SUNK COSTS OF EXPORTS: A ROLE FOR INDUSTRIAL DISTRICTS?

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1. Introduction

In a series of theoretical papers in the late 1980s Baldwin, Krugman and Dixit[1] proposed models of foreign market participation in which firms are called upon to pay sunk costs of exports. These models help explain some puzzles regarding trade flows: comparable exchange rate variations that produce different effects in different countries or in a given country at different dates; large increases in exports after a depreciation that are not followed by similar reductions when the exchange rate returns to its pre depreciation level.

According to this literature, a firm paying sunk costs to enter foreign markets is reluctant to abandon them even if the favourable macroeconomic conditions cease to exist. If sunk costs matter, the decision to export in a given period depends on whether or not the firm is already present in the foreign markets. This generates persistence in a firm's decision to export. As a consequence, temporary fluctuations of the exchange rate may have persistent effects on a country's export function.

The first paper to test the existence of sunk costs using firm-level data was by Roberts and Tybout (1997; henceforth RT). They derived and estimated a model of a firm's decision to export with sunk costs, in which the proposed strategy for identifying the importance of these costs was based on the difference between the behaviour of exporting firms, which did not have to pay any costs to enter foreign markets, and that of firms that are only active in the domestic market and have to pay such costs to become exporters. RT used a sample of 650 Colombian plants for the period 1981-89, finding, with a probit model, that previous exporting status significantly affected the current probability of exporting.

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[*] Bank of Italy, Economic Research Department. We thank Chiara Bentivogli, Guido de Blasio, Sergio de Nardis, Luigi Guiso, Francesco Paternò, Fabiano Schivardi, Luigi Federico Signorini and Roberto Tedeschi for their useful comments. Claudia Borghese provided valuable editorial assistance.

[1] Baldwin (1988 and 1989), Baldwin and Krugman (1989), Dixit (1989), Krugman (1989).

Using the same model, although sometimes estimated differently, other authors have concluded favourably for the existence of sunk costs of exports. Bernard and Wagner (2001) did so in the case of 7,600 German manufacturing plants between 1978 and 1992; Campa (2000) for 2,200 Spanish manufacturing firms between 1990 and 1997; Bernard and Jensen (2001) for 13,600 US manufacturing plants in 1984-1992.

Exploiting the huge variability in Italian data for the exchange rate, export flows and the number of exporting firms, this work estimates RT's model for a very large panel of Italian manufacturing firms

The empirical analysis highlights the importance of sunk costs: an exporting firm in year *t*, which therefore has already paid such costs, has a probability of exporting in the next year that is 70 percentage points greater than that of an otherwise identical non-exporting firm.

The probability of exporting also varies with the characteristics of the firm and the macroeconomic conditions. It increases with labour productivity and the size of the firm, while it decreases with average wages. Firms that are part of industrial groups are more likely to gain access to foreign markets; the probability increases when the exchange rate depreciates, and rises with world demand and when domestic demand is weak.

Industrial districts make a significant contribution in this respect: the probability of exporting is greater for firms in industrial districts. Although district firms are concentrated in sectors with a comparative advantage, this result is obtained by controlling for the different sectoral propensities to export. Bearing in mind the strong positive correlation between propensity to export and firm size, the contribution of industrial districts, which, by definition, are made up of small and medium-sized firms, is even more important.

The paper also shows that activities entailing the payment of sunk costs – collecting information on demand and the functioning of the institutional environment in the foreign country, establishing a distribution network abroad, and promoting products, etc. – must be carried out immediately when entering a foreign market, the effect of these activities appears to depreciate quite slowly. These results strengthen the macroeconomic effect of structural changes in the aggregate supply of exports described above.

The impact of sunk costs varies with the characteristics of the firm. According to Caves (1989), the “quasi-fixed” nature of such costs is a much greater barrier for small and medium-sized firms. Das *et al.* (2001) and Tybout (2001) argue instead that what matters is not the size of the firm, but the amount of exports. The results obtained in this work support Cave’s thesis, suggesting a that special attention should be paid to the problem of the accessing of foreign markets by Italian firms, which are mostly small or medium-sized.

Finally, the paper adopts an innovative methodology to study the nature of sunk costs. We focus in particular on a commonly accepted and important component: the acquisition of information regarding foreign markets. The identifying hypothesis used in the work is that the firms that most easily collect information should encounter fewer barriers to entry. Therefore we consider two possible channels: some firms may possess more information (or of higher quality, or obtained at lower price) because they are more exposed to information spillovers, whereas others have a better technology for collecting, storing and using information. The results suggest that both channels exist.

Grouping economic sectors according to their relative endowment of information and communication technologies, we find that firms belonging to the best-endowed sectors ‘fear’ sunk costs of entry less.

The role of information spillovers in industrial districts is worth investigating. According to recent papers on Italian industrial districts – thoroughly surveyed by Signorini (2000) – a district is a place where the efficient and informal circulation of information is one of the most important elements, and this, in turn, is reflected in the ability of the firms located there. Being located in a circumscribed area and making similar decisions, district firms easily learn from each other, If we classify the firms in the sample according to whether or not they belong to an industrial district, this hypothesis is confirmed: the firms in industrial districts are in a better position to overcome the barriers to export than those not belonging to a district. This result is clearly linked to the working of information spillovers.

The barrier to exporting, which is linked to the payment of sunk costs for entering foreign markets, may be offset in economic agglomerations such as industrial districts. If we also consider the relationship between the limitation imposed by sunk costs and firm size, the evidence regarding industrial districts appears even more significant.

The rest of the paper is organized as follows. In the next section, we describe the data-set, while section 3 is devoted to the theoretical model and to the estimation strategy. The results of the base model are presented in section 4. We then focus on the three principal innovations: the timing of sunk costs (section 5), the relation between such costs and firm size (section 6), and the role of information (section 7).

