The Micro Foundations of Export Behaviour: Empirical Investigations

by

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Abstract

This dissertation presents the results of an empirical investigation into the nature, causes and consequences of the export activity from the point of view of the firm. It comprises five essays, analysing the following topics:

- Chapter 1 investigates the dynamics of export behaviour among British small and medium sized firms (SMEs) in the nineties. We develop a dynamic model of entry decision in a foreign market that takes into account both unobserved firm heterogeneity and genuine state dependence. After controlling for unobservable firm heterogeneity, we find that up to 75 percent of export persistence in the data is explained by "true" state dependence, and that this dependence is greater among old companies than young companies. Moreover, observable firm characteristics such as size and ownership play a significant role in distinguishing exporters from non-exporters.

- Chapter 2 reports the results of an empirical investigation of the determinants of export diversification among Spanish exporters. The lack of theory, the unclear past empirical evidence and the use of the census of Spanish exporting firms justifies the use of semi-parametric regression techniques to characterise the pattern of export diversification as a firm becomes more internationalised. Unlike other studies, the finding suggests that the success of strong export-orientated firms relies heavily on both product and market specialisation.

- Chapter 3 analyses the role of information spillovers in the export destination decision by SMEs. With uncertainty and sunk entry costs, small firms will tend to export to countries where other local exporters have previous experience as information is cheaper and more reliable. In our application for Spain, the findings suggest that geographical agglomeration of exporting firms of the same industry selling to one destination significantly affects the probability of small-medium sized firms exporting to the same destination. The probability to export to one particular destination is also (positively) affected by firm characteristics such as size and export intensity, and gravitational factors such as the level of development and the physical proximity of the destination country.

- Chapter 4 examines the measurement of market power in an international duopoly market, the ceramic tile industry, over the period 1988-1998. After estimating the marginal costs of each competitor export group, we use both cross-section and time-series techniques to evaluate the degree of competition in this industry. The results suggest that Italian producers are "leaders" and Spanish producers are "followers" in a market characterised by substantial positive

- Chapter 5 investigates the relationship between export activity and technical efficiency using a large panel of firms in the UK manufacturing industry during the nineties. The findings show a positive impact of export status on long-run efficiency among those industries in which the UK reveals a comparative disadvantage, suggesting the important role played by firm competitiveness to overcome industry comparative disadvantage factors. In our analysis of short run efficiency changes, we do not find evidence that efficiency improves as firms become export dependent. markups.

To my parents and my wife

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0.3 Introduction

This dissertation presents the results of an empirical investigation on the behaviour of exporting firms: the determinants of the export decision, the marketing strategy of regular exporters, and the consequences of exporting on firm efficiency and profitability. First, we investigate the characteristics of those firms that engage in trade using a multiperiod discrete choice model (chapter 1). Second, we examine the determinants of both export diversification and the selection of export markets (chapter 2 and chapter 3). Third, we focus on the measurement of competition in the international markets (chapter 4). Fourth, we focus on the measurement and determinants of the efficiency differences between exporting firms compared with their non-exporting counterparts (chapter 4). This introduction provides the motivation and a brief outline.

Growing liberalisation, integration and competition in world economies since the post-war period have been responsible for the increasing engagement of firms in exporting activities. The export trade has grown exponentially from approximately $40 billion in 1945 to more than $5 trillion in 1998, a value that exceeds the gross national products of each nation in the world except the USA. Export activity has been one of the fastest growing economic activities, consequently exceeding the rate of growth in world economies output over the past three decades. Consequently, the contribution of exports to total world economic activity has increased considerably in recent years, and currently accounts for approximately 23 percent of world gross domestic output (World Trade Organisation, 1999).

Export activities are important for the economic well-being of a nation as well as a critical factor in the economic development process. From a macroeconomic perspective, exports increase the demand for domestic production, enrich the foreign exchange rate reserves and provide employment. In microeconomic terms, exporting can give individual firms a competitive advantage, improve their financial position, increase capacity utilisation, and raise technological standards.

Concerning the important role of exporting, governments continuously undertake export stimulation programs. In developing countries, export-growth economic policy has been emphasised as a strategy for economic development. Export growth is important not only in developing economies but in developed economies as well. For example, the steady decline in the U.S. share of world exports of manufactured goods between 1955 and 1977 led the U.S. government to list export stimulation as one of its national goals in 1978.

In order to develop an effective promotion program undertaken by governments or by firms themselves, it is necessary to understand the factors that influence export operations and how these factors interact. Traditional trade theory is concerned mainly with factors that are noncontrollable by the firm. The role of the individual firm and its controllable factors such as product mix, organisation and size have received little attention in the economic literature until very recently. The renewed interest among economists in investigating the empirical regularities of export supply is explained by recent advances on microeconomic theory of export supply and easier access to available microdata, compared to past emphasis on aggregate exports and studies of export demand.

