NBER WORKING PAPER SERIES

WHY SOME FIRMS EXPORT

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Working Paper 8349
http://www.nber.org/papers/w8349

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 2001

We thank Gordon Hanson, Whitney Newey, Steve Pischke and participants in several seminars for helpful comments. We also thank Mark Roberts and Jim Tybout for sharing their Gauss programs. The research in this paper was conducted at the Center for Economic Studies. Research results and conclusions expressed are those of the authors and do not necessarily indicate concurrence by the Bureau of the Census. The paper has not undergone the review the Census Bureau gives its official publications. It has been screened to insure that no confidential data are revealed. The views expressed herein are those of the authors and not necessarily those of the National Bureau of Economic Research.

Why Some Firms Export
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NBER Working Paper No. 8349
July 2001
JEL No. F20, D21, L60

ABSTRACT

This paper presents a dynamic model of the export decision by a profit-maximizing firm. Using a panel of U.S. manufacturing plants, we test for the role of plant characteristics, spillovers from neighboring exporters, entry costs and government export promotion expenditures. Entry and exit in the export market by U.S. plants is substantial, past exporters are apt to reenter, and plants are likely to export in consecutive years. However, we find that entry costs are significant and spillovers from the export activity of other plants negligible. State export promotion expenditures have no significant effect on the probability of exporting. Plant characteristics, especially those indicative of past success, strongly increase the probability of exporting as do favorable exchange rate shocks.

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1 Introduction

Politicians are convinced that helping exporters is a no-lose issue. The argument in its most elemental form goes as follows: exports are good and exporters are good firms, thus helping domestic firms export is good policy. The desire to promote exports is not limited to officials at the national level. All 50 U.S. states have offices to assist firms in selling goods and services abroad and the resources devoted to export promotion by states rose from $21 million to $96 million from 1984 to 1992 (NASDA, 1993). There has been a concurrent boom in export activity. Merchandise exports grew three times faster than overall manufacturing during the same period. In this paper, we provide empirical evidence on the export decision by U.S. manufacturing firms. In a dynamic framework, we consider the impact of individual plant attributes, barriers to entry, exchange rates, spillovers, and export promotion during a period of extraordinary export growth. In doing so we propose a simple estimation strategy to identify the role of sunk costs and unobserved plant heterogeneity.

We model the decision of the firm to export and test several hypotheses about the factors that increase the propensity for exporting. Starting with the characteristics of the firm itself, we ask whether size, labor force composition, product mix, and past performance are important for entry in foreign markets. Next, we directly address several ongoing debates in the trade literature about factors that might matter in the export decision. A set of theoretical models by Dixit (1989a,b), Krugman (1989) and others suggest that hysteresis in exports may be due to the sunk costs in entering the export market at the firm level. We test for the possible presence of entry costs by looking at the effects of exporting yesterday on exporting today. In addition we construct industry exchange rates and estimate the participation response to favorable price movements. The literature on economic geography and trade (Krugman 1992) hypothesizes that activities of neighboring firms may reduce entry costs. We estimate the impact of spillovers from the activities of other firms in the same industry or region. Finally, we consider direct evidence on the efficacy of government intervention with data on state expenditures for export promotion.

Two recent papers on firms in developing countries, Roberts and Tybout (1997) and Aitken, Hanson, and Harrison (1997) examine factors influencing the export decision. Roberts and Tybout (1997) develop a dynamic model of the export decision by a profit-maximizing firm and test for the presence and magnitude of sunk costs using a sample of Colombian plants. They find that sunk costs are large and are a significant source of export persistence. They also find that unobserved heterogeneity across plants plays a significant role in the probability that a firm exports. In a static framework, Aitken, Hanson, and Harrison (1997) examine the role of geographic and sectoral spillovers on exporting by plants in Mexico. They find that the presence of multinational exporters in the same industry and state increases the probability of exporting by Mexican firms.

The recent work on the export behavior of firms has emphasized the heterogeneity of firm characteristics.[1] Comparing plants at a point in time, Bernard and Jensen (1995, 1997) document large, significant differences between exporters and non-exporters among U.S. manufacturing plants. Exporters have more workers, proportionally more white collar workers, higher wages, higher productivity, greater capital intensity, higher technology intensity, and are more likely to be part of a multi-plant firm. However, these substantial cross-section differences between exporters and non-exporters cannot tell us about the direction of causality, i.e., do good firms become exporters or do exporters become good firms. Roberts and Tybout (1997) include some plant characteristics in their work and find that plant size, plant age, and the structure of ownership are positively related to the propensity to export. Aitken, Hanson, and Harrison (1997) report evidence that plant size, wages, and especially foreign ownership are positively related to the decision to export.

We employ a rich set of plant variables including indicators of past success, labor quality, ownership structure, and product introductions to shed light on the role of plant characteristics in the export decision. We find that these plant attributes can explain a large fraction of the probability that a plant exports and, perhaps not surprisingly, past success is the best plant level indicator of future exporting.

Our estimates of entry costs are significant for U.S. plants. Exporting today increases the probability of exporting tomorrow by 36%.We also find that plant heterogeneity is substantial and important in the export decision; only a subset of plants have the necessary characteristics to be exporters. Favorable exchange rate shocks do increase participation in exporting but we find no role for geographic or industry spillovers, and no effect of state export promotion on exporting.

We begin by developing a simple model of the decision to enter the export market by the firm considering the role of entry costs and other forms

[1] Throughout this paper, we abuse terminology and freely interchange the terms 'firms' and 'plants', as has been the practice in the empirical literature on micro export behavior. As in other studies, due to limitations of the data, we use the plant as the unit of observation for the empirical work.

of intertemporal spillovers. Next, in section 3, we discuss the characteristics of our sample of 13,550 plants from 1984 to 1992, including differences between exporters and non-exporters and rates of transition in and out of exporting. In section 4 we present the estimation strategy and issues regarding specifications and identification. Section 5 contains the main results. In Section 6 we consider alternative estimation strategies. We conclude with implications of the results for policy and future research.

2 Modelling the Export Decision

We model the decision to export by the rational, profit-maximizing firm as analogous to the decision to market a new product. The firm considers expected profits today and in the future from the decision to enter the foreign market net of any fixed costs. We proceed in several steps, first outlining the decision of the firm in the single period case and then incorporating multiple periods and entry costs.

We assume that the firm is always able to produce at the profit-maximizing level of exports, q_{it}^*, if it enters the foreign market. In the one period case with no entry costs, the firm receives profits

$$\pi_{it}\left(X_t, Z_{it}\right) = p_t \cdot q_{it}^* - c_{it}(X_t, Z_{it}|q_{it}^*) \tag{1}$$

where p_t is the price of goods sold abroad and $c_{it}\left(\cdot\right)$ is the variable cost of producing quantity q_{it}^*. Exogenous factors affecting profitability, such as exchange rates, are denoted as X_t, while firm-specific factors are denoted by Z_{it}.[2] Firm characteristics that might increase the probability of exporting include size, labor composition, productivity, product mix, and ownership structure. Besides shocks to demand, we focus on several additional exogenous factors which might affect the probability that the firm exports, including direct or indirect subsidies to exporting establishments and spillovers from the presence of nearby exporters who reduce or raise the costs of needed inputs such as high skilled labor or specialized capital.

If expected profits are greater than zero, then the firm will export. The export status of firm i in period t is given by Y_{it}, where

$$\begin{array}{l} Y_{it} = 1 \text{ if } \pi_{it} \geq 0 \\ Y_{it} = 0 \text{ if } \pi_{it} < 0 \end{array} . \tag{2}$$

[2] Prices faced by the firm presumably depend on X_t and possibly on elements in Z_{it} as well, i.e. $p_t = p_t(X_t, Z_{it})$. To simplify notation, we write prices as p_t throughout.

