Sunk costs to exports*

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Abstract

Using a very large panel dataset of Italian manufacturing firms, we test an empirical model of foreign markets participation with sunk costs. The time period of analysis (1982-99) is exceptionally informative: the large fluctuations of the lira exchange rate have determined significant flows of firms in and out of foreign markets. We find that sunk costs to exports are very important: past experience on foreign markets raises the probability of exporting by about 70 percentage points. While the factors imposing these costs depreciate quite slowly, new exporters must pay for them in the very first periods after entry. We then relate sunk costs to firm size and find that sunk costs are an important barrier to export especially for the myriad of Italian small and medium firms. Finally, we provide some new evidence that sunk costs have indeed to do with the need of collecting information on foreign market/country characteristics.

Keywords: Exports, sunk costs, firm size, binary choice models
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1 Introduction

In the last decade, Italy's exports have gone through exceptional swings. According to aggregate trade statistics, exported quantities experienced major difficulties before the strong lira depreciation in 1992. Afterwards and until the occurrence of the Asian and Russian financial crises in 1997, there has been a great resurgence of exports: exporting became a more widely diffused activity across Italian manufacturing firms, exporters could increase their market shares almost everywhere, Italian products entered for the first time new markets - in particular developing countries in South East Asia and Latin America. Then the crises have slowed down Italian firms' sales abroad and reduced their market shares.

When dealing with exports, the first thought goes to exchange rates. Undoubtedly, the events above have been mainly affected by the evolution of the exchange rate of the lira. Looking at the trade-weighted nominal effective exchange rate, the lira has depreciated by 12.6 percent between August and October 1992. Later on, in 1995, another big drop has produced further gains in terms of price competitiveness; this effect has been, though, short-lived and after few months the exchange rate was almost back to the previous levels. After the 1996 strong appreciation, the lira experienced for a couple of years an almost stable nominal effective exchange rate after which it followed the weakness of the euro.

Trade effects, in terms of timing, magnitude and duration, induced by exchange rate movements depend on firm's behavior. The goal of this paper is to shed some light on two specific aspects of Italian firms' behavior. On one side, we limit our analysis to the decision of entry into and exit out of foreign markets: we therefore neglect any consideration on the decision of the amount to be exported. Secondly, we focus on sunk costs to export that have a lot to do with the entry/exit decision; these costs may originate from the need of collecting information about demand, learning about the functioning of the institutional and legal environment, establishing a distribution system, marketing and promoting the product, etc.

As pointed out by a series of theoretical papers in the late eighties (Baldwin, 1988 and 1989; Baldwin and Krugman, 1989; Dixit, 1989b; Krugman, 1989), sunk costs may help to explain some empirical puzzles: comparable exchange rate fluctuations[1] may produce significantly different effects in different countries; these effects can also differ in a given country when occurring at different dates. Moreover, it might happen that large depreci-

[1] These considerations may equally apply to economic policies.

ations (or, equivalently, appreciations) appear to have smaller effects than small depreciations (appreciations). Sometimes, while large increases in export follow a depreciation no similar reductions occur when the exchange rate goes back to its pre - depreciation level.

According to these authors, the key element is that sunk costs make the firm's export supply function dependent on the exporting vs not-exporting status in previous periods. As a consequence, the aggregate export supply function depends on the type and number of exporters in previous periods; thus the aggregate effect of a given exchange rate fluctuation differs across time and across countries simply because the type and the number of incumbent exporters are different. Then sunk costs produce hysteresis in trade flows: temporary shocks determining massive entry of firms in foreign markets might have permanent effects since these firms, after paying sunk costs, find it convenient to stay in the market even when the shock ends.

Few papers have tested this hypothesis using firm-level data. The seminal paper is by Roberts and Tybout (1997): on a sample of 650 Colombian plants over the period 1981-89, using a model detecting the importance of sunk costs through the degree of persistence in firms' foreign market participation, they find clear support to sunk costs' existence. A similar result is obtained by Bernard and Wagner (1998) on a sample of 7,624 German manufacturing plants between 1978 and 1992 and by Bernard and Jensen (2001) for 13,606 US manufacturing plants in 1984-1992. According to Campa (2000), the same holds for Spanish manufacturing firms (2,188 firms over the period 1990-97); however, he shows that the impact of entry and exit flows on aggregate trade is quite limited[2].

We show that sunk costs are very important for Italian manufacturing firms: at time t the probability of exporting grows by 70 percentage points when a firm was already exporting at time $t-1$. We then look at sunk costs along various different dimensions. The first one relates to their temporal structure. We ask how fast the factors, for which newly exporting firms are called to pay sunk costs, depreciate and how soon firms must pay upon entry. The estimated low depreciation rate and the resulting need of paying sunk costs immediately after entry implies that the break in the aggregate export function caused by the lira turmoil during the '90s should be relatively long

[2]Interestingly, Campa (2000) analyzes the role of exchange rate uncertainty. According to Dixit (1989a), the need to pay sunk costs makes uncertainty about future conditions a crucial variable for firm's decision. The idea is that greater uncertainty increases the option value to wait so that firms may decide not to enter (exit) foreign markets despite quite profitable (unprofitable) current conditions; in other words, the inaction band enlarges with uncertainty. However, Campa do not find evidence in favor of this effect.

lasting.

Then we move to the relationship between sunk costs and firm size. As argued by Caves (1988), we show that sunk costs are indeed a higher barrier to exports for smaller firms; moreover, this is true independently of sectoral specialization. Needless to say, this has important policy implications in the case of Italy where 95 per cent of manufacturing firms have less than 10 employees.

Finally, we innovate on the existing literature by investigating over the nature of sunk costs. We focus on a specific, but often cited, aspect which is the need of collecting information on foreign market/country' characteristics before selling. We distinguish our firms according to their exposure to information spillovers and/or their direct ability to collect and process useful information. In both cases, we find that information collection is indeed a component of sunk costs.

Our exercise allows to relate various firm characteristics to the probability of exporting. In line with previous works, the probability grows with firm size and productivity, while it decreases with unit labor costs. Firms operating within wider industrial groups get access to foreign markets more likely; the same is true for firms located in industrial districts, confirming the important positive role such industrial agglomerations have in Italy. Despite we control for a wide set of firm specific characteristics, the sectoral dummies still matter: firms operating in Italian specialization sectors have a higher probability to export.

As compared to the other papers cited above, we provide a richer characterization of the macroeconomic effects on exports by including the real effettive exchange rate, the world and the domestic demand. The latter one deserves a word. It appears that the probability to export decreases significantly with domestic demand, to say that Italian firms look at foreign market in a sort of residual way, i.e. when demand in Italy is scarce.

The rest of the paper is organized as follows. In the next section, we describe the dataset and provide some general descriptive statistics. We also look at figures on foreign markets entry and exit flows as emerging from the sample. Section 3 is devoted to the theoretical model; a detailed description of our estimation strategy is given in section 4. After that, we present the results (section 5) for the base model. The temporal structure of sunk costs is analyzed in section 6, the interaction between sunk costs on one side and size and information on the other are in section 7 and 8, respectively. Some concluding remarks are left to the last section.

2 The data

In the empirical analysis we use a subsample of firms from the Centrale dei Bilanci (Company Accounts Data Service, CADS)[3]. For approximately 30,000 firms per year, CADS collects information on a large number of balance sheet items and some firm characteristics. Data are available from 1982 to 1999. Balance sheets are reclassified in order to reduce the dependence on accounting conventions used by each firm to record income figures and asset values. The focus of CADS on the level of borrowing skews the sample toward larger firms and as a consequence toward Northern firms. Moreover, since banks deal mainly with firms that are creditworthy, the sample is also biased toward better than average quality borrowers.

After ruling out outliers and firms in the first and in the last percentiles computed along various dimension, we end up with about 270,000 observations. The distribution of firms across years is described in the first row of Table 1: the size of our sample grows monotonically from 9,000 firms in 1982 to 18,000 in 1994, after that, it drops down to 11,000. About 8 per cent of firms are present in all the eighteen years (a similar percentage for only 1 year), 50 per cent are however observed for at least 8 years. The sample has a quite good coverage: in terms of total value added and employment in the Italian manufacturing, our sampled firms covers between 21 and 30 per cent. Importantly, the coverage over total exports is also very high (between 13.5 and 26.5 per cent).

In Table 2 we provide summary statistics relatively to three years: 1985, 1990, 1995 refer to different cyclical points. Descriptive statistics refer to the full sample and to the subsample of exporting firms. Sample values on sales, value added and employees testify that, despite CADS's bias towards large firms, we still have a good relative representativeness of smaller ones. In 1995 firm size ranges from 4 to more than 1,000 employees with a mean equal to 98 and a median equal to 58. In terms of sales, value added and number of employees, the maximum, the mean and the median reach a peak in 1995 and a trough in 1990. Average firm age is around 20 years; the oldest firm is 140 years old. The average unit wage grows over time from 21 to 28 (1995 equivalent) thousands of euros. Exporting firms are on average larger, makes more sales and produce a higher value added. They also pay

[3] Centrale dei Bilanci is the organization in charge of gathering and managing the data. It has been established in the early '80s jointly by the Bank of Italy, the Italian Banking Association (ABI) and a pool of leading banks with the goal of collecting and sharing information on borrowers. Thus the sample is not randomly drawn since firms enter only by borrowing from one of the pooled banks.

higher average unit wages.