The main objective of this dissertation is to assess at the micro level the empirical significance of the export supply on firm behaviour and performance. The rest of the dissertation is structured in five chapters. Chapter 1 studies the dynamics of export behaviour using a panel data of 1679 small and medium sized firms following the 1991 recession. We use a simple dynamic model of entry decision in a foreign market by a profit-maximising firm to disentangle the effects of unobserved firm heterogeneity and genuine state dependence. We also control for the "initial conditions" problem that arises when the start of the observation period does not coincide with the start of the stochastic process generating firms' export decisions. The results show that observed persistence in export behaviour is explained by a mix of firm heterogenity and state dependence due to irreversible investment. After controlling for unobservable firm heterogeneity, we find that up to 75 percent of export persistence in the data is explained by state dependence, and that this dependence is greater among old companies than young companies. Moreover, observable firm characteristics such as size and ownership play a significant role in distinguishing exporters from non-exporters. In addition, some industry-level characteristics such as export spillovers or macroeconomic influences such as the volatility of exchange rates exhibit a positive impact on export decision while others such as market destination uncertainty or industry growth rate of exports have no effect on export decision in our results. Finally, we find no evidence that the 1991 recession influences firms' export decision in subsequent years as the hypothesis of serial correlation in the error term is rejected by the data. This suggests both that our findings provide a valid indication of the SMEs "typical" export behaviour in the face of significant exogenous macroeconomic instability, and that only very large shocks influence potential and actual exporters' willingness to participate in export markets.

Chapter 2 investigates the determinants of export diversification. The international business literature assumes that increased involvement in exporting encourages diversification to a larger number of countries. If volatility of profits increases with the proportion of revenues from abroad, firms will diversify exports as a strategy for risk-spreading in order to ensure an stable cash flow in international markets and to increase the probability of staying in the international markets. There are also reasons for firms to become more specialised as they become more export-orientated. If international trade theories predict that comparative advantage forces or stimulates industry specialisation, why do we not expect exporters to become more specialised in production and marketing to succeed in exporting. Concentration of exports can be viewed as a strategy of firm internationalisation by achieving economies of scale in production and distribution.

Using a unique data set (the distribution of export sales by product and country of all Spanish manufacturing firms with more than 20 workers in 1988), we develop firm-level indices of export diversification by both product and destination. Next we analyse empirically the optimal marketing strategy of exporters using semi-parametric regression techniques to represent graphically the export diversification trajectory of a representative firm, as its sales become more export-orientated. In our application for the Spanish case, we find that exporters opt for a strategy of market diversification in the early stages of internationalisation. As expected, light exporters begin selling to few markets. As they become more export-orientated they explore new destinations, exhibit a more even distribution of sales across destinations and choose a sample of more heterogeneous countries. After reaching certain level of exports, the number of destinations becomes fixed, the selection of destinations is more homogenous and the distribution of export value tends to be more concentrated in a few destinations. Finally, we find a negative correlation between product diversification and firm internationalisation in almost all the analysed industries. The finding suggests that the success of export-orientated exporters relies heavily on product specialisation.

Chapter 3 proposes an empirical model of firms' decision about export destinations. We estimate a multinomial logit model for the probability that a firm exports to a particular destination. The choice of markets is dependent on three factors: information spillovers, distance, and economic size. With uncertainty and sunk entry costs, small firms will tend to export to large countries in order to enhance the scale of production, to close countries to reduce the transport cost, and to countries where other local exporters have previous experience as information is cheaper and more reliable. The basis for our study is data on exports by country of destination of 5229 Spanish manufacturers in 1988. We construct different indicators of geographical concentration of exporters selling to specific destinations to identify the origin of the information spillovers: localisation, MNEs or urbanisation economies. The findings suggest that geographical agglomeration of exporting firms selling to one destination significantly affects the probability of small-medium sized firms exporting to the same destination. The source of information spillovers is localisation externalities, that is, concentration of domestic exporters of the same industry. There is no evidence that the presence of multinationals or urbanisation economies significantly affects the choice of destination of exporters in our sample. The significance of localisation economies persists in spite of controls, which shows how the probability to export to one particular destination is also (positively) affected by firm characteristics (size and export intensity), and gravitational factors (level of development and physical proximity of the destination country).

Chapter 4 combines three different approaches to estimate market power in an international duopoly model: evaluation of the firm's pricing-to-market policy, calculation of the residual demand of each exporter group, and estimation of an structural model of demand and supply.

Advantages, disadvantages and complementaries between the approaches are discussed. These techniques are implemented using data on prices and quantities of Italian and Spanish exporters of ceramic tiles, the two world-wide leaders over the period 1988-1998. In the cross-section analysis of market power across destinations, the results suggest that Italian producers are "leaders" and Spanish producers are "followers" in a market characterised by substantial positive markups. The time series analysis of the French export market reveals that there are positive markups in the short run, but they disappear in the long run.

Chapter 5 investigates the relationship between export activity and technical efficiency. We address two specific questions: 1) Is this relationship affected by the trade-orientation of the industry that the firm belongs to?; 2) How does ownership affect this relationship? To answer the questions, we use a sample of 2279 UK manufacturing firms in selected industries over the period 1992-1998. Results can be summarised as follows. First, the data suggest higher levels of efficiency for exporting firm relative to domestic-orientated firms. Second, firms that export a small fraction of their sales have marginally lower efficiency levels that firms with high propensity to export. Therefore, the descriptive statistics suggest that the superior efficiency performance of exporters is mainly due to their export status, not the export intensity of sales. Third, the econometric analysis confirms that export activity has a positive impact on the long run efficiency performance, after controlling for firm size, age and foreign participation in capital assets. Moreover, we show that the link between export activity and efficiency is stronger among firms operating in import competing industries. These findings suggest firm-specific attributes such as managerial quality or internal organisation play an important role in the exporting firms' performance in sectors with comparative disadvantage, compared to sectors in which exporting firms benefit from the comparative disadvantage forces in the country they compete in abroad. Fourth, competition abroad has a weak impact on short run efficiency improvement, compared to other sources of competition such as yardstick competition or competition in the domestic market. In general, controlling for ownership does not change the results about the lack of impact of foreign competition on efficiency changes.