2.1 Experience

Extensions of the single period model to multiple periods is fairly straightforward when there are no entry costs. The expected profits of the firm become

$$\Pi_{it}\left(X_t, Z_{it}\right) = \mathrm{E}_t\left(\sum_{s=t}^{\infty} \delta^{s-t}\left[p_s q_{is}^* - c_{is}(X_s, Z_{is}|q_{is}^*)\right]\right). \tag{3}$$

As long as the cost function does not depend on the level of output in a previous period, this version of the multi-period problem is identical to the single period model. However, if there is any effect of production today on costs tomorrow,

$$c_{it} = c_{it}(X_t, Z_{it}, q_{it-1}^*|q_{it}^*) \text{ and } \frac{\partial c_{it}\left(\cdot\right)}{\partial q_{it-1}^*} \neq 0,$$

then export status of the firm today will play a role in the decision to export tomorrow. This might occur if there is learning by doing in production of the export good. The value function for the dynamic programming problem is given by

$$V_{it}\left(\cdot\right) = \max_{\{q_{it}^*\}}\left(\pi_{it} \cdot Y_{it} + \delta \mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^*\right]\right). \tag{4}$$

and a firm will choose to export in period t, i.e. $Y_{it} = 1$, if

$$\pi_{it} + \delta \mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^* > 0\right] > \delta \mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^* = 0\right]. \tag{5}$$

2.2 Entry Costs

One focus of the existing literature on the decision to export has been on the role of sunk costs.[3] It is natural to think of costs associated with entering foreign markets that may have the character of being sunk in nature. These might include the cost of information about demand conditions abroad or costs of establishing a distribution system. We refer to these as entry costs and, for ease of exposition, we assume these costs recur in full if the firm

[3] The theoretical literature on sunk costs and exporting is developed in papers by Dixit (1989a,b), Baldwin (1988), Baldwin and Krugman (1989), and Krugman (1989). Roberts and Tybout (1997) empirically address the question of entry and exit costs in the decision to export by the profit maximizing firm. In considering sunk costs, our model follows theirs.

exits the export market for any amount of time.[4] Profits for the firm in single period maximization problem with entry costs are given by

$$\widetilde{\pi}_{it}\left(X_t, Z_{it}, q^*_{it-1}\right) = p_t q^*_{it} - c_{it}(X_t, Z_{it}, q^*_{it-1}|q^*_{it}) - N \cdot (1 - Y_{it-1}) \tag{6}$$

where N is the entry cost for the firm. The firm does not have to pay the entry cost if it exported in the previous period, i.e. if $Y_{it-1} = 1$. Firms will export if expected profits net of entry costs are positive, $Y_{it} = 1$ if $\widetilde{\pi}_{it} > 0$.

Incorporating entry costs in a dynamic framework provides an extra mechanism for today's export decision by the firm to influence future decisions to export. This formulation of entry costs as sunk costs yields an option value to waiting and thus increases the region where the firm chooses not to act. The firm chooses a sequence of output levels, $\{q^*_{is}\}^{\infty}_{s=t}$, that maximizes current and discounted future profits,

$$\Pi_{it} = \mathrm{E}_t \left(\sum_{s=t}^{\infty} \delta^{s-t} \left[\widetilde{\pi}_{is} \cdot Y_{is}\right] \right), \tag{7}$$

where period-by-period profits are given by equation 6 and, as usual, are constrained to be non-negative since the firm always has the option not to export. This is equivalent to the firm choosing whether to export in each period since we allow the firm to always pick the within period profit maximizing quantity. The value function is the same as before with the addition of potential entry costs in the within period profits,

$$V_{it}\left(\cdot\right) = \max_{\{q^*_{it}\}} \left(\widetilde{\pi}_{it} \cdot \left[q^*_{it} > 0\right] + \delta \mathrm{E}_t \left[V_{it+1}\left(\cdot\right) \mid q^*_{it}\right]\right). \tag{8}$$

A firm will choose to export in period t, i.e. $q^*_{it} > 0$, if

$$\begin{aligned} p_t q^*_{it} + \delta \left(\mathrm{E}_t \left[V_{it+1}\left(\cdot\right) \mid q^*_{it} > 0\right] - \mathrm{E}_t \left[V_{it+1}\left(\cdot\right) \mid q^*_{it} = 0\right]\right) \\ > c_{it} + N_{it} \cdot \left(1 - Y_{it-1}\right). \end{aligned} \tag{9}$$

The difference in the multi-period models with and without entry costs comes through the added intertemporal link between exporting today and exporting tomorrow embodied in the cost of entry. However, without a structural model of the production function, and cost function, we will be

[4] It is possible that there may be costs associated with exiting the export market, akin to one time charges for closing a plant, however they will not change the structure of the model or the estimation equation. In our empirical work, we test whether these entry costs recur fully after one period or whether there is some persistent benefit from having exported more than one year in the past.

unable to identify intertemporal spillovers due to learning and those due to sunk costs.

While we choose to think about the export decision as the introduction of a new good, one might imagine that firms choose total production quantities regardless of the intended destination. Only after production do firms then decide which market, domestic or foreign, will yield the highest profits. This plausible alternative approach to exporting yields almost identical implications for the value function given above and for our estimation strategy with the notable exception that sunk costs should be negligible.

Our empirical work starts from the specification in equation 9. Rather than parameterize the cost function, we choose to employ a non-structural model in testing hypotheses about the role of firm characteristics, externalities, entry costs, and government expenditures in the decision to export by the firm. Before outlining the estimation strategy, we discuss our panel of plants and their characteristics.

3 Exporting and Plant Characteristics

To develop an understanding of why particular firms export, we assemble a sample of continuously operating plants from 1984 to 1992. We use all such plants in the Annual Survey of Manufactures (ASM) from the Longitudinal Research Database of the Bureau of the Census. The choice of a continuous panel is motivated by two issues. To include observations on as many years as possible, we were obliged to look at plants in the ASM. Certain plants, primarily larger establishments, are sampled with certainty in each ASM, other plants are included as non-certainty cases in a particular 5 year wave. These non-certainty cases are automatically dropped in the subsequent 5 year wave. Given our need to estimate a dynamic specification with lagged endogenous variables, we chose to assemble as long a panel as possible.[5]

As a result of these criteria, the resulting sample of 13,550 plants is not representative of the far larger population of 197,000+ manufacturing establishments in the Census of Manufactures (see Table 1).[6] Plants in our sample are substantially larger and far more likely to be exporters than

[5] We also dropped any plant that failed during the sample period. Including such plants would necessitate modelling the probability of death, seriously complicating the empirical work. This assumption is not innocuous, however, as exporting plants fail less frequently than non-exporters.

[6] The total population of manufacturing establishments is 300,000+ of which 197,000+ are surveyed directly in the Census of Manufactures. See U.S. Bureau of the Census (1987) for details.

manufacturers generally. As a result, the plants we observe are among the most important in manufacturing, accounting for 41% of total employment, 52% of total output, and 70% of total exports in 1987. These features mean that we are not necessarily estimating the 'true' probability of exporting. In particular, we have little to say about the behavior of small plants. However, we do capture the preponderance of the export activity in the U.S. economy, suggesting that implications for policy from the sample should be robust.

Table 2 shows the export characteristics of the sample for 1984 and 1992. The export boom of the late 1980s and early 1990s shows up clearly in the sample. Exporters went from 48% of the plants in 1984 to more than 54% in 1992. At the same time, the real value of exports at the average plant rose from $10.3 million to $17.0 million. This rapid rise meant that the share of shipments exported was climbing from 8.5% to 11.4% even as the number of exporters increased.