Table 3 describes firm distribution in terms of sectors and location. Above 70 percent of our firms are located in the North, less than 10 percent in the South. The sectoral distribution reflects, at least on a qualitative basis, the Italian specialization. The most represented industry is indeed the one producing industrial and commercial machinery (excluding computer and office equipment); many firms (about 18 per cent) operate in the so called traditional sectors (textile, apparel and leather), while very few belongs to the most innovative "computer and office equipment" and "measuring and controlling instruments". Limiting to exporters, the share of firms operating in the sectors of specialization grows; they are also mainly located in the northern part of Italy.

The propensity to export grows with firm size (Table 4). In 1995 it goes from 40.4 per cent for firms with less than 50 employees to 75.2 for those with more than 300 employees. Moreover, these figures have significantly increased across time[4]. Adding the sectoral dimension, some interesting patterns come out. Among small firms, the propensity to export is the largest in traditional sectors, which is a clear indication on the structure of these sectors. On the contrary, firms producing "industrial and commercial machinery" show high relative propensities for each size class.

We now turn to some statistics on flows of firms in and out foreign markets (Table 5). For a given pair of years, the top part of the table is a transition matrix: out of the number of firms exporting at time t, it gives the proportion of those exporting and not exporting at time $t+1$; the same for firms not exporting at time t. The Table therefore provides entry and exit rates together with the degree of persistence to stay in and out foreign markets. These flows are then related, in the median part of the table, to the evolution of the Italian real effective exchange rate (based on production prices), to those of world export volume and of Italian domestic demand[5]. The last two rows show the ratio between entrants and exitants' exports over total exports in the sample.

Not surprisingly, entry (No_t - Yes_{t+1} sequence) and exit (Yes_t - No_{t+1} sequence) rates peaked during the period 1992-95. Before the lira depreciation, the difficulties of Italian firms on foreign markets were quite evident:

[4] More precisely, these increases have been themselves increasing in size. Between 1985 and 1995, the propensity to export has grown by 20 per cent for small firms, 23 per cent for medium firms and 37 per cent for large ones.

[5] All three indices are equal to 100 in 1993. The real effective exchange rate is produced by the Bank of Italy: the methodology is described in Economic Bulletin no. 26). The world export volume is taken from IMF, the domestic demand index by Istat.

30 per cent of exporters abandoned foreign markets in 1992, the subsequent year this fraction jumped to 45.4 per cent. Later on, the strong depreciation of the lira has supported entry: for 1993, 1994, 1995 entry rates have been, respectively, equal to 17.2, 19.3 and 25.2. In 1994 and 1995 the acceleration of foreign demand provided a further push to new exporters. It is much relevant to notice that in these years entering and exiting firms produced even one third of total exports; this is to say that these flows of firms had a huge impact on Italian aggregate trade[6]. Interestingly, since 1997, despite entry rates not too smaller than their time average, the contribution of entering firms to total export values has dramatically decreased. This testifies a dominance of small firms among new entrants, which in turn might reflect two facts: the long history of increasing openness of the Italian economy and the 1992-95 depreciation episodes which have favored a thorough internationalization among medium and large firms.

In general, Table 5 shows a quite promising picture. Most of the years, the relationship between exchange rate and world exports on one side and entry and exit rates on the other side has the expected sign and intensity. The effect of domestic demand is less evident: in general it seems to emerge a negative correlation confirming that propensity to export grows when domestic demand is weak, *ceteris paribus*.

Nonetheless, flow patterns can not be read only according to macroeconomic variables; various firm and sector specific factors and also economic policies, both domestic and foreign ones, affect firms' decision about export participation. Moreover, sunk costs make the relationship between exchange rate, world demand and entry/exit even more complex: what matters is not only the current value of exogenous variable but also expectations over the evolution of these variables and the degree of uncertainty characterizing such expectations. A more structural analysis is therefore needed and this is what we address in the next sections.

3 The theoretical model

The theoretical model, from which we derive our reduced-form empirical specification, is taken from Roberts and Tybout (1997)[7]. We present it here starting from the firm's static problem with no sunk costs of entry and exit

[6] This is contrary to what found by Campa (2000) on a sample of Spanish manufacturing firms.

[7] The same model is used by Bernard and Wagner (1997), Campa (2000) and Bernard and Jensen (2001).

and then introducing a more general multiperiod structure with sunk costs. Finally, we extend Roberts and Tybout' model to consider a more complex temporal structure of sunk costs.

Let us define by $\pi_{i,t}$ firm i's profits from exporting at time t. Assuming zero entry and exit (sunk) costs and indicating with $q^*_{i,t}$ the profit maximizing level of exports, the foreign market participation problem of firm i at time t is as follows

$$\max_{y_{i,t}\in\{0,1\}} \pi_{i,t} \equiv [p_{i,t}(q^*_{i,t}, e_t, Z_{i,t}, X_t)q^*_{i,t} - c_{i,t}(e_t, X_t, Z_{i,t}|q^*_{i,t})]y_{i,t} \tag{1}$$

where $p_{i,t}$ is the price of firm i's output on foreign markets in domestic currency, which is likely to depend on the quantity $q^*_{i,t}$, on the exchange rate e_t, on various firm characteristics[8] summarized by the vector $Z_{i,t}$ and, finally, on other aggregate (besides exchange rate) factors X_t. Reasonably, the same variables influence also the cost $c_{i,t}$. The optimal strategy $y^*_{i,t}$ is easily derived:

$$y^*_{i,t} = \begin{Bmatrix} 1 & \text{if} & \pi_{i,t} \geq 0 \\ 0 & \text{if} & \pi_{i,t} < 0 \end{Bmatrix} \tag{2}$$

In a multiperiod context, the problem generalizes to

$$\max_{\{y_{i,\tau}\}_{\tau=t}^{\infty}} \Pi_{i,t} = E_t\left(\sum_{\tau=t}^{\infty} \delta^{\tau-t}\pi_{i,\tau}\right) \tag{3}$$

where δ is the one-period discount factor. If in a given period revenues and costs do not depend on past choices, then firm is called to maximize a sequence of static problems as in (1) and the solution will be again (2).

One interesting case in which this condition of "intertemporal independence" does not hold is when firms must pay entry (and exit) costs that are partially sunk. In this case, the participation problem differs if the firm has paid such costs in the past or not. As a result, an entering firm must take into account foreign market's future conditions; an exiting one must consider that its current decision will heavily affect future profits by imposing to pay sunk costs in case of reentry in foreign markets. When we explicitly include these costs, per period profits from exporting become

$$\widetilde{\pi}_{i,t}(y_{i,t-1}) = y_{i,t}\left[\pi_{i,t} - (1 - y_{i,t-1})K\right] - (1 - y_{i,t})y_{i,t-1}F \tag{4}$$

[8]These characteristics impact on prices through costs, product quality, efficacy of distribution and marketing policies, etc.

where $y_{i,t-1}$ defines firm i's state (exporter vs non exporter) at the beginning of period t, $\pi_{i,t}$ are now gross (of sunk costs) profits from exporting, K is the level of sunk entry costs and F is the one of sunk exit costs. The Bellman equation for this problem is as follows

$$V_{i,t}(y_{i,t-1}) = \max_{y_{i,t}\in\{0,1\}} \widetilde{\pi}_{i,t}(y_{i,t-1}) + \delta E_t\left(V_{i,t+1}(y_{i,t})\right) \tag{5}$$

and the optimal strategy results to be

$$y^*_{i,t} = \begin{Bmatrix} 1 \text{ if } & \pi_{i,t} + \delta E_t\left(V_{i,t+1}(1)\right) - (1-y_{i,t-1})K \geq 0 + \delta E_t\left(V_{i,t+1}(0)\right) - y_{i,t-1}F \\ 0 \text{ if } & \pi_{i,t} + \delta E_t\left(V_{i,t+1}(1)\right) - (1-y_{i,t-1})K < 0 + \delta E_t\left(V_{i,t+1}(0)\right) - y_{i,t-1}F \end{Bmatrix}$$

that can be written as

$$y^*_{i,t} = \begin{Bmatrix} 1 & \text{if } \pi_{i,t} + \delta A - K + (K+F)y_{i,t-1}) \geq 0 \\ 0 & \text{if } \pi_{i,t} + \delta A - K + (K+F)y_{i,t-1}) < 0 \end{Bmatrix} \tag{6}$$

where $A = [E_t\left(V_{i,t+1}(y_{i,t}=1)\right) - E_t\left(V_{i,t+1}(y_{i,t}=0)\right)]$.

The structural estimation of this model would require to choose a specific functional form for the profit function and a particular process for the exchange rate and the other exogenous aggregate variable. We choose instead the following reduced-form specification

$$y_{i,t} = \alpha_0 + \alpha_1 y_{i,t-1} + \beta e_t + \gamma X_t + \theta Z_{i,t} + \epsilon_{i,t} \tag{7}$$

where a positive α_1 would prove the existence of sunk costs. More precisely, since α_1 proxies for $(K+F)$, it measures the width of the inaction band within which firms neither enter nor abandon foreign markets[9]. It is worth mentioning that we capture sunk costs through persistence in firm's behavior; the idea is that firms with past experience in foreign markets are more likely to be exporters today than those without that experience, *ceteris paribus* (state dependence).