2. The data

In the empirical analysis we use a sub-sample of firms taken from the yearly survey of approximately 30,000 firms, conducted by the Centrale dei Bilanci (Company Accounts Data Service, or CADS). The CADS collects information on some characteristics of firms and on a large number of balance-sheet items.

After ruling out outliers and firms in the first and last percentiles computed along various dimensions, we end up with about 270,000 observations, corresponding to an unbalanced panel of about 31,000 firms. For the empirical analysis we have used the observations for the years 1982-1999.

Table 1

Sample coverage

(as a percentage of total manufacturing sector)

	1982	1983	1984	1985	1986	1987
Value added	21.4	22.1	23.4	24.6	26.0	26.5
Employees	21.2	21.8	23.3	24.3	25.2	25.7
Exports	14.0	13.5	19.0	20.1	21.4	21.5
	1988	1989	1990	1991	1992	1993
Value added	26.7	27.6	28.7	29.3	29.4	29.8
Employees	26.7	28.1	28.8	28.4	27.5	27.2
Exports	21.5	23.3	24.2	24.3	20.3	18.6
	1994	1995	1996	1997	1998	1999
Value added	29.2	25.6	25.5	24.8	23.5	22.5
Employees	27.0	23.6	24.1	23.4	22.7	21.7
Exports	23.4	24.3	26.5	26.5	26.1	24.9

As shown in Table 1, the sample has quite good coverage: our firms account for between 21 and 30 per cent of value added and employment in Italian manufacturing and for between 13.5 and 26.5 per cent of total exports in nominal terms. About one tenth of the firms remain in the sample for 18 years, half for at least 8 years and 5 per cent for one year only.

The data on total sales, value added and number of employees show that, despite the CADS's bias toward better and larger firms, smaller businesses are also well represented. For 1995 firm size ranges from 4 to 1,000 employees, with a mean of 98 and a median of 58. Average firm age is around 20 years; the oldest is 140 years. Exporting firms are on average larger and have higher value added; they also pay better wages.

Over 70 per cent of the firms in the sample are located in the North, and less than 10 per cent in the South. The sectoral distribution (Nace Rev. 1 classification-two digits) reflects Italy's specialization, at least in qualitative terms: the best-represented sector is that of industrial and commercial machinery, while about 18 per cent of the firms operate in the so-called traditional sectors (textiles, clothing and leather), and very few belong to the innovative information and communication technology sector. Among exporting firms, the share operating in the sectors of specialization is larger. The propensity to export increases with firm size; moreover, it rises considerably with time: between 1985 and 1995 the propensity to export rose by 20 per cent among small firms, 23 per cent among medium-sized firms, and 37 per cent among large firms.

Table 2 contains statistics on the flow of firms in and out of foreign markets. The top part of the table is a transition matrix: for any pair of years (t, t+1), it shows the proportion of firms exporting at time t that also export at t+1, and the proportion that do not; similarly for firms that did not export at t. The table therefore provides entry and exit rates, together with the degree of persistence in and out of foreign markets. These flows are then related, in the middle part of the table, to the percentage changes in Italy's real effective exchange rate (*REER*, based on the production process), world export volumes (*WT*) and Italian domestic demand (*DD*).[2]

[2] All three indices are equal to 100 in 1993. The real effective exchange rate is calculated by the Bank of Italy: the methodology is described in Economic Bulletin No. 26. World export volumes are taken from the IMF, the domestic index from Istat.

The last two rows show the ratio between entering/exiting firms' exports and total exports in the sample.

Not surprisingly, entry (No_t-Yes_{t+1} sequence) and exit (Yes_t-No_{t+1}) rates peaked in the period 1992-95. Before the lira's depreciation in September 1992, the difficulties of Italian firms on foreign markets were evident: 30 per cent of exporters abandoned foreign markets in 1992; the following year this fraction jumped to 45.4 per cent. Later, the large

Table 2

Entry, exit and persistence
(percentages)

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
Change in *REER*		-3.0	-0.2	-1.1	6.1	3.4	2.4	2.1	4.2	-0.5
Change in *WT*		2.5	8.3	3.4	4.3	6.3	8.9	7.0	5.6	4.6
Change in *DD*		0.4	3.2	3.1	2.7	4.0	3.8	2.9	2.6	2.1
X_{t+1}	Entry	13.6	28.7	13.4	14.6	13.0	13.6	21.6	13.6	12.2
X_t	Exit	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
Change in *REER*		-2.3	-14.2	-2.0	-4.6	11.0	0.3	1.4	-2.8
Change in *WT*		4.4	3.8	10.0	10.0	6.2	10.4	4.6	5.6
Change in *DD*		0.5	-4.5	2.1	2.2	0.6	2.7	3.0	2.8
X_{t+1}	Entry	11.6	31.7	33.8	19.7	11.8	8.5	5.9	4.9
X_t	Exit	24.6	31.2	15.9	5.4	5.9	4.8	3.1	5.5

Notes: Percentages. Yes and No refer, respectively, to being or not being an exporter. Therefore the sequence No-Yes identifies entering firms, Yes-No exiting firms, Yes-Yes and No-No, respectively, the firms that stay in and out foreign markets. The upper part of the table contains the entry, exit and persistence rates. In the lower part X is the share of total exports due to entering and exiting firms.

depreciation of the lira supported entry: for 1993, 1994, 1995 the entry rates were respectively 17.2, 19.3 and 25.2 per cent. In 1994-95 foreign demand accelerated, providing a further stimulus for new exporters.

In general, Table 2 draws a fairly promising picture: the huge variance in export participation decisions, along with the large degree of persistence in firm behaviour, creates an ideal environment for identifying empirically the role of sunk costs. Moreover, the fact that entry and exit rates of firms explain almost one third of total exports is further indication that the decisions affecting entry and exit from foreign markets merits close study from an aggregate point of view.[3]

3. The model and the identification strategy

Our theoretical model is taken from Roberts and Tybout (1997); only a basic description is given in this section.