Table 3 reports means of plant characteristics for exporters and non-exporters in 1984 and 1992 for the sample. In addition, columns 3 and 6 present percentage differences between exporters and non-exporters after controlling for 4-digit (SIC - standard industrial classification) industry and state. In both periods, there are substantial differences between the two types of plants. Exporters are substantially larger, pay higher wages, have higher productivity, and are more likely to belong to a multi-plant firm. Controlling for industry and state in 1984, we find that exporters are substantially larger (37%-44%), pay higher wages to all types of workers (3.0%-10.9%), and are more productive (6.7%-10.5%).

The picture remains largely unchanged in 1992: exporters are still substantially larger, pay higher wages, and are more productive than non-exporters in the same state and industry. While the size difference between exporters and non-exporters shrank slightly, the wage and productivity differentials are essentially unchanged or slightly greater in the latter period. While exporting has become more commonplace in recent years, there still remain substantial differences between exporters and non-exporters.

3.1 Transitions In and Out of Exporting

The preceding results show clearly that exporters differ substantially from non-exporters, even within the same industry. To understand the magnitude of the flows in and out of exporting, we look at the transition rates in our sample of plants.

In Figure 1, we show the numbers of exporters and non-exporters in our sample as well as the fraction of each group that switched status from year to year. The export boom of the early 1990s is evident. Exporters accounted for just under half of the plants in 1984 but by 1992 there had been a net gain of 344 plants, raising the share of exporters to 54%.

Exporting is not a once and forever phenomenon. Year-to-year transition rates are large. On average over the period, 13.9% of non-exporters begin to export in any given year while 12.6% of exporters stop. Even in the later part of the sample, during the export boom, exits averaged over 10% per year and entries more than 14% per year. The rise in exporting comes more from a decline in exits than a rise in entrants. This substantial degree of mixing in the export market bodes well for testing our hypotheses, as we have numerous observations both for exits and entries.[7]

While substantial numbers of plants enter and exit the export market each year and exporting became more prevalent during the period, there is still a large degree of persistence in the export status of an individual plant. Columns 1 and 2 of Table 4 report the fraction of exporters and non-exporters in 1984 who were also exporters in one of the subsequent eight years.[8] Among plants that exported in 1984, 80.3% were exporting four years later and 78.6% were exporting in 1992. Non-exporters show similar persistence, 78.2% remained non-exporters in 1988 and 70.4% were non-exporters in 1992.

Columns 3 and 4 of Table 4 report the predicted rates of persistence if exits and entrants were chosen randomly using the calculated annual transition rates. At all horizons, the predicted persistence is substantially lower than that observed in the sample. From this we conclude that there is a substantial amount of reentry by former exporters, i.e., they have higher probabilities of exporting after having exited the export market. Similarly, former non-exporters have a higher propensity to stop exporting.

We would like to know whether this persistence in exporting results from attributes of the plants themselves, i.e., certain plants are more export-oriented, or from sunk costs, i.e., exporting begets more exporting.[9] To provide some evidence on the relative importance of the two effects we look

[7] Roberts and Tybout (1997) report average entry and exit rates of 2.7% and 11.0% per year respectively for Columbian plants and fully 86% of the plants in their sample never change export status. In their sample of 2113 Mexican plants, Aitken, Hanson, and Harrison (1997) find only 245 plants changed export status from 1986-1989. During that same period 39.4% of the plants in our sample switched status.

[8] These percentages treat plants that exit and reenter the same as plants that export continuously. For example, the exporter percentage for 1986 includes plants that exported in 1984, 1985, and 1986 as well as those that exported just in 1984 and 1986.

[9] This is the fundamental problem we will face in the estimation of the decision to export, i.e. the identification of unobserved plant heterogeneity and sunk costs.

at the distribution of exporting sequences in the data. We make the assumption that plant heterogeneity affects the fraction of time that a plant is an exporter, but not the probability of exporting in consecutive periods. We then calculate the probability a plant follows a given sequence of exporting and non-exporting conditional on the fraction of the time the plant is an exporter. If plant effects are important, we expect to see concentrations of plants both exporting in most years and not exporting in most years. If sunk costs are important, we expect to observe runs of exporting and non-exporting rather than random switching.

Table 5 reports the distribution of plants across all the 128 possible sequences of exporting and non-exporting for the seven years from 1986-1992. Clearly, a large fraction of plants exports in all seven years, 28.2%, and an equally large fraction, 29.0%, never exports.[10] In addition, plants are more likely to export once (7.5%) or for six years (11.4%) than for three (5.0%) or four (5.9%). We also observe that runs of exporting and non-exporting are common events. Figure 2 reports the probability that a plant follows a given sequence conditional on the fact that it exported in 3 of 7 years. Sequences with runs, such as 1110000 and 0000111, are more prevalent than those without runs, 0010101 and 0101010.

To get some perspective on the heterogeneity of entry and exit across industries, we report the average annual entry and exit rates by two digit industry in Figure 3. Printing (SIC 27) and petroleum (SIC 29) and apparel (SIC 23) show lower entry and exit rates than the average, however most industries are similar to the overall pattern of switching.

Taken together the preceding results suggest that both unobserved plant heterogeneity and sunk costs are likely to be important in the decision to export. We turn now to the estimation of the model in section 2 considering the role of plant characteristics, sunk costs, spillovers and government export promotion.

4 Empirical Methodology

From the multi-period model with entry costs given in section 2, we find that a firm exports if current and expected revenues are greater than costs,

$$Y_{it} = \begin{cases} 1 & \text{if } \widehat{\pi}_{it} > c_{it} + N \cdot (1 - Y_{it-1}) \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

[10] Alternatively, depending on one's priors, one could conclude that a surprisingly large fraction of the plants switches in and out of exporting.

where

$$\widehat{\pi}_{it} \equiv p_t q_{it}^* + \delta \left(\mathrm{E}_t \left[V_{it+1} (\cdot) \mid q_{it}^* > 0 \right] - \mathrm{E}_t \left[V_{it+1} (\cdot) \mid q_{it}^* = 0 \right] \right). \tag{11}$$

Our goal is to identify and quantify factors that increase the probability of exporting. We estimate these effects using a binary choice non-structural approach of the form

$$Y_{it} = \begin{cases} 1 & \text{if } \beta X_{it} + \gamma Z_{it} - N \cdot (1 - Y_{it-1}) + \varepsilon_{it} > 0 \\ 0 & \text{otherwise} \end{cases}. \tag{12}$$

Plant characteristics are included in the vector Z_{it}, while other factors such as terms of trade shocks, industry demand shocks, state-industry spillovers, and government subsidies are included in X_{it}. X_{it} includes a plant subscript since we calculate some exogenous variables for individual plants.

4.1 Experience and Entry Costs

As noted previously, the most difficult, and most important, issue in the estimation of equation 12 concerns the identification of the parameter on the lagged endogenous variable. It is highly likely that there are unobserved characteristics such as product attributes or managerial ability which affect the decision to export by the firm. Since these characteristics are potentially permanent, or at least highly serially correlated, and unobserved by the econometrician, they will induce persistence in export behavior, either in or out of the market, and thus will cause us to overestimate the entry costs and experience effects discussed above.[11] In practice this means that the error term, ε_{it}, can be thought of as comprising two components, a permanent plant-specific element, κ_i, and a transitory component, η_{it}.

There are several potential estimation strategies for this dynamic binary choice framework with unobserved heterogeneity, including probit with random or fixed effects, conditional logit, and linear probability models with fixed or random effects. A starting point in choosing among the available specifications is the decision whether unobserved plant heterogeneity is better modelled as fixed or random effects. The use of random effects requires that the plant effects be uncorrelated with the regressors. Most fixed effects models, on the other hand, produce biased and inconsistent parameter estimates, especially for the coefficient on the lagged dependent variable.

[11] See Heckman (1981) for an analysis of the theoretical issues and Roberts and Tybout (1997) for a discussion in the exporting context.