The model as specified above and, consequently, equation (7) embed some strong simplifications. First of all, K and F do not vary across firms. This is highly implausible: the level of sunk costs must differ according to the type of product - that may require different marketing strategies and distribution policies - to firm characteristics - size, management ability,

[9] In a diagram with export market profitability on the vertical axis and time on the horizontal one, the upper band, above which firms enter the foreign market, is increasing in K; the lower band, below which incumbent firms abandon the market, is decreasing in F.

location, relative importance of exports in terms of total sales - and to foreign market's features - large vs small, developed vs developing. To some extent, we will relax this assumption in the empirical analysis.

Secondly, equation (7) presumes that sunk entry costs must be paid again by all non-exporting firms independently of their experience before $t-1$; in other words, the model above implies that all the factors imposing sunk costs depreciate completely after one period. More reasonably, instead, depreciation occurs more slowly, especially if such factors relate to some learning activity: we will show it empirically. Finally, we extend Roberts and Tybout (1997) by allowing entrant firms to pay sunk costs over a sequence of periods instead of only in the entry period.

Appendix Adescribes in details how to amend the model in these two cases.

4 The estimation strategy

The estimation of equation (7) raises a number of issues. A first one relates to the well known omitted variable bias caused by unobserved firm characteristics. On one hand, these unobserved factors may induce persistence to the extent they are time invariant: in our specific case this source of persistence will naturally be picked up by the state dependence we are looking for; as a result we would end up in the so called "spurious state dependence" problem (Heckman, 1981a), that materializes in a mistakenly high coefficient of the lagged dependent variable. On the other hand, these omitted variables are very likely correlated with the firm characteristics included as regressors so that the coefficients of the latter ones result to be inconsistently estimated. Notationally, the problem can be represented by decomposing the residual $\epsilon_{i,t}$ into two pieces:

$$\epsilon_{i,t} = v_i + u_{i,t} \tag{8}$$

where v_i denotes time invariant firm specific unobserved characteristics and $u_{i,t}$ is a random error.

One strategy would be to control for as many as possible firm characteristics to empty v_i of any significance in the estimate: it is quite intuitive that this strategy finds an obvious limit in the content of the dataset. Chamberlain (1984) proposes a more realistic one that has been successfully implemented by Arulampalam et al. (1998) and Henley (2001). Chamberlain suggests to model somehow the unobserved heterogeneity, for example assuming it can be proxied by a vector of means of the observable characteristics, i.e.

$$v_i = a_0 + a_1' \bar{Z}_i + \xi_i \tag{9}$$

where now ξ_i is by construction orthogonal to $Z_{i,t}$ for any i and any t; in words, ξ_i is that part of unobserved heterogeneity which is not correlated with observed firm characteristics[10]. In equation (7), the omitted variable problem is solved substituting $\epsilon_{i,t}$ with equations (8) and (9) to get[11]

$$y_{i,t} = \alpha_0' + \alpha_1 y_{i,t-1} + \beta e_t + \gamma X_t + \theta Z_{i,t} + a_1' \bar{Z}_i + \xi_i + u_{i,t} \tag{10}$$

More intuitively, Chamberlain's solution simply amounts to add a regressor proxying for the part of unobserved heterogeneity that is correlated with the regressors. The presence of ξ_i calls for an estimate with random or fixed effects: we will come back on this later on.

Estimation of dynamic models like ours faces another serious difficulty, known as the "initial conditions problem" (Heckman, 1981b). The problem regards the exporting status of a firm in its first year of observation, i.e., $y_{i,0}$ which is not very likely firm's first year of life[12]. For obvious reasons, this observation is not modelled when estimating equation (10) since the sample does not provide the lagged status and the other lagged controls. One important consequence is that $y_{i,0}$ is correlated with $\xi_{i,0}$ so that the estimate of α_1 is inconsistent. More seriously, if unobserved factors are positively related to the probability of exporting, then α_1 results to be overestimated so as to conclude in favor of artificially high sunk costs. To account for this problem, we follow Heckman (1981b) who suggests to estimate a reduced form equation to model the first year observation:

$$y_{i,0} = b + \beta e_0 + \gamma X_0 + \theta Z_{i,0} + a_1' Z_i + \eta_i \tag{11}$$

where we again include the vector of means to control for unobserved heterogeneity. Evidently, equation (11) differs from equation (10) only because it lacks the lagged dependent variable.

[10] It must be also noted that, given the orthogonality between v_i and $u_{i,t}$, ξ_i is also orthogonal to $u_{i,t}$.

[11] $\alpha_0' = \alpha_0 + a_0$

[12] More elegantly, Arulampalam et al. (1998) write: "...the start of the observation period does not coincide with the start of the stochastic process generating [exporting] experience."

Following Orme (1999), we estimate the model given by equations (10) and (11) in two steps[13]. In the spirit of Heckman selection bias procedure, we first estimate the presample equation (11) using a probit model over the first three observations of each firm, then we take the estimated residuals $\hat{\eta}$ and add them to equation (10) to get

$$y_{i,t} = \alpha_0' + \alpha_1 y_{i,t-1} + \beta e_t + \gamma X_t + \theta Z_{i,t} + a_1' \bar{Z}_i + \delta \hat{\eta}_i + \omega_i + u_{i,t} \qquad (12)$$

with the idea that $\hat{\eta}_i$ proxies for that part of unobserved heterogeneity which is correlated with $y_{i,0}$ so that ω_i is at the end the remaining unobserved heterogeneity that is now orthogonal both to the lagged dependent variable and to the other firm specific regressors.

Finally, we follow Roberts and Tybout (1997) and assume that $u_{i,t}$ has a first-order autoregressive structure, $u_{i,t} = \rho u_{i,t-1} + \tau_{i,t}$, which aims to account for the persistence that may derive from transitory shocks. Now it is $\tau_{i,t}$ to be independently and identically distributed.

We estimate equation (12) using a random effects probit model. As argued by Heckman (1981b), the use of fixed effects in probit models provides inconsistent estimates ("incidental parameters problem"); this inconsistency becomes a more serious problem when the time dimension is small or the model is dynamic.

With this specification, we slightly innovate over the other papers on the same topics. Roberts and Tybout (1997) and Campa (2000), that estimate a random effects probit model with initial conditions, do not introduce the vector of means to control for unobserved heterogeneity; our results will show it instead to be an important correction. Bernard and Wagner (1998) and Bernard and Jensen (2001) do not even implement the presample estimation[14].

5 The results

The results from the estimation of equation (12) are shown in Table 6. In column [1] they refer to a simpler specification not including firm specific

[13]It must be said that this simplifying two-step estimation procedure would be a good approximation of a more complete model only if the correlation between η_i and ξ_i is small. However, Arulampalam (1998) has shown that the procedure provides acceptable results in a wider variety of cases.

[14]They do not estimate a Probit model but a linear probability one without any individual effect, then in levels with fixed effects, finally in differences.

regressors, the vector of their means and the correction for the initial conditions[15] but only three macroeconomic variables. The Italian real effective exchange rate based on the domestic production prices ($REER$) measures price competitiveness of Italian products on international markets: not surprisingly, the probability to export is higher in years of real depreciation of the domestic currency (increase of the index). WT, which indexes world trade conditions, has also a positive sign since firms more likely export when facing a higher external demand. Finally, DD proxies for domestic demand to test the hypothesis that Italian firms sell abroad especially when demand is scant in Italy. Surprisingly, domestic demand's (negative) effect (-.033) is, in absolute terms, stronger than the (positive) one of foreign demand (.013), to say that foreign market participation is more reactive to domestic than to external conditions. Speculatively, this might be due to small size and low internazionalization of the average Italian manufacturing firm. Overall, it must be said that the three variables provide a more complete description of the effects of the macroeconomic environment on exports than what can be inferred in other papers: Roberts and Tybout (1997), Bernard and Wagner (1998) and Bernard and Jensen (2001) use time dummies; Campa (2000) looks at the effect of the exchange rate but does not control for foreign and domestic demand.

Column [1] provides also clear evidence in favor of sunk costs; the coefficient of y_{t-1} is significantly positive and quite large: having past experience makes current exporting an almost certain activity (the marginal effect amounts to about 90 per cent).

In column [2] we look at the impact of the presample estimation (see Appendix B). The correction term (res) has a strongly significant coefficient ($t-statistic$ 22.49), signalling we had an initial conditions problem in column [1]. As a result, the marginal effect of y_{t-1} drops to .819 from .866, but remains quite high and significant.

We then introduce a first set of firm specific variables (column [3]). The size of the firm may be relevant for a series of reasons. In the presence of fixed costs to get access to foreign markets, larger firms face easier times. Krugman (1984) argues that firms may decide to export part of their production in order to exploit scale economies[16]. Often size is interpreted as a proxy for firm's success and efficiency. The positive relationship between

[15] Obviously, we will appreciate their contribution by including them in the regression once at a time.