The per-period profit function of a firm that must decide whether or not to export or not can be written as follows:

$$\tilde{\pi}_{i,t}(y_{i,t-1}) = y_{i,t}[\pi_{i,t} - (1 - y_{i,t-1})K] - (1 - y_{i,t})y_{i,t-1}F \qquad (1)$$

where $y_{i,t-1}$ defines firm i's state (exporter versus non-exporter) at the beginning of period t, K is the level of sunk entry costs, F is that of exit costs; $\pi_{i,t}$, the per-period profits net of entry and exit costs, may be explicitly written as follows:

$$\pi_{i,t} \equiv [p_{i,t}(q^*_{i,t}, Z_{i,t}, X_t)q^*_{i,t} - c_{i,t}(X_t, Z_{i,t} \mid q^*_{i,t})]y_{i,t} \qquad (2)$$

where $p_{i,t}$, the price of firm i's output on foreign markets in domestic currency, depends on the exported quantity $q^*_{i,t}$, on various firm characteristics summarized by vector $Z_{i,t}$ and on aggregate factors X_t, such

3 Campa (2000), on the contrary, finds that the contribution of firms that enter and exit foreign markets is not relevant for total Spanish exports.

as the exchange rate and world demand. Reasonably, the same variables also influence the cost $c_{i,t}$.

It is worth highlighting that equation (2) refers to the extra profits from exporting, i.e. the profits in excess of those made on the domestic market, and neglects the problem of the exported quantity decision by setting $q_{i,t}$ to its optimal level.

The Bellman equation for this problem is as follows:

$$V_{i,t}(y_{i,t-1}) = \max_{y_{i,t}\in\{0,1\}} \tilde{\pi}_{i,t}(y_{i,t-1}) + \delta E_t(V_{i,t+1}(y_{i,t})) \tag{3}$$

and the optimal strategy

$$y^*_{i,t} = \left\{ \begin{array}{ll} 1 \;\; if & \pi_{i,t} + \delta A - K + (K+F)y_{i,t-1} \geq 0 \\ 0 \;\; if & \pi_{i,t} + \delta A - K + (K+F)y_{i,t-1} < 0 \end{array} \right\} \tag{4}$$

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

The structural estimation of this model would entail choosing a specific functional form for the profit function and a particular process for the exogenous aggregate variable: Das *et al.* (2001) opt for this approach. We choose instead the following reduced-form specification in line with Roberts and Tybout (1997):

$$\Pr(y_{i,t} = 1) = \Phi(\alpha_0, \beta y_{i,t-1}, \gamma X_t, \phi Z_{i,t-1}) \tag{5}$$

where α_o is a constant term and Z is lagged to avoid obvious problems of endogeneity. A positive and significant β would prove the existence of sunk costs. More precisely, as a *proxy* for *(K+F)* it measures the width of the inaction band where firms neither enter nor abandon foreign markets.[4] It is worth recalling that here sunk costs are captured

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

through persistence in a firm's behaviour; the idea is that firms with past experience in foreign markets are more likely to be exporters than those without that experience.

Equation (5) identifies a binary choice model that we estimate using a probit specification, i.e., $\Phi(.)$ is assumed to be the standard normal distribution.

The estimation of equation (5) raises a number of issues. The most important is the classical omitted variable problem caused by unobserved firm characteristics: the likely correlation between unobservables and regressors results in inconsistent estimates of the coefficients of the latter. In our case the problem is even more serious: insofar as unobserved factors are time invariant and therefore a source of persistence, they will be picked up by the coefficient of the lagged dependent variable that will then be overestimated. This is what Heckman (1981a) calls the "spurious state dependence" problem. Notationally, this problem can be represented by decomposing the residual in (5), $\varepsilon_{i,t,}$ into two pieces: ν_i denoting time-invariant firm-specific unobserved characteristics and $u_{i,t}$ identifying the truly random component:

$$\varepsilon_{i,t} = \nu_i + u_{i,t} \qquad (6)$$

How do we deal with this problem? One strategy would be to control for as many firm characteristics as possible to empty ν_i: it is quite intuitive that this strategy finds an obvious limit in the content of the data-set. An alternative, which is usually feasible in panel data estimation, is the "within" estimator that explicitly accounts for unobserved factors through firm-level fixed effects. Unfortunately, we cannot pursue this because of the "incidental parameters problem": Heckman (1981b) shows that the use of fixed effects in probit and logit models provides inconsistent estimates if the number of firms is very large, as is our case. This inconsistency becomes even more serious in dynamic models.

We therefore follow a different strategy which has been proposed by Chamberlain (1984) and consists in adding a regressor proxying for unobserved heterogeneity, built using the observable firm-level regressors. As recently suggested by Arulampalam *et al.* (1998) and Henley (2001), this new regressor can be the vector of the observable characteristic means:

$$v_i = a_o + a_1 \overline{Z}_i + \xi_i \tag{7}$$

where now ξ_i is by construction orthogonal to $Z_{i,t}$ for any i and any t.[5] In conclusion, we solve the omitted variable problem by substituting the error term of equation (5) with equations (6) and (7).

The estimation of dynamic models such as ours encounters another serious difficulty, known as the "initial conditions problem" (Heckman, 1981b). This problem stems from the fact that the firm's first year in the sample (t=0) is not very likely to be its first year of existence; it follows that the initial observation cannot be modeled, as equation (5) suggests, using the dependent and the other lagged controls. One important consequence is that $y_{i,0}$ is correlated with $\xi_{i,0}$ so that the estimate of β is inconsistent. More seriously, if unobserved factors are positively related to the probability of exporting, then β is overestimated so as to spuriously conclude in favour of high sunk costs.

