the composition of the destinations of aggregate exports changed over time. We find that although export volumes rose sharply over the period, with a few exceptions trade shares have remained quite stable. For example, Germany accounted for 5.4% of total US exports in 1987 and accounted for 5.8% in 2003. Among the top 40 export destinations in 1987, the rank correlation between export shares in 1987 and 2003 is 88%. These countries account for 92% of total US exports in 1987. We present the shares for the top 20 export destinations in 1987 and their corresponding shares in 2003 in Table 4.

Although we focus on the determinants of changes in export status, it is clear that there have also been significant expansions in total exports through the intensive margin of trade. These changes suggest that the incentives to sell abroad have increased significantly over time. In the aggregate, manufacturing exports as a percentage of GDP rose by 35% over the period 1987-2003. In Figure 4 we graph the average level of real foreign sales across exporting plants by year. Estimates are for plants with 20 or more employees and exclude the computer and semiconductor industries due to the strong decline in prices over time; estimates including all industries show a significantly stronger increase over time. In order to look at percentage changes we normalize these figures such that the average in 1987 is set equal to one. We find that average foreign sales increased steadily by 49% over the time period. These results are robust to limiting the sample to plants with 10 or more employees, 250 or more employees, or to single plant firms. They also hold when looking at firms in different Census of Manufactures samples. Thus, even though both the number and fraction of plants that export increased significantly, the average level of foreign sales for each of these plants has also increased. Eaton, Kortum and Kramarz (2011) suggest that decreases in the costs of entering foreign markets should lower average foreign sales; these figures thus suggest that either these costs have increased or that other factors were important in determining export trends.

To get a sense of how changes in the extensive margin have affected overall trade volumes, we use information from each year in which we have data from the Census of Manufactures. This allows us to track the universe of small as well as large plants over time. The fact that the intensive margin dominates trade volumes in the short-run has been documented by, among others, di Giovanni and Levchenko (2009) and Bernard, Jensen, Redding, and Schott (2007). Authors have only recently begun to focus on the relative importance of the extensive margin for aggregate trade volumes over longer time horizons, however. Table 5 reports the contribution to Census year aggregate exports by plants that exported in a given prior Census year. When the time horizon is greater than five years we limit these figures to plants that exported in each intervening Census year. Thus, only 46% of aggregate exports in 2002 came from plants that exported in 1987, 1992, and 1997. These numbers underestimate the importance of changes along the extensive margin since they are not restricted to plants that exported continuously in all prior years.[7] Removing any continuous exporting restriction, we find that 57% of trade in 2002 is from plants that export in 1987 and 2002.

In Figure 5 we look at annual rates of entry, exit, and export status persistence. Plants that persist are those which continue exporting or only selling to the domestic market. In

[7] We are unable to calculate year-to-year statistics based on continuously exporting plants due to the breaks between ASM panels. These figures echo related results reported in Bergoeing, Micco, and Repetto (2011) for Chile 1990-2007, Bernard, Jensen, Redding and Schott (2007) for the aggregate US economy (including non-manufacturing sectors) for 1993-2003, and Eaton, Eslava, Kugler and Tybout (2007) for Colombia 1996-2005. The analysis in Table 5 is done with the plant identifier lbdnum. The results from using the alternative plant identifier ppn are similar.

each year we limit the sample to plants that existed in the previous year, such that the percent of plants that enter, exit, and keep the same export market status adds up to 100% in each year. Due to changes in the plants included across different ASM sampling frames, we limit the graph to plants with 250 or more employees. We find similar trends, however, within and across different ASM sampling frames for plants with 20 or more employees. In order to make the changes in the series clear we use two different axes, with entry and exit rates depicted using the scale on the right axis and persistence levels on the left axis.

It is our expectation that if the barriers to entry in foreign markets fell dramatically, we should see significantly less persistence in export market status over time. Indeed, if they fell to zero, plants would be able to enter without cost. They would also be more likely to exit since re-entry would also be free. This intuition is developed more formally in Sections 3 and 4. We instead find that the level of persistence stayed roughly constant over time, with a mean of 85% and a standard deviation of less than 3%. The level of persistence amongst exporters, which can be denoted as $E[y_{it} \mid y_{it-1} = 1]$ where y_{it} is a 0/1 indicator for export status, also remained stable over time. Thus, export market participation increased at the same time that export status persistence remained stable. The rise in the number of exporters documented in Figures 1-3 was driven by entry rates regularly outpacing exit rates, rather than changes in the frequency of entry and exit. These results suggest that dramatic declines in the costs of entering foreign markets are unlikely.

3 Reduced Form Estimations

In this section we consider reduced form evidence on how the costs of entering foreign markets have changed over time. While our structural estimations in the next section will allow us to study a number of different industries in depth, the reduced form approach will give us a sense of how these costs have changed for the manufacturing sector as a whole. Drawing upon the seminal work of Dixit (1989) and Baldwin and Krugman (1989), several prior studies have used a simple binary choice model of whether or not to export to test for the existence of barriers to entry in foreign markets.[8] Here, we use this approach to get a sense of how these costs have changed over time. The basic premise of the model is that a plant will sell abroad if the benefits from exporting exceed the additional costs of doing so. The benefits include the extra gross revenues that it could make as well as any option value associated with being an exporter in the future. In addition to the extra expenses associated

[8] See Roberts and Tybout (1997b), Bernard and Wagner (2001), and Bernard and Jensen (2004a).

with increased production, the costs include barriers to entry for plants that did not export previously. Specifically, a plant that has not exported for more than two years must pay a sunk cost F_0 to enter the foreign market and a re-entry cost F_R if it last exported two years ago.[9] The model can be reduced to a simple decision rule where

$$y_{it} = \begin{cases} 1 & \text{if } p^*_{it} - F_0 + F_0 \cdot y_{it-1} + (F_0 - F_R) \cdot \tilde{y}_{it-2} \geq 0 \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

Here y_{it} is plant $i's$ export status in year t and $\tilde{y}_{it-2} = y_{it-2}(1 - y_{it-1})$ is an indicator function for whether the plant last exported two years prior to year t. The term p^*_{it} can be written as

$$p^*_{it} = p_{it} + \delta \left(E_t \left[V_{it+1} \mid y_{it} = 1 \right] - E_t \left[V_{it+1} \mid y_{it} = 0 \right] \right)$$

It is determined by the extra gross profit that the plant could make by exporting this year p_{it} plus the option value associated with being an exporter next period. This option value, in turn, is given by the difference in the discounted future expected value of being an exporter today relative to only selling domestically. In the model if there are no costs to entering the foreign market, the condition for exporting in equation (1) collapses to $p_{it} \geq 0$. In this case, the plant decides whether or not to export based solely on what is most profitable today and ignores dynamic considerations. Thus, once controlling for factors that account for changes in p_{it}, if there are no costs to entering foreign markets we should see a lack of state dependence in exporting status.

To obtain an estimating equation that will allow us to look at changes in F_0 and F_R we need to parameterize $p^*_{it} - F_0$. A number of factors likely influence this term, such as changes in plant productivity and fluctuations in foreign income. We use the following functional form

$$p^*_{it} - F_0 \approx \mu_i + X'_{it}\beta + \phi_t + \varepsilon_{it}$$

to develop the specification

$$y_{it} = \mu_i + X'_{it}\beta + \alpha_1 \cdot y_{it-1} + \alpha_2 \cdot \tilde{y}_{it-2} + \phi_t + \varepsilon_{it} \tag{2}$$

This equation provides the basis for our estimations. The vector X_{it} contains a number of

[9] Prior studies have found little difference between the costs of entering foreign markets anew and entering after three years of not exporting. They have also found a small difference between F_0 and F_R above. The model can be extended to include a cost of exiting L, which makes the coefficient α_1 in equation (2) a function of $F_0 + L$. We think these costs are likely to be small. See Heckman (1981a) and Chamberlain (1985) for discussions of econometric issues relating to identifying true state dependence.

covariates that predict export market participation. These include the ratio of nonproduction to total employment, an indicator function for change of product and the logarithms of employment, total factor productivity, and average wages. Productivity is estimated with the approach of Levinsohn and Petrin (2003). We also include an industry-level trade-weighted exchange rate series.[10] Unobserved plant specific factors that influence p^*_{it} are captured in the term μ_i. Business cycle effects and other time varying factors are absorbed into the year fixed effects ϕ_t. The coefficients $\alpha_1 = F_0$ and $\alpha_2 = (F_0 - F_R)$ parameterize the importance of barriers to entry in foreign markets. Larger estimates of α_1, for example, suggest higher sunk costs F_0.

Table 6 presents the results from estimating the specification in (2) over the period 1989-2003. Standard errors in parentheses are clustered at the plant level and plant-specific characteristics in X_{it} are lagged by one period in order to avoid issues of simultaneity. In column (1) we present our findings from estimating equation (2) as presented above. The coefficients on y_{it-1} and $\tilde{y}_{it-2}$ are quite similar to the magnitudes found in other studies for the US that consider different time periods.[11] Column (2) presents our baseline results. We include interaction terms of the variables y_{it-1} and $\tilde{y}_{it-2}$ with an indicator function for the post-1995 period $Post_t$. The coefficient estimates on these interaction terms will then indicate how the costs F_0 and F_R compare in the second half of the period to those in the first. We find a small decline the coefficient α_1 in the second part of the panel and a somewhat larger decrease in α_2. Controlling for other factors, exporting last year raises a plant's probability of exporting by 44% over the period 1989-1995 and by 40% over 1996-2003. These results are consistent with those found in column (1) in terms of how the coefficients on the interaction terms compare to those on the unaltered lagged export status covariates. Given the magnitudes of the coefficients on the interaction terms, we interpret these estimates to suggest relatively small declines in the costs F_0 and an increase in the costs of re-entering foreign markets F_R. The size of each of these coefficients, however, suggests that the changes in these costs are unlikely to have been significant enough to have played a determinative role in export trends.

In our estimations in columns $(1)-(2)$ we allow entry into the sample but drop plants that died during the sample period. This approach allows us to abstract from plant death, which is not explicitly a part of the model. We present the results from alternatively considering a fully balanced panel with no entry or exit into the sample over the 1989-2003 period in

[10] Each exchange rate is a geometric export-weighted average of bilateral real exchange rates where the weights are constructed using 3 digit SIC export data. We follow the aggregation method used by the US Federal Reserve, as detailed in Loretan (2005). We use the same industry-level exchange rate series for both our reduced form estimations and structural analysis.

[11] See Bernard and Jensen (1999), Bernard and Jensen (2004b).

column (3). We find similar estimates to those shown in columns (1) and (2). This is reassuring not only for the validity of our reduced form approach but also for our structural estimations, where we are constrained to use a balanced panel approach. We also considered a sample that contained no restrictions in terms of entry and exit into the sample. We find similar results with this sample definition as well.

In addition to the results presented in Table 6, we come to similar conclusions when considering alternative approaches to our baseline specification. These include using different definitions of the post-period indicator function $Post$, only considering plants with 350 or more employees, dropping the computer and semiconductor industries, using different covariates in the term X_{it}, using current values of plant-specific characteristics in the vector X_{it}, adding the variable "Last exported three years ago" and its interaction with $Post_{95}$, and limiting the analysis to single-plant firms. This last robustness check is especially reassuring as it alleviates concerns related to multi-plant firms. Standard errors are similar when clustering by firm or by industry at the 3 digit SIC level. The estimations using a balanced panel were also robust to these alternative estimation approaches. A final concern here is that the results may be affected by one of three potential biases (i) Nickell bias (ii) initial conditions bias and (iii) bias from serially correlated errors. The first two should be attenuated in our current estimations given the length of the panel ($T = 17$). In the next section we will consider an approach that explicitly accounts for serially correlated shocks. Prior work by Bernard and Jensen (2004), however, suggests that our estimates are not being significantly biased by these issues. We are currently in the process of estimating the specification in (2) with a simulated maximum likelihood estimator of a random effects dynamic probit model that uses the GHK algorithm of Geweke, Hajivassiliou, and Keane. This approach will address each of these concerns.