[16] As argued by Basevi (1970), it might be that a firm sells abroad even at a price lower than the average total cost just to exploit the overall cost reduction deriving from the expansion of production.

firm size and propensity to exports have already found a vast empirical support: among others, Bernard and Jensen (1998) find that US exporters display ex ante faster sales and employment growth than non-exporters; Ferragina and Quintieri (2001) show that Italian exporting firms are *ex ante* larger. We confirm this evidence: the variable *size* (which is the logarithm of the number of employees) is positive and strongly significant.

Age is also often used to proxy for firm efficiency[17]. Relying on previous evidence for Italian manufacturing firms (Bugamelli et al., 2000), we allow for a non linear relationship between age and probability to export and include a quadratic term. However, we find that age does not play any role. A control for the ownership structure is provided by the dummy variable *group* that is equal to 1 if a firm belongs to an industrial group: not surprisingly, such firms find it easier to export part of their production.

We also include sector and location dummies: the former ones follow the two digits of the Nace Rev. 1 classification, the latter ones distinguish between North West, North East, Center and South. A different feature of firm's location is captured by the dummy *distr* that identifies if a firm belongs to an industrial district[18]. The positive role of industrial districts for the Italian economy is well documented[19]: here we find that indeed districtual firms are more likely to become exporters. This result deserves particular attention in the light of two considerations. Given the sectoral dummies, the higher than average export propensity of districtual firms is not the result of their specialization in sectors of Italian comparative advantage (textile and clothing, leather and leather products, furniture, etc.): it is rather that positive network externalities are at work within districts. Moreover, these externalities benefit small and medium size firms that, as just shown, face major difficulties to export. Last but not least, the inclusion of firm controls further reduces persistence in exporting behavior: the marginal effect of the

[17] Tybout (1996) for Chile and Roberts (1996) for Colombia find that the probability of failure declines with plant's age. According to Liu and Tybout (1996), Colombian failing firms are always less productive than surviving ones. For the US, the same patterns are found by Dunne et al. (1989). In other words, the idea is that market forces select out inefficient producers so that older firms are more efficient and therefore more competitive in world markets.

[18] According to the Italian National Statistical Institute (Istat), a district is identified as a local labor system, which is a territorial grouping of municipalities characterized by a certain degree of commuting by the resident population, with a high concentration of small and medium size firms belonging to the same two-digit sector. To construct our dummy variable, we have merged our dataset with the Industrial District Database constructed by Istat.

[19] Signorini (2000) offers a thourough and critical discussion and reviews a wide set of empirical works.

lagged dependent variable goes now to .75.

Bernard and Wagner (1997) show that highly productive German firms are more likely to become exporters. For some developing countries, Clerides et al. (1997) find that this probability is larger in low cost firms. Ferragina and Quintieri (2001) conclude that Italian exporters are more human capital intensive, technologically more advanced, more productive and with lower labor unit costs. Along these lines, in column [4] we include labor productivity ($ywork$ is the log of the value added per worker at 1995 constant prices) and average unit labor costs ($wage$ is the log of the ratio between total labor costs, at 1995 constant prices, and the number of employees). They have the expected sign, positive for productivity and negative for wage. It is worth mentioning that $wage$ measures cost and price competitiveness in that we explicitly control for firm productivity: interestingly, if dropping $ywork$, the coefficient of $wage$ becomes marginally positive in that more productive firms also pay higher salaries.

In column [5] we look at other two firm characteristics that are more directly related to exporting activity. $Market$, given by the ratio of marketing, distribution and advertising expenses over sales, aims to measure the degree of firm (or, better, product) visibility and, somehow, the quality of customer services. $xsales$ is the percentage of sales that a firm make on foreign markets; intuitively, the higher it is, the more likely is that a firm will not abandon foreign markets, independently of sunk costs to exports. The persistence induced by a high $xsales$ has more to do with sunk costs implied by the establishment of the firm as itself than with sunk costs to exports; for such firms, leaving foreign markets is somehow equivalent to an economic failure or to a significant (and costly) reorganization of activity (for example, through a reduction of employment and other inputs). Moreover, $xsales$ can also serve as a proxy for unobserved characteristics that are strongly relevant for exporting activity (e.g., managers speak english). Both coefficients are significantly positive and contribute to largely reduce the coefficient of y_{t-1} whose marginal effects goes down to .70.

In the last column of the Table we add the control for unobserved heterogeneity, i.e. the vector of means of the regressors as suggested by Chamberlain (1984). More precisely, we include all the time-varying firm specific regressors with the exception of the percentage of exported sales, which is evidently endogenous to the participation decision. Importantly, most of the coefficients of the lagged regressors remain significant, though definitely smaller. The invariance of the marginal effect of the lagged dependent variable (.70) may be interpreted as if we had already eliminated all the persistence caused by unobserved firm characteristics.

Finally, the sectoral and location dummies deserve a comment. Despite the wide set of firm level controls, we find that the international specialization matters. The coefficients are strongly significant and positive for textile, apparel, leather and leather products, industrial and commercial machinery, furniture and fixture. Firms located in the South and, to a lesser extent, in the central part of Italy lag behind; this could reflect both their smaller degree of industrial development and their bigger distance from the main destination markets (e.g., EU).

5.1 Marginal effects

In Table 8 we provide the marginal effects only for the relevant regressors from column [6] in Table 6. The standard methodology to compute marginal effects in a Probit estimation is reported in the note to the Table.

Before quantifying the impact of the explanatory variables on the probability of exporting, two remarks are needed. Firstly, due the dynamic specification of our model with the lagged dependent variable there are three possible ways of computing marginal effects starting from a single estimated coefficient $\hat{\beta}_i$: we can use either one of the three average predicted values of the dependent variable $(\bar{x}'\hat{\beta})$ which refer to the entire sample of firms, to the subsample of firms exporting or not exporting at $t-1$. In the Table, these effects are reported, respectively, under the headings "all firms", "$y_{t-1} = 1$", "$y_{t-1} = 0$".

Secondly, the average predicted value must serve as benchmark to assess the relative importance of a marginal effect. As resulting from the Table, the average estimated probability to export is around 44 per cent for the entire sample, goes up to 86 per cent for firms with past experience on foreign markets, drops to 12 per cent for not exporting firms[20]. If we let y_{t-1} captures the constant difference in probability between firms with and without past experience, then the marginal effects of the other variables can be referred to the average probability when $y_{t-1} = 0$ (that is, to 12 per cent), which is also a more interesting information from the point of view of policy makers.

Having said that, let us proceed with some simple calculations. From $REER$, it results that a 1 per cent real depreciation raises the probability to export by 0.2 percentage points; therefore the 1992 crisis of the lira exchange rate have made access to foreign markets more likely by about 3.2 percentage

[20] Not surprinsingly, the marginal effect of y_{t-1} (reported in curly brackets in Table 6) is equal to the difference between .86 and .12.

points, which can be considered a big effect since it corresponds to one fourth of the average probability. Increases in foreign and domestic demand have impacts that are, respectively, three and six times bigger than that of foreign exchange[21].

The marginal effect of *size* (.04 percentage points) is saying that adding 10 employees to a firm raises its probability of exporting by .4 percentage points which is about 3 per cent of the average probability. Being located in a district or belonging to an industrial group increases probability by almost 1 percentage point, that is a big 10 per cent of the average probability.

The impact of the continuous variables *ywork* and *wage* can be better described through elasticities rather than marginal effects[22]. It results that a 1 per cent increase in the level of labor productivity raises the probability of exporting by about .07 per cent; an equivalent effect derives from a 1 per cent decrease in the average unit wage.

5.2 Robustness

Our results show to be robust to various changes in the dataset and in the empirical specification.

Our approach has been to keep in the dataset all firms with reasonable figures to maximize the dimension of the working sample; however, this does not prevent us from the risk that some firms with peculiar characteristics may drive the results. We think, for example, of firms that we observe for less than three consecutive years[23]. Since persistence in firm's behavior is more likely over short than long periods, these firms may display an artificially higher than average persistence and thus induce an unpward bias in the coefficient of y_{t-1}. A similar overestimation can in theory be induced by firms intermittently appearing and disappearing from the sample. Given our dataset's bias toward better firms, these "marginal" firms may appear in periods of good performance where they also export and disappear in bad periods when they instead make zero sales on foreign markets. This in and

[21] This may also reflect a scale effect: in the time series dimension, a one per cent change in demand is relatively larger than a one per cent change in the exchange rate.

[22] To compute the elasticity $\varepsilon_{P(y),x_i}$, it suffices to multiply the marginal effect $\frac{\partial P(y=1)}{\partial x_i}$ by the average value of x_i and dividing it by the normal cumulative distribution function evaluated at the average predicted probability, i.e. $\varepsilon_{P(y),x_i} = \frac{f(\bar{x}'\hat{\beta}) * \hat{\beta}_i * \bar{x}_i}{F(\bar{x}'\hat{\beta})}$. In the case of logarithmic variables, the elasticity simplifies to $\varepsilon_{P(y),x_i} = \frac{f(\bar{x}'\hat{\beta}) * \hat{\beta}_i}{F(\bar{x}'\hat{\beta})}$.

[23] In the specification with just one lag of the dependent variable they are not necessarily dropped by the estimation procedure.

out of the export market that would reduce overall persistence is *de facto* not considered in our estimation. We have therefore excluded these firms and re-estimated the specification given in column [6] of Table 6 obtaining, in both cases, the same results.