Chapter 1

The decision to enter and exit foreign markets. Evidence for UK SMEs

1.1 Introduction

One stylised fact in international trade is the persistence of trade flows at the aggregated level. Baldwin (1988) and Dixit (1989) set up the micro-foundations for persistence in trade based on the idea of hysteresis. If the exchange of goods between countries requires some "sunk" investment and firms perceive demand and prices abroad as uncertain, the optimal strategy by firms will be a "wait-and-see-attitude". In this environment, the export participation decision of a firm will be strongly conditioned by how difficult is to distinguish permanent from transitory profit opportunities. Only large changes in the firm conditions or its environment will stimulate entry/exit into foreign markets. Small changes will have no effect so firms will remain in the same export status period after period.

Earlier empirical investigations by Ait-Sahalia (1994) and Giovannetti and Saimiei (1996) found mixed evidence of the hypothesis of hysteresis leading entry/exit decisions using aggregate trade data for US, Japan, Germany and UK. They unfortunately provide only an indirect test for state dependence in the export decision since the aforementioned analytical model of entry/exit is based on individual behaviour.[1]

Although there is persistence in trade flows, recent empirical evidence using plant and firm level data show that the transition rates into and out of export markets are relatively high in both developed and developing countries. Bernard and Jensen (1995, 1999) for US [1976-1987] find that 18 percent of exporting plants left the export market and 9 percent of nonexporters began foreign shipments in an average year. Bernard and Wagner (1997) for Germany [1978-1989] report 8 percent of exporting plants left the export market and 14 percent of nonexporters began foreign shipments in an average year. Aitken et al. (1997) for Mexico [1986-1989] report an striking 47 percent entry rate into foreign markets for large companies in the four-years period after trade liberalisation. Robert and Tybout (1998) for Colombia [1981-1989] observe that 10 percent of exporting plants cease exporting and 5 percent of nonexporters began foreign shipments in an average year. Liu et al. (1999) note that 10 percent of firms in the electronic Taiwanese industry that exported in 1990 did not export in 1992 and 12 percent of firms did not export in 1990 but enter by 1992. Bonacorssi (1992) and Aw et al. (1997) provide evidence of higher turnover rates in foreign markets for small-medium firms than for large firms in Italy and Taiwan, respectively. Both studies suggest the presence of minimal sunk costs as explanation for high turnover rates.

The vast majority of empirical models on export participation are static and include only observable firm-specific characteristics (Glejser et al., 1980; Braunerhjielm, 1999). However, dynamic models are needed to evaluate the importance of new factors such us permanent unobservable firm heterogeneity and genuine state dependence in the firm's decision to sell abroad. Roberts and Tybout (1997) find strong evidence of state dependence as key factor explaining the export decision among Colombian manufacturing plants: the initial "sunk cost" invest-

[1] The pass-through exchange rate model model also explains persistence in exported quantities based on price adjustment in non-competitive markets. If market shares are perceived as a kind of investment made through costly creation of consumer reputation, and of distribution networks, changes in environment conditions such as an appreciation of the domestic currency, will induce exporters to absorb the new costs in the markups to maintain competitiveness (Froot and Klemperer, 1989). Again, firms will exhibit persistence in their export status.

ment or learning from exporting is completely depreciated after two years without exporting. Bernard and Jensen (1997) discover that within-industry plant heterogeneity is as important as state dependence in explaining export decision among US manufacturing firms. These findings suggest that some, and only some firms self-select into export activity since exporting demands specific plant characteristics.

This paper contributes to these recent empirical literature estimating a dynamic model of entry/exit decision using a large panel data of UK manufacturing firms over the period 1992-1998. Unlike previous studies, we focus on small and medium enterprises (SME) to evaluate the importance of state dependence and firm heterogeneity in the export decision.

There are several reasons why the perspective of a smaller firm to international operations is very different from the one of larger firms. The amount and quality of resources, such as managerial resources, educated employees, capital and capacity, is typically lower among SMEs compared to large firms. This point is reinforced by the fact that a firm's ability to find and utilise external resources such as public institutions or cooperative firm networks much depends on its own resources. Another important consequence of "smallness" is that the firm is responsive to unique and random factors.