4 Structural Estimation

4.1 Model

In this section, we turn to a structural approach to address how the costs of entering foreign markets have evolved. The extra structure afforded by the model allows us to provide numerical estimates of the costs of entering foreign markets in different time periods. Specifically, we use the estimation methodology developed by Das, Roberts, and Tybout (2007) to look at the average level of foreign market entry costs facing plants over the 1987-1997 and 1992-2003 periods. Comparing these cost estimates across the two panels will then give us a sense of how they have changed. In addition to addressing the question of the determinants of the rise in export intensity, our results contribute to the emerging literature on estimating the magnitude of these barriers. Indeed, these costs have not been estimated with panel data outside of Colombia and Chile.

Here we lay out the basics of the model underlying the estimation approach; further details are contained in the appendix. All plants in the model serve the domestic market and face the choice of whether or not to sell their goods abroad. The foreign and domestic markets are segmented from one another and are both monopolistically competitive. We abstract from entry and exit into production in the domestic market, requiring the use of a balanced panel in our estimations. We assume that plants' marginal costs do not respond to output shocks, simplifying the model significantly by isolating the decision to serve foreign markets from domestic concerns. Plants are forward-looking in the sense that, although they do not know what their future realizations of marginal costs, foreign demand, and the exchange rate will be, they know the Markov processes by which these factors evolve and set their expectations accordingly.

The log potential profits from selling in the foreign market π_{it}^* for plant i in year t is defined as

$$\ln\left(\pi_{it}^*\right) = \psi_0 z_i + \psi_1 e_t + v_{it} \tag{3}$$

where z_i indexes time-invariant plant characteristics and e_t is the exchange rate facing the plant. v_{it} is a stationary, serially correlated disturbance term that captures shifts in factors that determine potential export profits. Examples of these factors include changes in productivity, factor input prices, tariffs, transportation costs, and demand. Although this general form is quite parsimonious, it allows for significant flexibility in accounting for many of the other potential explanations for changes in export status. We assume that v_{it} is the sum of m stationary and independent $AR(1)$ processes. Formally, we have $v_{it} = \sum_{j=1}^{m} x_{jit}$

where i indexes plants, t the time period, and j the type of potential shock. Each of these potential shocks can be written $x_{jit} = \lambda_x^j x_{jit} + w_{xjt}$, where w_{xjt} is normally distributed with mean zero and variance σ_{wj}^2. The composite term v_{it} therefore follows an $ARMA\,(m, m-1)$ process. We define x_{it} as the $m \times 1$ vector of shocks to profits, where $v_{it} = \iota' x_{it}$ and ι is a vector of ones. The exchange rate e_t follows the AR(1) process $e_t = \lambda_0 + \lambda_e e_{t-1} + w_{et}$ where w_{et} is normally distributed with mean zero and variance σ_w^2. The parameters λ_0, λ_e, σ_w and the distribution of w_{et} are known to all plants. For ease of exposition, we denote $\Psi = (\psi_{01}, ..., \psi_{0k}, \psi_1) = (\psi_0, \psi_1)$ and collect the parameters λ_x^j and σ_{wj} into the diagonal matrices Λ_x and $\sum_\omega$.

The relevant variable for the empirical analysis of a plant's decision of whether or not to export is the level of foreign profits that it could make. Our data, however, only contain information on total revenues and export revenues. In order to make estimation possible we draw upon two aspects of the model mentioned above: first, markets are monopolistically competitive, and second, foreign and domestic markets are segmented. We further denote c_{it} as the marginal cost of production, $\eta_i > 1$ as a plant-specific foreign demand elasticity, and P_{it}^f as the domestic currency price of exports. If the plant exports, it would optimally choose to price its goods such that $c_{it}^f = P_{it}^f \left(1 - \eta_i^{-1}\right)$. This implies that potential foreign revenues R_{it}^{f*} and variable costs C_{it}^{f*} to exporting can be written as $C_{it}^{f*} = R_{it}^{f*} \left(1 - \eta_i^{-1}\right)$ if we multiply both sides of this expression by the optimal quantity of exports. Using the fact that $\pi_{it}^* = R_{it}^{f*} - C_{it}^{f*}$, this condition implies that potential export profits are given by

$$\pi_{it}^* = \eta_i^{-1} R_{it}^{f^*} \tag{4}$$

Taking logs and substituting this expression into (3) yields

$$\ln\left(R_{it}^{f^*}\right) = \ln\left(\eta_i\right) + \psi_0 z_i + \psi_1 e_t + v_{it} \tag{5}$$

This relationship provides a way to estimate the parameters that determine export profits and allows us to account for a significant amount of plant heterogeneity in our estimations to follow. It does, however, create an incidental parameters problem with the introduction of the parameters $\eta = \{\eta_i\}_{i=1}^n$. As the number of plants in the sample grows, so too does the number of parameters.

To solve this problem we explicitly use data on costs and revenues. This information can be used to identify η. We begin by assuming that the ratio of foreign demand elasticities to domestic demand elasticities is $1+\upsilon$ for all plants in the industry. By steps analogous to those used to derive (4), profit maximization and segmented markets imply that we should observe $C_{it}^d = R_{it}^d \left(1 - \eta_i^{-1}[1+\upsilon]\right)$ in the domestic market. Combining this with (4) and invoking the assumption of segmented markets, optimally selected production for all markets must satisfy

$$C_{it} = C_{it}^{f} + C_{it}^{d} = R_{it}^{f}\left(1 - \eta_i^{-1}\right) + R_{it}^{d}\left(1 - \eta_i^{-1}\left(1 + \upsilon\right)\right) \tag{6}$$

Dividing this expression by $R_{it} = R_{it}^{f} + R_{it}^{d}$, rearranging, replacing optimal with realized values, and including an error term ξ_{it} yields

$$1 - \frac{C_{it}}{R_{it}} = \eta_i^{-1}\left(1 + \upsilon\frac{R_{it}^{d}}{R_{it}}\right) + \xi_{it} \tag{7}$$

Here R_{it}^{d}, R_{it}, and C_{it} are the plant's realized domestic revenue, total revenue, and total variable cost. We assume that the error term ξ_{it} comes from measurement error in the costs C_{it} and follows the AR(1) process $\xi_{it} = \lambda_{\xi}\xi_{it-1} + w_{\varsigma t}$, where $w_{\varsigma t}$ is normally distributed with variance σ_{ς}^{2}. We can then use this expression to form the density $f_c\left(C_{i0}^{T} \mid R_{i0}^{fT}, R_{i0}^{dT}, \theta\right)$.

The equation (3) gives us an expression for the baseline level of profits that plants earn from foreign markets in each period. In looking at the plant's dynamic problem of whether or not to export, we further allow each plant to receive a shock to profits each period of $\kappa + \varepsilon_{1it}$. κ is common to all plants and ε_{1it} is allowed to vary across plants i and years t. Plants must also pay an up-front, sunk cost to enter foreign markets $\gamma_s z_i + \varepsilon_{2it} - \varepsilon_{1it}$. These one-time costs γ_s depend on time invariant plant characteristics z_i, are paid fully in the first year of exporting, and are allowed to vary across plants and time. Examples of these costs include market research, setting up distribution channels, learning about foreign regulations and documentation requirements, and a number of other non-tariff barriers. It is the estimation of these parameters γ_s in which we are most interested. Note that γ_s parameterizes the typical costs that plants face and not necessarily the costs that are paid by plants that begin to sell abroad. Indeed, all else equal, the plants that enter are those that are likely to have drawn a favorable shock of $\varepsilon_{2it} - \varepsilon_{1it}$. We assume that ε_{jit} are serially uncorrelated, normally distributed with mean zero and variance $\sigma_{\varepsilon j}^{2}$, and are uncorrelated with v_{it} and e_t for each $j = 1, 2$. For the sake of exposition, we let $\sum_{\varepsilon} = diag\left(\varepsilon_{1it}, \varepsilon_{2it}\right)$ and $\Gamma = \left(\gamma_{s1}, \gamma_{s2}, ..., \gamma_{sk}, \kappa\right) = \left(\gamma_s, \kappa\right)$.

We are now in a position to describe the plant's decision of whether or not to export. Let y_{it} be an indicator variable for whether plant i exported in year t. Using the expression for gross potential export profits π_{it}^{*} from (3), we can write

$$u\left(\cdot\right) = \begin{cases} \pi_{it}^{*}\left(e_t, x_{it}, z_i\right) + \kappa + \varepsilon_{1it} & \text{if } y_{it} = 1 \text{ and } y_{it-1} = 1 \\ \pi_{it}^{*}\left(e_t, x_{it}, z_i\right) + \kappa - \gamma_s z_i + \varepsilon_{2it} & \text{if } y_{it} = 1 \text{ and } y_{it-1} = 0 \\ 0 & \text{if } y_{it} = 0 \end{cases} \tag{8}$$

The plant's potential net export profits depend on its prior export status, since we assume that sunk costs have to be paid if the plant did not export in the previous year.

In each period t, the plant observes the values of e_t, x_{it}, ε_{jit}, and z_i and forms its expectations about the future using the fact that it knows the processes by which these terms evolve. The plant then determines the decision rule of whether or not to export $y_{it} = y\left(e_t, x_{it}, z_i, \varepsilon_{jit}, y_{it-1} \mid \theta\right)$ which maximizes its net discounted expected profit stream over a 30 year horizon. Formally, we have the Bellman equation

$$V_{it} = \max_{y_{it}\in\{0,1\}} \left\{u\left(e_t, x_{it}, z_i, \varepsilon_{jit}, y_{it-1}, y_{it} \mid \theta\right) + \delta E_t V_{it+1}\right\} \tag{9}$$

where

$$E_t V_{it+1} = \int_{e'}\int_{x'}\int_{\varepsilon'} V_{it+1}\cdot f_e\left(e' \mid e_t, \theta\right)\cdot f_x\left(x' \mid x_t, \theta\right)\cdot f_\varepsilon\left(\varepsilon' \mid \varepsilon_t, \theta\right) d\varepsilon' dx' de'$$

and θ collects all the parameters

$$\theta = \left(\Psi, \eta, \upsilon, \Lambda_x, \Sigma_\omega, \Gamma, \Sigma_\varepsilon, \lambda_0, \lambda_e, \sigma_w, \lambda_\xi, \sigma_\varsigma\right)$$

The decision rule of whether or not to export can be written as a binary choice problem $y_{it} = I\left(y_{it}^* > 0\right)$. Here $I(\cdot)$ is an indicator function and y_{it}^* is a comparison of the benefits from exporting and from not exporting

$$y_{it}^* = u\left(e_t, x_{it}, z_i, \varepsilon_{it}, 1, y_{it-1} \mid \theta\right) + \delta\Delta E_t V_{it+1}\left(e_t, x_{it}, z_i \mid \theta\right) \tag{10}$$

where

$$\Delta E_t V_{it+1}\left(e_t, x_{it}, z_i \mid \theta\right) = E_t\left[V_{it+1} \mid y_{it} = 1\right] - E_t\left[V_{it+1} \mid y_{it} = 0\right]$$

The first term in (10) reflects the direct benefits today from exporting, whereas the second term reflects the option value of being an exporter tomorrow.