Small exporters can instead cause an underestimation of y_{t-1}. The reason is quite intuitive. Firms can export very small amounts without getting any real access to foreign markets but simply matching demand from an importer that has its own distribution network. Indeed excluding firms that exported in a year less than 200,000 euros slightly raises the coefficient of the lagged dependent variable to 2.07.

One can argue that an AR(1) structure of the error does not capture all the persistence that may derive from transitory but not too short exogenous shocks. We have therefore extended it to an AR(2) without recording any difference in the results. The same has happened adding more lags of the firm specific regressors.

Finally, we have increased the disaggregation of the location (96 provinces instead of four macroareas) and sectoral (4 instead of 2 digits) dummies to control for fixed effects that might be strong locally and/or at product level. Again we have registered no changes in our relevant coefficients.

6 The temporal structure of sunk costs

A characteristic of sunk costs to exports which is key to assess the impact of a domestic currency devaluation over aggregate trade is their temporal structure. With this, we mean mainly two things. On one side, we are interested to understand how fast the factors (for example, knowledge, experience, reputation) for which firms pay sunk costs depreciate. Intuitively, the smaller is their depreciation rate, the longer lasting is the effect of an even temporary shock on aggregate trade. On the other side, we want to understand how firms pay these costs upon entry: do they pay for all of them upon entry or can they distribute them over some periods? In the latter case, the persistence effect of sunk costs would be reduced.

Depreciation is detected through the estimation of equation (A2) where we add dummy variables to capture the number of years a firm has been out of foreign markets. The interpretation of the coefficients is identical to the one of y_{t-1}: a positive and significant coefficients for Y_{t-j} says that a firm that exported last time j years ago is more persistent than one that never exported or did it more than j years ago: this is to say that in case of reentry this firm is called to pay a lower amount of sunk costs (relatively to sales). We would also expect the coefficient of Y_{t-j} be decreasing in j as a signal that some depreciation occurs, notwithstanding.

In Table 9 we report only the coefficients of sunk costs in that the results for the other variables do not significantly change. The coefficient of the second lag (Y_{t-2}) is strongly significant and positive; factors behind sunk costs, though, clearly depreciate. When adding the third lag, the results are qualitatively confirmed: firms with past experience show some persistence even if progressively less than actual exporters[24]. We have added further lags and concluded that increasing depreciation brings the coefficient close to zero when $j = 6$.

We then tackle the problem of how sunk costs are paid over firm's export experience. In column [3], we estimate equation (A4) and include one lag that aims to single out (of the mass of firms exporting at $t-1$) firms that did not export between[25] $t-6$ and $t-2$. The coefficient of S_{t-1} is not significantly different from zero. The evidence that these costs must be fully paid in the entry period is confirmed in columns [4] and [5] where exporters with, respectively, two and three years of experience are identified.

The combination of these two results is saying that persistence in foreign market participation due to the need of paying sunk entry costs has very long lasting effects that are also very strong just from the beginning. In a sense, this evidence suggests that the the structural change occurred to the Italian aggregate export function after the lira depreciations in 1992 and 1995 should be still there: due to the strong and prolonged persistence, subsequent reappreciations (in particularly in 1996) should indeed not have had a too big impact on the aggregate function.

7 Size

So far we have imposed a unique sunk costs coefficient to all firms, which is admittedly a quite strong assumption. In this section we relax it distinguishing firms according to their size. In doing so, we can also test the relative importance of two hypotheses, one proposed by Caves (1989), the other one by Tybout (2001).

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[24] The addition of more lags makes y_{t-1} more capable of measuring the differential persistence between exporters and firms that never exported since persistence of firms that ceased exporting just few years before t is now captured by Y_{t-j}. As a result, the coefficient of y_{t-1} grows. We must admit we have no explanation for the reduction of the coefficient as compared to Table 6.

[25] The choice of $t-6$ is related to our previous result.

If sunk costs relate to information acquisition, organizational matters and similar things, Caves (1989) argues they should come in an almost fixed amount independently of firm size. Thus smaller firms would encounter relatively higher barriers to entry into foreign markets[26]. A further argument to support this hypothesis is that bigger firms typically dispose of a larger and cheaper network to collect information. As a result, larger firms can more easily adjust to fluctuations in export markets profitability through entry and exit.

The validity of this hypothesis would directly call for policy interventions. On one side, one peculiarity of the Italian economy is its extremely large share of small firms as compared to other industrialized countries; on the other side, in 1998 only half of the exporting firms had less than 10 employees despite these firms counts for 95 per cent in the population.

Caves' hypothesis can be tested against the (not necessarily) alternative view proposed by Tybout (2001) that argues that what matters is not firm size but size of exports; his idea is that firms value the level of sunk costs to exports in terms of the amount of sales they would contribute to generate in foreign markets.

Table 10 summarizes the results that are definitively in favor of Caves' view[27]. While the interaction of lagged export participation with size of exports (measured as yearly deviation from its sample mean) is not significant (column [1]), the one with firm size (again in deviation from its yearly mean) is strongly significant (column [2]). The result holds when including both terms (column [3]).

One might argue that size is simply a proxy for technology. Firms in sectors like textile, clothing, leather are smaller because their production technologies do not entail increasing returns to scale. The same techologies, along with specific marketing and distribution policies, might also impose higher sunk costs to exports: for example, it is widely accepted that Italian traditional products compete on international markets through their better quality, that might require more aggressive (and costly) marketing strategies.

In column [4] we add the interaction between y_{t-1} and the sectoral dummies to control for this alternative explanation. The results are clearcut. Firm size really matters: its negative coefficient reduces in absolute terms by a negligible amount and remains strongly significant[28]. Moreover, the

[26] The result is qualitatively the same if sunk costs are an increasing but concave function of firm size.

[27] Again we work on the full model of column [6] in Table 6.

[28] After all, Pagano and Schivardi (2001) show that Italy's peculiarity in terms of firm size holds in any sector.

new interaction terms are by a large extent not different from zero, with the exception of leather and industrial and commercial machinery, whose firms show a significantly lower (and also similar) degree of persistence.

8 Information

A natural question that arises when thinking of sunk costs to exports is about their nature. It is commonly accepted that one important component of sunk costs is the acquisition of information on foreign market demand and various institutional aspects. In this section we show that indeed information affects persistence in and out foreign markets and therefore, given our modeling strategy, imposes firms to pay sunk entry costs. It is worth mentioning that we simply testify that information collection issues have to do with sunk costs, but we are not capable of measuring their relative importance.

A way to detect the importance of information is to distinguish firms according to their ease to overcome informational barriers, whose relevance is bigger the more expensive and/or inefficient is the process of collecting, processing and storing information. We would affirmatively conclude that information is important if firms facing ex ante lower barriers had also a smaller inaction band (i.e., a lower coefficient of y_{t-1}).

Informational barriers vary across firms through two main channels. One indirect channel is firm's exposure to information spillovers. Along the lines traced by the theoretical literature on social learning, two are the necessary conditions for an economic agent to learn from others' actions: a) sharing an analogous decision problem (similarity); b) easily and readily observing such actions. Following Guiso and Schivardi (2000), the Italian industrial districts are an useful laboratory to detect the relevance of information spillovers: they satisfy by construction condition a), while the requirement of firms' physical proximity can satisfactorily proxy condition b). We therefore interact the dummy variable *distr* with the lagged dependent variable and find (column [1] of Table 11) that indeed belonging to an industrial district helps reducing the relevance of sunk costs.

Firms in industrial district are, by definition, smaller than average. Thus the industrial district dummy may combine the positive effect coming from informational spillovers to the negative one related to firm size. To control for the latter and let the former to emerge, we add to the regression the interaction between size and y_{t-1}. The result (column [3]) confirms our intuition.

Again one might argue that the industrial district dummy is in fact capturing some technological aspects rather than informational spillovers: we have indeed seen that two important districtual sectors ("leather and leather products" and "industrial and commercial machinery") display less persistence than average. To wipe out any doubt, we explicitly take into account sectoral specificities of sunk costs, again through the interaction terms between y_{t-1} and the sectoral dummies. In column [3] we show that the informational spillover story holds.

Firms can differ also for their ability to directly collect, process and store information. A possible way to test this hypothesis is to subdivide firms in terms of their endowment of information and communication technologies (ICT). Reasonably, those firms that have made larger investments in these technologies are in principle more able to collect and process information of any kind or, alternatively, they can do it at lower costs and more efficiently[29]. Unfortunately, we do not have data on ICT capital at firm-level; we therefore restore to sectoral information.

To this purpose, we use the sectoral ratio between ICT capital and value added as computed by Bugamelli and Pagano (2001) and identify the following ICT intensive sectors: "printing and publishing", "rubber and plastics products", "fabricated metal products", "industrial and commercial machinery", "computer and office equipment", "measuring and controlling instruments", "motor vehicles and other transportation equipment". The dummy variable ICT is equal to 1 if a firm belongs to one of these sectors.

One consideration is worthy. The two groups we have created are satisfactorily balanced in terms of both their relative contribution to Italian manufacturing value added and their export propensity: we can therefore exclude the results will be driven by comparative advantage forces rather than by ICT intensity. To this end, it must also be noticed that while "industrial and commercial machinery" is considered ICT intensive, "leather and leather products" is not.