The traditional approach to exporting behaviour by SMEs describes it as a slow process where the firm gradually increases its commitment to international operations (Bilkey and Tesar, 1978). SMEs first start from being not interested in exporting, then filling possible unsolicited export orders, selling to psychologically close countries or using foreign markets as residual destinations, and ending to committed involvement in international marketing. The slow and cautious nature of the process follows from greater perceived uncertainty and risk associated with international business decisions compared to home-market operations. This "stages model" of international marketing is too universal as it explicitly ignores the decision-making of the firm as well as the industry characteristics in which the firm operates. "Smallness" implies lack of resources and information, concentration of the decision-making, and greater concern about risk and uncertainty. It seems plausible to assume that costs of exporting, such as costs from product adaptation, market research, advertising and marketing or possible sales organisation abroad, may be marked if the firms itself is small. If export activity involves learning behaviour and SME's commitment in the process of internationalisation determines its benefit, it will be more profitable to start exporting early than late. In that case, small young companies are more likely to start exporting than small old companies that never exported before.

The cautiousness of the internationalisation process by SMEs can be seen to be due to the costs of commitments to international marketing are partly sunk. In the decision of internationalization, waiting can have a value especially if a firm experiences uncertainty about the commitment to exporting, due to some random component in the entrepreneur's skills, or perceived uncertainty related to the future exchange rate. Under this circunstances, if the expected adoption of exporting involves sunk cost, such a marketing campaign to settle the firm's position in the foreign markets, the firm will do better postponing its decision. This is because by waiting it can avoid the subnormal return from exporting that would realise if the exchange rate became less favourable for the firm. Therefore, past export experience by SMEs becomes crucial to understand its export decision every year.

The firm's decision maker in SMEs is the most important person influencing the exporting process. First, ownership structure (i.e. independent versus subsidiary or domestic-owned versus foreign-owned) will be crucial to understand the firm's commitment in the export decision. Second, unobservable managerial characteristics such as skills, perception of risk in international markets or attitute towards diversification of markets, may account for the bulk of export decision and they need to be taken into account in the model of SMEs decision to export.

Econometrically, the estimation of a dynamic model of export participation is complex. The adequate specification of the econometric model becomes crucial to estimate the determinants of export decision since persistence could depend not only on past experience, but also on unobserved firm heterogeneity or purely autocorrelated random shocks. In addition, the model should take into account the extra problem of endogenous "initial conditions", that is, the gap between the origin of the stochastic process generating the sequence of export decisions for each firm (or year of set up of the company) and the first year of the window of observations over the period of analysis.

The data consist on 1679 small-medium sized (<250 workers) firms with less than 35 years operating in the manufacturing industry in 1992. Compared to other studies, our data shows a relatively low entry/exit rate in/out foreign markets every year (on average, about 3 percent). The results show that such an observed persistence in export behaviour is explained by a mixed of "true" state dependence and firm heterogeneity, while the existence of purely autocorrelated shocks is rejected by the data. After controlling for unobservable firm heterogeneity, we find that up to 70 percent of export persistence in the data is explained by state dependence, and that this dependence is greater among old companies than young companies. Observable firm-specific characteristics also are important determinants of export status: medium-sized foreign-owned firms are more likely to be exporters than small-sized domestic-owned firms. We find mixed evidence of industry-level characteristics affecting firm's decision to export. On the one hand, there is no evidence of correlation between perceived uncertainty about the export market destinations or growth rates in export markets and the firm's export decision. On the other hand, the results show a positive impact of spillovers in export decision measured by geographical concentration of manufacturing activity.

The remainder of the chapter is set out as follows. First we develop a simple dynamic econometric model of the export participation decision. Next we present the data and the econometric results. A final section summarises the findings and concludes.

1.2 An empirical model of export decision

Recent reseach has examined the determinants of firms' entry into and exit from the export sector. We briefly summarise the theoretical model and its empirical counterpart, before detailing the econometric concerns inherent in the reduced form estimation of the model. [2] We consider a monopolistic competition industry in which each firm faces a downward sloping

[2] See Roberts and Tybout (1998) for more details.

demand curve in the markets where it operates, yet views itself as being too small to strategically influence the behaviour of other producers. The domestic and foreign demands for the firm's product are

$$q_i = \phi_i p_i^{\epsilon_i} u_i \qquad i = A, B \tag{1.1}$$

where $p_i$are the prices in each market i, ϕ_i captures the usual demand shifters (domestic and foreign income levels and other goods' prices) in each market i. The elasticity of demand ϵ_i is larger than one and u_i reflects instability and uncertainty about exchange rates. If $X = (\phi_i, u_i)$, the current period gross operating profits can be written

$$\begin{aligned} \widetilde{\pi}_{it}(X, Z, F, Y_{it}) &= R_{it}(\cdot, X, Y_{it}) - c^v(\cdot, Z) \\ &= \left(p^A q^A\right) + \left(p^B q^B\right) Y_{it} - c^v(\cdot, Z) - F(1 - Y_{it-1}) \end{aligned} \tag{1.2}$$

where R_{it} is the total revenue function, $c^v(\cdot, Z)$ is the variable cost of producing total output and F captures entry sunk-costs in the export market. Y_{it} is an indicator function such that Y_{it} is equal to one if the decision to export in period t is positive, and zero otherwise. The demand shifters X affect firm's profitability through revenues while industry-specific and firm-specific factors Z affect firms' profitability through changing variable costs. For simplicity we maintain the expression for the variable costs function as being independent of the export decision.[3]

If firms can price discriminate between foreign and domestic markets, producers would simply participate in foreign markets – choosing the profit-maximising level of exports – whenever the condition marginal revenue is equal to marginal cost is satisfied. In the absence of firm-specific sunk costs (F=0), there exists a threshold such that, given demand conditions, all firms with a marginal variable costs below the threshold self-select into export activities[4].