4.2 Estimation

Using the expressions developed above to describe a plant's intensive and extensive margin exporting decisions, we then develop a likelihood function that allows us to estimate the parameters in one step

$$L(D \mid \theta) = \prod_{i=1}^{n} f_c\left(C_{i0}^T \mid R_{i0}^{fT}, R_{i0}^{dT}, \theta\right) \cdot P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i, \theta\right) \tag{11}$$

Here $D = \{D_i\}_{i=1}^n$ denotes the data for all firms. $f_c\left(C_{i0}^T \mid R_{i0}^{fT}, R_{i0}^{dT}, \theta\right)$ is determined by the expression in (7) and the likelihood $P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i, \theta\right)$ is formed from the relationships implied by the extensive margin decision. We provide more details about the construction of $P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i, \theta\right)$ in the appendix. Estimating the likelihood function $L(D \mid \theta)$ with classical methods presents two problems. First, while this feature of the approach allows us to account for a significant amount of plant heterogeneity, we are faced with an incidental parameters problem in that we need to estimate $\eta = \{\eta_i\}_{i=1}^n$. To add to this, the likelihood function is highly non-standard and unlikely to be globally concave in θ. To circumvent these issues, we use a Bayesian approach and write the posterior distribution of the parameters with $P(\theta \mid D) \propto q(\theta) L(D \mid \theta)$, where $q(\theta)$ gives our prior beliefs about the parameters. To characterize the posterior distribution $P(\theta \mid D)$, we then use the random walk Metropolis-Hastings algorithm. This algorithm essentially allows us to estimate $E(\theta \mid D)$ by performing Monte Carlo integration using a Markov chain.

Computational constraints place some restrictions on the level of heterogeneity for which these estimates can account. To characterize the time invariant plant characteristics that affect sunk costs and export profits, we let z_i equal an indicator function based on plant size. The threshold for z_i is set to be equal to the median level of sales in 1987, such that half of the plants are considered large in the first panel for each industry. We keep this threshold for the second panel, capturing changes in plant sales. The number of $AR(1)$ processes additively included in the profit function disturbance term is set to two $v_{it} = x_{1it} + x_{2it}$, intuitively reflecting separate cost and demand shock processes. We set the discount rate δ to 0.9. In order to ease computational costs, we do not estimate the parameters for the exchange rate process simultaneously with the rest of the model. Instead, we estimate them separately using export-weighted industry real exchange rates constructed with the same approach as those described in Section 3. We fit each of these series with an $AR(1)$ process from 1972 until the last year of each panel to give estimates of $\hat{\lambda}_0$, $\hat{\lambda}_e$, and $\hat{\sigma}_w$. These parameters are then treated as fixed for the purposes of the estimation of the model.

For the rest of our parameters, we have to specify a prior distribution. With a few exceptions, we make these distributions reasonably diffuse to let the data speak for itself. To impose non-negativity on the variance parameters, our priors are that they are distributed log normally with a mean of zero and a variance of 2. Our priors on the root of each AR(1) process are that they are distributed uniformly on $(-1, 1)$. This ensures that these processes are stationary. We also set a more restrictive prior for η_i due to the incidental parameters problem. Following the empirical literature, we set the prior such that $\ln(\eta_i - 1) \sim N(2, 1)$. This implies a mean and standard deviation for η_i of 12.2 and 16.0, respectively. It also ensures that $\eta_i > 1$, which is a necessary condition for the model. The prior for υ, the parameter that determines the ratio of foreign and domestic demand elasticities, is also assumed to be uniform on $[-5, 5]$. The priors for other parameters are given in Table 7.

Given these preliminaries, it is possible to provide intuition about the main sources of variation used to identify the sunk cost parameters. First note that for any type of plant the probability of exporting is an increasing function of the gross potential profit stream that it could earn in foreign markets. If there are no barriers to entry, the probability that a plant exports today should not depend on whether it exported yesterday. Plants with similar gross potential profit streams should have the same probability of exporting regardless of their exporting history. If there are significant up-front costs, however, plants that previously exported should have a higher probability of exporting since they do not need to pay to enter. The higher these costs are, the bigger the difference should be between plants that exported previously and those that did not. Thus, differences in the exporting frequencies of plants with similar gross potential export profit streams but different exporting histories in our data provide significant identifying variance for the sunk cost parameters.

4.3 Results

In choosing the industries that we focused on, we used several criteria to narrow down our choices (i) there were enough plants in each panel to allow for identification (ii) the industry was sufficiently export oriented (iii) it did not experience large, idiosyncratic shocks that would make our results unrepresentative (iv) like aggregate exports, the overall destination composition of industry exports was relatively stable and (v) the industries were in different 2 digit SIC sectors in order to get a broad view.[12] As mentioned above, these criteria led us to consider three 1987 SIC industries: Preserved Fruits and Vegetables (SIC 203), Aircraft and Parts (SIC 372), and Measuring and Controlling Devices (SIC 382). Table 12 lists the 4 digit subindustries that comprise these 3 digit sectors. We use two panels, 1987-1997 and 1992-2003, and estimate the level of sunk costs γ_s in each period.

[12] Due to data constraints, we are limited in considering a model with only two countries. This assumption has advantages as well as drawbacks. Hanson and Xiang (2011) develop an empirical test to understand the structure of these costs. They find evidence that they are global rather than bilateral in nature. This noted, we limit our structural analyses to industries where the destination of industry exports have remained stable over time by region. Considering a number of industries further alleviates concerns related to this modeling choice.

Tables 8-11 present the results. In Table 8 we present the estimates for our main sunk cost parameters by industry. Tables 9-11 present the full estimation results for each industry and time period. For each parameter we report the estimated mean and standard deviation, although median values give similar results. All figures are in 1987 dollars. For each panel we consider 50k draws from the posterior distribution to construct our estimates.[13] Despite generally using highly diffuse prior distributions, the posterior distributions for most of our parameters are fairly concentrated. This suggests that the estimates are primarily informed by the data itself rather than the values that we chose for our priors. We looked at the results from several different levels of thinning the chain. Here we alternately constructed our estimates by keeping every 2nd, 5th, 10th, 50th, or 100th draw. This standard robustness check for Monte Carlo Markov Chain (MCMC) methods is often used to diagnose a lack of convergence of the chain to the posterior distribution $P(\theta \mid D)$ or slow movement of the chain across the parameter space ("slow mixing"). These different levels of thinning all give comparable results.

Consistent with the small changes that we see in the reduced form estimations, we generally find comparable results for γ_s across the two different time periods. The Aircraft and Parts and Measuring and Controlling Devices industries experienced little change in the costs that they faced while the Preserved Fruits and Vegetables sector experienced a decrease. Internal calculations using the elasticity estimates for each plant suggest that the magnitude of the sunk costs are equal to a few years of the average level of exporting profits. Interestingly, we find similar estimates for γ_s for larger and smaller plants across each of the panels. These results suggest that differences in plant size do not alter the costs that plants face in our samples. Elasticity estimates are also consistent with the values suggested by the literature. In concert with our estimates from Section 3, we interpret these results to suggest that declines in these costs are unlikely to have been a major factor for the level of entry that we see in the data.

5 Discussion

In this section we perform back-of-the-envelope calculations to better understand the determinants of the increase in the percentage of plants that export. Our intent is to investigate

[13] Acceptance rates are kept within the range suggested by the literature and we use a burn-in period of at least 50k iterations. We looked at a number of diagnostic statistics to check for convergence. These tests are reviewed at length in Brooks and Roberts (1998). See the appendix for further details about the MCMC estimation methods.

whether a standard model can match this rise without changes in the costs of entering foreign markets. This exercise will give us a sense of whether or not our estimates are reasonable. We find that the model can easily account for the patterns that we see in the data using standard calibrations of the parameters. Here we provide one particular accounting, although other approaches are also sufficient to match the data. We consider a two-country version of the model of Chaney (2008) and assume as he does that the distribution of productivity is Pareto. The main facts that we want to match are that 21% of plants exported in 1987 and that 35% exported in 2003. In the model, we can write this as

$$P\left(\phi > \phi_x^{87} \mid \phi > \phi_p^{87}\right) = \left(\frac{\phi_p^{87}}{\phi_x^{87}}\right)^{\theta} = .21 \tag{12}$$

and

$$P\left(\phi > \phi_x^{03} \mid \phi > \phi_p^{03}\right) = \left(\frac{\phi_p^{03}}{\phi_x^{03}}\right)^{\theta} = .35 \tag{13}$$

Here ϕ_p is the threshold level of productivity ϕ needed to produce. ϕ_x is the threshold level needed to access foreign markets profitably. If we divide the expression in (14) by that in (15) and assume that $\theta = 4$ and $\sigma = 4.77$,[14] we have

$$\frac{\phi_p^{87}}{\phi_p^{03}}\frac{\phi_x^{03}}{\phi_x^{87}} = \left(\frac{.21}{.35}\right)^{\frac{1}{4}} = .880 \tag{14}$$

In explaining the shift in the threshold for exporting, we consider the expression for ϕ_x across 1987 and 2003

$$\frac{\phi_x^{03}}{\phi_x^{87}} = \left(\frac{f_x^{03}}{f_x^{87}}\frac{Y_j^{87}}{Y_j^{03}}\right)^{\frac{1}{\sigma-1}} \frac{w_i^{03}}{w_i^{87}}\frac{P_j^{87}}{P_j^{03}}\frac{\tau_{ij}^{03}}{\tau_{ij}^{87}} \tag{15}$$

The parameter $\tau_{ij} > 1$ is the level of iceberg transportation costs, w_i is the home country wage, P_j is the foreign price index, f_x is the cost of entering the foreign market, and Y_j is the level of foreign income. From the ASM, we know that real wage growth in US manufacturing has been quite stagnant. As discussed by several authors, with the exception of NAFTA, tariffs on US goods also did not change significantly over the period; they were in general quite low and stayed that way. Hummels (2007) in turn notes modest reductions in the ad valorem air and ocean freight rates on US goods over 1987-2003. Using a gravity equation

[14] These values are consistent with an estimate for the slope parameter on the Pareto sales distribution of $\zeta = \frac{\theta}{\sigma-1} = \frac{4}{4.77-1} = 1.06$. Note that as long as the values of θ and σ are chosen to satisfy this ratio, there is a range of values that give results similar to our specific parameter choices. This value for σ is well within the range of 3 and 10 suggested by the literature.

framework that accounts for other important factors besides tariffs and transportation costs, Jacks, Meissner, and Novy (2008) also find little change in τ_{ij} for the US 1987-2000. Debaere and Mostashari (2010) further look at imports into the US over 1989-1999 and argue that changes in τ_{ij} have played a minor role in explaining the large changes in the range of goods imported into the US. This was due to both the small estimated effects of variable trade costs on the extensive margin of trade as well as the small changes in US protection over the period.[15]

Motivated by this empirical evidence as well as our estimations above, we consider matching the extensive margin trends that we see in the data assuming that $\tau_{ij}^{03} = \tau_{ij}^{87}$ and $\left(w_i^{03}/P_j^{03}\right) \div \left(w_i^{87}/P_j^{87}\right)$ stayed constant. Our work above further allows us to reasonably assume that $f_x^{03} = f_x^{87}$. Alternatively assuming that increases in w_i/P_j were cancelled by the modest declines in τ_{ij} would give us similar results. Using trade shares from 1987 as weights, we calculate a rise in real foreign income amongst 40 top US export destinations of 67%.[16] With these equalities and $\sigma = 4.77$, plugging into equation (15) yields

$$\frac{\phi_x^{03}}{\phi_x^{87}} = .872$$

This suggests that observed growth of foreign incomes are sufficient to explain nearly all of the change in export market participation as expressed in (14) even without the likely contributions of other factors. This significant role for foreign income, however, is consistent with the pervasive nature of these trends for all industries and US regions. Furthermore, it is compatible with empirical evidence from Baier and Bergstrand (2001), Jacks, Meissner, and Novy (2011), and Whalley and Xin (2011) who study the factors that drove aggregate worldwide exports since the 1950s.[17]

[15] Others, however, have argued for a larger effect of changes in variable trade costs on exports. See Yi (2003), Bernard, Jensen, and Schott (2006), and Cuñat and Maffezzoli (2007). For evidence of changes in wages in US manufacturing, see the figures in the Annual Survey of Manufacturers-based US Census publication *Statistics for Industry Groups and Industries: 2005*.