To account for this problem we again follow Heckman (1981b), who suggests estimating a reduced-form equation to model the first-year observation:

$$\Pr(y_{i,0} = 1) = \Phi(\alpha_0, \gamma X_0, \phi Z_{i,0}) \tag{8}$$

where we again include the vector of means to control for unobserved heterogeneity. Evidently, equation (8) differs from equation (5) only because it lacks the lagged dependent variable, while we take the contemporaneous regressors to take into account the firm's controls.

Here we follow Orme (1997) and tackle the two equations (5) and (8) in two steps:[6] we first estimate the "pre-sample model" using the first three observations of each firm, and then we derive the estimated residuals $\hat{\eta}_i$ that we plug as regressor in the equation (5) to get:

[5] In other words, ξ_i is that part of unobserved heterogeneity that is not correlated with observed firm characteristics. It should be also noted that, given the orthogonality between υ_i: and $u_{i,t}$, ξ_i is also orthogonal to $u_{i,}$.

[6] 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 were small. However, Arulampalam (1998) has shown that the procedure provides acceptable results in a wider variety of cases.

$$\Pr(y_{i,t}=1)=\Phi(\alpha'_0,\beta y_{i,t-1},\gamma X_t,\phi Z_{i,t-1},a_1'\overline{Z}_i,\delta\hat{\eta}_i) \quad (9)$$

where $\hat{\eta}_i$ controls for that part of unobserved heterogeneity that is correlated with $y_{i,0}$.

A further adjustment to our empirical specification involves the error term. We follow RT and assume that the random component $u_{i,t}$ has a first-order autoregressive structure, $u_{i,t}=\rho u_{i,t-1}+\tau_{i,t}$; this is necessary to eliminate from β the persistence generated by transitory shocks. Now it is $\tau_{i,t}$ that is independently and identically distributed.

We estimate both equations (8) and (9) with a panel version of a GLM probit with first-order auto-correlation in the disturbances. We have also tried a random-effect probit without auto-correlation in the disturbances and have found almost identical results on a qualitative basis. We present here only the GLM probit since, as clearly stated by Tybout (2001), auto-correlation of the error component is crucial.

4. The results

The results from the estimation of equation (9) are shown in Table 3.[7] In column [1] they refer to a simpler specification not including firm-specific regressors, the vector of their means and the correction for the initial conditions, but only three macroeconomic variables. In our view, these three variables provide a more interesting description of the effects of the macroeconomic environment on export participation than can be inferred from other papers.[8]

Italy's real effective exchange rate based on domestic production prices (*REER*), a measure of Italian product price competitiveness on

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7 The drop in the number of observations from 270,000 to 160,000 is due to the combined effect of the pre-sample model, using 85,000 observations, and the lagged dependent variable, which excludes firms observed for less than two consecutive years.

8 RT, Bernard and Wagner (2001) 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. The drawback of our approach is that the macroeconomic variables we are using do not exhaust all the relevant macro factors: we have also tried with time dummies without significant differences in the results.

international markets, has the expected effect: the probability of exporting is greater in years of real depreciation of the domestic currency (increase of the index). *WT*, which indexes world trade conditions, also has a positive sign: firms are more likely to export when faced with larger external demand. Finally, the negative effect of domestic demand (*DD*) suggests that Italian firms sell abroad especially when demand is scant in Italy; surprisingly, this effect is larger in absolute terms than that of foreign demand, indicating that foreign market participation is more reactive to domestic, negative, conditions than to external, positive, conditions. positive.

With this specification, sunk costs seem quite important: from the coefficient of y_{t-1}, past experience makes current exporting an almost certain activity (the marginal effect, which is reported in braces, is about 0.90).

In the second column we can see the impact of the pre-sample estimation. The correction term (*res*) has a strongly significant coefficient, signalling that we had an initial problem of conditions in column [1]. As a result, the coefficient of the lagged variable decreases: the marginal effect drops to 0.82, but remains quite high and significant. We then introduce sector and location dummies,[9] and a wide set of firm-specific variables (column [3]), whose effect is, as expected, to reduce persistence significantly: now the marginal effect of export experience decreases by 10 per cent to 0.74.

The control for firm size (*size*) (which is the logarithm of the number of employees) is needed for various reasons: Krugman (1984) argues that firms may decide to export part of their production in order to exploit scale economies; often size is interpreted as a proxy for firm efficiency. Indeed, we find that the coefficient of *size* is positive and strongly significant.[10] Firm age (*age*), often used to proxy for firm efficiency,[11] does not play any role in the probability of exporting.

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9 Sectors follow the 2-digits of the Nace Rev.1 classification. Location dummies are at macro-area level and distinguish: North-West, North-East, Centre and South and Islands).

10 Among others, Bernard and Jensen (1998) find it for US exporters, Ferragina and Quintieri (2001) for Italian exporters.

11 Based on the work by Dunne *et al.* (1989) for the US, Tybout (1996) for Chile, Roberts (1996) and Liu and Tybout (1996) for Colombia, the idea is that market forces select out inefficient producers so that older firms are more efficient and therefore more competitive in world markets. Relying on (continues)

Tipically, exporting activity is for productive and cost-competitive firms.[12] We therefore include labour productivity (*ywork* is the log of the value added per worker at 1995 constant prices) and average wage (*wage* is the log of the ratio between total labour costs, at 1995 constant prices, and the number of employees), which have the expected sign: positive for productivity and negative for wage.[13] The variable *market*, given by the ratio of marketing, distribution and advertising expenses to sales, aims to measure the degree of firm and product visibility and, somehow, the quality of customer service: it turns out to have a significantly positive effect on the probability of exporting. Firms belonging to industrial groups (the dummy variable *group*) find it easier to export part of their production.

