EXPORT ENTRY AND EXIT
BY GERMAN FIRMS

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ABSTRACT

This paper examines the decision to enter the export market by German firms. While exports

have played an important role in recent German business cycle movements, little is known about the

export supply response of German firms. This paper presents a dynamic model of the export decision

by a profit-maximizing firm. Using a panel of German manufacturing plants, we test for the role of

plant characteristics and sunk costs in the entry decision. We find evidence for substantial sunk costs

in export entry; exporting today by a plant increases the probability that the plant will export

tomorrow by 50%. This advantage depreciates quickly, falling by two thirds in a year. We also find

evidence that plant success, as measured by size and productivity, increases the likelihood of

exporting.

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1 Introduction

As with several past episodes, the recent uptick in the business cycle in Germany appears to be driven largely by exports. While German GDP increased by 1.8% per year from 1993 to 1997, German exports increased 7.0% per year over the same period, accounting for all the increase in aggregate output. At the same time, while exchange rates with other European nations were relatively stable in advance of the expected adoption of monetary union, on a trade-weighted basis the mark was depreciating, by 6% from January 1995 to January 1998. The decline against the dollar was substantially larger, 17% over the same period. To understand how much of the export (and output) growth was driven by these exchange rate movements, we must first understand the responses of German firms to external shocks. In this paper we use a unique longitudinal data set for a large number of manufacturing establishments in Germany to demonstrate what firm characteristics are important for export entry and to investigate the magnitude of the sunk costs of starting to export.

Large changes in exchange rates are hypothesized to have significant effects on the trade flows of a country. However, the timing and magnitude of these changes in the short run are in part determined by the ability of firms to adjust their output in response to the changes in relative prices. Aggregate output changes result from two related but distinct activities by firms. First, existing exporters can increase their export intensity. This may result either from a redirection of output destined for the domestic market to foreign customers or from an overall increase in production coupled with an expansion of exports. The alternative mechanism for the export response is through entry of existing or new firms into the export market. In this paper we examine this latter channel of entry into the export market. We consider what firm characteristics are important for entry as well as the magnitude of the sunk costs of starting exporting.

The role of exporting economic performance and economic growth in particular has been a topic of research for many years. In recent years, the advent of large microeconomic data sets for a variety of countries, both developed and less-developed, has led to a resurgence of work attempting to understand the causal nature between exporting and firm performance. Bernard and Jensen (1998) show that U.S. exporters have faster sales and employment growth than non-exporters in the same industry but do not have faster

productivity growth. They also find that there are large ex-ante advantages in terms of both growth rates and levels for future exporters. Bernard and Wagner (1997) study the relationship between firm success and exporting in German plants and also find that high productivity, large firms are more likely to become exporters ex-ante but do not outperform non-exporters after entry. In a sample of three developing countries, Clerides, Lach, and Tybout (1997) also find that exporting does not lower average variable cost relative to non-exporters. They also find some evidence that low cost firms are more likely to enter.

The literature on exporting and firm performance has also considered the role of entry costs in the export decision. Roberts and Tybout (1997) model the entry decision by Colombian firms and using an empirical strategy based on a dynamic probit with plant random effects conclude that there are substantial entry costs. In their sample, prior exporting experience can increase the probability of exporting by as much as 60 percentage points. They also find that larger, older plants that are part of a multi-plant firm are more likely to export. Bernard and Jensen (1997) employ a linear probability framework with fixed plant effects and also find substantial sunk costs in export entry. Export experience in the previous year increases the probability of exporting by 40%, although the entry advantage depreciates very quickly. Bernard and Jensen (1998) find that larger, high wage, and more productive plants are more likely to enter as are plants that have recently changed their product line.

In this paper we consider the role of sunk costs and plant characteristics in the export entry decision by German plants in Lower Saxony. We start by documenting the aggregate relationship between real exchange rate changes and movements in and out of the export market by German plants. The results are not unexpected, as the mark appreciates, exit rates increase and entry rates decline. Conversely, depreciations not only lead to increasing ratios of exports to sales but also induce entry. However, the magnitudes of the entry and exits are not large, so we are led to suspect that there are substantial costs associated with the decision. To determine the likelihood that entry occurs after a favorable exchange rate shock, we write down a model of entry into the export market and estimate the magnitudes of the sunk costs. We find that current exporting increases the probability of future exporting by 50%. The longer firms are out of the export market, the smaller the benefit of past export experience. In addition, we find that successful plants, as

measured by size or productivity, are more likely to become exporters, as are plants with greater shares of skilled workers.

In the next section, we describe our sample of plants and outline the differences between exporters and non-exporters. Section 3 discusses the extent of entry and exit by plants in Lower Saxony during the 1980s and the aggregate movements in exchange rates and output. In section 4, we present the model of the decision to export. Section 5 discusses alternative methodologies for estimating the binary panel data model with firm effects and Section 6 contains the estimation results. Section 7 concludes.