[16] We include the top 42 US export destinations in 1987 with the exception of Taiwan and Kuwait due to missing data. We consider changes in real foreign income and the real level of entry costs f_x due to units cancelling in the expression in parentheses in equation (16).

[17] For example Whalley and Xin (2011) use a calibrated trade model and find a 76% role for income growth in the factors that drove world trade 1975-2004. Baier and Bergstrand (2001) and Jacks Meissner, and Novy (2011) instead consider estimations based on the gravity equation and find similar results. They study the periods 1958-1988 and 1950-2000, respectively. As each of these papers study bilateral trade flows, however, these results do not distinguish between the roles of domestic productivity growth and foreign income growth in driving exports from a given country.

6 Conclusion

In this study we have documented a significant shift towards exporting for US plants over 1987-2006. In looking at why this occurred we considered a natural explanation that has been suggested as a primary cause for similar trends in other countries: declines in the up-front costs of entering foreign markets. Across different approaches to understanding this issue, we show that reductions in these barriers were unlikely to have played a significant role in these trends. We instead find that other factors that determine export market participation are sufficient to explain these trends. Our work represents an initial attempt to understand how the costs to entering foreign markets have evolved over time.

We close with a discussion of a few areas of research that are likely to be fruitful for future work. Firstly, qualitative evidence on the determinants of export market entry costs would be tremendously valuable. Despite the evidence presented here and their ubiquity in trade models, there is surprisingly little direct survey evidence about these costs. Retrospective research in this area could help us better understand the results presented above. Secondly, much of the work on understanding the effects of free trade agreements focuses on how declines in tariffs affect aggregate trade volumes. Total trade tends to increase through extensive margin adjustments following these agreements, however, and the details of these accords often include provisions likely to reduce barriers to entry. Disentangling these effects would significantly improve our understanding of how different impediments affect trade and would likely yield more accurate analyses of potential policy changes. Finally, an improved understanding of the experiences of other countries would also provide further insight into the evolution of the barriers to entry in foreign markets. We attempted to obtain data to expand our analysis to countries beyond the US, but were unable to locate a data set with sufficient history and detail. Further analyses on the experiences of firms in other countries would add greatly to our understanding of trends in international trade.

7 References

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8 Appendix

In this appendix we provide further details about our structural estimation approach. We begin by describing how we develop the extensive margin likelihood in sections 8.1 and 8.2. We then describe our approach to calculating the option value associated with exporting $\Delta E_t V_{it+1}(e_t, z_i, x_{it} \mid \theta)$. A description of our Bayesian MCMC estimation approach closes. The discussion of the model here and in the main text follows Das, Roberts, Tybout (2007); see this paper for further details about the model and estimation approach.

8.1 Extensive Margin Likelihood

For the purposes of estimation, we can connect the binary choice decision problem laid out in the body of the text to a likelihood function that uses our data from US plants. We begin by writing observed export profit shocks as

$$v_i^+ = \left\{ \ln\left(R_{it}^f\right) - \ln(\eta_i) - \psi_0 \cdot z_i - \psi_1 \cdot e_t \mid R_{it}^f > 0 \right\}$$

We can then write the export profit shock for plant i in each year t as a function of these observed shocks and a set of m *iid* standard normal random variates μ_i such that $x_{it} = x_{it}\left(v_i^+, \mu_i\right)$. For each plant, we can write

$$\begin{aligned} P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i\right) &= P\left(y_{i0}^T, v_i^+ \mid e_0^T, z_i\right) \\ &= P\left(y_{i0}^T \mid e_0^T, z_i, v_i^+\right) \cdot h\left(v_i^+\right) \\ &= \left[\int_{\mu_i} P\left(y_{i0}^T \mid e_0^T, z_i, x_0^T\left(v_i^+, \mu_i\right)\right) \cdot g(\mu_i)\, d\mu_i\right] \cdot h\left(v_i^+\right) \end{aligned}$$

where the density functions for μ_i and v_i^+ are given by $g(\mu_i)$ and $h\left(v_i^+\right)$. We discuss how to construct $g(\mu_i)$, $h\left(v_i^+\right)$ and the term $\Delta E_t V_{it+1}(e_t, x_{it}, z_i \mid \theta)$ in the next sections of the appendix. The value of $P\left(y_{i0}^T \mid e_0^T, z_i, v_i^+\right)$ will be calculated using the distribution of $g(\mu_i)$ and Monte Carlo integration, drawing several μ_i from $g(\mu_i)$, plugging into $P\left(y_{i0}^T \mid e_0^T, z_i, x_0^T\left(v_i^+, \mu_i\right)\right)$, and averaging. The term $P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i, \theta\right)$ can then be linked to our data by factoring out the initial conditions such that

$$P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i\right) = P\left(y_{i1}^T \mid e_1^T, z_i, x_1^T\left(v_i^+, \mu_i\right), y_{i0}\right) \cdot P\left(y_{i0} \mid e_0, z_i, x_0\left(v_i^+, \mu_i\right)\right)$$

Given computational constraints, we use Heckman's (1981) solution to the initial conditions problem, and estimate $P\left(y_{i0} \mid e_0, z_i, x_0\left(v_i^+, \mu_i\right)\right)$ using

$$
\begin{aligned}
P\left(y_{i0} \mid e_0, z_i, x_0\left(v_i^+, \mu_i\right)\right) &= \left(\Phi\left(\alpha_0 + \alpha_1' z_i + \alpha_2' x_0\left(v_i^+, \mu_i\right)\right)\right)^{y_{i0}} \cdot \\
&\quad \left(1 - \Phi\left(\alpha_0 + \alpha_1' z_i + \alpha_2' x_0\left(v_i^+, \mu_i\right)\right)\right)^{1-y_{i0}}
\end{aligned}
$$

Using backward induction along with Rust's (1997) random grid algorithm, we can calculate $\Delta E_t V_{it+1}\left(e_t, x_{it}, z_i \mid \theta\right)$ in each period. We then further use the export market participation rule in (8) to develop the likelihood function

$$
\begin{aligned}
P\left(y_{i1}^T \mid e_1^T, z_i, x_1^T\left(v_i^+, \mu_i\right), y_{i0}\right) &= \prod_{i=1}^{T} \left[E_{\varepsilon_{it}}\left(I\left(y_{it}^* > 0 \mid e_t, z_i, x_t\left(v_i^+, \mu_i\right), \varepsilon_{it}, y_{it-1}\right)\right)\right]^{y_{it}} \cdot \\
&\quad \left[E_{\varepsilon_{it}}\left(I\left(y_{it}^* \leq 0 \mid e_t, z_i, x_t\left(v_i^+, \mu_i\right), \varepsilon_{it}, y_{it-1}\right)\right)\right]^{1-y_{it}}
\end{aligned}
$$

Differences across plants and time in terms of export market participation, costs, and foreign and domestic sales will then help pin down our parameters of interest. In particular, variation in export market participation by firms that would earn similar levels of profits in export markets but that are different in terms of their prior foreign market presence will be important in identifying sunk entry costs.

8.2 Density Functions for Foreign Market Profit Shocks

In this section we describe how we construct $h\left(v_i^+\right)$ and $x_0^T\left(v_i^+, \mu_i\right)$ mentioned in Section 8.1. These are elements that form part of $P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i\right)$. We begin by deriving the density function for

$$
\begin{aligned}
v_i^+ &= \left\{\ln\left(R_{it}^f\right) - \ln\left(\eta_i\right) - \psi_0 \cdot z_i - \psi_1 \cdot e_t \mid R_{it}^f > 0\right\} \\
&= \left\{v_{it} \equiv \iota' x_{it} \mid R_{it}^f > 0\right\}
\end{aligned}
$$

For each plant we observe $q_i = \sum_{t=0}^{T} y_{it}$ values of v_i^+. We first assume that each x_{it} process is in long-run equilibrium such that $x_{it} \sim N\left(0, \Sigma_\omega\left(I - \Lambda_x^2\right)^{-1}\right)$. Thus, we have $h\left(v_i^+\right) = N\left(0, \Sigma_{vv}\right)$ where $E\left[v_{it}^2\right] = \iota'\left(x_{it}x_{it}'\right)\iota = \iota'\Sigma_\omega\left(I - \Lambda_x^2\right)^{-1}\iota$ and $E\left[v_{it}v_{it-k}\right] = \iota'\Lambda_x^{|k|}\Sigma_\omega\left(I - \Lambda_x^2\right)^{-1}\iota$ where $k \neq 0$.

The next key element in constructing $P\left(y_{i0}^T, R_{i0}^{fT} \mid e_0^T, z_i\right)$ is to develop the function $x_0^T\left(v_i^+, \mu_i\right)$. We first write x_{i0}^T as an $mT \times 1$ vector $x_{i0}^T = \left(x_{i0}', \ldots, x_{iT}'\right)'$. Given the $q_i \times 1$ vector v_i^+ we can write

$$
x_{i0}^T \mid v_i^+ \sim N\left(\Sigma_{xv}\Sigma_{vv}^{-1}v_i^+, \Sigma_{xx} - \Sigma_{xv}\Sigma_{vv}^{-1}\Sigma_{xv}'\right)
$$

Here $\Sigma_{xx} \equiv E\left(x_{i0}^T \cdot x_{i0}^{T\,\prime}\right)$ and $\Sigma_{xv} \equiv E\left(x_{i0}^T \cdot v_i^{+\,\prime}\right)$; the elements of these matrices are given by $E\left(x_{it} \cdot x_{it+s}'\right) = \Lambda_x^{|s|} \cdot \Sigma_\omega \cdot \left(I - \Lambda_x^2\right)^{-1}$ and $E\left(x_{it} \cdot v_{it+s}\right) = \Lambda_x^{|s|} \cdot \Sigma_\omega \cdot \left(I - \Lambda_x^2\right)^{-1}\iota$. See

Chow (1983) for further discussion.

We can then use these expressions to write

$$x_{i0}^T = x_{i0}^T \left(v_i^+, \mu_i\right) = \begin{cases} Av_i^+ + B\mu_i & \text{if } q_i > 0 \\ B\mu_i & \text{if } q_i = 0 \end{cases}$$

Here $A = \Sigma_{xv}\Sigma_{vv}^{-1}$, $BB = \Sigma_{xx} - \Sigma_{xv}\Sigma_{vv}^{-1}\Sigma_{xv}'$, and μ_i is an $mT \times 1$ vector of *iid* standard normal random variables with density function $g(\mu_i) = \prod_{j=1}^{mT} \phi\left(\mu_{ij}\right)$. We can use this expression to form $x_{it} = x_t\left(v_i^+, \mu_i\right)$ and $x_{is}^T = x_s^T\left(v_i^+, \mu_i\right)$ that are then a part of

$$P\left(y_{i0}^T \mid e_0^T, z_i, v_i^+\right) = \int_{\mu_i} P\left(y_{i0}^T \mid e_0^T, z_i, x_{i0}^T\left(v_i^+, \mu_i\right)\right) \cdot g(\mu_i) \cdot d\mu_i$$

Specifically, we can then use this functional form to simulate $P\left(y_{i0}^T \mid e_0^T, z_i, v_i^+\right)$. This is done by (i) drawing a set of S vectors μ_i from $g(\mu_i)$ (ii) using the values to calculate $x_{i0}^T\left(v_i^+, \mu_i\right)$ and (iii) averaging over the resulting values to calculate $P\left(y_{i0}^T \mid e_0^T, z_i, v_i^+\right)$.