Again our estimation (column [4]) supports the hypothesis that information matters for sunk costs to exports: the coefficient of $ICT * y_{t-1}$ is negative and strongly significant ($t - statistics$ -12.16). The results holds invariantly when the interaction with firm size is added to the regression

[29] It is widely acknowledged that the Internet revolution has the potential to reduce the degree of inequality across agents in terms of information collection: through Internet everybody can in principle learn about events occuring in any angle of the globe. This argument should, even more strongly, apply to firms: business-to-business and business-to-consumer activities identify new Internet-based and cheaper practices to get in touch with suppliers and customers.

(column [5]).

9 Concluding remarks

Due to the large fluctuations of the lira exchange rate, many Italian manufacturing firms have entered foreign markets during the nineties. Their contribution to aggregate exports has turned out to be significant. If entry requires paying costs that are partially sunk, these flows have permanently changed the aggregate export supply function.

In this paper we study the export participation decision of Italian manufacturing firms in order to assess the importance of sunk costs to exports. We find that they are significant: prior export experience increases the probability of exporting by 70 percentage points.

Moreover, these costs seem to be an impediment in particular for small firms. This raises two considerations. On one side, the strong lira devaluations have offered small firms an extraordinary opportunity to enter foreign markets; moreover, due to the inertia induced by sunk costs, these firms are not likely to exit in the near future. On the other side, though, a very large number of small firms is still producing only for the domestic market (according to Istat, in 1998 more than 90 per cent of firms with less than 50 employees had zero exports); given the large share of these firms in the Italian manufacturing industry, sunk costs to export remain a very important factor to be considered by export promoting policies. An indirect help might come from policies aiming to support the diffusion of the new information and communication technologies.

References

[1] Arulampalam, W. (1998), "State Dependence in Unemployment Incidence for British Men: Sensitivity to Model Assumptions", *University of Warwick, mimeo.*

[2] Arulampalam, W., A. L. Booth and M.P. Taylor, (1998), "Unemployment Persistence", *Oxford Economic Papers,* vol. 52, pp. 24-50

[3] Baldwin, R. E. (1988), "Hysteresis in import prices: the beachhead effect", *American Economic Review*, vol. 78, pp. 773-785.

[4] Baldwin, R. E. (1989), "Sunk costs hysteresis", *NBER Working Paper*, no. 2911.

[5] Baldwin, R. E. and P. R. Krugman (1989), "Persistent trade effect of large exchange rate shocks", *Quarterly Journal of Economics*, vol. 104, pp. 635-654.

[6] Bank of Italy (1998), *Economic Bulletin* no. 26.

[7] Basevi, G. (1970), "Domestic demand and ability to export", *Journal of Political Economy*, vol. 78, pp. 330-337.

[8] Bernard, A. B. and J. B. Jensen (1998), "Exceptional exporters performance: cause, effect or both?", *Journal of International Economics*, vol. 47, pp. 1-25.

[9] Bernard, A. B. and J. B. Jensen (2001), "Why some firms export", *NBER Working Paper*, no.8349.

[10] Bernard, A. B. and J. Wagner (1997), "Exports and success in German manufacturing", *Weltwirtschaftliches Archiv*, vol. 133, pp. 134-157.

[11] Bernard, A. B. and J. Wagner (1998), "Export entry and exit by German firms", *NBER Working Paper*, no. 6538.

[12] Bugamelli, M., P. Cipollone and L. Infante (2000), "L'internazionalizzazione delle imprese italiane negli anni novanta", *Rivista Italiana degli Economisti*, no. 3.

[13] Bugamelli, M. and P. Pagano (2001), "Barriers to investment in ICT", *Bank of Italy*, *Temi di discussione*, no. 420.

[14] Campa, J. M. (2000), "Exchange rates and trade: how important is hysteresis in trade?", mimeo, IESE.

[15] Caves, R. E. (1989), "International differences in industrial organization" in R. Schmalensee and R. Willig (eds), *Handbook of Industrial Organization*, vol. 2. Amsterdam: North Holland.

[16] Chamberlain, G. (1984), "Panel Data", in S. Griliches and M. Intriligator, (eds.), *Handbook of Econometrics*, Amsterdam: North Holland, pp. 1247-1318.

[17] Clerides, S., S. Lach and J. Tybout (1998), "Is learning-by-exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco", *Quarterly Journal of Economics*.

[18] Dixit, A. (1989a), "Entry and exit decisions under uncertainty", *Journal of Political Economy*, vol. 97, pp. 620-638.

[19] Dixit, A. (1989b), "Hysteresis, import penetration, and exchange rate pass-through", *Quarterly Journal of Economics*, vol. 104, pp. 205-228.

[20] Dunne, T., M.J. Roberts and L. Samuelson, (1989), "The growth and failure of US manufacturing plants", *Quarterly Journal of Economics*, vol. 105, pp. 671–698.

[21] Ferragina, A. M. and B. Quintieri (2001), "Caratteristiche delle imprese esportatrici italiane", in Beniamino Quintieri (ed.), *Le imprese esportatrici italiane: caratteristiche, performance e internazionalizzazione*, Bologna: Il Mulino.

[22] Guiso, L. and F. Schivardi (2000), "Information spillovers and factor adjustment", *Bank of Italy*, *Temi di discussione*, no. 368.

[23] Heckman, J. (1981a), "Statistical models for discrete panel data", in Charles Manski and Daniel McFadden (eds), *The structural analysis of discrete data*, Cambridge: MIT Press.

[24] Heckman, J. (1981b), "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.

[25] Henley, A. (2001), "Self-Employment Choice: the Role of State Dependence and Initial Circumstances", *University of Wales Aberystwyth, mimeo.*

[26] Krugman, P. R. (1984), "Import protection as export promotion: international competition in the presence of oligopoly and economies of scale", in H. Kierzkowski (ed.), *Monopolistic competition and international trade*, Oxford: Oxford University Press.

[27] Krugman, P. R. (1989), *Exchange rate stability*, Cambridge: MIT Press.

[28] Liu, L. and J. R. Tybout (1996), "Productivity growth in Chile and Colombia: panel-based evidence on the role of entry, exit and learning", in M. J. Roberts and J. R. Tybout (eds), *Industrial revolution in developing countries: micro patterns of turnover, productivity, and market structure*, Oxford: Oxford University Press.

[29] Orme, C. D. (1997), "The Initial Conditions Problem and Two-Step Estimation in Discrete Panel Data Models", *University of Manchester, Working Papers.*

[30] Roberts, M. J. (1996), "Colombia, 1977-1985: producer turnover, margins and trade exposure" in M. J. Roberts and J. R. Tybout (eds), *Industrial revolution in developing countries: micro patterns of turnover, productivity, and market structure*, Oxford: Oxford University Press.

[31] Roberts, M. J. and J. R. Tybout, (1997), "The decision to export in Colombia: an empirical model of entry with sunk costs", *American Economic Review,* vol. 87, pp. 545-564.

[32] Signorini, L.F. (ed.) (2000), *Lo sviluppo locale: un'indagine della Banca d'Italia sui distretti industriali*, Roma: Donzelli.

[33] Tybout, J. R. (1996), "Chile, 1979 - 1986: trade liberalization and its aftermath", in M. J. Roberts and J. R. Tybout (eds), *Industrial revolution in developing countries: micro patterns of turnover, productivity, and market structure*, Oxford: Oxford University Press.

[34] Tybout, J. R. (2001), "Plant and firm level evidence on "new" trade theories", *NBER Working Paper* no. 8418.

A Extensions of the theoretical model

To allow for a richer temporal structure of sunk costs, we modify equation (7) following Roberts and Tybout (1997). We identify with K the sunk entry cost that must be paid by those firms which never exported or did it only a long time ago. For the other firms, we introduce a sunk cost K^j where $j > 1$ indicates the number of years in which the firm has been out of the export market. Analytically, we write:

$$\widetilde{\pi}_{i,t}(y_{i,t-1}) = y_{i,t}\left[\pi_{i,t} - (1 - y_{i,t-1})K - \sum_{j=2}^{J}(K^j - K)Y_{i,t-j}\right] - (1 - y_{i,t})y_{i,t-1}F \tag{A1}$$

where $Y_{i,t-j} = y_{i,t-j} * \prod_{k=1}^{j-1}(1 - y_{i,t-k})$ is equal to 1 when a firm exported at $t-j$, exited at $t-j+1$ and did not reenter afterward[30]: in such a case, $(K^j - K)$ goes to add to K leaving a re-entry cost equal to K^j. In line with a positive depreciation rate, we would expect $K^2 \leq K^3 \leq ... \leq K^n \leq ... \leq K$. The equation we are going to estimate in this case is then the following:

$$y_{i,t} = \alpha_0 + \alpha_1 y_{i,t-1} + \alpha_2 Y_{i,t-2} + ...\alpha_j Y_{i,t-j} + \beta e_t + \gamma X_t + \theta Z_{i,t} + \epsilon_{i,t} \tag{A2}$$

To distinguish, instead, the timing according to which firms pay the entry costs, we identify with M^j the sunk cost paid at time t by a firm which entered j years before (after at least n periods out of foreign markets) and did not exit afterwards. The correspondent indicator function is as follows: $S_{i,t-j} = \prod_{p=1}^{j} y_{i,t-p} * \prod_{k=j+1}^{j+n}(1 - y_{i,t-k})$, so that

$$\widetilde{\pi}_{i,t}(y_{i,t-1}) = y_{i,t}\left[\pi_{i,t} - (1 - y_{i,t-1})K - \sum_{j=2}^{J} M^j S_{i,t-j}\right] - (1 - y_{i,t})y_{i,t-1}F \tag{A3}$$

The equation to be estimated becomes:

$$y_{i,t} = \alpha_0 + \alpha_1 y_{i,t-1} - a_1 S_{i,t-1} - a_2 S_{i,t-2} - ...a_j S_{i,t-j} + \beta e_t + \gamma X_t + \theta Z_{i,t} + \epsilon_{i,t} \tag{A4}$$

[30] Obviously, $Y_{i,t-j}$ is equal to zero in all the other cases.