2   Exporters and Non-exporters in Lower Saxony

We start by describing our sample of plants and the differences between exporters and non-exporters.[1] The data come from an annual survey of manufacturing establishments conducted in Germany. However, due to the confidentiality requirements under German law, permission of the State government is required for use of any micro data. To date, only the state of Lower Saxony has permitted researchers to make use of the data.[2] We employ an unbalanced panel of 7,624 German manufacturing plants in Lower Saxony from an annual survey of all establishments with 20 or more employees. Data coverage includes employment, value of shipments, value of exports, annual wages by two categories of workers, production worker hours, investment values, and value of production.

Table 1 contains means by export status (exporter/non-exporter) for each year in the sample. The fraction of plants exporting ranged from a low of 38% in 1981 to 47% by 1991. In 5 of the 14 years, net flows of plants into exporting were negative. The share of output shipped abroad by the average exporting plant in the sample moved in a relatively narrow range from 18.03% in 1978 to a peak of 22.15% in 1987 and 1988.

Table 1 also shows some of the cross-sectional differences between exporters and non-exporters. As found in every study of exporting, the most

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[1]See Bernard and Wagner (1997) for more information on the performance of exporters and non-exporters in the panel.

[2]Thus we caution that our results may not be comparable for other German states. However, as of now there is no basis for comparison. See the appendix in Bernard and Wagner (1997) for more information on the construction of the data. Also see Methner (1992).

striking difference between exporters and non-exporters is their relative size. Exporters in Lower Saxony are more than twice as large as non-exporters and have higher labor productivity as well. Exporters paid their blue collar workers 25% more per hour on average than non-exporters, while white collar workers earned salaries 22% greater at exporting plants. The fraction of blue collar workers in the total workforce was about three quarters for both exporters and non-exporters.[3]

3   Entry and Exit

In this section, we consider the role of exchange rate changes in determining the export entry and exit patterns of the German plants. Table 2 contains a detailed breakout of entry and exit by year for plants in the sample. Plants are divided into four categories, continuing exporters, non-exporters, entrants and exits. As shown in Figure 1, entry and exit rates are negatively correlated over the period with a correlation coefficient of -0.35, significant at the 1% level. This is especially true for 1985 and 1988 which were years of substantial entry and lower exit. Export intensity and entry go hand in hand as is shown in Figure 2. Years of substantial entry by new exporters are also years in which existing exporters increase the fraction of shipments going abroad.

The natural explanation for the variation in entry, exit and intensity is fluctuations in the real exchange rate. Figures 3 and 4 show the variation in the real exchange rate (\$/DM 1972=100) and entry and intensity respectively. Correlations for both export measures are strongly negative and significant, -0.61 and -0.75 respectively. As one might expect if there are sunk costs in entering, but not in expanding export shipments, the real exchange rate effects are larger for export intensity than for entry rates. Interestingly, the correlations between lagged values of the real exchange rate and export entry are not significant, suggesting alternatively that sunk costs might not be as important for German firms. However, these aggregate numbers do not let us disentangle firm specific factors from aggregate shocks. To do this we first review a model of entry with sunk costs in the next section.

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[3]These numbers differ slightly from those reported in Bernard and Wagner (1997) which were for the years 1978 and 1992.

4   Modelling the Export Decision

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) and Bernard and Jensen (1997) empirically address the question of entry and exit costs in the decision to export by the profit maximizing firm.

We follow Roberts and Tybout (1997) and Bernard and Jensen (1997) in modelling 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 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}.[4] Firm characteristics that might increase the probability of exporting include size, labor composition, productivity, product mix, and ownership structure.

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

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

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

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

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[4]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.

As long as the cost function does not depend on the level of output in a previous period, the solution of this multi-period problem is identical to the single period case.

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, the costs of establishing a distribution system, or the search costs of identifying local bankers and transport companies.[5] We refer to these as entry costs and, for ease of exposition, we assume these costs recur in full if the firm exits the export market for any amount of time.[6] Profits for the firm in single period maximization problem with entry costs are given by

$$\widetilde{\pi}_{it}\left(X_t, Z_{it}, Y_{it-1}\right) = p_t q_{it}^* - c_{it}(X_t, Z_{it}|q_{it}^*) - N \cdot (1 - Y_{it-1}) \tag{4}$$

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 a means 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, $\{q_{is}^*\}_{s=t}^{\infty}$, that maximizes current and discounted future profits,

$$\Pi_{it} = \mathrm{E}_t \left(\sum_{s=t}^{\infty} \delta^{s-t} \left[\widetilde{\pi}_{is} \cdot Y_{is} \right] \right), \tag{5}$$

where period-by-period profits are given by equation 4 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

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[5]Interviews by the first author with small U.S. manufacturers suggest that distribution networks and financing arrangements represent sizable one-time costs in terms of time and money.