The required assumption for random effects is quite likely violated in our export decision model as plant characteristics such as size, wage levels, and ownership characteristics are apt to be correlated with product attributes, managerial ability, technology and other unobserved plant effects. As a result, unlike previous studies, we choose to work with a linear probability framework,

$$Y_{it} = \beta X_{it-1} + \gamma Z_{it-1} + \theta Y_{it-1} + \varepsilon_{it}, \tag{13}$$

for its computational simplicity and because it allows us to model the unobserved plant effects as fixed. In section 6, we compare the results from the linear probability model with those from a probit model with random effects.

We proceed in several steps. First, we estimate equation 13 in levels, ignoring any plant effects. The levels specification gives us an upper bound on the importance of sunk costs.[12] Bernard and Jensen (1995) show that plants switching export status from non-exporter to exporter, and vice versa, undergo dramatic contemporaneous changes in size, employment composition, and wages. However, the direction of the causality remains uncertain in that analysis so we lag all plant characteristics and other exogenous variables one year to avoid possible simultaneity problems.

Next, we explicitly consider the role of permanent plant effects, κ_i, as in

$$Y_{it} = \beta X_{it-1} + \gamma Z_{it-1} + \theta Y_{it-1} + \kappa_i + \eta_{it}. \tag{14}$$

We estimate equation 14 first in levels, i.e., fixed effects, and then in differences. The fixed effects estimates are almost surely biased downwards and inconsistent but give us a lower bound for the importance of the lagged endogenous variable. For the specification in first differences, we employ an instrumental variables estimator and use two lags of the levels of the right hand side variables as instruments, i.e. (X_{it-2}, X_{it-3}, Z_{it-2}, Z_{it-3}, Y_{it-2}, Y_{it-3}),

$$\Delta Y_{it} = \beta \Delta X_{it-1} + \gamma \Delta Z_{it-1} + \theta \Delta Y_{it-1} + \Delta \eta_{it}. \tag{15}$$

This specification avoids the serious problem of inconsistent estimates found in the fixed effects model.[13]

The structure of the error term, η_{it}, is important in the interpretation of the results. For example, if shocks are transitory, $cov(\eta_{it}, \eta_{it-1}) = 0$,

[12] The levels specification also allows us to observe the effects of time-invariant plant attributes on export probabilities. Any variables that do not change over time, such as multinational status, will be perfectly correlated with the fixed effect.

[13] See Holtz-Eakin, Newey, and Rosen (1988) and Keane and Runkle (1992).

then relatively large entry costs will lead to persistence in exporting (or non-exporting) while small entry costs will allow firms to enter and exit the market more often.[14] Persistent shocks, $\eta_{it} = \delta\eta_{it-1} + \nu_{it}$, with δ near one, can overcome the effects of large entry costs. Firms observing a positive shock today believe that their good fortune will persist and that the value of entry is large. Unmodelled persistence in the error structure would be picked up by the lagged endogenous variable and thus incorrectly interpreted as high entry costs. Our specification in first differences should help alleviate this problem as well, although we will suffer a loss in efficiency if the shocks are purely transitory.

4.2 Plant Characteristics

Drawing on the cross-sectional comparisons of exporters and non-exporters above and elsewhere, we consider several hypotheses about the role of plant characteristics in the export decision. Perhaps the most obvious plant attributes to consider are those related to past success. It would appear to be relatively uncontroversial to claim that good firms become exporters, however, a substantial fraction of export policy assumes instead that exporters become good firms. The measures of plant success we consider include size and productivity. Consistently in all samples and time periods, exporters are much larger plants. Size may proxy for several effects; larger firms by definition have been successful in the past, but size may be associated with lower average, or marginal, costs, providing a separate mechanism for size to increase the likelihood of exporting. We use productivity, measured by total factor productivity, as an additional measure of plant success.

We also consider the role of labor quality. If exported goods are of higher quality and thus have a higher value to weight ratio, then we would expect the quality of the workforce to be positively related with entrance into foreign markets. To proxy for workforce quality, we use lagged average wages and the ratio of white collar to total employees.

A sizable body of research has focused on the role of multinationals, and ownership more generally, in cross-border trade.[15] We include dummy variables for multinational status and multi-plant firms to capture these ownership effects.[16] Finally, we consider aspects of the products themselves.

[14] All discussions of large entry costs are relative to the magnitude of shocks hitting the firm.

[15] See Brainard (1997).

[16] Since these characteristics do not change over time, they will be included only in the levels estimates.

To see whether firms export after introducing new products, we include a dummy for plants that have changed products. The product change dummy equals one if the 4-digit industry code of the plant switches.

4.3 Exchange Rates

In addition to considering the role of plant characteristics, we test a number of hypotheses from the literature on exporting. Of particular interest is the participation response to favorable exchange rate shocks. Since aggregate exchange rate movements will be washed out by the inclusion of time dummies, we construct industry specific exchange rates. The exchange rate for each four digit industry is a weighted average of the real exchange rate indices for the top 25 US export destinations. The weights are the average shares of exports from that industry for that destination over the period.

The use of these industry exchange rates gives us a unique opportunity to estimate the supply response of exporters to price shocks. Of course, we will be estimating the differential response across industries and may be underestimating the response to aggregate exchange rate movements.

4.4 Spillovers

One emerging body of work focuses on the spillovers between the activities and locations of other firms and export behavior. Aitken, Hanson, and Harrison (1997) use a static model of the export decision to estimate the impact of other exporters, and in particular multinationals, in the same region and industry. They argue that externalities of this form reduce the cost of access to foreign markets. If there are significant entry costs and the proximity of exporters reduces these costs, then there will be a dynamic effect increasing the probability of exporting today and thus tomorrow. We test for spillovers using such a dynamic specification.

A separate form of externality might arise if the presence of other exporters lowers the cost of production, possibly by increasing the availability of specialized capital and labor inputs. This spillover enters directly through the cost function. We include spillover variables in our set of exogenous variables, recognizing that in a general equilibrium model such activities would be endogenously determined. We consider three separate forms of spillovers, region-specific, industry-specific and local to the industry and region. Region-specific spillovers are captured by export activity in the same state but outside the 2-digit (SIC) industry. Industry-specific spillovers occur within the same industry but outside the state of the plant, while local spillover are captured by export activity in the same industry and state as the plant.[17] To gauge the magnitude of exporting activity within each category, we use two separate measures, the number of plants that export and the quantity of exports from plants in the category.

4.5 Subsidies

The rapid growth in state government expenditures for export promotion suggests that policy-makers believe that there are substantial social benefits to assisting exporting. State export promotion has several potential benefits. By gathering information on foreign markets, states may reduce the cost of entry and thus promote export participation. This would be evident through a reduction in entry costs. Alternatively, states may provide a coordination role for potential, or current, exporters and thus decrease the costs of exporting. This might be seen through increased numbers of exporters within the state or through increased volumes by existing exporters. Of course, a positive effect of state expenditures on export participation is necessary but not sufficient to show that such outlays are beneficial.

We include state expenditures on export promotion in our set of regressors. Unfortunately, these figures are only available for alternating years in the sample so we interpolate to fill in the missing years. In addition, we recognize that public expenditures are not necessarily exogenous; increasing numbers of exporters in a state may induce state officials to commit resources to exporting.

5 Empirical Results

Our data set consists of 13550 plants yielding 94902 observations for the levels regressions and 71166 for the instrumental variables specification in first differences. The lagged export status variable is 0 if the plant did not export last year, 1 if it did. Table 6 reports results from the linear probability specifications, levels, fixed effects, and differences, for the basic model. Table 7 contains the results for the basic model with spillovers and state export promotion expenditures.