Table A-1: Presample estimation

$REER$	.002	$ywork$	.095
	(.001)		(.019)
WT	.002	$wage$	-.056
	(.001)		(.028)
DD	-.004	$market$	.965
	(.002)		(.184)
$size$	.149	$distr$	.051
	(.018)		(.008)
age	-.198	$group$	.062
	(.112)		(.015)
age^2	.088		
	(.051)		
No. obs.	85,309		
$Prob > \chi^2$	.000		

Notes: Random Effects Probit estimates, heteroskedasticity-robust standard errors in parenthesis; estimation includes also a constant term. The dependent variable is the current status (exporters vs non exporter). For the regressors see also Table 7.

B Initial conditions problem

Following Heckman (1982), we estimate equation (11) over the first three years of observations for each firm. The explanatory variables include the real effective exchange rate ($REER$), the domestic (DD) and external demand (WT), the (log of) firm size ($size$) and firm age (age), the (log of) labor productivity ($ywork$) and average unit wage ($wage$), the ratio between advertising/marketing/distribution expenses and sales ($market$), the industrial district ($distr$) and group ($group$) dummies. The vector of means of the time-varying regressors and the sectoral and location dummies are also included but not reported in Table A-1.

Table 1: Sample size

	1982	1983	1984	1985	1986	1987
number of firms in the sample	9,426	10,291	12,154	13,408	14,688	15,265
value added (% of total manuf.)	21.4	22.1	23.4	24.6	26.0	26.5
employees (% of total manuf.)	21.2	21.8	23.3	24.3	25.2	25.7
value of exports (% of total manuf.)	14.0	13.5	19.0	20.1	21.4	21.5
	1988	1989	1990	1991	1992	1993
number of firms in the sample	16,182	18,027	18,710	18,619	18,760	18,428
value added (% of total manuf.)	26.7	27.6	28.7	29.3	29.4	29.8
employees (% of total manuf.)	26.7	28.1	28.8	28.4	27.5	27.2
value of exports (% of total manuf.)	21.5	23.3	24.2	24.3	20.3	18.6
	1994	1995	1996	1997	1998	1999
number of firms in the sample	18,162	11,914	11,803	11,547	11,151	10,620
value added (% of total manuf.)	29.2	25.6	25.5	24.8	23.5	22.5
employees (% of total manuf.)	27.0	23.6	24.1	23.4	22.7	21.7
value of exports (% of total manuf.)	23.4	24.3	26.5	26.5	26.1	24.9

Table 2: Sample means

	1985		1990		1995	
	full sample	only export	full sample	only export	full sample	only export
sales (thou.of 1995 euro)	11,167	13,381	11,331	13,819	18,674	22,748
value added (thou.of 1995 euro)	3,065	3,752	2,984	3,651	4,847	6,015
employees (sample mean)	85	105	76	95	98	118
employees (sample median)	43	55	37	50	58	72
capital stock/value added	0.67	0.84	1.34	1.12	1.76	1.44
firm age	16	17	18	19	21	22
average unit wage (thou.of 1995 euro)	21.4	21.4	23.6	23.9	28.2	28.7
Marketing expenses (% of sales)	3.1	3.5	3.4	3.9	0.7	1.0

Table 3: Distribution of sample by sector and location

	1985		1990		1995	
	full sample	only export	full sample	only export	full sample	only export
Food, beverages and tobacco	9.4	5.8	8.7	5.5	10.8	7.0
Textile	10.2	12.0	9.5	11.3	10.7	12.2
Apparel and related products	4.1	5.2	4.1	5.1	3.8	4.2
Leather and leather products	4.4	6.8	4.7	7.0	5.0	5.4
Lumber and wood products	2.4	1.3	2.4	1.4	1.9	1.5
Paper and allied products	2.9	1.8	2.7	2.1	2.9	2.4
Printing and publishing	2.4	1.0	3.0	1.2	2.4	1.3
Petroleum refining and related ind.	0.1	0.1	0.2	0.1	0.3	0.2
Chemicals and allied products	6.1	5.3	5.6	4.9	6.0	6.1
Rubber and plastic products	5.7	5.9	5.7	5.6	5.9	6.2
Stone, clay, glass	7.8	5.5	7.2	5.6	6.1	4.7
Primary metal products	4.4	3.6	4.0	3.2	4.1	4.0
Fabricated metal products	10.2	9.0	10.6	9.4	9.6	9.6
Industrial and commercial machinery	14.1	19.4	14.5	19.8	13.8	17.5
Computer and office equipment	0.3	0.2	0.4	0.3	0.2	0.2
Electrical equipment	4.0	4.0	4.5	4.2	4.3	4.3
Audio, video and comm. equipm.	1.9	1.9	2.2	1.9	1.7	1.7
Measuring and controlling instrum.	1.6	2.1	1.8	2.2	1.9	2.0
Motor vehicles	1.7	2.1	1.6	1.6	2.1	2.4
Other transportation equipment	1.2	1.1	1.1	1.1	1.0	0.8
Furniture, fixture and miscell. manuf.	5.4	6.0	5.7	6.7	5.5	6.5
Total	100	100	100	100	100	100
North West	44.7	49.3	44.1	47.2	44.1	48.3
North East	28.1	28.6	28.1	29.8	30.4	33.2
Center	17.4	18.4	18.1	18.4	17.1	14.4
South	9.8	3.7	9.6	4.6	8.4	4.2
Total	100	100	100	100	100	100

Table 4: Propensity to export by sector and size

	1985			1990			1995		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
Food, bever. and tobacco	20.2	34.1	35.2	20.7	31.8	30.2	26.3	43.8	55.6
Textile	45.2	47.7	64.5	42.2	47.0	66.2	55.0	59.1	84.0
Apparel and related products	46.1	54.3	55.9	42.6	50.5	67.4	48.4	62.9	71.8
Leather and leather products	56.9	68.7	80.0	50.6	67.7	69.2	45.9	66.8	92.8
Lumber and wood products	13.2	35.3	25.0	16.7	37.7	20.0	31.9	51.7	75.0
Paper and allied products	18.5	34.5	60.0	20.9	39.8	66.7	27.2	50.3	94.4
Printing and publishing	9.3	22.1	33.3	10.2	24.1	28.6	15.6	35.3	35.7
Petrol. refining and relat. ind.	9.1	28.6	0.0	5.0	10.0	22.2	25.0	45.5	0.0
Chemicals and allied products	27.0	41.0	54.3	26.2	42.4	48.7	39.8	61.9	68.1
Rubber and plastic products	33.9	54.0	59.3	29.6	51.6	50.0	40.6	62.4	100.0
Stone, clay, glass	24.3	36.2	39.5	23.4	43.0	32.7	28.3	46.8	66.7
Primary metal products	23.0	42.5	58.5	20.6	40.2	45.7	35.8	60.7	72.0
Fabricated metal products	27.9	44.4	60.0	26.3	45.2	64.4	43.0	54.8	83.7
Ind. and comm.machinery	49.3	62.5	62.2	45.7	58.8	69.0	54.3	69.6	87.8
Computer and office equip.	11.1	35.3	50.0	20.0	33.3	62.5	27.8	50.0	83.3
Electrical equipment	33.7	45.3	48.9	30.0	43.9	34.4	37.4	59.3	71.7
Audio, video and com. equip.	36.7	41.7	50.0	26.0	45.2	39.4	25.8	63.0	51.6
Measur. and control. instr.	48.6	53.6	72.7	40.0	52.7	65.2	39.0	56.6	80.8
Motor vehicles	36.9	51.7	68.4	32.1	39.3	55.0	52.9	56.4	71.1
Other transportation equip.	33.8	46.9	28.1	31.8	41.4	36.8	34.2	40.6	52.9
Furniture, fixture and misc. m.	39.6	52.9	76.9	38.0	55.3	73.7	49.4	68.4	80.0
Total	33.6	47.8	54.7	31.7	47.2	51.8	40.4	58.6	75.2

Notes: (a) firms with less than 50 employees; (b) firms with between 51 and 300 employees; (c) firms with strictly more than 300 employees.