8.3 Calculating the Option Value $\Delta E_t V_{it+1}(e_t, z_i, x_{it} \mid \theta)$

In obtaining an estimate of the latent value of exporting

$$y_{it}^* = \left[u\left(e_t, z_i, x_{it}, \varepsilon_{it}, y_{it} = 1, y_{it-1} \mid \theta\right) - 0\right] + \delta \Delta E_t V_{it+1}\left(e_t, z_i, x_{it} \mid \theta\right)$$

the term $u(e_t, z_i, x_{it}, \varepsilon_{it}, y_{it} = 1, y_{it-1} \mid \theta)$ can be calculated using the functional forms presented in the text. To obtain an estimate for $\Delta E_t V_{it+1}(e_t, z_i, x_{it} \mid \theta)$ we begin by using backward induction over a 30 year time horizon to first calculate

$$V_{it}^O = \delta E_t V_{it+1}\left(e_{t+1}, x_{it+1}, z_i \mid y_{it} = 0, \theta\right)$$
$$V_{it}^E = \pi\left(e_{t+1}, x_{it+1}, z_i, \theta\right) - \kappa - \gamma_s \cdot z_i + \delta E_t V_{it+1}\left(e_{t+1}, x_{it+1}, z_i \mid y_{it} = 1, \theta\right)$$
$$V_{it}^S = \pi\left(e_{t+1}, x_{it+1}, z_i, \theta\right) - \kappa + \delta E_t V_{it+1}\left(e_{t+1}, x_{it+1}, z_i \mid y_{it} = 1, \theta\right)$$

Here V_{it}^O is the expected value of only selling domestically in period t, V_{it}^E is the expected value from entering the foreign market, and V_{it}^S is the expected value of continuing to sell abroad. The algorithm begins in the last year in which $E_t V_{it+1} = 0$ and then calculates V_{it}^O, V_{it}^E, and V_{it}^S backwards successively until the current period is reached. We use Rust's (1997) random grid algorithm to integrate numerically over the state variables x and e. We calculate

$$\begin{aligned}
E_t\left[V_{it+1} \mid y_{it}=1\right] &= E_t \max\left(V^O_{it+1}, V^S_{it+1} + \varepsilon_{1it+1}\right) \\
&= \int_{x_{t+1}}\int_{e_{t+1}} \left[\begin{array}{c} \Phi\left(\frac{V^S_{it+1}-V^O_{it+1}}{\sigma_{\varepsilon 1}}\right) \times \left[V^S_{it+1} + \sigma_{\varepsilon 1} \cdot \left[\frac{\phi\left(\frac{V^S_{it+1}-V^O_{it+1}}{\sigma_{\varepsilon 1}}\right)}{\Phi\left(\frac{V^S_{it+1}-V^O_{it+1}}{\sigma_{\varepsilon 1}}\right)}\right]\right] \\ +\Phi\left(\frac{V^O_{it+1}-V^S_{it+1}}{\sigma_{\varepsilon 1}}\right) \cdot V^O_{it+1} \end{array}\right] \\
&\quad \cdot f\left(x_{t+1} \mid x_t\right) \cdot f\left(e_{t+1} \mid e_t\right) \cdot dx_{t+1} \cdot de_{t+1}
\end{aligned}$$

and

$$\begin{aligned}
E_t\left[V_{it+1} \mid y_{it}=0\right] &= E_t\left[\max\left(V^O_{it+1}, V^E_{it} + \varepsilon_{2it+1}\right)\right] \\
&= \int_{x_{t+1}}\int_{e_{t+1}} \left[\begin{array}{c} \Phi\left(\frac{V^E_{it}-V^O_{it+1}}{\sigma_{\varepsilon 2}}\right) \cdot \left[V^E_{it} + \sigma_{\varepsilon 2} \cdot \left[\frac{\phi\left(\frac{V^E_{it}-V^O_{it+1}}{\sigma_{\varepsilon 2}}\right)}{\Phi\left(\frac{V^E_{it}-V^O_{it+1}}{\sigma_{\varepsilon 2}}\right)}\right]\right] \\ +\Phi\left(\frac{V^O_{it+1}-V^E_{it}}{\sigma_{\varepsilon 2}}\right) \cdot V_{0it+1} \end{array}\right] \\
&\quad \cdot f\left(x_{t+1} \mid x_t\right) \cdot f\left(e_{t+1} \mid e_t\right) \cdot dx_{t+1} \cdot de_{t+1}
\end{aligned}$$

8.4 Monte Carlo Markov Chain Methods

We take $S = 50k$ draws of the posterior distribution $P(\theta \mid D)$ to construct our estimates using the random-walk Metropolis-Hastings algorithm. These draws are taken after an initial burn-in period that allows the chain to converge to the posterior distribution. The means and standard deviations are estimated with $\bar{\theta} = \frac{1}{S}\sum_{s=1}^{S}\theta^s$ and

$$\sqrt{\frac{1}{S}\sum_{s=1}^{S}\left(\theta^s - \bar{\theta}\right)\cdot\left(\theta^s - \bar{\theta}\right)'}$$

where θ^s is a given draw of the entire parameter vector from the posterior distribution. We use a Metropolis-Hastings algorithm in which we update the different components of the parameter vector separately in each iteration of the chain. We choose to partition θ with $\theta^s = (\theta^s_1, \theta^s_2, \ldots, \theta^s_8)$ where $\theta_1 = \Psi$, $\theta_2 = \Lambda_x$, $\theta_3 = \Sigma_\omega$, $\theta_4 = \Gamma$, $\theta_5 = \Sigma_\varepsilon$, $\theta_6 = \eta$, $\theta_7 = (\upsilon, \rho, \sigma_\xi)$, $\theta_8 = \varsigma$. Once starting values for the chain are chosen, for each iteration we perform the following steps. These steps are then repeated for each iteration.

1. Draw a potential new value for one of the subvectors θ_i based on the value from the previous iteration of the chain. This can be written as $\tilde{\theta}^*_i = \tilde{\theta}^s_i + \upsilon^s_i$ where $\tilde{\theta}^s_i$ is the value of the subvector from the previous iteration and υ^s_i is a mean-zero vector of shocks. The covariance matrix for υ^s_i, Σ_{υ_i}, is chosen before the estimations begin and is held fixed throughout.

2. Define $\tilde{\theta}^s_{-i}$ as the set of parameters in θ excluding those in $\tilde{\theta}^s_i$. Calculate the ratio

$$\alpha_i^s = min\left(\frac{P\left(\theta_i^* \mid \theta_{-i}^s, D\right)}{P\left(\theta_i^s \mid \theta_{-i}^s, D\right)}, 1\right)$$

and update the set of parameters θ_i with

$$(\theta_i^{s+1}, \theta_{-i}^s) = \begin{cases} \left(\theta_i^*, \theta_{-i}^s\right) & \text{with probability } \alpha_i^s \\ \left(\theta_i^s, \theta_{-i}^s\right) & \text{with probability } 1 - \alpha_i^s \end{cases}$$

3. Conduct the same process for each block of parameters θ_i. Once this is done $\forall\ i$, we take the resulting value of θ as our draw from the chain. This process is repeated for each draw of the chain.

..

Table 1: Export Participation by Industry

	Plants that Export (%)			
Industry	1987	1992	1997	2003
Food	15	23	25	27
Tobacco	45	51	47	
(Beverage & Tobacco)				28
Textile Mill Products	16	25	28	
(Textile Mills)				40
(Textile Product Mills)				30
Apparel	5	9	13	13
Wood products	12	18	16	16
Furniture	10	25	24	18
Paper	19	31	32	35
Printing & Publishing	5	10	11	14
Chemicals	40	49	49	55
Petroleum & Coal	22	30	30	31
Plastics & Rubber	26	36	39	40
Leather	19	28	35	38
Nonmetallic Minerals	14	21	20	17
Primary Metals	27	39	39	43
Fabricated Metals	21	31	32	30
Machinery	33	43	41	56
Electronic & Other Electric Equipment	37	46	47	
(Electrical Equipment, etc.)				54
Instruments	48	55	56	
(Computer & Electronic Products)				58
Transportation Equipment	29	40	41	49
Miscellaneous Manufacturing	20	34	36	37
Total	21	30	32	35

Notes: The table lists the percentage of plants that export in each industry using the Census of Manufacturers in 1987, 1992, and 1997 and the Annual Survey of Manufacturers in 2003. Due to concerns about disclosure, the results reported for 1987 and 1992 are from Bernard & Jensen (2004b). The classification system used is 1987 US SIC for 1987-1997 and 2002 NAICS for 2003. Similar to other reported figures, estimates are for plants with 20 or more employees. While somewhat heterogeneous in size and timepaths, these results overall suggest that the trends pictured in Figure 1 were pervasive across industries. See also Figure 2.

Table 2: Export Participation by Region

	Plants that Export (%)			
Region	1987	1992	1997	2003
New England	25	37	37	42
Middle Atlantic	19	29	30	34
East North Central	25	34	35	39
West North Central	23	32	33	37
South Atlantic	18	27	29	32
East South Central	18	27	27	30
West South Central	19	28	28	31
Mountain	18	26	27	32
Pacific	21	31	31	33
Total	21	30	32	35

Notes: The table lists the percentage of plants that export in each US Census geographical division using the Census of Manufacturers in 1987, 1992, and 1997 and the Annual Survey of Manufacturers in 2003. We report the states corresponding to these divisions in Table 3. Similar to other reported figures, estimates are for plants with 20 or more employees. These results suggest that the trend pictured in Figure 1 was experienced widely across regions of the US. Indeed, the time paths of participation rates of each region match the overall trends across these years. See also Figure 3 and Table 3.

Table 3: Census Division of the States

Census Division	State	Census Division	State
New England	Connecticut	East South Central	Alabama
	Maine		Kentucky
	Massachusetts		Mississippi
	New Hampshire		Tennessee
	Rhode Island		
	Vermont	West South Central	Arkansas
			Louisiana
Middle Atlantic	New Jersey		Oklahoma
	New York		Texas
	Pennsylvania		
		Mountain	Arizona
East North Central	Indiana		Colorado
	Illinois		Idaho
	Michigan		New Mexico
	Ohio		Montana
	Wisconsin		Utah
			Nevada
West North Central	Iowa		Wyoming
	Nebraska		
	Kansas	Pacific	Alaska
	North Dakota		California
	Minnesota		Hawaii
	South Dakota		Oregon
	Missouri		Washington
South Atlantic	Delaware		
	District of Columbia		
	Florida		
	Georgia		
	Maryland		
	North Carolina		
	South Carolina		
	Virginia		
	West Virginia		

Notes: The table lists the states corresponding to the Census Divisions used for our calculations in Figure 3 and Table 2.

Table 4: Destinations of US Manufacturing Exports

	Share of US Exports (%)	
Country	1987	2003
Canada	25.3	19.6
Japan	11.1	7.2
Great Britain	5.8	5.4
Germany	5.4	5.8
France	4.7	3.3
Mexico	3.2	13.9
Korea	3.1	3.2
Australia	2.5	1.9
Taiwan	2.5	2.2
Italy	2.5	1.6
Singapore	2.1	2.5
Netherlands	2.1	2.4
China	1.9	4.1
Hong Kong	1.7	1.7
Venezuela	1.6	.3
Spain	1.4	.9
Saudi Arabia	1.3	.8
Brazil	1.2	1.3
Sweden	1.2	.5
Switzerland	1.1	.8

Notes: The table lists the destination composition of US manufacturing exports by value in 1987 and 2003. Thus, Germany accounted for 5.4% of total US exports in 1987 and 5.8% in 2003. Calculations are done using the UN Commodity Trade and Statistics Database. We present the share for the top 20 destinations in 1987 across the two different years. These countries account for 81.7% of US exports in 1987 and 79.4% in 2003. These figures demonstrate that the composition has remained stable over time. Shares come even closer when excluding Mexico from the analysis. Indeed, the rank correlation amongst the top 40 destinations in 1987 with their respective ordering in 2003 is 88%.

Table 5: Intensive Margin

	Starting			
Continuing	1987	1992	1997	2002
1987	1			
1992	0.75	1		
1997	0.58	0.79	1	
2002	0.46	0.58	0.71	1

Notes: The table lists the percentage of exports in each Census of Manufacturers (CMF) year that came from plants that exported in each of the previous Census years, starting in 1987. Thus, only 46% of exports in 2002 came from plants that exported in 1987, 1992, and 1997. Removing any continuous exporting restriction, we find that 57% of trade in 2002 is from plants that export in both 1987 and 2002. Similar to our other figures, estimations are limited to plants with 20 or more employees.