5.1 Estimates without plant effects

Column 1 of Table 6 reports the coefficients on plant characteristics, including lagged export status, on the probability of exporting from the linear

[17] The measures of local spillovers exclude the plant in question.

probability model in levels. Dummies for 4-digit industry, state, and year are included as well as the measure of industry exchange rates. Plant level variables enter significantly in the export decision and confirm the hypotheses about the role of plant characteristics. Large, productive plants have higher probabilities of exporting. The indicators of labor quality, high average wages and white collar employment share, also are significantly positively correlated with exporting. Ownership of the plant by a U.S. multinational increases the probability of exporting but being part of a multi-plant firm does not significantly increase the probability. We include a measures of product change, a dummy if the plant switched industry last year. A recent industry switch enters with a positive and significant coefficient. This provides the first evidence that new product introductions increase the probability of exporting. Our industry exchange rate measure enters with the expected negative sign, an appreciation of the domestic currency reduces the probability of exporting, although it is only significant at the 10% level.

As discussed above, if there are significant unobserved plant effects, the levels specification will yield inconsistent estimates and, in particular, will produce an upward biased coefficient on the lagged endogenous variable, and thus overestimate the role of sunk costs in exporting. We find that the coefficient on lagged export status is positive, significant, and improbably large, suggesting that exporting last year raises the probability of exporting today by 66%. Having last exported two years ago also enters with a very large, positive and significant coefficient suggesting that the sunk costs act like a slowly depreciating investment.

We now turn to the fixed effect estimates and our preferred instrumental variables specification in first differences.

5.2 Estimates with plant effects

Column 2 of Table 6 reports results from the fixed effects model in equation 14. As expected, the coefficients on lagged export status (our proxy for sunk costs) is greatly reduced to 0.203.[18] Similarly the coefficient on having last exported two years ago is much smaller, 0.027, although still significant at the 1% level. Controlling for plant fixed effects soaks up much of the effects of our plant characteristics, plant productivity and white collar worker shares are no longer significant. However, plant size and average plant wages are still strongly positively associated with the probability of exporting, even after controlling for plant fixed effects. In addition, the measure of product

[18] This reduction results from the biased estimates of the fixed effects model in relatively short panels.

change is still positive and significant and the exchange rate measure again is negative and significant.

Column 3 of Table 6 reports results from the IV differences specification in equation 15. Among the plant characteristics, plant size and average wages remain positive and significant, and the magnitudes of both coefficients rise dramatically. Other plant attributes, such as the fraction of white collar workers and productivity, are primarily level effects, as they are no longer significant in the differences specification and thus are indistinguishable from the plant fixed effect. Product changes continue to be significant determinants of exporting. Changing product categories last year increases the probability of exporting by 3.3%.

Lagged export status again enters with a positive and significant coefficient, again rejecting the hypothesis of no sunk costs.[19] Having exported last period increases the probability of exporting today by 36% while having last exported two years ago increases the probability by 10.5%. Controlling for plant effects yields a significant estimate of the combined role of entry costs and experience. This confirms the earlier descriptive results where transition rates were high but, at the same time, a large fraction of plants did not change their export status. There are strong plant-specific components to the decision to export, but transitions in and out are relatively easy for those plants with the correct set of attributes.

To provide a check on the robustness of the estimates of the sunk cost parameter we estimate the IV differences specification separately for each two digit manufacturing industry. In Figure 3 we saw that the amount of switching in and out of exporting was relatively stable across industries. In Figure 4 we show the point estimates on lagged export status for the IV difference specification by two digit industry. The estimates are quite stable across industries generally ranging from 0.25 to 0.40 with only miscellaneous manufacturing showing a dramatically higher estimate, 0.52, of the sunk costs of export entry.

5.3 Spillovers and Subsidies

We consider the role of spillovers from neighboring export activity in Table 7.[20] In defining proximity to a plant for spillovers, we consider both the role of geography and industry. As discussed above, we run two specifications,

[19] We caution that separate identification of entry costs and experience effects is not possible.

[20] To conserve space, we only report coefficients and indicate significance at the 10%, 5% and 1% levels in Table 7.

one with (log) counts of plants and the other employing the (log) quantity of exports. None of the spillover measures is positive and significantly different from zero. In several cases the spillover measure enters with a negative and significant coefficient.[21]

Table 7 also reports results with the measure of state export promotion. Contemporaneous state export promotion is slightly positive but not significant. As with spillovers, the selection of large plants may be exactly the wrong sample to observe the effects of state export promotion as most agencies explicitly target small and medium size firms.

The results presented in this section emphatically confirm the presence of entry costs in exporting. The magnitude of the sunk costs is significant and depreciates over time. Having exported last year increases the export probability by 36% while the benefit is reduced to 10.5% after two years. Plant characteristics, both observed (size, wage levels) and unobserved, play a major role in determining the export status of a plant. Exchange rate movements have the expected effect on export participation while spillovers and state government expenditures have no effect on exporting probabilities.

6 Alternative Estimation Strategies

We recognize that the linear probability specification pursued above is not the normal first choice for binary choice problems. The potential problems of such a estimation method are well known, i.e. that the predicted probabilities may lie outside of the 0-1 range. In this section, we discuss issues surrounding another estimation strategy, probit with and without random effects, focussing on the coefficients on the lagged dependent variable.[22]

The difficulties in consistently estimating a dynamic specification in panel data with persistent plant-specific errors are well known. Fixed effects estimators in models with lagged endogenous variables produce biased and inconsistent estimates. Heckman (1981) discusses the issue of state-dependence and plant effects in a binary choice model. Heckman proposes a random effects probit estimator although he notes that if the heterogeneity of the unobserved plant effects is large, the random effects probit estimate of the coefficient on the lagged dependent variable may be biased upwards. Holtz-Eakin, Newey, and Rosen (1988) discuss the problem in a vector au-

[21] In results not reported here, other measures of spillovers, such as those employed by Aitken, Hanson, and Harrison (1997), are also insignificant and usually negative.

[22] Coefficients on other variables are qualitatively similar across specifications. A full set of results for all variables is available on request.

toregressive framework with continuous dependent variables. They propose the differenced instrumental variable method that we employ in section 5.[23]

As discussed previously, there are compelling reasons to employ a fixed, rather than a random, effects specification as the fixed effects approach avoids the difficulty of correlated plant effects and regressors. If the time dimension of the panel is large enough, the bias induced by the fixed effects estimator will be small. Roberts and Tybout (1997), in their study of sunk costs in the export decision by Colombian plants, employ a version of the random effects probit estimator suggested by Heckman (1981). As in our specification, they assume the errors, ε_{it}, are comprised of a permanent plant-specific element and a purely transitory component, $\varepsilon_{it} = \kappa_i + \eta_{it}$. The permanent component, $\kappa_{i,}$ is assumed to be uncorrelated across plants, $cov(\kappa_i,\kappa_j) = 0$, and the transitory component, η_{it}, uncorrelated across time, $cov(\eta_{it,}\eta_{it-s}) = 0$.

These assumptions allow them to estimate equation 12 as a dynamic random effects probit, after assuming that the errors are normally distributed. The random effects probit suggested by Heckman (1981) uses a single parameter, $\sigma^2_{\kappa_i}$, to parameterize the distribution of the plant effect. However, this is may provide a poor fit to the underlying unobserved plant effects for the export decision problem if the distribution of plants is highly bimodal. Remember, that almost 30% of the plants in the sample never export and almost 30% continuously export. Any failure to adequately capture the distribution of plant effects will increase the coefficient on the lagged endogenous variable.[24]

To evaluate the various estimation strategies, we present some additional results for the base model concentrating on estimates of the coefficient on the lagged endogenous variable. Recall that ignoring plant effects, the estimated coefficient from the linear probability model was 0.66. Row 4 of Table 8 shows that a probit without plant effects yields an almost identical effect of

[23] Card and Sullivan (1988) first consider a conditional logit estimator to deal with individual effects but show that a sufficient statistic for the individual effect requires the full path of outcomes, both forward and backward in time. They then use a random effects estimator where the random effects are parameterized by a discrete distribution with four nodes. Such a specification may improve upon the random effects probit specification discussed below if the distribution of plant effects is indeed bimodal as discussed above.