[6]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.

maximizing quantity. The value function is the same as before with the addition of potential entry costs in the within period profits,

$$V_{it}\left(\cdot\right) = \max_{\{q_{it}^*\}} \left(\tilde{\pi}_{it} \cdot [q_{it}^* > 0] + \delta \mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^*\right]\right). \tag{6}$$

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

$$p_t q_{it}^* + \delta \left(\mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^* > 0\right] - \mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^* = 0\right]\right) \\ > c_{it} + N_{it} \cdot \left(1 - Y_{it-1}\right). \tag{7}$$

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.

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.

5 Empirical Methodology

From the multi-period model with entry costs given in section 4, we find that a firm exports if current and expected revenues are greater than costs,

$$Y_{it} = \begin{cases} 1 & \text{if } \hat{\pi}_{it} > c_{it} + N \cdot \left(1 - Y_{it-1}\right) \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

where

$$\hat{\pi}_{it} \equiv p_t q_{it}^* + \delta \left(\mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^* > 0\right] - \mathrm{E}_t\left[V_{it+1}\left(\cdot\right) \mid q_{it}^* = 0\right]\right). \tag{9}$$

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

$$Y_{it} = \begin{cases} 1 & \text{if } \beta X_{it} - N \cdot \left(1 - Y_{it-1}\right) + \varepsilon_{it} > 0 \\ 0 & \text{otherwise} \end{cases}. \tag{10}$$

Plant characteristics are included in the vector X_{it}, while other factors such as terms of trade shocks are incorporated in the residual, ε_{it}.

5.1 Experience and Entry Costs[7]

The most difficult issue in the estimation of equation 10 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.[8] 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}, which captures other, exogenous shocks.

There are several potential estimation strategies for this dynamic binary choice framework with unobserved heterogeneity, including probit with random effects, and linear probability models with fixed or random effects. The use of random effects requires that the plant effects be uncorrelated with the regressors. 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. Roberts and Tybout (1997), however, use a random effects probit specification in their analysis of sunk costs and entry. Most fixed effects models, on the other hand, produce biased and inconsistent parameter estimates, especially for the coefficient on the lagged dependent variable. Bernard and Jensen (1997) opt for a fixed effects linear probability model and attempt to control for the problem of a lagged endogenous variables by estimating the model in first differences with instrumental variables.

In this paper, we consider results from both a random effects probit specification and a linear probability model with fixed effects. The linear probability framework is given by

$$Y_{it} = \beta X_{it-1} + \theta Y_{it-1} + \varepsilon_{it}, \tag{11}$$

[7]This and the following subsections draw heavily on the discussion in Bernard and Jensen (1997b).

[8]See Heckman (1981) for an analysis of the theoretical issues and Roberts and Tybout (1997) and Bernard and Jensen (1997) for discussions in the exporting context.

while the random effects probit setup is

$$Y_{it} = \begin{cases} 1 & \text{if } \beta X_{it} - \theta Y_{it-1} + \kappa_i + \mu_{it} > 0 \\ 0 & \text{otherwise} \end{cases}. \tag{12}$$

We proceed in several steps. First, we estimate equation 11 in levels, ignoring any plant effects. The levels specification gives us an upper bound on the importance of sunk costs.[9] Bernard and Jensen (1998) and Bernard and Wagner (1997) 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

$$Y_{it} = \beta X_{it-1} + \theta Y_{it-1} + \kappa_i + \eta_{it}. \tag{13}$$

We estimate equation 13 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. $(X_{it-2}, X_{it-3}, Y_{it-2}, Y_{it-3})$,

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

This specification avoids the serious problem of inconsistent estimates found in the fixed effects model.[10] However, the IV specification introduces the potential problem that instruments perform poorly.

The probit specification in 12 also assumes that 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, κ_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 transform the problem into a dynamic random effects probit, after assuming that the

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[9]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.

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

errors are normally distributed. 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. Ideally, one would
instrument 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,
$cov(\kappa_i, \xi_{i0}) = \rho_1$. Given the lack of appropriate instruments we have run the
probit assuming the initial conditions are exogenous.

5.2   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 at-
tributes to consider are those related to past success. It would appear to be
relatively uncontroversial to claim that good firms become exporters, how-
ever, 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
value-added per employee, 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. We also include a dummy for
plants that belong to a multi-plant firm to allow for some degree of ownership
effects in the decision to export.

6   Empirical Results

We estimate all our various specifications on an unbalanced panel which
averages 9 years of data for more than 6400 plants totalling over 57,600 ob-

servations for the regressions in levels and over 51,000 for the first differences specification.[11] We divide the results into two sections. First we report specifications without controlling for any form of individual plant effect and then we consider the various methods of absorbing the individual heterogeneity. The first set of results allows us to examine the effects of time-invariant plant attributes, while the latter does not.