Table 6: Determinants of Export Status

Variable	Specification (1)	(2)	(3)
Exported last year	.420**	.444**	.456**
	(.007)	(.008)	(.009)
Exported last year * $Post_{95}$		-.044**	-.034**
		(.006)	(.007)
Last exported two years ago	.101**	.153**	.161**
	(.009)	(.013)	(.013)
Last exported two years ago * $Post_{95}$		-.094**	-.092**
		(.016)	(.017)
Total Employment	.001	-.002	-.007
	(.012)	(.012)	.013
Wages	.025**	.026**	.031**
	(.011)	(.011)	.013
Non-production/Total Employment	-.057**	-.06**	-.052**
	(.022)	(.021)	.024
Changed Product	.001	.001	.001
	(.001)	(.009)	.011
Productivity	.007**	.007**	.009**
	(.002)	(.002)	(.002)
Industry Exchange Rate	.021	.028	.041
	(.039)	(.039)	(.043)
Year Fixed Effects	Yes	Yes	Yes
Overall R^2	.510	.509	.514
Observations	65388	65388	54947

Notes: The table presents the results from estimating equation (2) in the text. The dependent variable is a 0/1 indicator for a given plant's export status in the current year. Standard errors are clustered at the plant level and non-exporting related plant-specific characteristics are lagged by one period in all specifications. The coefficient "Exported last year" is an increasing function of the costs of entering foreign markets anew F_0. The coefficient on "Last exported two years ago" is similarly an increasing function of the difference $F_0 - F_R$, where F_R is the cost of re-entering foreign markets after leaving the foreign market one year ago. $Post_{95}$ is an indicator function for the post-1995 part of the sample. The results suggest a modest decline in F_0 and an increase in F_R. Column (1) presents the results from estimating equation (2) with no interactions and column (2) contains our baseline results. Column (3) reports results from using a balanced panel. ** denotes significance at the 5% level.

Table 7: Prior Distributions

Parameters	Priors $N(\mu, \sigma)$
	Profits
ψ_{01} (intercept)	$\psi_{01} \sim N(0, 10)$
ψ_{02} (dom. size dummy)	$\psi_{02} \sim N(0, 10)$
ψ_1 (exchange rate)	$\psi_1 \sim N(0, 10)$
λ_x^1 (root, first AR)	$\lambda_x^1 \sim U(-1, 1)$
λ_x^2 (root, second AR)	$\lambda_x^2 \sim U(-1, 1)$
$\sigma_{\omega 1}^2$ (variance, first AR)	$\ln(\sigma_{\omega 1}^2) \sim N(0, 20)$
$\sigma_{\omega 2}^2$ (variance, second AR)	$\ln(\sigma_{\omega 2}^2) \sim N(0, 20)$
υ (foreign elas. premium)	$\upsilon \sim U[-5, 5]$
λ_ξ (root, measurement error)	$\lambda_\xi \sim U(-1, 1)$
σ_ξ (std. dev., measurement error)	$\ln(\sigma_\xi) \sim N(0, 2)$
	Elasticities of Demand
η_i (demand elasticity)	$\ln(\eta_i - 1) \sim N(2, 1)$
	Exporting Decision
γ_{s1} (sunk cost, small plants)	$\gamma_{s1} \sim N(0, 20)$
γ_{s2} (sunk cost, large plants)	$\gamma_{s2} \sim N(0, 20)$
κ (mean, ε_1 & ε_2)	$\kappa \sim N(0, 20)$
$\sigma_{\varepsilon 1}$ (st. dev., ε_1)	$\ln(\sigma_{\varepsilon 1}) \sim N(0, 20)$
$\sigma_{\varepsilon 2}$ (st. dev., ε_2)	$\ln(\sigma_{\varepsilon 2}) \sim N(0, 20)$
	Initial Conditions
α_0 (intercept)	$\alpha_0 \sim N(0, 50)$
α_1 (dom. size dummy)	$\alpha_1 \sim N(0, 50)$
α_2 (x_1)	$\alpha_2 \sim N(0, 50)$
α_3 (x_2)	$\alpha_3 \sim N(0, 50)$

Notes: The table presents the priors used for our structural estimations for each industry. The results are presented in Tables 8-12. We generally choose diffuse priors to allow the data to speak for itself. Variance parameters have log normal distributions to impose nonnegativity. The root of each $AR(1)$ process is bounded on $(-1, 1)$ in order to ensure stationarity. An extended description of how we chose these distributions is found in Section 4.2.

Table 8: Sunk Cost Parameter Estimates

	Panel	
Parameters for Each Industry	1987-1997	1992-2003
Preserved Fruits & Vegetables (203)		
γ_{s1} (sunk cost, small plants)	3.43 (0.35)	2.30 (0.21)
γ_{s2} (sunk cost, large plants)	3.27 (0.33)	2.05 (0.22)
Aircraft & Parts (372)		
γ_{s1} (sunk cost, small plants)	2.10 (0.43)	2.22 (0.49)
γ_{s2} (sunk cost, large plants)	2.16 (0.45)	1.99 (0.45)
Measuring & Controlling Devices (382)		
γ_{s1} (sunk cost, small plants)	2.84 (0.38)	2.50 (0.54)
γ_{s2} (sunk cost, large plants)	2.54 (0.41)	2.63 (0.64)

Notes: The table presents the sunk cost estimates γ_s for each industry over the time periods 1987-1997 and 1992-2003. Means are presented along with standard deviations in parentheses. Median estimates give similar results. We interpret these results as evidence against the argument that declines in the costs to entering foreign markets have played a significant role in export trends across manufacturing as a whole. Full results for each industry are found in Tables 9-11.

Table 9: SIC 203 Posterior Parameter Distributions (Means & Std Deviations)

Parameters	Preserved Fruits & Vegs. (203) 1987-1997	1992-2003
	Profits	
ψ_{01} (intercept)	-2.06 (0.23)	-2.06 (0.27)
ψ_{02} (dom. size dummy)	1.05 (0.30)	1.12 (0.35)
ψ_1 (exchange rate)	0.37 (1.50)	-0.31 (0.75)
λ_x^1 (root, first AR)	0.13 (0.03)	0.43 (0.05)
λ_x^2 (root, second AR)	0.71 (0.02)	0.90 (0.03)
$\sigma_{\omega 1}^2$ (variance, first AR)	0.04 (0.01)	0.53 (0.09)
$\sigma_{\omega 2}^2$ (variance, second AR)	1.36 (0.07)	0.43 (0.09)
υ (foreign elas. premium)	0.03 (0.04)	0.00 (0.04)
λ_ξ (root, measurement error)	0.88 (0.01)	0.84 (0.02)
σ_ξ (std. error, measurement error)	0.22 (0.03)	0.21 (0.02)
	Elasticities of Demand	
η_μ (demand elas., μ across plants)	13.39 (7.31)	12.68 (6.14)
η_σ (demand elas., σ across plants)	11.74 (6.89)	11.78 (6.29)
	Exporting Decision	
γ_{s1} (sunk cost, small plants)	3.43 (0.35)	2.30 (0.21)
γ_{s2} (sunk cost, large plants)	3.27 (0.33)	2.05 (0.22)
κ (mean, ε_1 & ε_2)	0.16 (0.03)	0.09 (0.02)
$\sigma_{\varepsilon 1}$ (std. error, ε_1)	1.72 (0.68)	1.42 (0.22)
$\sigma_{\varepsilon 2}$ (std. error, ε_2)	1.31 (0.54)	0.66 (0.09)
	Initial Conditions	
α_0 (intercept)	11.16 (10.21)	7.27 (6.87)
α_1 (dom. size dummy)	28.87 (18.26)	24.06 (16.18)
α_2 (x_1)	46.34 (26.12)	19.36 (66.10)
α_3 (x_2)	-71.33 (31.19)	32.73 (57.31)
Observations	$N = 112, T = 11$	$N = 101, T = 12$

Notes: The table presents the results from estimating the structural model presented in Section 4 for the Preserved Fruits and Vegetables industry (SIC 203) over the time periods 1987-1997 and 1992-2003. We find that the average level of sunk costs associated with entering foreign markets facing this industry γ_s declined somewhat over the period from $\sim$ \$3.3 million to $\sim$ \$2.2 million. Mean estimates of foreign demand elasticities are consistent with the findings in the literature.

Table 10: SIC 372 Posterior Parameter Distributions (Means & Std Deviations)

	Aircraft & Parts (372)	
Parameters	1987-1997	1992-2003
	Profits	
ψ_{01} (intercept)	-0.45 (0.30)	-0.33 (0.35)
ψ_{02} (dom. size dummy)	2.52 (0.43)	2.54 (0.43)
ψ_1 (exchange rate)	-0.06 (1.00)	0.31 (0.49)
λ_x^1 (root, first AR)	0.22 (0.09)	0.40 (0.08)
λ_x^2 (root, second AR)	0.97 (0.01)	0.97 (0.01)
$\sigma^2_{\omega 1}$ (variance, first AR)	0.57 (0.08)	0.41 (0.05)
$\sigma^2_{\omega 2}$ (variance, second AR)	0.16 (0.06)	0.19 (0.04)
υ (foreign elas. premium)	1.82 (0.13)	2.40 (0.39)
λ_ξ (root, measurement error)	0.98 (0.00)	0.98 (0.00)
σ_ξ (std. error, measurement error)	1.14 (0.12)	1.38 (0.26)
	Elasticities of Demand	
η_μ (demand elas., μ across plants)	12.40 (5.44)	12.13 (4.42)
η_σ (demand elas., σ across plants)	12.39 (6.10)	12.25 (5.09)
	Exporting Decision	
γ_{s1} (sunk cost, small plants)	2.10 (0.43)	2.22 (0.49)
γ_{s2} (sunk cost, large plants)	2.16 (0.45)	1.99 (0.45)
κ (mean, ε_1 & ε_2)	0.23 (0.05)	0.18 (0.05)
$\sigma_{\varepsilon 1}$ (std. error, ε_1)	0.83 (0.36)	0.90 (0.25)
$\sigma_{\varepsilon 2}$ (std. error, ε_2)	1.05 (0.29)	0.86 (0.16)
	Initial Conditions	
α_0 (intercept)	50.36 (22.80)	27.68 (16.76)
α_1 (dom. size dummy)	8.85 (18.06)	23.72 (19.60)
α_2 (x_1)	-9.95 (19.15)	-64.19 (26.86)
α_3 (x_2)	-47.56 (57.80)	53.59 (25.83)
Observations	$N = 924, T = 11$	$N = 948, T = 12$

Notes: The table presents the results from estimating the structural model presented in Section 4 for the Aircraft and Parts industry (SIC 372) over the time periods 1987-1997 and 1992-2003. We find that the average level of sunk costs associated with entering foreign markets facing this industry γ_s were relatively stable over time. Mean estimates of foreign demand elasticities are consistent with the findings in the literature.