Table 5: Entry, exit and persistence

t	$t+1$	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91
No	No	90.2	78.7	86.0	86.8	86.0	87.8	82.1	86.8	89.2
	Yes	9.7	21.3	14.0	14.2	14.0	12.2	17.9	13.2	10.8
Yes	No	25.1	15.5	17.8	21.8	19.8	23.9	23.0	19.6	19.7
	Yes	74.9	84.5	82.2	78.2	80.2	76.1	77.0	80.4	80.3
REER	% change	-3.0	-0.2	-1.1	6.1	3.4	2.4	2.1	4.2	-0.5
WT	% change	2.5	8.3	3.4	4.3	6.3	8.9	7.0	5.6	4.6
DD	% change	0.4	3.2	3.1	2.7	4.0	3.8	2.9	2.6	2.1
Entrants	% of X at t	13.6	28.7	13.4	14.6	13.0	13.6	21.6	13.6	12.2
Exitants	% of X at $t-1$	21.5	10.6	13.2	16.7	14.6	18.8	15.7	12.9	12.8

t	$t+1$	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
No	No	90.2	82.8	80.7	74.8	77.7	82.0	84.1	87.2
	Yes	9.8	17.2	19.3	25.2	22.3	18.0	15.9	12.8
Yes	No	30.0	45.4	27.8	11.5	10.3	8.7	6.2	9.0
	Yes	70.0	54.6	72.2	88.5	89.7	91.3	93.8	91.0
REER	% change	-2.3	-14.2	-2.0	-4.6	11.0	0.3	1.4	-2.8
WT	% change	4.4	3.8	10.0	10.0	6.2	10.4	4.6	5.6
DD	% change	0.5	-4.5	2.1	2.2	0.6	2.7	3.0	2.8
Entrants	% of X at t	11.6	31.7	33.8	19.7	11.8	8.5	5.9	4.9
Exitants	% of X at $t-1$	24.6	31.2	15.9	5.4	5.9	4.8	3.1	5.5

Notes: YES and NO refer, respectively, to be or not to be an exporter: the sequence $NO-YES$ identifies the fraction of entering firms, $YES-NO$ identifies the fraction of exiting firms: all rates (entry, exit, stay in and stay out) are computed only over the set of firms that are present in both years under consideration. For $REER$, WT and DD see Table 7.

Table 6: Base regression

	[1]	[2]	[3]	[4]	[5]	[6]
y_{t-1}	2.397*	2.265*	2.065*	2.045*	1.948*	1.939*
	(.009)	(.010)	(.010)	(.010)	(.012)	(.012)
	{.866}	{.819}	{.748}	{.740}	{.705}	{.702}
$REER_t$	.004*	.005*	.006*	.006*	.006*	.006*
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
WT_t	.013*	.014*	.014*	.014*	.013*	.013*
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
DD_t	-.033*	-.036*	-.035*	-.035*	-.034*	-.033*
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
$size_{t-1}$			.152*	.168*	.166*	.076*
			(.005)	(.005)	(.005)	(.018)
age_t			-.389	-.347	-.286	-.349
			(.368)	(.366)	(.365)	(.367)
age_t^2			.173	.156	.129	.157
			(.173)	(.173)	(.173)	(.173)
$ywork_{t-1}$				.168*	.168*	.097*
				(.013)	(.013)	(.020)
$wage_{t-1}$				-.070**	-.071**	-.102**
				(.023)	(.023)	(.034)
$market_{t-1}$				1.065*	1.067*	-.252
				(.109)	(.108)	(.157)
$xsales_{t-1}$					.291*	.288*
					(.024)	(.023)
$distr$			.024*	.023*	.022*	.021*
			(.005)	(.005)	(.005)	(.005)
$group$			.056*	.035*	.033*	.025**
			(.010)	(.010)	(.010)	(.010)
res		.270*	.381*	.392*	.375*	.381*
		(.012)	(.011)	(.011)	(.012)	(.012)
No. obs	162,283	159,214	159,214	159,214	159,214	159,214
$Prob > \chi^2$	.000	.000	.000	.000	.000	.000

Notes: Random Effects Probit estimates, heteroskedasticity-robust standard errors in parenthesis; marginal effects in brackets; all estimations include a constant term. The dependent variable is the current status (exporters vs non exporter); y_{t-1} is the status at $t-1$. For the other regressors see Table 7. * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.

Table 7: Description of firm specific regressors

$size$ is the log of the number of employees
age is the log of firm age
age^2 is the log of squared firm age
$ywork$ is the log of (deflated) value added per employee
$wage$ is the log of (deflated) average unit wage
$market$ is marketing, advertising and distribution expenses over sales
$xsales$ is the ratio between exported and total sales
$distr$ is a dummy variable which is equal to 1 if a firm belongs to an industrial district
$group$ is a dummy equal to 1 if the firm belongs to an industrial group
res is the residual of the presample model ("initial conditions")
$REER$ is Italian real effective exchange rate (index; 1993=100) based on production prices
WT is world export volumes (index; 1993=100)
DD is internal demand at constant prices (index; 1993=100)

Table 8: Marginal effects of base regression (column [6])

	all firms	$y_{t-1}=1$	$y_{t-1}=0$		*all firms*	$y_{t-1}=1$	$y_{t-1}=0$
$REER$	.002	.002	.002	$ywork_{t-1}$	.001	.001	.001
WT	.005	.004	.005	$wage_{t-1}$	-.001	-.001	-.002
DD	-.012	-.009	-.013	$xsales_{t-1}$	.104	.079	.114
$size$	.0003	.0002	.0004	$group$	.009	.007	.010
$distr$	.008	.006	.008				
$\overline{x}'\hat{\beta}$	.44	.86	.12				
$f(\overline{x}'\hat{\beta})$	.36	.28	.40				
$F(\overline{x}'\hat{\beta})$	.67	.80	.55				

Notes: In a Probit model, the marginal effect of the regressor x_i on the probability y is given by $\frac{\partial P(y=1)}{\partial x_i} = \frac{\partial F(x'\beta)}{\partial x_i} = f(x'\beta) * \beta_i$, where the normal density function $f(.)$ is conventionally evaluated at the predicted probability $\overline{x}'\hat{\beta}$ where $\overline{x}$ stands for the regressors' sample averages and $\hat{\beta}$ are the estimated coefficients of column [6] in Table 6. In the case of logarithmic variables ($size$, $ywork$, $wage$), the marginal effect is equal to $\frac{\partial P(y=1)}{\partial x_i} = \frac{\partial F(x'\beta)}{\partial x_i} = (f(\overline{x}'\hat{\beta}) * \hat{\beta}_i)/\overline{x}_i$.

Table 9: Temporal structure of sunk costs

	[1]	[2]	[3]	[4]	[5]
y_{t-1}	1.827*	1.926*	1.960*	1.958*	1.946*
	(.012)	(.013)	(.014)	(.014)	(.015)
Y_{t-2}	.516*	.564*			
	(.015)	(.016)			
Y_{t-3}		.455*			
		(.019)			
S_{t-1}			.033	.033	.041
			(.029)	(.029)	(.029)
S_{t-2}				.011	.015
				(.028)	(.028)
S_{t-3}					.016
					(.028)
No. obs	159,214	159,214	122,595	122,595	122,595
$Prob > \chi^2$	.000	.000	.000	.000	.000

Notes: Random Effects Probit estimates, heteroskedasticity-robust standard errors in parenthesis. The equations include the regressors of the full model of column [6] in Table 6. The variables Y_{t-j} is a dummy that takes on value equal to 1 if a firm exported for the last time j years ago; the dummy S_{t-j} is equal to 1 if a firm started exporting at $t-j$. A detailed description of these variables can be found in Appendix A. * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.

Table 10: Firm size and value of exports

	[1]	[2]	[3]	[4]
y_{t-1}	1.939*	1.946*	1.946*	2.026*
	(.012)	(.012)	(.012)	(.195)
$(dX * y)_{t-1}$	.001		.001	.001
	(.002)		(.003)	(.003)
$(dsize * y)_{t-1}$		-.057*	-.057*	-.054*
		(.009)	(.009)	(.009)
$size_{t-1}$	.076*	.102*	.102*	.100*
	(.018)	(.019)	(.019)	(.019)
No. obs	159,214	159,214	159,214	159,214
$Prob > \chi^2$	.000	.000	.000	.000

Notes: Random Effects Probit estimates, heteroskedasticity-robust standard errors in parenthesis. The equations include the regressors of the full model of column [6] in Table 6. $dsize$ is the number of employees in deviation from the yearly (log) mean ; dX is the value of exports in deviation from the yearly (log) mean. For the other regressors see Table 7. * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.

Table 11: Information

	[1]	[2]	[3]	[4]	[5]
y_{t-1}	1.963*	1.973*	2.035*	1.994*	1.999*
	(.015)	(.015)	(.195)	(.014)	(.014)
$(distr * y)_{t-1}$	-.026**	-.030**	-.025*		
	(.010)	(.010)	(.010)		
$(ICT * y)_{t-1}$				-.154*	-.149*
				(.018)	(.018)
$(dsize * y)_{t-1}$		-.059*	-.055*		-.054*
		(.009)	(.009)		(.009)
No. obs	159,214	159,214	159,214	159,214	159,214
$Prob > \chi^2$	.000	.000	.000	.000	.000

Notes: Random Effects Probit estimates, heteroskedasticity-robust standard errors in parenthesis. The equations include the regressors of the full model of column [6] in Table 6. ICT is a dummy variable that takes on a value equal to 1 for the sectors where the use of Information and Communication Technologies is higher than average: for the list of sectors see the text in Section 8 * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.