[24] One final, and important, problem remains in that the initial period export status, Y_{i0}, is not exogenous if there are permanent plant-specific components in the error term. Instruments for these initial values

$$\widehat{Y}_{i0} = f\left(X_{i,-1}, Z_{i,-1}\right) + \xi_{i0}$$

allow the errors to be correlated with the permanent plant-specific error, $cov(\kappa_i, \xi_{i0}) = \rho_1$.

0.66.[25] In row 5, we present the estimate from the random effects probit model for the entire panel. The effect of lagged export status is virtually unchanged at 0.62.

This result is quite surprising as it suggests that unobserved plant heterogeneity has a minor role in the persistence of exporting and that there are very large sunk costs. As suggested above, the source of this unchanged estimate is probably the poor fit of the underlying plant effect distribution. As a check, we estimate the random effects probit dropping plants that are continuous exporters or continuous non-exporters.[26] The coefficient on the lagged dependent variable drops substantially from 0.62 to 0.40, close to the estimate from the linear probability specification.

7 Conclusions

In this paper, we provide empirical evidence on the export decision by U.S. firms. In a dynamic framework, we consider the impact of barriers to entry, individual plant attributes, exchange rates, spillovers, and export promotion. In doing so we propose a simple estimation strategy to identify the role of sunk costs and unobserved plant heterogeneity.

The major results are that entry costs are significant for U.S. plants and plant heterogeneity is substantial and important in the export decision. The role of plant heterogeneity is less surprising but means that only a subset of plant may have the characteristics necessary to take advantage of favorable shocks. The key unanswered question is how firms obtain the characteristics that allow them to easily enter the export market.

We also test hypotheses about spillovers and subsidies from the recent literature on trade and firms. We find no role for geographic spillovers and, similarly, no evidence for the importance of export activity by other firms in the same industry. In addition, state government export promotion has no noticeable effects on exporting in our sample. We caution that our results on spillovers and subsidies may result from our sample selection criteria which limit our analysis to large plants.

[25] The coefficients from the probit cannot be directly interpreted in terms of probabilities. We evaluate the increase in the probability of exporting from having exported last period at the mean of the regressors.

[26] This is analogous to, but not the same as, a conditional probit. See Heckman (1981).

References

[1] Aitken, Brian, Gordon Hanson, and Ann Harrison. (1997) "Spillovers, Foreign Investment, and Export Behavior." *Journal of International Economics* v43, n1-2 : 103-32

[2] Baldwin, Robert. (1988) "Hysteresis in Import Prices: The Beachhead Effect." *American Economic Review*, 78(4) pp.773-785.

[3] Baldwin, Robert and Paul Krugman. (1989) "Persistent Effects of Large Exchange Rate Shocks." *Quarterly Journal of Economics*, Vol. 104, No. 4 pp. 635-654.

[4] Bernard, Andrew B. and J. Bradford Jensen. (1995). "Exporters, Jobs, and Wages in U.S. Manufacturing, 1976-1987." *Brookings Papers on Economic Activity, Microeconomics*. Washington DC.

[5] Bernard, Andrew B. and J. Bradford Jensen. (1997). Exporters, Skill-Upgrading, and the Wage Gap. *Journal of International Economics* v47, n1: 1-25.

[6] Brainard, Lael. (1997). "An Empirical Assessment of the Proximity/Concentration Tradeoff Between Multinational Sales and Trade." *American Economic Review* v87, n4 : 520-44 .

[7] Card, David and Daniel Sullivan, (1988) "Measuring The Effect of Subsidized Training Programs on Movements In and Out of Employment." *Econometrica*, Vol. 56, No. 3, pp.497-530.

[8] Dixit, Avinash. (1989a) "Entry and Exit Decisions Under Uncertainty." *Journal of Political Economy*, Vol. 97, No. 3 pp. 620-638.

[9] Dixit, Avinash. (1989b) "Hysteresis, Import Penetration, and Exchange Rate Pass-Through." *Quarterly Journal of Economics*, Vol. 104, No. 2 pp. 205-228.

[10] Heckman, James. (1981) "The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete Time-Discrete Data Stochastic Process." in Charles Manski and Daniel McFadden (eds.), *The Structural Analysis of Discrete Data*. Cambridge: MIT Press.

[11] Holtz-Eakin, Douglas, Whitney Newey, and Harvey Rosen. (1988) "Estimating Vector Autoregressions in Panel Data." *Econometrica*, Vol. 56, No. 6, pp 1371-1395.

[12] Keane, Michael and David Runkle (1992) "On the Estimation of Panel-Data Models with Serial Correlation When Instruments Are Not Strictly Exogenous." *Journal of Business and Economic Statistics*, Vol. 10, No. 1 pp. 1-29.

[13] Krugman, Paul. (1989) *Exchange Rate Instability*. MIT Press, Cambridge MA.

[14] Krugman, Paul. (1992) *Geography and Trade*. MIT Press, Cambridge MA.

[15] National Association of State Development Agencies. (1993) *State Export Program Database 1992*. Washington D.C.

[16] Roberts, Mark and James Tybout. (1997). "An Empirical Model of Sunk Costs and the Decision to Export." *American Economic Review* v87, n4: 545-64 .

[17] U.S. Bureau of the Census. (1987). *Census of Manufactures General Summary MC87-S-1*. Department of Commerce.

Table 1: Representiveness of the Sample - 1987

	All Plants 1987		Continuing Sample 1987	
	Exporters	Non-exporters	Exporters	Non-exporters
# of Plants	28,863	169,304	6,759	6,791
% of Sample	17.0%	83.0%	49.9%	50.1%
Average Size	252	58	673	365
Exports/Shipments	9.96%	0.00%	9.4%	0.00%
% of total employment	42.8%	57.2%	26.8%	14.5%
% of total shipments	52.4%	47.6%	36.3%	16.6%
% of total exports	100.00%	0.00%	70.6%	0.00%

Table 2: The Export Boom 1984-1992[1]

(evidence from the sample)

	1984	**1992**
% Exporters	47.6%	54.04%
Total Exports[a]	$73,807	$129,322
Exports/Shipments	8.5%	11.4%
Total Shipments by Exporters[a]	$ 738,079	$ 976,511

[1] These numbers are drawn from the sample of 13,550 continuing plants. Aggregate numbers are reported in Bernard and Jensen (1995).
[a] Millions of 1987$.

Table 3: Characteristics of Exporters and Non-Exporters

1984 and 1992

	1984			1992		
	Non-exporters	Exporters	% Difference[†]	Non-exporters	Exporters	% Difference[†]
Total Employment	376	688	0.372**	344	576	0.346**
Average Wage[a]	22,325	26,074	0.099**	22,862	26,400	0.067**
Wage - Blue Collar[a]	20,424	23,390	0.109**	20,434	23,123	0.067**
Wage - White Collar[a]	32,997	33,856	0.030**	33,774	34,991	0.036**
Shipments[b]	55,235	114,287	0.439**	61,975	126,903	0.416**
Shipments/ employee[c]	198,973	180,562	0.067**	230,929	221,506	0.070**
Value-added/ employee[c]	70,117	75,889	0.105**	88,559	97,649	0.123**
Multi-plant firm	91.2%	95.3%		92.8%	95.1%	

[†] Coefficient on export status in a regression of the log of the plant characteristic on export status, 4-digit industry dummies and state dummies.
** Significant at the 1% level.
[a] 1987$ per year.
[b] Thousands of 1987$
[c] 1987$ per employee