The baseline specification contains the plant characteristics mentioned above. These are plant size (employment), productivity (output per worker), labor force characteristics (average wage and white collar/total workers), and ownership (a multi-plant firm dummy). The proxies for sunk costs of entry are the coefficients on two measures of past export participation, export status in the previous year, and a dummy for whether the plant exported two years ago but not last year. This last measure allows us to capture the possibility that the capital expended in entering the export market does not depreciate immediately upon exiting.[12]

6.1   Estimates without plant effects

Table 3 contains estimates without controlling for plant heterogeneity.. Results from the linear probability model are given in column 1 and those from the probit model are in column 2. The results confirm the hypothesis that successful plants are more likely to enter the export market. The coefficients on size and productivity are significant in both specifications at the 1% level. The magnitudes do vary across the two estimation methodologies with all the coefficients much stronger in the probit results. The evidence on the importance of labor force characteristics also generally confirm that plants with higher wages and more skilled workers are more likely to export. The wage effects, however, are not significant and are the wrong sign in the linear probability framework. Surprisingly, plants that are a part of a multi-plant firm are significantly less likely to export than other plants. This is the opposite of findings by Bernard and Jensen (1997) for the U.S..

The estimates of sunk costs in these specifications without controlling for unobserved heterogeneity are immense. The point estimates in both cases exceed 0.84. Taken at face value, this would suggest that current exporters

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[11]Actual samples sizes may vary depending on the lag length chosen, however, none of the results are sensitive to the years included.

[12]It is preferable to think of this capital as information rather than physical investment.

are 80-90% more likely to export next year than are non-exporters. The co-efficient on the measure of export status two years hence are also positive, significant and in the case of the probit model, quite large.[13] Being out of the export market for a year does reduce the entry benefits of having once participated. The point estimates of the extent of the depreciation are 85% and 55% for two specifications. Based on these results one would conclude there are substantial sunk costs to entry and they depreciate substantially in a year, but not completely. However, as discussed above, these estimates incorporate any persistent unobserved heterogeneity and should be considered extreme upper bounds on the importance of sunk costs in the decision to export by German firms.

6.2 Estimates with plant effects

Table 4 contains our preferred estimates including several different methods for controlling for the unobserved components of the error term. Column 1 contains estimates from a linear probability model estimated in levels with plant fixed effects. Column 2 estimates a linear specification in first differences with lagged levels as instruments. The random effects probit results are presented in column 3 with the associated probability changes given in column 4.

The linear probability model in levels with plant fixed effects most likely overcontrols for unobserved plant heterogeneity and yields estimates of sunk costs that are biased downwards.[14] As before, measures of plant success, size and productivity, are significant predictors of future export status, as is the share of white collar workers at the plant. The new estimates on the magnitude of the sunk costs are dramatically lower than those without plant effects in the error. The one year ahead probability increase from being an exporter today is less than half as large, 38.0%, while the benefit of having been in two years previously is only 1.8%. The important fact is that both numbers are significant and positive. The likely downward bias in this set of results means that we can safely conclude that there are indeed sunk costs

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[13]Remember that this measure is actually a dummy which is one if the plant last exported two years ago.

[14]See Bernard and Jensen (1997) for a detailed discussion of this problem in the case of entry into exporting.

of entering the export market that yield increases in probability in the range
of 38%-85%.

Turning to the IV first differences specification in column 2, we find again
that the past export measures are significant and positive. Exporting today
increase the probability of exporting tomorrow by 52% while fully two thirds
of that benefit depreciate in one year. The other plant characteristics in the
IV-FD specification are generally not significant, with the exception of size
that shows up with the wrong sign at the 10% level. The poor performance of
the plant characteristics may be due partly to the nature of the instruments
used.[15]

Finally we consider the random effects probit results. Here we again find
strong, positive and significant effects of past exporting on current export
status. Exporting today increases the probability of being an exporter to-
morrow by 68% and the effect shows far less depreciation (42%) than in other
specifications.. In this framework, the plant effects are again significant and
in the expected directions, with measure of success, especially productivity,
being strongly correlated with future export status. Bernard and Jensen
(1997) discuss potential problems with the random effects estimators that
might lead to an overestimate of sunk costs. Looking over the entire set of
results, we suspect this might be only a relatively small problem in the Ger-
man data as the similarity of the IV-FD specification and the random effects
probit estimates is quite striking.

7   Conclusions

This paper provides another round of evidence on the relationship between
success and exporting at the plant or firm level. We have focussed our at-
tention on the role that plant characteristics play in determining which firms
enter and the magnitude of the costs, or barriers, that German firms face in
deciding to begin exporting.