Table 11: SIC 382 Posterior Parameter Distributions (Means & Std Deviations)

Parameters	Measuring & Controlling Devices (382) 1987-1997	1992-2003
	Profits	
ψ_{01} (intercept)	-0.16 (0.17)	-0.06 (0.17)
ψ_{02} (dom. size dummy)	0.83 (0.24)	1.47 (0.25)
ψ_1 (exchange rate)	-0.83 (0.62)	0.55 (0.45)
λ_x^1 (root, first AR)	0.16 (0.17)	0.61 (0.07)
λ_x^2 (root, second AR)	0.91 (0.03)	0.82 (0.08)
$\sigma_{\omega 1}^2$ (variance, first AR)	0.19 (0.06)	0.31 (0.06)
$\sigma_{\omega 2}^2$ (variance, second AR)	0.16 (0.05)	0.10 (0.06)
υ (foreign elas. premium)	1.36 (0.07)	2.10 (0.13)
λ_ξ (root, measurement error)	0.98 (0.00)	0.98 (0.00)
σ_ξ (std. error, measurement error)	0.84 (0.09)	1.11 (0.18)
	Elasticities of Demand	
η_μ (demand elas., μ across plants)	11.46 (6.68)	10.90 (6.68)
η_σ (demand elas., σ across plants)	8.01 (5.03)	5.88 (3.84)
	Exporting Decision	
γ_{s1} (sunk cost, small plants)	2.84 (0.38)	2.50 (0.54)
γ_{s2} (sunk cost, large plants)	2.54 (0.41)	2.63 (0.64)
κ (mean, ε_1 & ε_2)	0.85 (0.33)	1.43 (0.62)
$\sigma_{\varepsilon 1}$ (std. error, ε_1)	1.48 (0.29)	1.14 (0.51)
$\sigma_{\varepsilon 2}$ (std. error, ε_2)	2.09 (0.81)	4.44 (1.49)
	Initial Conditions	
α_0 (intercept)	40.80 (17.89)	51.39 (21.09)
α_1 (dom. size dummy)	28.84 (25.01)	-5.80 (18.55)
α_2 (x_1)	46.72 (24.20)	0.42 (29.67)
α_3 (x_2)	49.97 (40.25)	64.65 (32.81)
Observations	$N = 1056, T = 11$	$N = 828, T = 12$

Notes: The table presents the results from estimating the structural model presented in Section 4 for the Measuring and Controlling Devices industry (SIC 382) over the time periods 1987-1997 and 1992-2003. We find that the average level of sunk costs associated with entering foreign markets facing this industry γ_s were relatively stable over time. Mean estimates of foreign demand elasticities are consistent with the findings in the literature.

Table 12: Four Digit Subindustries For Structural Estimations

3 Digit SIC Industry	4 Digit SIC Subindustry
Preserved Fruits and Vegetables (203)	Canned specialties (2032)
	Canned fruits and vegetables (2033)
	Dehydrated fruits, vegetables, and soups (2034)
	Pickles, sauces, and salad dressings (2035)
	Frozen fruits and vegetables (2037)
	Frozen specialties, n.e.c. (2038)
Aircraft and Parts (372)	Aircraft (3721)
	Aircraft Engines and Engine Parts (3724)
	Aircraft Parts and Equipment, N.E.C. (3728)
Measuring and Controlling Devices (382)	Laboratory Apparatus and Furniture (3821)
	Environmental Controls (3822)
	Process Control Instruments (3823)
	Fluid Meters and Counting Devices (3824)
	Instruments to Measure Electricity (3825)
	Analytical Instruments (3826)
	Optical Instruments and Lenses (3827)
	Measuring and Controlling Devices, N.E.C. (3829)

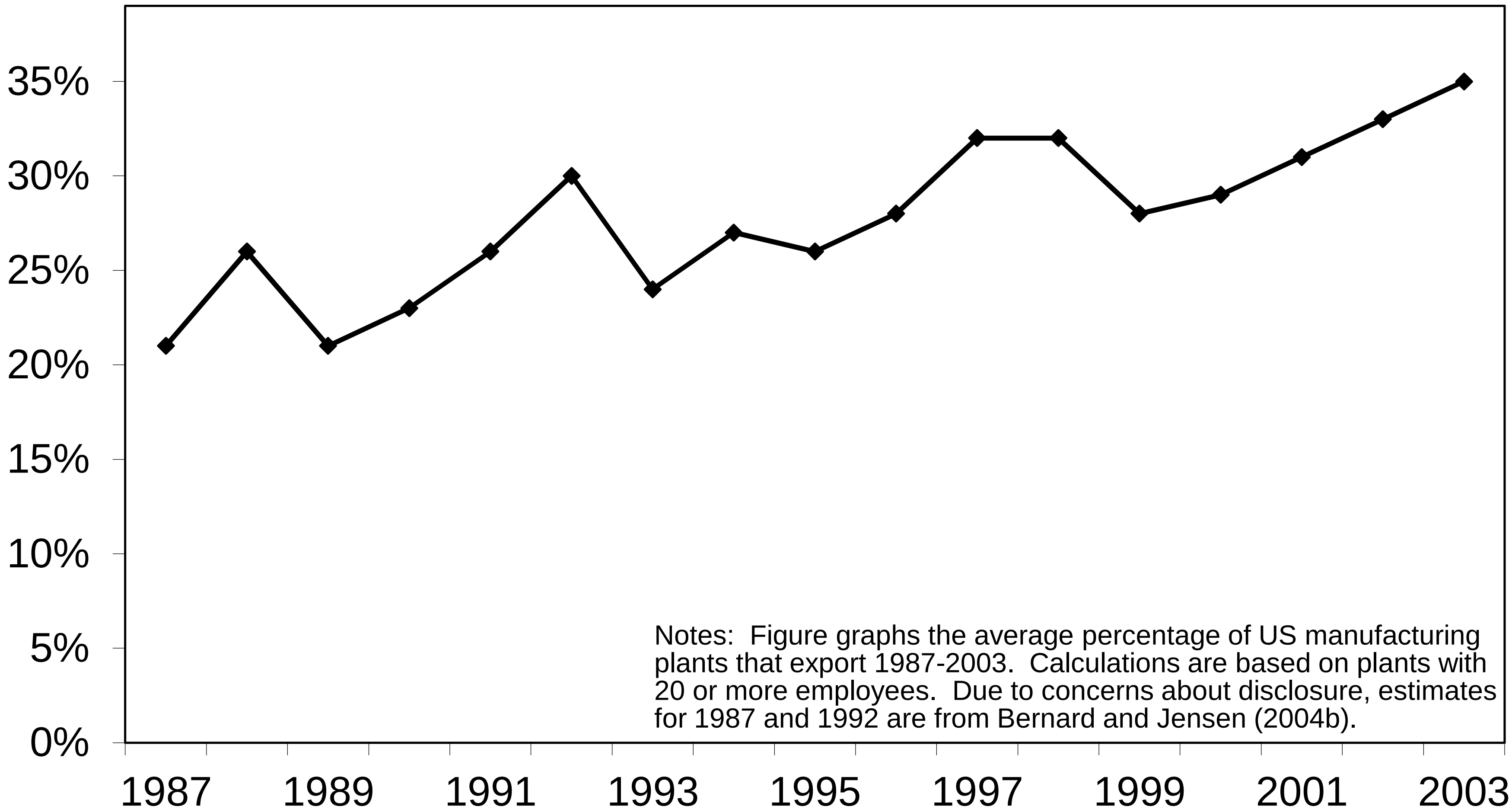
Notes: The table lists the 4 digit 1987 SIC industries that compose the 3 digit 1987 SIC industries that we consider for our structural analyses.

Table 13: Evolution of Nontariff Barriers

	Tariff Lines Affected (%)	
Category	1994	2004
Price Control Measures (antidumping, min import prices)	7	2
Finance Measures (foreign exchange regs)	2	2
Automatic Licensing Measures (prior surveillance)	3	2
Quantity Control Measures (quotas, seasonal prohibition)	49	35
Monopolistic Measures (sole importing agency)	1	2
Technical Measures (requirements for testing, disclosing information, packaging, certain product characteristics)	32	59
Number of Countries	52	97
Number of Tariff Lines	97706	545078

Notes: The figures in the table report the percentage of types of goods (tariff lines) that are affected by each nontariff barrier to trade. They are cited from United Nations Conference on Trade and Development (2005) and support the report's contention that the technical barriers to trade have increased substantially over time.

Fig. 1: Percentage of US Manufacturing Plants That Export



Notes: Figure graphs the average percentage of US manufacturing plants that export 1987-2003. Calculations are based on plants with 20 or more employees. Due to concerns about disclosure, estimates for 1987 and 1992 are from Bernard and Jensen (2004b).