Figure 1: Transitions In and Out of Exporting

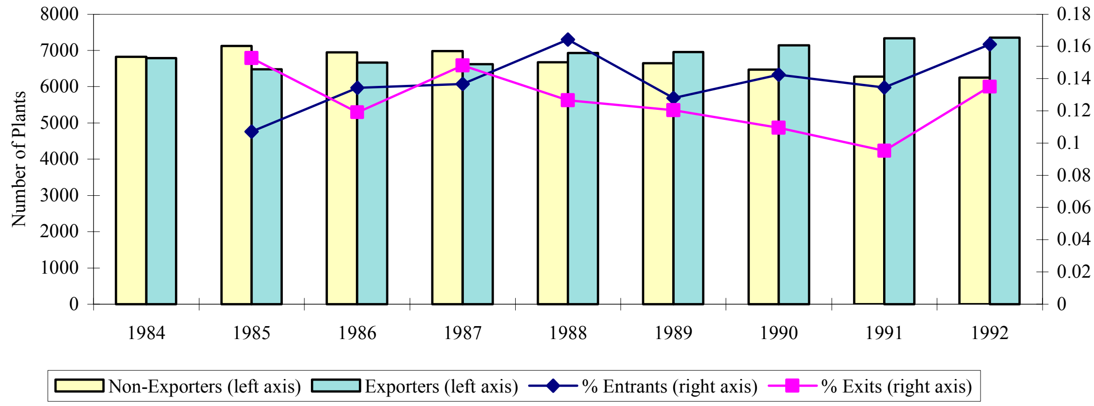

Table 4: Long Run Export Persistence

Fraction of 1984 Plants with Same Export Status[1]

	(1) Exporters Actual	(2) Non-Exporters Actual	(3) Exporters Expected	(4) Non-Exporters Expected
1985	84.7%	89.3%	84.7%	89.3%
1986	83.5%	85.4%	76.7%	78.6%
1987	79.6%	82.0%	68.5%	69.2%
1988	80.3%	78.2%	65.0%	58.9%
1989	79.4%	77.1%	61.7%	52.2%
1990	80.0%	74.9%	60.4%	45.4%
1991	80.5%	72.6%	60.0%	39.8%
1992	78.6%	70.4%	58.3%	50.2%

[1] The numbers in columns 1 and 2 represent the percentage of exporters (non-exporters) in 1984 who were also exporters in the listed year, i.e. 78.6% of the plants that exported in 1984 also exported in 1992. The numbers in columns 3 and 4 represent the expected percentages if entering and exiting plants were chosen randomly from the population with annual transition rates given by the data.

Table 5: Export Sequences 1986-1992

Export Sequence	Percentage of Plants	Export Sequence	Percentage of Plants
0000000	29.02%	0001111	1.21%
0000001	2.71%	0010111	0.23%
0000010	0.87%	0011011	0.17%
0000100	0.49%	0011101	0.13%
0001000	0.57%	0011110	0.40%
0010000	0.67%	0100111	0.16%
0100000	0.73%	0101011	0.06%
1000000	1.50%	0101101	0.04%
0000011	1.25%	0101110	0.04%
0000101	0.24%	0110011	0.09%
0000110	0.48%	0110101	0.04%
0001001	0.15%	0110110	0.06%
0001010	0.12%	0111001	0.14%
0001100	0.22%	0111010	0.11%
0010001	0.12%	0111100	0.15%
0010010	0.04%	1000111	0.29%
0010100	0.10%	1001011	0.07%
0011000	0.32%	1001101	0.02%
0100001	0.15%	1001110	0.10%
0100010	0.06%	1010011	0.10%
0100100	0.06%	1010101	0.03%
0101000	0.08%	1010110	0.03%
0110000	0.27%	1011001	0.09%
1000001	0.43%	1011010	0.04%
1000010	0.09%	1011100	0.20%
1000100	0.09%	1100011	0.22%
1001000	0.07%	1100101	0.10%
1010000	0.32%	1100110	0.09%
1100000	0.90%	1101001	0.07%
0000111	1.37%	1101010	0.04%
0001011	0.16%	1101100	0.08%
0001101	0.08%	1110001	0.29%
0001110	0.32%	1110010	0.19%
0010011	0.15%	1110100	0.12%
0010101	0.06%	1111000	0.68%
0010110	0.07%	0011111	1.97%
0011001	0.14%	0101111	0.33%
0011010	0.04%	0110111	0.19%
0011100	0.19%	0111011	0.15%
0100011	0.15%	0111101	0.21%
0100101	0.04%	0111110	0.33%
0100110	0.06%	1001111	0.46%
0101001	0.04%	1010111	0.21%
0101010	0.01%	1011011	0.11%
0101100	0.01%	1011101	0.12%
0110001	0.08%	1011110	0.32%
0110010	0.01%	1100111	0.47%
0110100	0.07%	1101011	0.15%
0111000	0.18%	1101101	0.08%
1000011	0.21%	1101110	0.25%
1000101	0.07%	1110011	0.35%
1000110	0.09%	1110101	0.11%
1001001	0.07%	1110110	0.21%
1001010	0.02%	1111001	0.35%
1001100	0.04%	1111010	0.28%
1010001	0.05%	1111100	0.78%
1010010	0.04%	0111111	2.85%
1010100	0.02%	1011111	1.84%
1011000	0.10%	1101111	1.19%
1100001	0.24%	1110111	1.29%
1100010	0.11%	1111011	0.91%
1100100	0.04%	1111101	0.94%
1101000	0.10%	1111110	2.34%
1110000	0.51%	1111111	28.23%

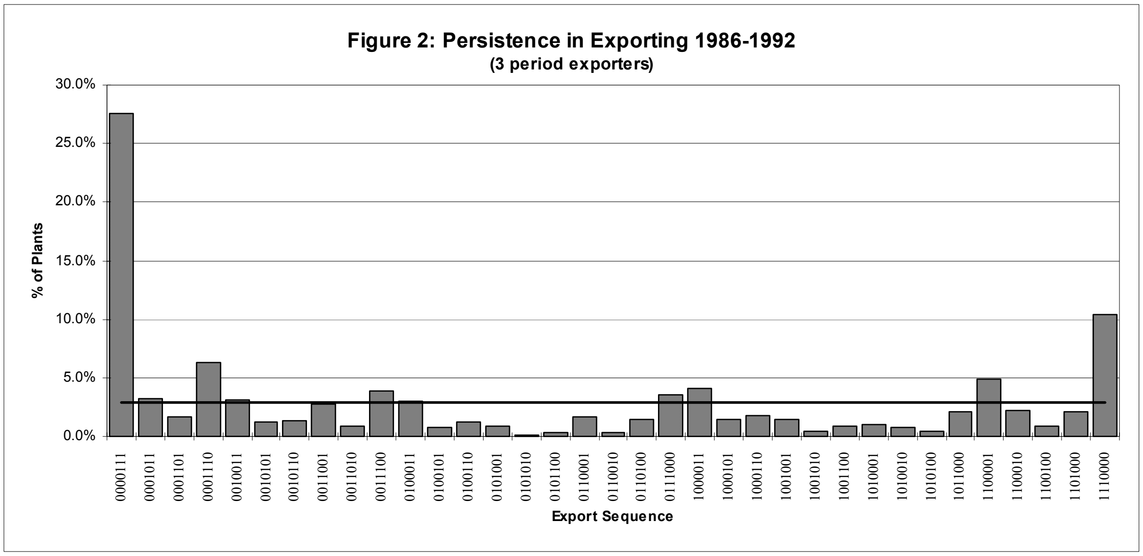

Figure 2: Persistence in Exporting 1986-1992
(3 period exporters)

Solid line indicates the percentage if all sequences are equally likely.