Our results from a dynamic binary choice model of the decision to enter
provide strong support that there are substantial sunk costs for export entry.
The range, estimated as the decreased probability of entering if the firm is out
of the market today, run between 38% and 89%. The most reasonable point

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[15]The instruments perform much better for predicting switches export status than em-
ployment and productivity changes.

estimates, however, suggest a magnitude on the order of just over 50%. These results are in between those estimated using U.S. (Bernard and Jensen 1997) and developing country data (Roberts and Tybout 1997), with U.S. firms apparently facing the lowest sunk costs to exporting. The capital needed to enter the market does not depreciate entirely after one period, although our preferred estimates suggest that as much as two thirds has dissipated in a year.

The results confirm that good plants are much more likely to become exporters. Measures of size and productivity are positive and significant in most specifications. In addition, plants intensive in skilled workers are more likely to export. This provides independent evidence for the growing literature on the relationship between exporting and success. While exporters have desirable performance characteristics when compared to non-exporters in almost every industry and country,[16] the growing consensus, confirmed in our results, is that success leads to exporting rather than exporting leading to success.

The results in this paper suggest an important area of future research is the measurement of the various components of sunk costs of export entry and the extent to which they take on the characteristics of public goods. In addition, further work is needed on how the increasing economic integration in Europe will affect cross-border activities by German and other firms.

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[16]See Bernard and Jensen (1998) and Bernard and Wagner (1997).

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Table 1: Exporters and Non-Exporters

Year	Status	No. of firms	Export quota (percent)	Hours per worker - blue collar workers	Hourly wages blue collar workers (DM; real, 1985)	Salaries - White Collar (1000 DM; real, 1985)	No. of employees	Fraction of blue collar workers	Sum of sales in Germany (1000 DM; real, 1991)	Exports (1000 DM; real, 1991)	Value of production (1000 DM; real, 1991)
78	0	2853		1876	16.59	42.74	53.50	0.75	10869		9583
	1	1798	18.03	1717	21.18	51.99	278.45	0.75	42615	20006	50344
79	0	2845		1849	17.29	44.19	54.31	0.75	11269		9955
	1	1791	18.24	1707	21.70	53.11	280.91	0.75	44339	21447	52201
80	0	2796		1828	17.44	44.64	55.31	0.75	11457		9961
	1	1767	18.87	1680	22.41	54.41	288.27	0.74	44015	23164	54018
81	0	2909		1796	17.41	44.52	53.71	0.74	11248		9932
	1	1780	20.10	1644	22.32	54.29	279.85	0.74	42251	24509	52487
82	0	2754		1776	17.30	43.85	53.08	0.73	10799		9840
	1	1761	20.94	1613	22.08	54.62	273.80	0.73	41020	24975	51702
83	0	2665		1802	17.14	44.17	52.58	0.73	11282		9536
	1	1736	20.75	1648	21.88	55.11	266.52	0.73	42796	24512	52394
84	0	2570		1802	17.17	44.45	52.56	0.73	11366		9517
	1	1745	21.75	1654	22.30	55.95	262.21	0.73	42643	28544	55459
85	0	2397		1780	17.49	44.67	53.27	0.73	12294		9972
	1	1818	21.95	1663	22.20	56.26	257.32	0.73	42198	30305	56618
86	0	2301		1767	18.16	46.76	55.10	0.74	12632		10459
	1	1837	21.76	1698	22.77	58.58	263.83	0.73	43550	28809	56833
87	0	2270		1750	18.81	47.88	56.31	0.73	13361		10657
	1	1800	22.15	1586	24.90	60.73	263.52	0.73	45127	28686	56323
88	0	2179		1776	18.97	48.85	56.35	0.72	13738		10626
	1	1829	22.15	1597	25.42	62.27	259.44	0.73	46687	29822	57786
89	0	2232		1735	19.53	49.13	57.23	0.73	14469		11258
	1	1885	22.08	1581	25.79	62.72	255.87	0.73	47319	32032	60188
90	0	2252		1727	20.33	50.58	59.42	0.73	15655		11982
	1	1900	21.12	1565	26.32	64.04	261.79	0.74	51793	31347	61425
91	0	2248		1706	21.06	51.35	61.85	0.74	16263		13113
	1	1954	19.77	1553	27.16	65.38	257.81	0.73	58104	29770	63903
92	0	2340		1702	21.53	52.18	60.33	0.73	16107		12552
	1	1970	19.82	1556	27.82	67.10	251.00	0.72	55249	27362	63702