Regarding the role of industrial districts, we use the dummy variable *distr* to identify whether a firm belongs to an industrial district or not. The positive role of industrial districts in the Italian economy is well documented (Signorini, 2000). Here we confirm it: district firms are indeed more likely to become exporters. This result deserves particular attention in the light of two considerations. Given the sectoral dummy, the higher than average export propensity of district firms is not the result of their specialization in sectors in which Italy has a comparative advantage (textiles and clothing, leather and leather products, furniture, etc.); rather, a positive network of externalities is at work within districts. Moreover, these externalities benefit small and medium-sized firms which, by definition, are the backbone of districts and, as just shown, encounter greater difficulties in exporting.

In column [4] we introduce the percentage of sales that a firm makes on foreign markets (xsales). Intuitively, the higher this percentage is, the more likely it is that a firm will not abandon foreign markets, irrespective of sunk costs of exporting. The persistence induced by a high value of xsales has more to do with sunk costs of establishing the firm itself than

previous evidence for Italian manufacturing firms (Bugamelli *et al.,* 2000), we introduce a quadratic term for age, allowing for a non-linear relationship between age and the probability of exporting.

12 Bernard and Wagner (1997) show that highly productive German firms are more likely to become exporters. For some developing countries, Clerides *et al.* (1998) find that this probability is greater in low cost firms.

13 It is worth mentioning that *wage* measures price and cost competitiveness in that we explicitly control for firm productivity; if in fact we drop *ywork* from the regression, the coefficient of *wage* becomes marginally positive as more productive firms also pay higher salaries.

Table 3

Base regression

	[1]	[2]	[3]	[4]	[5]
$y_{t\text{-}1}$	2.397*	2.265*	2.045*	2.001*	1.939*
	(0.009)	(0.010)	(0.010)	(0.012)	(0.012)
	{0.866}	{0.819}	{0.740}	{0.725}	{0.702}
$REER_t$	0.004*	0.005*	0.006*	0.006*	0.006*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
WT_t	0.013*	0.014*	0.014*	0.013*	0.013*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
DD_t	-0.033*	-0.036*	-0.035*	-0.034*	-0.033*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$size_{t\text{-}1}$			0.168*	0.166*	0.076*
			(0.005)	(0.005)	(0.018)
age_t			-0.347	-0.286	-0.349
			(0.366)	(0.365)	(0.367)
age_t^2			0.156	0.129	0.157
			(0.173)	(0.173)	(0.173)
$ywork_{t\text{-}1}$			0.168*	0.168*	0.097*
			(0.013)	(0.013)	(0.020)
$wage_{t\text{-}1}$			-0.070**	-0.071**	-0.102**
			(0.023)	(0.023)	(0.034)
$market_{t\text{-}1}$			1.065*	1.067*	-0.252
			(0.109)	(0.108)	(0.157)
$xsales_{t\text{-}1}$				0.291*	0.288*
				(0.024)	(0.023)
Distr			0.023*	0.022*	0.021*
			(0.005)	(0.005)	(0.005)
group			0.035*	0.033*	0.025**
			(0.010)	(0.010)	(0.010)
res		0.270*	0.392*	0.375*	0.381*
		(0.012)	(0.011)	(0.012)	(0.012)
No. obs	162,283	159,214	159,214	159,214	159,214
Prob>χ^2	0.000	0.000	0.000	0.000	0.000

Notes: GLM probit estimates of equation (9) with first-order auto-correlation in the disturbances (9); heteroskedasticity-robust standard errors in parentheses; marginal effects in braces. The dependent variable is the current status (exporter vs. non-exporter); $y_{t\text{-}1}$ is the status at t-1; for the other regressors see the Appendix. All estimations include a constant term, from column [3] on they also include sectoral (2 digits of the Nace Rev. 1 classification) and location dummies (4 macroareas). * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.

with sunk costs of exporting. For such firms, leaving foreign markets is somehow equivalent to economic failure or to a significant and costly reorganization of activity.[14] The coefficient of *xsales* is significantly positive and helps to reduce further the coefficient of $y_{t\text{-}1}$, whose marginal effect falls to 0.725.

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).[15] It is important to note that all the lagged regressors remain significant, though with a smaller marginal effect on the probability of exporting. Chamberlain's correction turns out to be very useful to reduce further the coefficient of $y_{t\text{-}1,}$ whose marginal effect is now 0.70.

The sectoral and location dummies merit some comment. Despite the wide set of firm-level controls, international specialization still matters. The probability of exporting is, *ceteris paribus*, significantly greater for textiles, clothing, leather and leather products, industrial and commercial machinery, furniture and fixtures. Firms located in the South and, to a lesser extent, in the Centre of Italy lag behind, possibly reflecting both their smaller degree of industrial development and their greater distance from the main destination markets, EU countries in particular.[16]

The model performs quite well. Comparing the actual frequencies and the predicted probabilities for past exporters ($y_{t\text{-}1}$=1) and past non-exporters ($y_{t\text{-}1}$=0), the differences are minimal (see Table 4). Table 5 provides some estimation for evaluating succintly the importance of past experience with respect to firms' characteristics and to macroeconomic variables. The percentiles refer to the distribution of firms in terms of predicted probabilities computed using the estimated coefficients for all the variables except $y_{t\text{--}1}$: these probabilities were then computed separately for firms with and without export experience.

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14 It can be argued that *xsales* also serves as a proxy for unobserved characteristics that are strongly relevant for exporting activity (e.g., managers speak English).

15 More precisely, we include all the time-varying firm-specific regressors with the exception of the percentage of exported sales, which, in the long run, is evidently endogenous to the participation decision.

16 The interaction between $y_{t\text{-}1}$ and the macroeconomic variables signal that persistence is much greater when external conditions are relatively better. This means that the difference between the "persistence in" and the entry rates in good periods is larger than the difference between the "persistence out" and the exit rates in bad periods. Speculatively, we might conclude that entry costs are more important than exit costs.