The presence of sunk costs or non-recoverable fixed cost of entry in the international markets

[3]The general form of cost structure can be modified in order to emphasise specific factors that may affect the decision to export : (i) production cost complementarities - Bassevi (1970) ; (ii) learning-by-exporting - Clerides et al (1998) ; (iii) spillovers by neighbouring exporting firms in the same region and/or industry - Aitken (1997). These extra factors can be easily included and tested in the empirical model, conditional to data availability.

[4]A similar result holds when we assume that the variable cost function is separable by market destination.

explains the dynamics of trade reaction to exchange rate or trade policy changes. The fixed investment costs of exporting are represented by the cost of setting up a dealership network, advertising or marketing research. For simplicity we will assume that entry costs recur in full if the firm exits the export market for any amount of time. Firms will export if expected profit net of entry costs is positive, $Y_{it} = 1$ if $\widetilde{\pi}_{it}(\cdot) > 0$.[5]

Dynamic specification

In a multi-period framework our profit function becomes

$$V_{it} = \max_{q^A, q^B, Y_{it=\{1,\infty)}} E_t \left(\sum_{s=t} \delta^{s-t} \left[\widetilde{\pi}_{is} Y_{is} \right] \right) \quad (1.3)$$

where E_t is an expectations operator conditioned on the set of information available at time t, and δ is the one-period discount rate. We assume that firms never wish to liquidate. This expression is equivalent to the firm choosing whether to export in each period since we allow the firm to always pick the within period profit maximising quantities in each market. The Bellman's optimality principle states that the processes $\{q_{it}^A, q_{it}^B, Y_{it}\}$ to the firm's program are the period-by-period solutions to the sequence of Bellman's Equation

$$V_{it} = \max_{q^A, q^B, Y_{it}} \{ \widetilde{\pi}_{it} Y_{it} + \delta E_{t+1} \left[V_{it+1}(\cdot) Y_{it} \right] \} \quad (1.4)$$

A firm that did not export in period t-1 will choose to export in period t, i.e. $Y_{it} = 1$ if

$$\pi_{it}(Y_{it} = 1) - \pi_{it}(Y_{it} = 0) + \delta E_{t+1} \left[V_{it+1}(\cdot)(Y_{it} = 1) \right] - \delta E_{t+1} \left[V_{it+1}(\cdot)(Y_{it} = 0) \right] > F(1 - Y_{it-1}) \quad (1.5)$$

The left-hand side term represents the current net operating profits from total sales in the domestic and foreign market plus the expected discounted future payoff from remaining an exporter. The right-hand side term contains the sunk-cost fee associated with new entry or re-entry. Incumbent exporters continue exporting and non-exporters begin exporting whenever

[5] Note that the firm maximises total profits including both domestic and foreign sales. We allow the possibility that selling abroad itself is not profitable but the firm gets higher profits producing for both markets than selling only in the domestic market due to the possibility of economies of scale in production

the first term is larger than the second term. Note that the first term must be larger for non-exporters than for incumbent exporters due to start-up costs. We define the latent variable Y_{it}^* as current net operating profits plus the expected future return from being an exporter in period t, that is, the left part of equation (1.5).

Theoretical models suggest that sunk costs create hysteresis in the sense that they widen the range of profits between those firms that enter and those firms that exit. In addition, sunk costs causes a firm to treat exit differently from entry. Therefore, firms that exit and re-enter the export market may pay different start-up costs than firms that never exported. Specifically, define F^0 as the start-up cost for a non-exporter with no previous experience and F^j as the start-up cost faced by a firm that last exported $j-1$ years ago (note that F^1=0). This generalisation of equation (1.5) implies that the *ith* firm will export in year t, $Y_{it} = 1$ whenever

$$Y_{it}^* \geq F^0 - \sum_{j=1}^{J}(F^0 - F^j)\widetilde{Y}_{it-j} \tag{1.6}$$

where $\widetilde{Y}_{it-j}$ is one if the firm last exported in year t-j and zero otherwise. Now the condition to start exporting can be written as a dynamic discrete choice process

$$Y_{it} = \begin{Bmatrix} 1 \text{ if } Y_{it}^* - F_0 \geq -\sum_{j=1}^{J}(F^0 - F^j)\widetilde{Y}_{it-j} \\ 0 \text{ otherwise} \end{Bmatrix} \tag{1.7}$$

Reduced-form equation

The export participation equation (1.7) needs to be transformed into an estimable equation. We start expressing the latent variable as a reduced form in exogenous observable factors that affect the expected future profitability of the firm $x_{it} = (X_{it}, Z_{it}, \varphi_t)$, which includes firm-specific factors, industry characteristics, and a temporal component reflecting common aggregated shocks, φ_t, and an individual error term ϵ_{it},

$$Y_{it}^* - F^0 = x_{it}\beta + \epsilon_{it} \tag{1.8}$$

We also assume the sunk entry costs faced for all the companies that enter in different years are identical ($F^j = F, \forall j > 1$) and $\gamma = F^0 - F$. The representation of the export market participation decision becomes

$$Y_{it} = \begin{Bmatrix} 1 \text{ if } x_{it}\beta + \gamma Y_{it-1} + \epsilon_{it} \geq 0 \\ 0 \text{ otherwise} \end{Bmatrix} \tag{1.9}$$