Table 2: Entry and Exit

Year	No. of Firms exporting in t	No. of Firms not exporting in t	No. of Firms exporting in t and t-1 (1,1)	No. of Firms exporting in t that did not export in t-1 (0,1)	No. of Firms not exporting in t that did export in t-1 (1,0)	No. of Firms not exporting in t and t-1 (0,0)
1978	1798	2853				
1979	1722	2917	1625	97	112	2805
1980	1717	2966	1628	89	103	2863
1981	1711	2890	1617	94	102	2788
1982	1720	2904	1620	100	84	2820
1983	1688	2743	1569	119	104	2639
1984	1690	2622	1576	114	86	2536
1985	1742	2447	1602	140	78	2369
1986	1758	2334	1645	113	98	2236
1987	1726	2296	1640	86	112	2184
1988	1767	2238	1647	120	90	2148
1989	1789	2174	1685	104	86	2088
1990	1823	2264	1728	95	104	2160
1991	1862	2251	1767	95	88	2163
1992	1878	2301	1795	83	102	2199

Table 3: Estimating the Probability of Entry, No Plant Effects

	(1) LP-OLS	(2) Probit[1]
Last Exported in t-1	0.849***	0.895***
	(0.007)	(0.006)
Last Exported in t-2	0.128***	0.396***
	(0.015)	(0.016)
Size	0.021***	0.098***
	(0.004)	(0.004)
Productivity	0.009***	0.023***
	(0.002)	(0.005)
Multi-plant	-0.015***	-0.089***
	(0.003)	(0.008)
Wage	-0.004	0.040***
	(0.006)	(0.014)
Non-production	0.034***	0.071**
	(0.011)	(0.025)
Year Dummies	Yes	Yes
Industry Dummies	Yes	No

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[1] Coefficients represent the change in probability of exporting due to a one standard deviation increase in the independent variable evaluated at the means of the other variables (or a change from 0-1 in the case of a dummy variable).

Table 4: Estimating the Probability of Entry, Plant Effects

	(1)	(2)	(3)	(4)[2]
	LP-FE	LP-FD	REProbit	
Last Exported in t-1	0.380***	0.518***	3.288***	0.68
	(0.005)	(0.048)	(0.038)	
Last Exported in t-2	0.018***	0.168***	1.061***	0.40
	(0.006)	(0.025)	(0.051)	
Size	0.040***	-0.016*	0.320***	0.01
	(0.004)	(0.009)	(0.021)	
Productivity	0.009***	-0.001	0.179***	0.06
	(0.002)	(0.004)	(0.022)	
Multi-plant	-0.008		-0.224***	-0.07
	(0.006)		(0.041)	
Wage	0.004	0.000	0.171***	0.02
	(0.008)	(0.012)	(0.067)	
Non-production	0.036**	-0.031	0.208*	0.01
	(0.016)	(0.026)	(0.112)	
Year Dummies	Yes	Yes	Yes	

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[2] Coefficients represent the change in probability of exporting due to a one standard deviation increase in the independent variable evaluated at the means of the other variables (or a change from 0-1 in the case of a dummy variable).
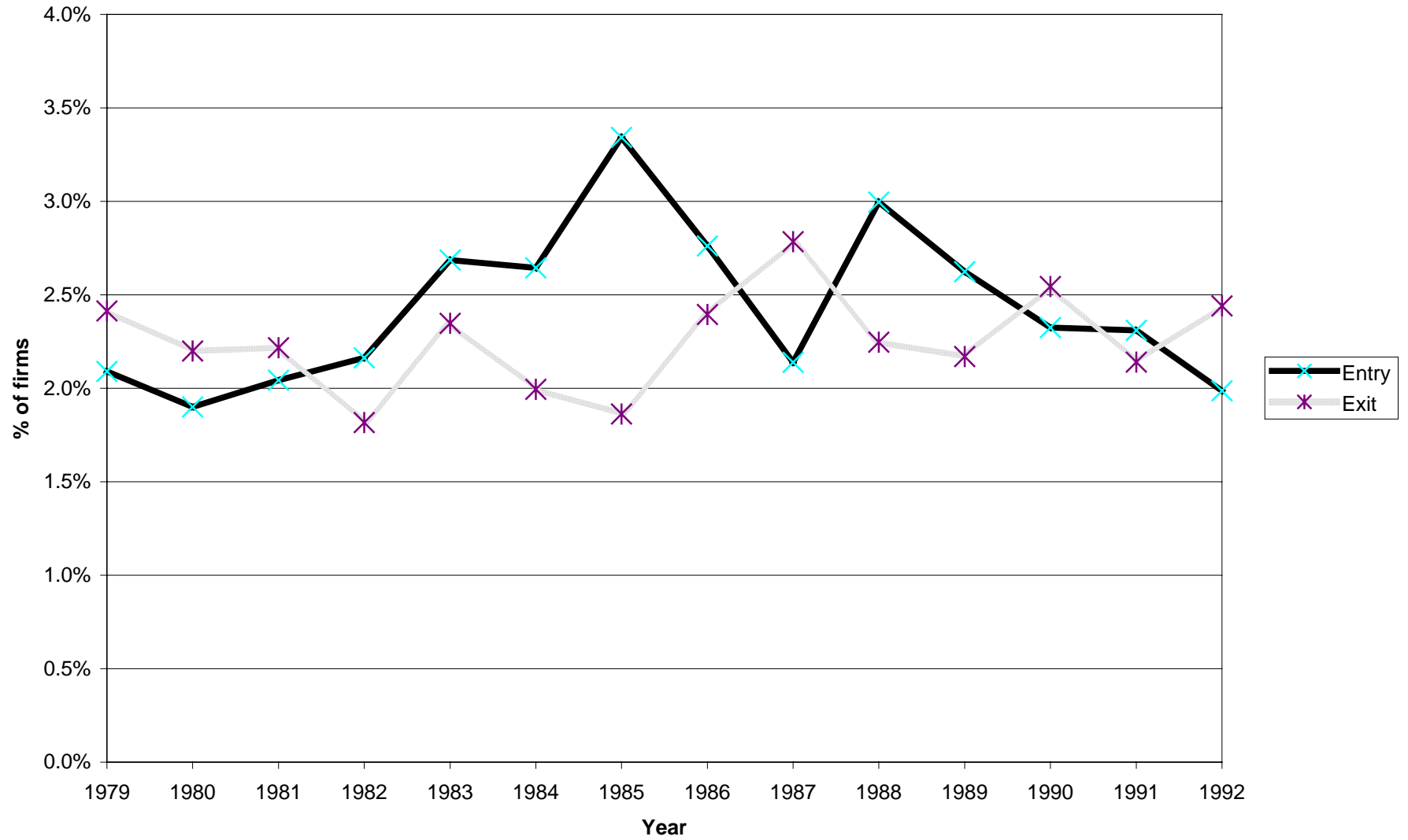
Figure 1: Entry and Exit Rates