Two results emerge clearly. Export experience matters much more than the other regressors: the increase in the predicted probability due to experience ranges from 68 to 71 percentage points; it is slightly higher for firms in the upper percentiles. Passing from the 25th to the 75th percentile has instead an impact in terms of probability, which is on average less than 10 percentage points. Although it is larger in absolute terms for firms with y_{t-1}=1, it is more significant in relative terms for firms with y_{t-1}=0 whose probability of accessing foreign markets increases by almost 50 per cent.

Table 4

Goodness of fit

	Actual	Predicted
$y_{t-1} = 0$	0.154	0.120 [0.062]
$y_{t-1} = 1$	0.815	0.862 [0.070]

Notes: Predicted probabilities from the estimation of the model in column [5] of Table 3. Standard errors are in brackets.

Table 5

Export experience versus the other regressors

	25th percentile	50th percentile	75th percentile
$y_{t-1} = 0$	0.141	0.166	0.205
$y_{t-1} = 1$	0.823	0.871	0.915

Notes: Predicted probabilities from the estimation of the model in column [5] of Table 3. Percentiles refer to the distribution of firms according to the predicted probabilities computed using the estimated coefficients for all the variables except y_{t-1}.

4.1 *Robustness*

Our results are robust to various changes in the data-set and the empirical specification. Up to now we have kept in the data-set all firms with reasonable figures so as to maximize the size of the working sample. However this does not exclude the risk that some firms with very peculiar characteristics may drive the results. This could be the case for firms that have been in the sample for less than three consecutive years:[17] since the persistence of a firm's behaviour is more likely over short than long periods, these firms may induce an overestimation of the coefficient of y_{t-1}. A similar overestimation can be induced by firms intermittently appearing and disappearing from the sample. Given the data-set's bias toward better firms, these "marginal" firms may appear in periods of good performance, when they also export, and disappear in bad periods, when instead they make zero sales on foreign markets. This in-and-out of the export market that would reduce overall persistence is de facto not considered in our estimation as the firm stays in the sample intermittently.

We have therefore excluded these firms and re-estimated the last specification (column [5] in Table 5), obtaining in both cases the same results.

On the other hand, small exporters can cause an underestimation of β. 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 less than 200,000 euros in a year raises the coefficient of the lagged dependent variable slightly (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 exogenous shocks. We have therefore extended it to an AR(2) without recording any difference in the results. The same happened when more lags of the firm-specific regressors were added.

Finally, we have increased the disaggregation of sector dummies from 2 to 4 digits and the location ones from 4 macro-areas to 96 provinces

[17] Obviously for more than one, otherwise they would be excluded owing to the dynamic specification.

to control for fixed effects that might be strong at the local or product level. Again we register no relevant changes.

5. Timing

So far we have assumed a very simplified structure for export experience: firms that exported two or three years earlier should behave like firms that have never exported; exporters' behaviour does not differ with the number of years a firm has been present on foreign markets. In other words, the simplified model implies that all the assets whose acquisition entails sunk costs depreciate fully after one period and must be acquired immediately upon entry.

The objective of this section is to relax these assumptions and allow for (i) a smaller depreciation rate, which is particularly reasonable if sunk costs are related to knowledge and reputation, and, (ii) the spread of acquisition costs over several periods.

Depreciation is detected by adding to equation (9) dummy variables capturing the number of years a firm has been out of foreign markets. The interpretation of the coefficients is identical to that of $y_{t\text{-}1}$: a positive and significant coefficient for $Y_{t\text{-}j}$ says that a firm that last exported j years ago is more persistent than one that has never exported or did so more than j years ago. Such a firm has to pay only a fraction of sunk costs if it decides to export again. We would also expect the coefficient of $Y_{t\text{-}j}$ to be decreasing in j as a signal that some depreciation occurs notwithstanding.

In Table 6 we report only the coefficients of $y_{t\text{-}1}$ and $Y_{t\text{-}j}$, since the estimated coefficients for all the regressors included in column [5] of Table 3 are unchanged. The coefficient of $Y_{t\text{-}2}$ is strongly significant and positive, confirming that firms that exported two years ago have a higher probability of exporting today than firms that have never exported. The fact that the coefficient of $Y_{t\text{-}2}$ is smaller than that of $y_{t\text{-}1}$ signals that the depreciation rate is positive: in terms of marginal effects, it ranges from 0.70 to 0.20. When the third lag is added, this evidence is fully confirmed. We find (but do not report here) that the coefficient of $Y_{t\text{-}j}$ dies out at j=6.

We then tackle the problem of how assets for exporting activity are acquired during a firm's export experience; in column [3] we include a dummy variable ($S_{t\text{-}1}$) to single out, from the mass of firms exporting at *t*-1, the firms that did not export between[18] *t*-6 and *t*-2. The coefficient of $S_{t\text{-}1}$ is not significantly different from zero. The evidence that sunk costs must be fully paid in the entry period is confirmed in columns [4] and [5], which identify exporters with, respectively, two and three years of experience.

In a sense, this evidence suggests that the structural change that occurred in the Italian aggregate export function after the lira depreciation of 1992 and 1995 was immediate and had medium-long run effects.

Table 6

Timing

	[1]	[2]	[3]	[4]	[5]
$y_{t\text{-}1}$	1.827*	1.926*	1.960*	1.958*	1.946*
	(0.012)	(0.013)	(0.014)	(0.014)	(0.015)
$Y_{t\text{-}2}$	0.516*	0.564*			
	(0.015)	(0.016)			
$Y_{t\text{-}3}$		0.455*			
		(0.019)			
$S_{t\text{-}1}$			0.033	0.033	0.041
			(0.029)	(0.029)	(0.029)
$S_{t\text{-}2}$				0.011	0.015
				(0.028)	(0.028)
$S_{t\text{-}3}$					0.016
					(0.028)
No. obs	133,066	108,024	122,595	122,595	122,595
$Prob>\chi^2$	0.000	0.000	0.000	0.000	0.000

Notes: GLM probit estimates of equation (9) with first-order auto-correlation in the disturbances; heteroskedasticity-robust standard errors in parentheses. The dependent variable is the current status (exporter vs. non-exporter); $y_{t\text{-}1}$ is the status at *t*-1; the variable $Y_{t\text{-}j}$ is a dummy that takes on value equal to 1 if a firm exported for the last time *j* years ago; the dummy $S_{t\text{-}j}$ is equal to 1 if a firm started exporting at *t-j*. All the estimations include all the regressors of the full model of column [5] of Table 3. * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.