Fig. 2: Industry Decomposition

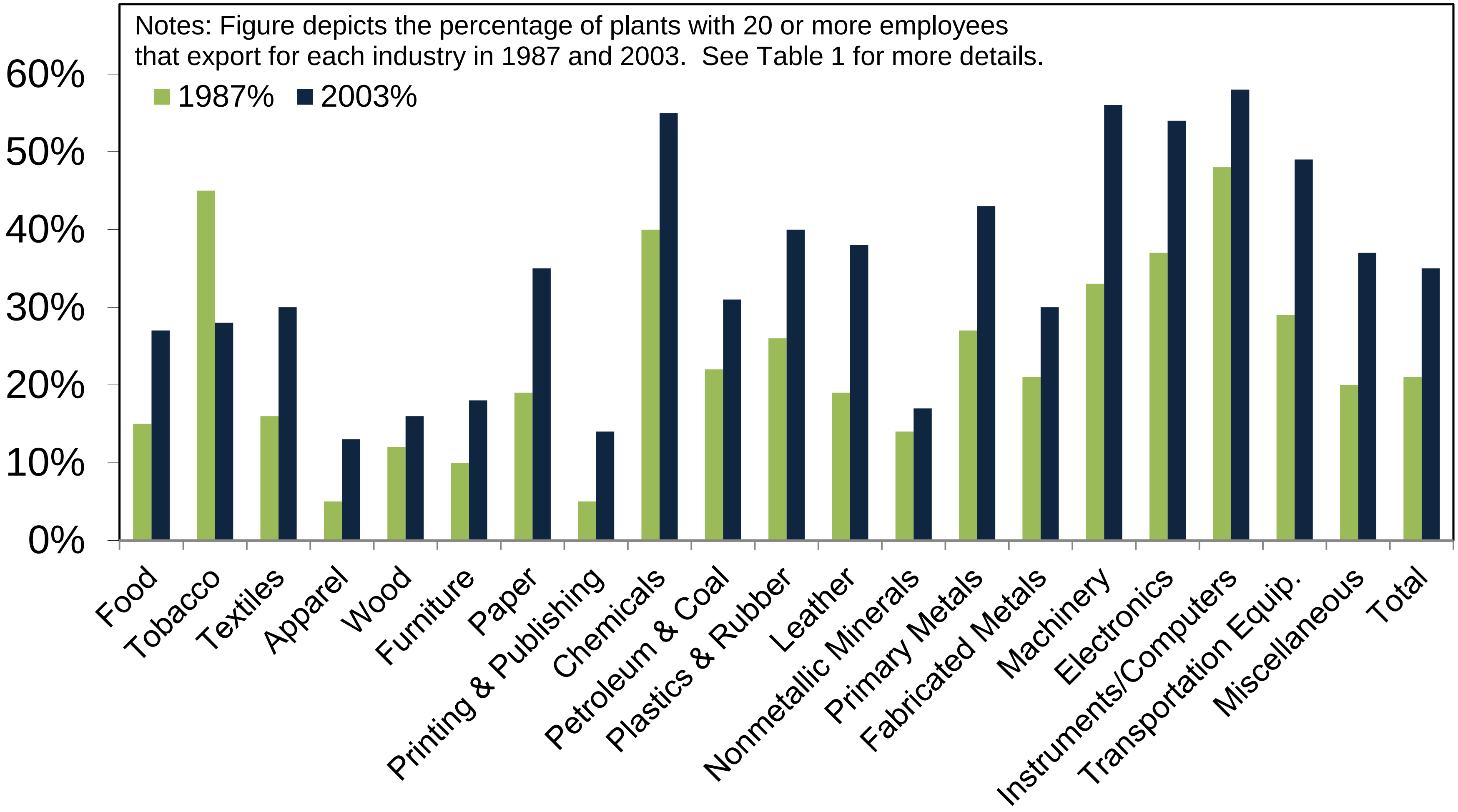


Fig. 3: Geographical Decomposition

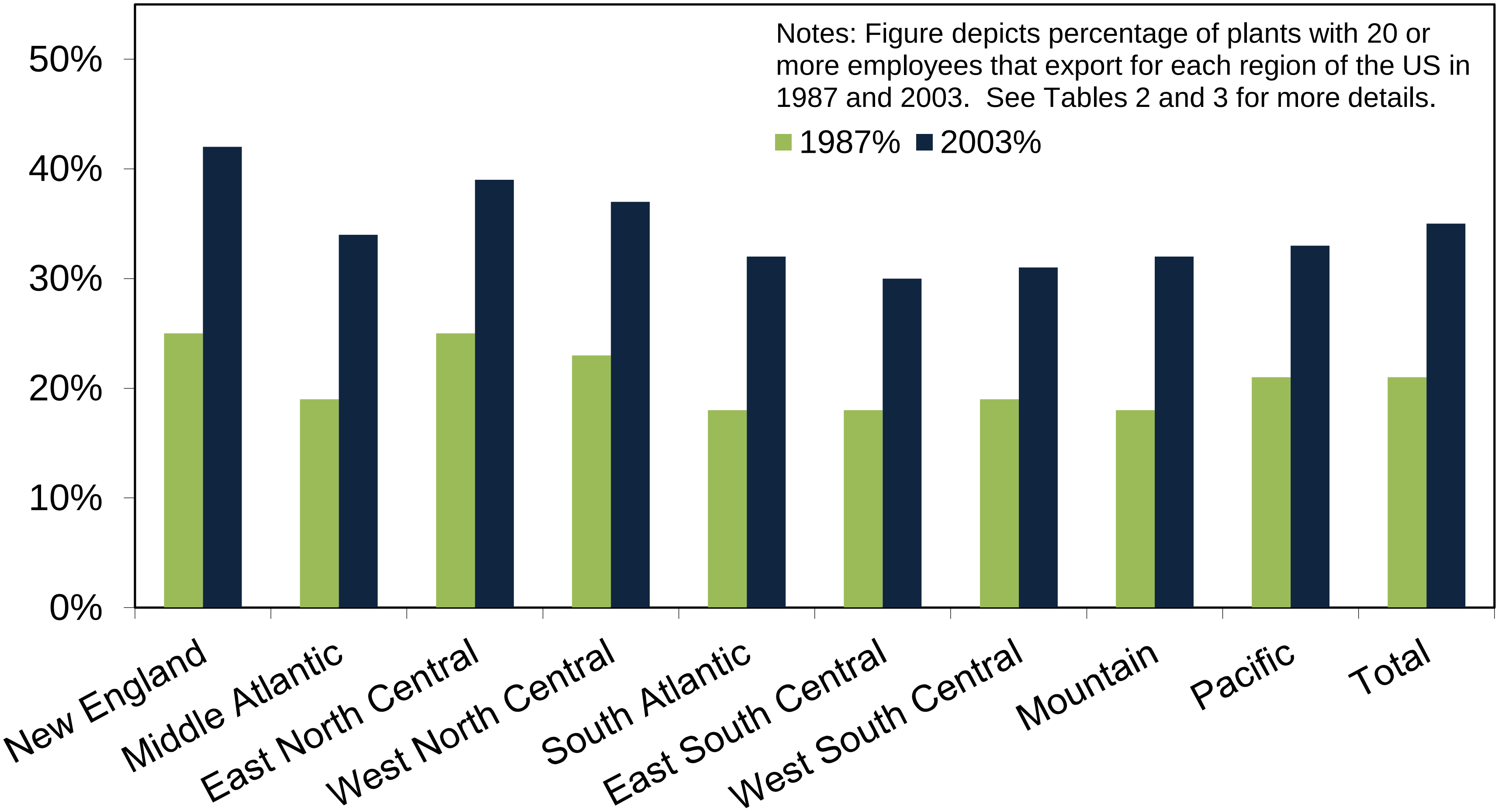


Fig. 4: Average Foreign Sales Per Exporter

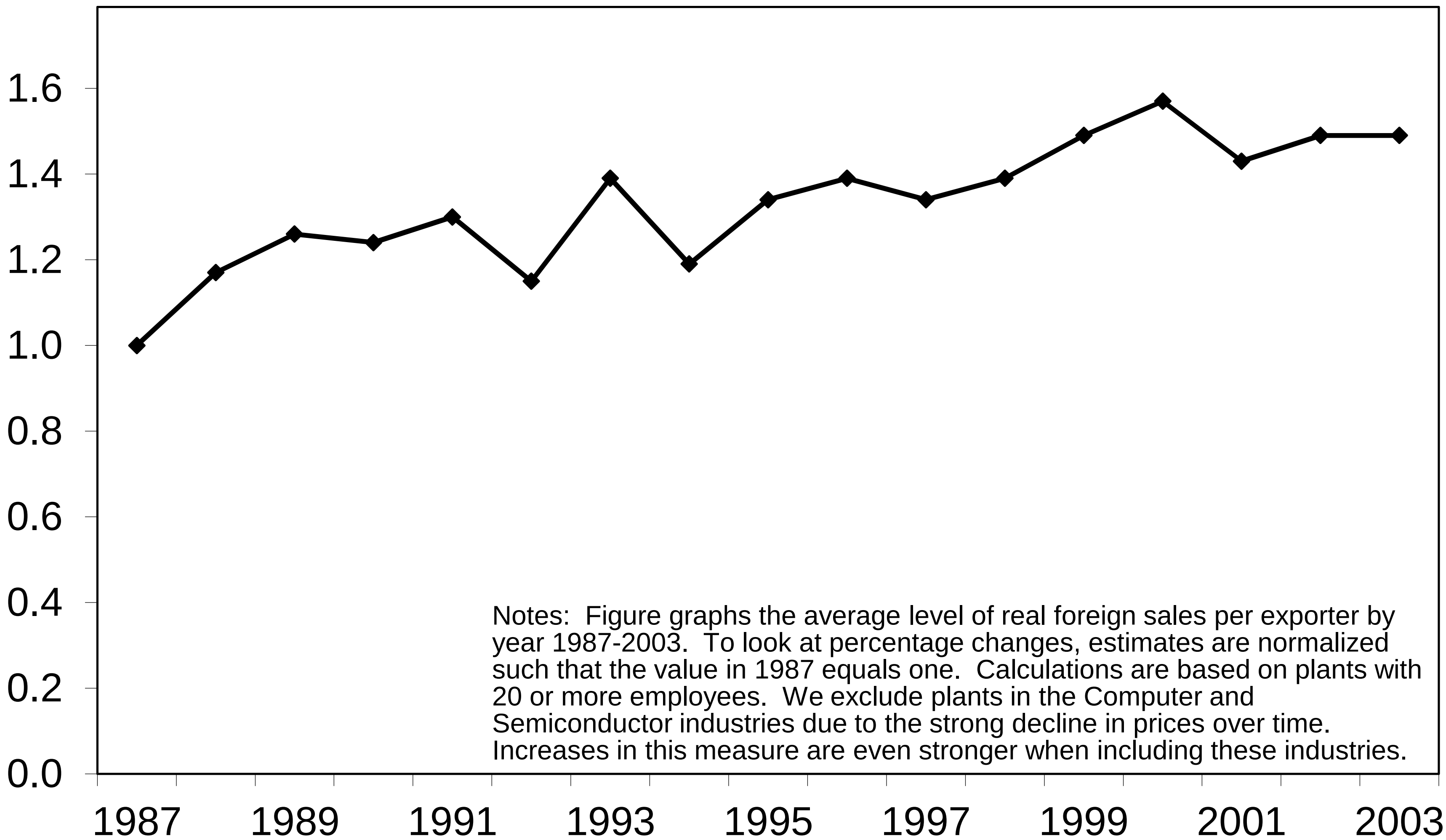
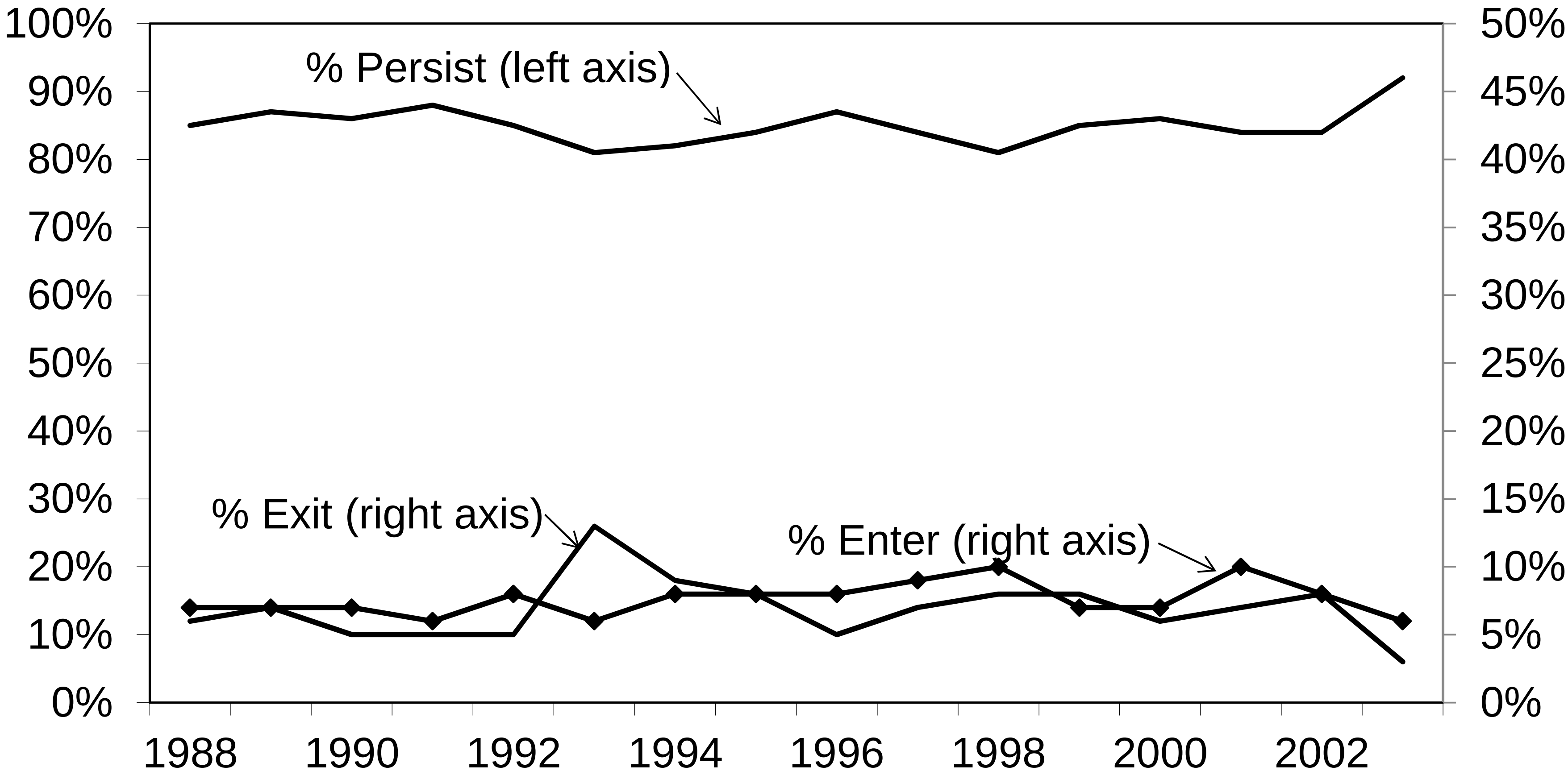


Fig. 5: Export Persistence, Entries, and Exits



Notes: Figure depicts the annual percent of plants that enter foreign markets, exit, or keep the same export status (domestic or exporter). In each year, the sample is confined to plants that existed in the prior year, such that % Entries + % Exits + % Persist = 100%. Due to changes across ASM sampling frames these figures are limited to plants with 250 or more employees. The exit and entry values for 1988-1992 are from Bernard and Jensen (1999) Table 7 due to disclosure concerns.