Econometric issues

Our empirical model for firm i at year t is

$$y^*_{it} = x_{it}\beta + \gamma y_{it-1} + \varepsilon_{it} \quad \text{where} \quad t = 2, ..., T \text{ and } i = 1, ..., N \tag{1.10}$$

where y^*_{it} denotes the unobservable firm propensity to export, x_{it} is a vector of observable characteristics affecting y^*_{it} and ε_{it} is the unobservable error term. A firm is observed to be an exporter when the profitability of its action crosses a threshold (zero in this case), that is, if $y^*_{it} > 0$.

Our dynamic specification suggests that firms exporting in the past are more likely to export today. Persistence in export activity can be due to many factors. It might be that it is necessary for a certain set of observable or unobservable characteristics to become an exporting firms so once a firm starts exporting it carries on every year. Another possibility is that firms that want to export have to incur relevant sunk costs to start so the experience of exporting one year alters the future likelihood of exporting. Finally, highly correlated positive shocks may induce firms to export one year after another independently of whether firm characteristics are adequate or the firm has previous export experience. These three conceptually distinct explanations of export persistence plus the additional problem in our dynamic specification of the correlation between the initial period observations and the unobservable firm characteristics are discused below.

Modelling structural dependence and population heterogeneity

Past exporting experience may change the future export history of a firm, since the spectrum of options is altered. This is what happens in a model of exports that combines the presence of sunk costs with uncertainty in the foreign markets. The permanent effect of past experience on future outcomes is termed *structural dependence.* Alternatively, some firms export every year because they have some unobservable characteristics that increase their propensity to export. This second explanation is called *population heterogeneity* (Heckman, 1981a)

Several *structural dependences* have to be considered about export persistence by individual firms: 1) the state dependence, i.e. how the previous state occupied by a firm (exporting or no exporting) affects the current state; 2) the duration dependence, i.e. the experience effect of how many years a firm has been an exporter or not in the past; 3) the output dependence, i.e. companies export continuously when they have very high export-sales ratio. The term y_{it-1} in our empirical specification captures state dependence.

Population heterogeneity is assumed to be captured by a firm-specific time-invariant component in the error term such that ϵ_{it} is written as

$$\epsilon_{it} = \widetilde{\alpha_i} + u_{it} \tag{1.11}$$

where both $\widetilde{\alpha_i}$ and u_{it} are orthogonal to each other and independent of the observable exogenous characteristics x_{it} for all i and t. If we assume that u_{it} is independent normal distributed with mean zero and variance σ_u^2, we can use conventional computational techniques to estimate a dynamic probit model as a random effect model. In order to marginalise the likelihood, we assume that $\widetilde{\alpha_i}$ is independent normal distributed with mean zero and variance σ_α^2 and is independent of the u_{it}. However, if $\widetilde{\alpha_i}$ is not independent of x_{it} for all t and i, the maximum likelihood estimates will be inconsistent due to omitted variable bias. To account for a possible correlation over time between the unobservable characteristics and the covariates in a random effect model, Chamberlain (1984) suggests to account for this problem by assuming that $\widetilde{\alpha_i}$ is a linear function in the means of all the time-varying covariates, $\widetilde{\alpha_i} = \overline{x_i}\psi + \alpha_i$,

$$y_{it}^{*} = x_{it}\beta + \overline{x_i}\psi + \gamma y_{it-1} + \alpha_i + u_{it} \quad \text{where} \quad t = 2, ..., T \text{ and } i = 1, ..., N \tag{1.12}$$

Modelling permanent shocks

The structure of the error term u_{it} in equation (1.11) is important in the interpretation of the nature of export persistence. For example, if shocks are purely transitory, $cov(u_{it}, u_{it-1}) = 0$, then relatively large entry costs will lead to persistence in exporting (or non-exporting) while small entry costs will allow firms to enter and exit the market more often. Persistent shocks, $u_{it} = \varpi u_{it-1} + \mu_{it}$ with ϖ near one, can overcome the effects of large entry costs. Firms perceiving a positive shock today believe that their good fortune will persist and that the value of entry is large. Unmodelled persistence in the error term structure would be picked up by the lagged endogenous variable and thus incorrectly interpreted as high entry costs.

$$y_{it}^{*} = x_{it}\beta + \overline{x_i}\psi + \gamma y_{it-1} + \widetilde{\alpha_i} + u_{it} \text{ where } u_{it} = \varpi u_{it-1} + \mu_{it} \tag{1.13}$$

A dynamic probit model with an autorregresive error term can be estimated using simulated smooth maximum likelihood with the GHK (Geweke, Hajivassiliou, Keane) simulator (Borsh-Supan and Hajivassiliou, 1993).