[18] The choice of *t*-6 is related to our previous result.

6. Size

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

If sunk costs relate to information acquisition, organizational matters and such like, Caves (1989) argues they should come in an almost fixed amount irrespective of firm size. As a consequence, small and medium-sized firms would encounter relatively higher barriers to entry into foreign markets than large firms.

Caves's hypothesis can be tested against the (not necessarily alternative) view proposed by Das *et al.* (2001), who argue that what matters is not firm size but the volume of exports. In a structural model of export market participation, they show that sunk costs are qualitatively relevant only for small-scale exporters. An important implication from the macroeconomic point of view is that hysteresis effects caused by sunk costs are important only for marginal exporters and not for the aggregate exports of a country.

Table 7 summarizes the results, which definitely hold in favour of Caves's view.[19] While the interaction of lagged export participation with the size of exports – measured as the deviation from the yearly sample mean – is not significantly different from zero (column [1]), the interaction with firm size – again in deviation from the yearly sample mean – is highly significant (column [2]). The result holds when both terms are included (column [3]).

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

[19] Again we work on the full model of column [5] in Table 3.

Table 7

Firm size and value of exports

	[1]	[2]	[3]	[4]
y_{t-1}	1.939*	1.946*	1.946*	2.026*
	(0.012)	(0.012)	(0.012)	(0.195)
$(dX{*}y)_{t-1}$	0.001		0.001	0.001
	(0.002)		(0.003)	(0.003)
$(dsize{*}y)_{t-1}$		-0.057*	-0.057*	-0.054*
		(0.009)	(0.009)	(0.009)
$Size_{t-1}$	0.076*	0.102*	0.102*	0.100*
	(0.018)	(0.019)	(0.019)	(0.019)
No. obs	159,214	159,214	159,214	159,214
$Prob{>}\chi^2$	0.000	0.000	0.000	0.000

Notes: GLM probit estimates of equation (9) with first-order auto-correlation in the disturbances; heteroskedasticity-robust standard errors in parentheses. The dependent variable is the current status (exporter vs. non exporter); y_{t-1} is the status at t-1; *dsize* is the number of employees in deviation from the yearly sample mean; *dX* is the value of exports in deviation from the yearly sample mean. All the estimations include all the regressors of the full model of column [5] of Table 3. * identifies significance of the coefficient at 0.1 per cent; ** identifies significance at 1 per cent.

In column [4] we add the interactions between y_{t-1} and the sectoral dummies to control for this alternative explanation. The results are clear-cut: firm size really matters, and its negative coefficient decreases in absolute terms by a negligible amount and remains highly significant. Moreover, the new interaction terms of y_{t-1} are to a large extent not different from zero, except in the leather and industrial and commercial machinery sectors, where firms show a significantly lower degree of persistence.

At first sight, the coefficient of the interaction between y_{t-1} and firm size appears to be small. Indeed further investigations, based on the estimation of the coefficient for groups of firms of different size, confirm in particular that we find a strong decrease in the coefficient only for firms with more than 250 employees.

Since sunk costs do not constrain marginal exporters, but do constrain small and medium-sized firms, we use Das *et al.*'s (2001) argument and conclude that sunk costs are important even from an aggregate perspective.

7. Information

In the business literature it is commonly accepted that a substantial part of sunk costs to export stem from the need to acquire information on foreign market demand and various institutional aspects of the importer country. The target of this section is to test whether these motives actually affect persistence in and out of foreign markets. However, it is worth mentioning that our test tells us nothing about the relative importance of information collection with respect to other factors.

One way of assessing the importance of information is to separate firms according to the ease with which they overcome informational barriers: we would conclude that information is an important component of sunk costs to exports if firms facing *ex ante* lower barriers also show a smaller persistence.

Informational barriers may vary across firms through two main channels.

One indirect channel is firms' exposure to information spillovers. Along the lines traced by the theoretical literature on social learning, there are two necessary conditions for an economic agent to learn from others' action: i) sharing a similar decision problem; ii) easily and readily observing such actions. Following Guiso and Schivardi (2000), Italian industrial districts are an useful laboratory for detecting the relevance of information spillovers. They satisfy by construction condition i), and, thanks to the requirement of firms' proximity within the district, indirectly also condition ii). We therefore interact the dummy variable *distr* with the lagged dependent variable and find (column [1] of Table 8) that belonging to an industrial district does help reduce the relevance of sunk costs of exporting.[20]

Firms in industrial districts are small. As a consequence, the dummy *distr* may combine the positive effect of information spillovers with the negative one relating to firm size. To control for the latter we also add the interaction between the lagged dependent and the firm size: as shown in column [2] the coefficient of *distr** $y_{t\,1}$ increases in absolute terms.

[20] The regression includes all the variables that are present in column [5] of Table 3, and hence the main effect of *distr*, too.

We acknowledge that our argument is not yet watertight. We first have to wipe out any doubt that we might instead be capturing district-specific features that affect sunk costs but are not related to information spillovers at all. Relying on the seminal work of Marshall (1890), there are three reasons for firms to agglomerate geographically: 1) the availability of a pooled market of specialized workers; 2) the proximity of input suppliers and final consumers; 3) a set of technological and knowledge spillovers.