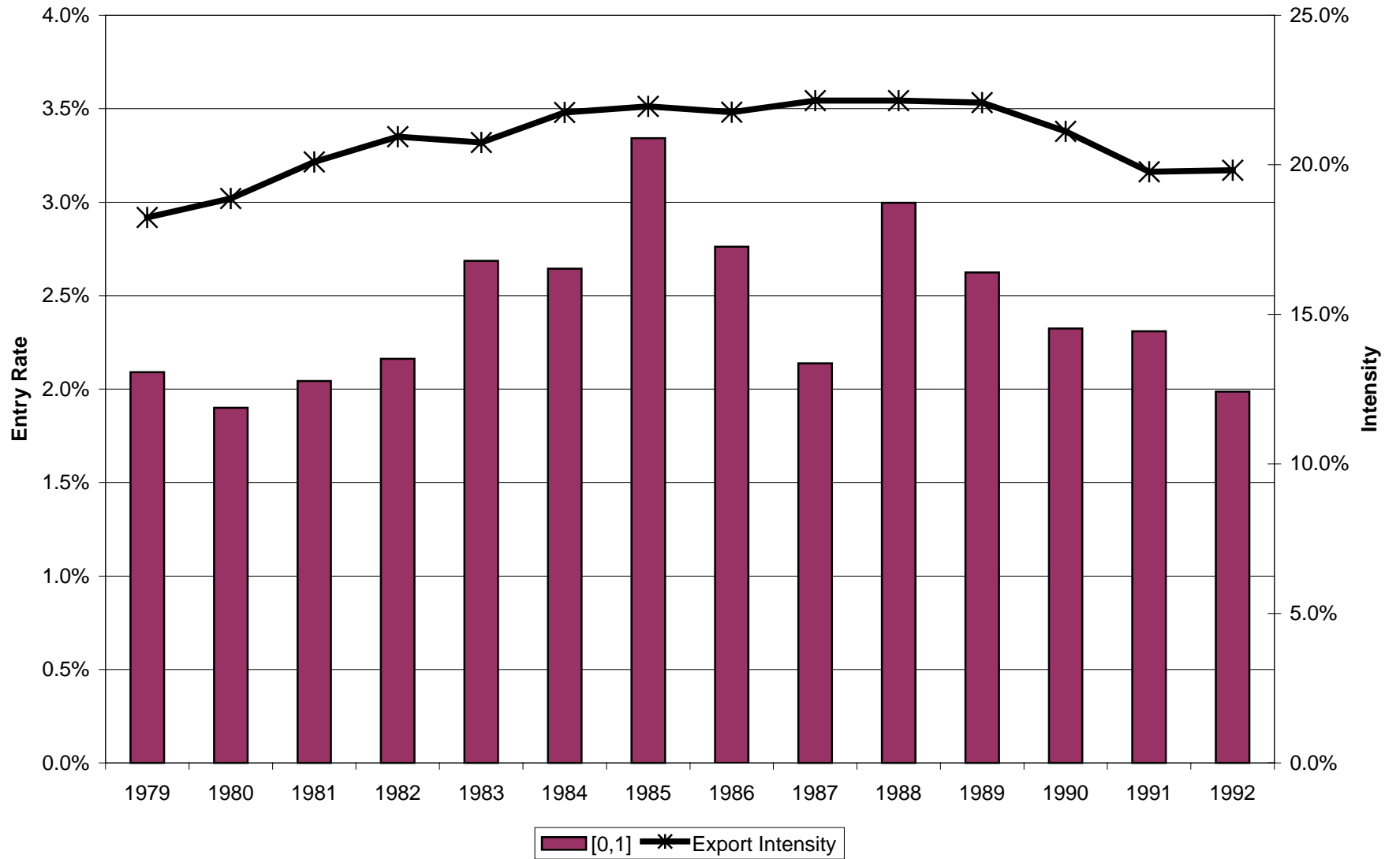**Figure 2: Entry and Intensity**
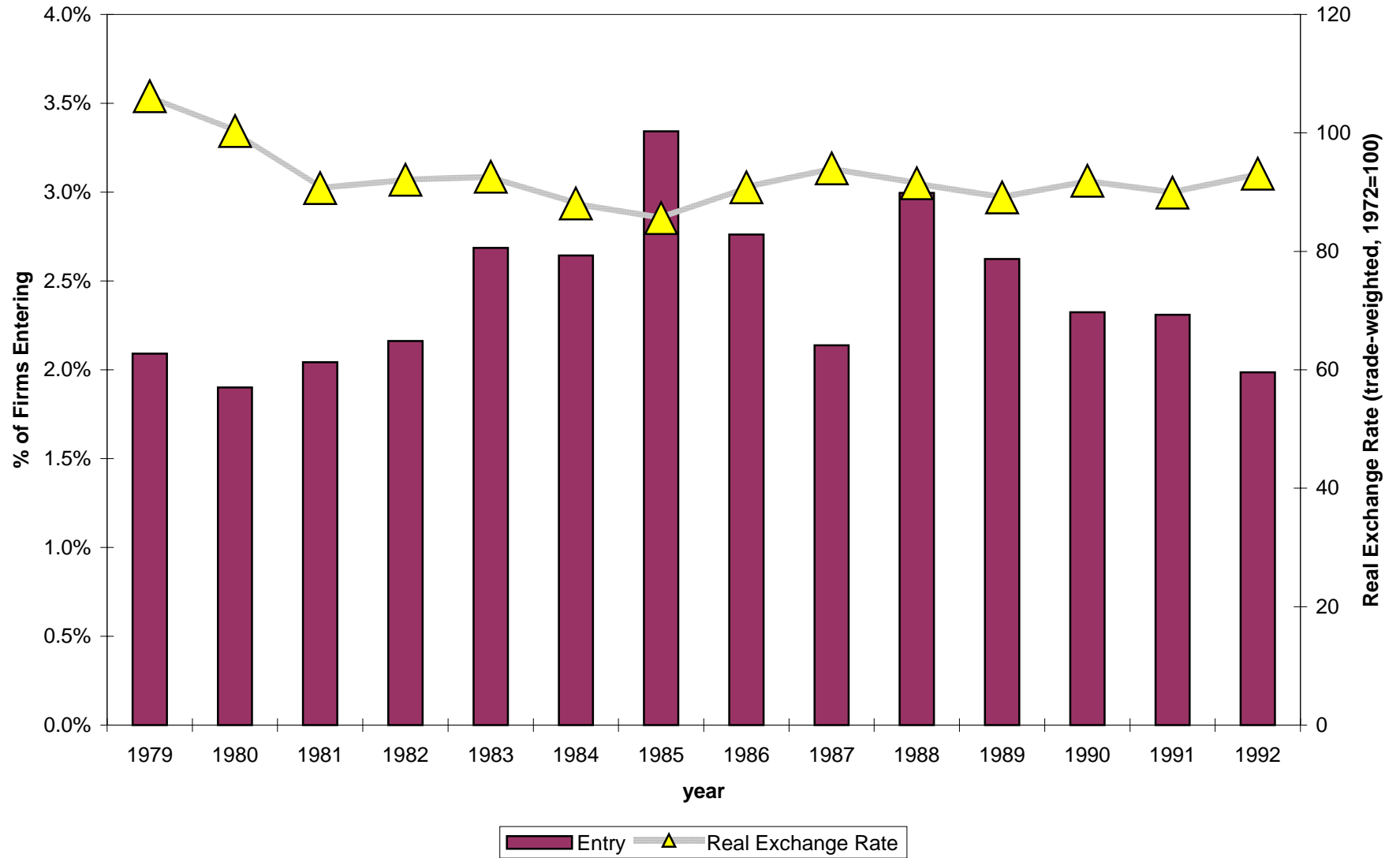
Figure 3: Export Entry and the Real Exchange Rate

Figure 4: Export Intensity and the Real Exchange Rate