The initial conditions problem

The initial conditions problem arises when the start of the observation period does not coincide with the start of the stochastic process generating individuals' exporting "first" experience. Technically the problem occurs if y_{i1} is correlated with the unobservable α_i. The problem arises because the beginning of the observation period in our sample does not coincide with the start of the stochastic process generating firm's past status. Since it is possible that there is a history of past decisions, we account for this problem following Heckman (1981c) and first specify a reduced form equation for the initial observation as follows:

$$y_{1i}^{*}=\lambda z_i + \eta_i \tag{1.14}$$

where $var(\eta_i) = \sigma_\eta^2$ and z_i is a vector of strictly exogenous instruments, including variables relevant in period 1 along with pre-sample information affecting the likelihood of exporting.

We define $corr(\alpha_i, \eta_i) = \rho$ as the correlation between α_i, the unobservable heterogeneity parameter, and η_i, the error term in the initial condition equation. To account for $\rho \neq 0$, we use a linear specification, in terms of orthogonal error components,

$$\eta_i = \theta\alpha_i + u_{i1} \tag{1.15}$$

By construction α_i and u_{i1} are orthogonal to one another, then $\theta = \frac{cov(\eta_i, \alpha_i)}{var(\alpha_i)} = \frac{\rho\sigma_\eta}{\sigma_\alpha}$ and $var(u_{i1}) = \sigma_\eta^2(1-\rho^2)$. Moreover, we assume that the initial observation y_{i1} is uncorrelated with u_{it} and also u_{i1} is uncorrelated with x_{it} for all i and t. Substitute (1.11) in (1.10) and (1.15) in (1.14) to obtain

$$\begin{aligned} y_{it}^{*} &= x_{it}\beta + \overline{x_i}\psi + \gamma y_{it-1} + \alpha_i + u_{it} \quad \text{where} \quad t = 2, ..., T \text{ and } i = 1, ..., N \qquad (1.16) \\ y_{i1}^{*} &= \lambda z_i + \theta\alpha_i + u_{i1} \quad \text{where} \quad t = 1 \quad \text{and } i = 1, ..., N \qquad (1.17) \end{aligned}$$

In the estimation of the two equation model we use a two-step method suggested by Orme (1997), in the spirit of Heckman's standard sample selection correction method which is a valid approximation in the case of small values of ρ. [6] To account for the correlation between the initial condition and the unobserved heterogeneity α_i, we define an alternative specification for α_i

[6] Arulampalam et al. (1998) have implemented succesfully Orme's two-step estimation method to study unemployment persistence.

$$\alpha_i = \delta\eta_i + w_i \tag{1.18}$$

By construction, η_i and w_i are orthogonal to one another , $\delta = \frac{\rho\sigma_\alpha}{\sigma_\eta}$, and $var(\alpha_i) = \sigma_\alpha^2(1-\rho^2)$. The random effect probit model, under the new specification of α_i becomes

$$y_{it}^* = X_{it}\beta + \overline{X_i}\psi + \gamma y_{it-1} + \delta\eta_i + w_i + u_{it} \quad \text{where} \quad t = 2, ..., T \text{ and } i = 1, ..., N \tag{1.19}$$

The model has two firm-specific random error components in (1.19) η_i, w_i. Under the assumption of bivariate distribution of (η_i, α_i), $E[w_i/y_{i1}] = 0$ but $E[\eta_i/y_{i1}] = e_i$, where $e_i = \frac{(2y_{i1}-1)\phi(\lambda z_i)}{\Phi(\{2y_{i1}-1\}\lambda z_i)}$ by construction. Since u_{it} is assumed to be orthogonal to the regressors x_{it}, we can treat w_i as the usual time-invariant error component in the random effect probit model provided we can correct for the unobservable η_i. Since e_i is a probit generalised error in the probit equation (1.18) we can replace η_i by its conditional expectation in (1.19) and estimate the random effect probit model equation with an additional regressor e_i under the assumption of normality

$$y_{it}^* = x_{it}\beta + \overline{x_i}\psi + \gamma y_{it-1} + \delta\widehat{e}_i + w_i + u_{it} \quad \text{where} \quad t = 2, ..., T \text{ and } i = 1, ..., N \tag{1.20}$$

A test of the null hypothesis that $\rho = 0$ is given by the t-statistic of the coefficient of the additional regressor $\widehat{e}_i$.[7] If we impose a factor analytical structure in the error term, that is, the correlation between successive errors for the same individual is a constant,

[7]Unfortunately, the assumption of bivariate normality of (η_i, α_i) implies that w_i (the new error component that enters the random effects probit model specification) has variance $var(w_i|y_{i1}) = \sigma_\alpha^2(1-\rho^2\xi_i^2)$ where $\xi_i^2 = \frac{\phi(\lambda z_i)}{(\Phi(\lambda z_i)\Phi(-\lambda z_i))^{1/2}}$. Orwe (1997) shows, from Monte-carlo results, that the heteroskedasticity producing inconsistent parameter estimates disappears for small values of ρ. The condition of "small ρ" is also required for $var(w_i) \cong \sigma_\alpha^2$.

$$r = corr(w_i + u_{it}, w_i + u_{it-1}) = \frac{\sigma_\alpha^2}{\sigma_u^2 + \sigma_\alpha^2} \quad \text{t=2,...,T} \tag{1.21}$$

so r is the proportion of the variance attributed to the unobserved individual heterogeneity in the total variance of the error term. If we normalise $\sigma_u^2 = 1$ an estimate of ρ is approximated by $\delta \left(\frac{1-r}{r}\right)^{1/2}$ where δ is the coefficient attached to the probit generalised error variable $\widehat{e}_i$.