Table 8

Information

	[1]	[2]	[3]	[4]	[5]	[6]
y_{t-1}	1.963*	1.973*	1.999*	2.035*	1.994*	1.999*
	(0.015)	(0.015)	(0.015)	(0.195)	(0.014)	(0.014)
$(distr*y)_{t-1}$	-0.026**	-0.030**	-0.032*	-0.025*		
	(0.010)	(0.010)	(0.010)	(0.010)		
$(ICT*y)_{t-1}$					-0.154*	-0.149*
					(0.018)	(0.018)
$(dsize*y)_{t-1}$		-0.059*	-0.061*	-0.055*		-0.054*
		(0.009)	(0.009)	(0.009)		(0.009)
$(dprod*y)_{t-1}$			0.011			
			(0.020)			
$(Dsector*y)_{t-1}$	no	no	no	yes	no	no
No. obs	159,214	159,214	159,214	159,214	159,214	159,214
$Prob>\chi^2$	0.000	0.000	0.000	0.000	0.000	0.000

Notes: GLM probit estimates of equation (9) with first-order auto-correlation in the disturbances; heteroskedasticity-robust standard errors in parentheses. The dependent variable is the current status (exporter vs. non-exporter); y_{t-1} is the status at t-1; *ICT* is a dummy variable that takes on a value equal to 1 for sectors where the use of information and communication technologies (ICT) is greater than average: for the list of sectors see the text in Section 7; *dsize* is the number of employees in deviation from the yearly sample mean; *dprod* is firm's labour productivity in deviation from the yearly sample mean; *Dsector* are two-digit sectoral dummies. All the estimations include all the regressors of the full model of column [5] in Table 3 (therefore including a constant term, sectoral and location dummies). * identifies significance of the coefficient at 0.1 per cent. ** identifies significance at 1 per cent.

De Blasio and Di Addario (in this volume) have recently confirmed previous evidence that district firms, and workers, do not benefit from labour market pooling.

As to technological externalities, these should lead to higher firm productivity. In column [3] our regression also includes the interaction between the lagged dependent and firm productivity (*dprod*) – again measured as a deviation from the yearly sample mean – which evidently is neither significant nor impacts on the significance of the coefficient $distr{*}y_{t\ 1}$.

A further argument might be that with *distr* we are simply not randomly grouping sectors; in particular, given the concentration in industrial districts of sectors of comparative advantage, differences in the degree of persistence might be due not specifically to district firms but to district sectors.[21] To rule out this, we explicitly add the interaction between $y_{t\ 1}$ and the sectoral dummy: column [4] shows the coefficient of $distr{*}y_{t\ 1}$, which remains significantly different from zero.

We are not yet satisfied, however. The non-technological spillovers within industrial districts are not necessarily information-related. Sunk costs of exports include the establishment of distribution networks or the marketing and promotion of products abroad: it might easily be that one of the benefits of being located in a district is the better availability of this kind of business service, which helps to reduce sunk costs. As neatly shown by Cannari and Signorini (2000), this is not the case: on the basis of various indicators (share of district workers employed in activities such as R&D, software production and related services, other professional services to firms), they find that such services are relatively less widespread within industrial districts than in other industrialized but not district areas and even in other non-industrialized areas. They therefore conclude that such formal market activities are not peculiar to industrial districts, where instead informal factors related to the diffusion of unmodified knowledge prevail.

Firms may also differ as to their ability to directly collect, process and store information. A possible way of testing this hypothesis is to subdivide firms according to their endowment of information and

21 Indeed, we have seen that two important district sectors, "leather and leather products" and "industrial and commercial machinery", display less persistence than average.

communication technologies (ICT). Reasonably, firms that have made larger investments in ICT are in principle better able to collect and process information of any kind or, alternatively, can do it at lower costs and more efficiently.

To this end, 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 plastic 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 the firm belongs to one of these sectors.

One consideration is worth making. 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 rule out the possibility that the results are driven by comparative advantage rather than by ICT intensity.[22]

Again our estimation (column [5]) supports the hypothesis that information matters for sunk costs of exporting. The coefficient of $ICT{*}\,y_{t\;1}$ is negative and statistically significant. The results hold unchanged when the interaction of the lagged dependent with firm size is added (column [6]).

8. Concluding remarks

Owing to the large fluctuations in the lira exchange rate, many Italian manufacturing firms entered markets during the 1990s and their contribution to aggregate exports has been considerable. The importance of sunk costs of exporting and their relatively slow depreciation rate also suggest that the lira’s depreciation should be fairly long-lasting.

Despite that, entry into foreign markets is still an open issue in Italy: in 2000 only 17.3 per cent of manufacturing firms were exporters. In this regard, our result that sunk costs constitute a special barrier to export for

[22] To this end, it should be noted that while “industrial and commercial machinery” has ICT=1, “leather and commercial machinery” has ICT=0.

smaller firms must be combined with the evidence that such firms represent a huge proportion of Italian manufacturing firms but have a very low export participation rate: in Italy about 95 per cent of manufacturing firms have fewer than 10 employees, and not 3 per cent of them sold products abroad during 2000.

On the basis of our results, export promoting policies should take care of firms' information needs. Not surprisingly, this is what happens in reality: a large proportion of the export promoting measures currently in place in Italy – managed by various government institutions – aim to provide information on foreign countries, on business opportunities abroad and the like.

In this framework industrial districts confirm their positive role for exporting. Not only do industrial districts show a greater propensity to export, but firms belonging to a district more easily overcome informational barriers to entering foreign markets.

APPENDIX

The regressors:

REER is the 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)

size is the log of the number of employees;

age is the log of firm age;

ywork is the log of (deflated) value added per employee;

wage is the log of (deflated) average wage;

market is marketing, advertising and distribution expenses over sales;

distr is a dummy variable that is equal to 1 if the 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 pre-sample model ("initial conditions").

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