Figure 3: Industry Switching In and Out of Exporting

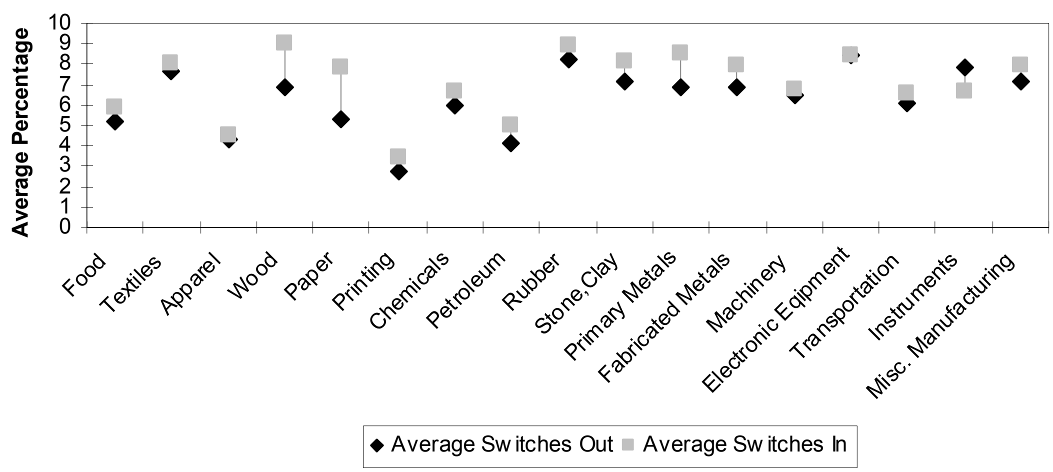

Table 6: The Decision to Export
(Plant Characteristics and Entry Costs)

	Levels (1)	Fixed Effects (2)	IV-First Differences (3)
Plant-Level Variables[1]			
Exported last year	0.655**	0.203**	0.362**
	(0.001)	(0.004)	(0.017)
Last exported two years ago	0.271**	0.027**	0.105**
	(0.005)	(0.005)	(0.011)
Total Employment	0.029**	0.040**	0.290**
	(0.001)	(0.005)	(0.093)
Wage	0.037**	0.031**	0.133*
	(0.005)	(0.009)	(0.054)
Non-production/Total Employment	0.031**	-0.025	-0.147
	(0.008)	(0.016)	(0.106)
Productivity	0.017**	0.001	-0.023
	(0.003)	(0.004)	(0.025)
Changed product since last year	0.028**	0.033**	0.033**
	(0.007)	(0.007)	(0.011)
Industry Exchange Rate	-0.053[+]	-0.059*	0.058
	(0.027)	(0.026)	(0.069)
Multi-plant dummy	0.007		
	(0.005)		
Multinational	0.017**		
	(0.003)		
Year Dummies	Yes	Yes	Yes
Industry dummies	Yes		
State dummies	Yes		
N	94902	94902	71166

** significant at the 1% level.
* significant at the 5% level.
[+]significant at the 10% level.

[1] All plant characteristics are lagged one year.

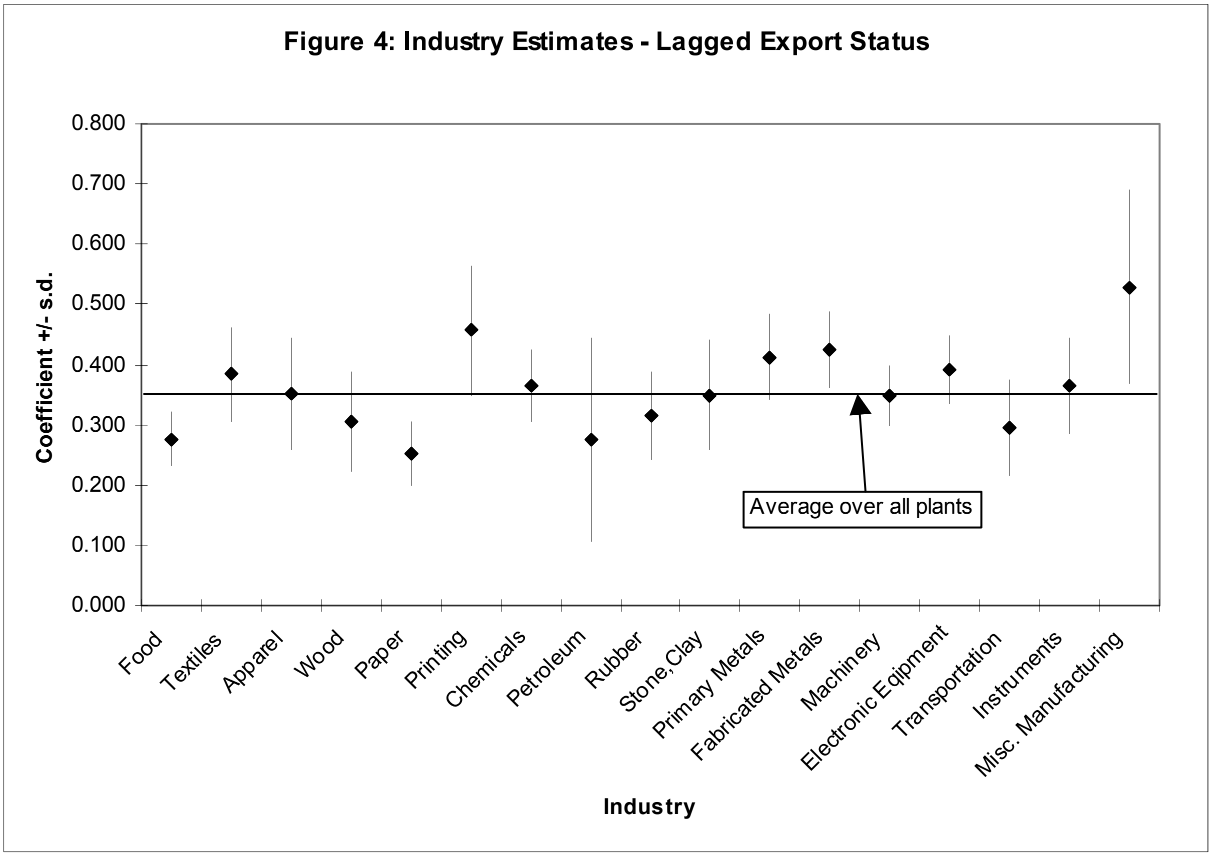
Figure 4: Industry Estimates - Lagged Export Status
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Coefficient +/- s.d.
Average over all plants
Food
Textiles
Apparel
Wood
Paper
Printing
Chemicals
Petroleum
Rubber
Stone,Clay
Primary Metals
Fabricated Metals
Machinery
Electronic Eqipment
Transportation
Instruments
Misc. Manufacturing
Industry

Table 7: Spillovers and Subsidies

	IV-First Differences (1)	IV-First Differences (2)
Plant-Level Variables[1]		
Exported last year	0.362**	0.362**
Last exported two years ago	0.105**	0.105**
Total Employment	0.304**	0.306**
Wage	0.141**	0.144**
Non-production/Total Employment	-0.144	-0.157
Productivity	-0.023	-0.026
Changed product since last year	0.033**	0.033**
Industry Exchange Rate	0.057	0.061
State Exporters (outside industry)	0.016	
Industry Exporters (outside state)	-0.010*	
State-industry Exporters	-0.002	
State Exports (outside industry)		0.005
Industry Exports (outside state)		-0.003
State-industry Exports		-0.001*
Export Promotion Subsidies	0.001	0.001
N	71046	71003

Year dummies included.
** significant at the 1% level.
* significant at the 5% level.
[+]significant at the 10% level.

[1] All plant characteristics are lagged one year; all spillover and subsidy variables are contemporaneous.

Table 8: Estimates from Alternative Specifications

	Lagged Export Status[1]
Linear Probability	
No Plant Effects	0.66
Fixed Effects	0.20
First Differences	0.36
Probit	
No Plant Effects	0.66
Random Effects - All Plants	0.62
Random Effects - Switchers	0.40

[1] Number represent point estimate for linear probability models, change in probability at means of other RHS variables for probit models. All are significant at the 1% level.