As shown in Heckman (1981b), under the additional assumption that w_i and u_{it} are jointly multi-variate normal, this model can be easily estimated by noting that the distribution of y_{it}^* conditional on w_i, x_{it}, and y_{it-1} is independent normal.

$$\begin{aligned} \Pr ob(y_{it} &= 1|x_{it}, y_{it-1}, \widehat{e_i}, w_i,) & (1.22)\\ &= \Pr ob\left(\frac{u_{it}}{\sigma_u} > -x_{it}\frac{\beta}{\sigma_u} - \overline{x_i}\frac{\psi}{\sigma_u} - \frac{\gamma}{\sigma_u}y_{it-1} - \frac{\delta}{\sigma_u}\widehat{e}_i - \frac{\sigma_\alpha}{\sigma_u}\widetilde{w}_i\right) & (1.23)\\ &= \Phi\left(x_{it}\frac{\beta}{\sigma_u} + \overline{x_i}\frac{\psi}{\sigma_u} + \frac{\gamma}{\sigma_u}y_{it-1} + \frac{\delta}{\sigma_u}\widehat{e}_i + \frac{\sigma_\alpha}{\sigma_u}\widetilde{w}_i\right) & (1.24) \end{aligned}$$

where $\widetilde{w}_i = \frac{w_i}{\sigma_\alpha}$ and Φ is the distribution function of the standard normal variate.

Normalising the variance of u_{it}, $\sigma_u^2 = 1$ for all t to obtain and marginalising the conditional likelihood for y_{it} with respect to the w_i gives the likelihood function for the sample,

$$\prod_i \{\int_{-\infty}^{\infty} (\prod_{i=2}^{T} \Phi\left[(2y_{it} - 1)\left(x_{it}\beta + \overline{x_i}\psi + \gamma y_{it-1} + \delta\widehat{e}_i + \sigma_\alpha \widetilde{w}_i\right)\right] \phi(\widetilde{w})d\widetilde{w}\} \tag{1.25}$$

The random effects probit model with such a restriction on the error covariance matrix can be estimated using Gaussian-Hermite Quadrature approximations to univariate integrals (Butler and Moffit, 1982).[8]

[8] This paper utilises the econometric package LIMDEP 7.0 for the estimation of the random effect probit. LIMDEP 7.0 uses the normalisation $\sigma_u^2 = 1$ instead of the overall variance (Greene, 1998). If we want to compare our results with those of the pooled probit model, Arulampalam (1999) shows that the estimated coefficients of the random effect probit model using LIMDEP should be multiplied by a factor $\sqrt{1-r}$.where r is the proportion of the variance that is attributed to the individual specific error component in the total unexplained variation.

1.3 Data and variables description

Transition rates

In order to implement our empirical model we need a large panel data of firms with information about their export status. The data used in this work are based on firm-level data from UK manufacturing industry between 1992 and 1998. Firm-level data was obtained from balance sheets and annual reports in FAME database (Financial Analysis Made Easy). The data includes total sales, destination of sales -domestic and exports, year of registration in Company House, ownership, geographic location, employment, wages, profits, fixed assets, operating costs and four digit industry codes in which firms operate. Our sample contains 1679 firms with less than 250 employees in 1992. Appendix 1.A. explains the construction of the data set as well as details of the variables used in the paper.

The number of firms that change their export status at least once over the period 1992-1998 is 215 (12.8 % of the sample). Table 1.3 shows the transition rates into and out of the export market for our sample of UK companies across years. The first row of conditional probabilities shows the probability of being a regular exporter. The second row presents the probability to cease exporting, conditional on being an exporter the previous year, and the third row presents the probability of being a new exporter (that is, the probability to export at time t+1, conditional on not exporting at time t). The conditional probabilities to maintain the export status are very high, above 97% across years. The probability of being an entrant in 1993 conditional on not exporting in 1992 was only 4% and the probability of exiting in 1993 conditional on exporting in 1992 was only of 1%. In subsequent years, these conditional probabilities vary from 5%-6% for new entrants and 1%-2% for exiters. Table 1.3 suggests that, based on raw data, there is considerable persistence in the export decision measured on annual data, even though our sample represents only those firms with higher probability a priori to change their export status.

Description of variables in the dynamic probit model

In our empirical model of the export participation decision (1.20), the main explanatory variables are firm-specific characteristics and the export status in the previous year. In addition, the initial condition equation required the inclusion of pre-sample characteristics that may affect the decision to export before 1994, our first year observation. The variation in net expected profits from exporting is captured through four time-varying firm characteristics (size, labour quality, managerial skills and financial situation), three time-invariant firm characteristics over the period (year of creation of the company, ownership and number of industries in which the firm operates), a constant term , a variable of export prices, 14 industry dummies defined at the two-digit SIC92 level and a set of 4 regional dummies (Scotland, North of England, Midlands and Wales, South of England). Macroeconomic shocks are captured through time dummies for each year. The past export status enters in interactive form with age to account for differences in the perceived sunk investment in exporting depending on firm experience.

The *size* of the firm is measured by total tangible assets and it is expected to have a positive impact on the probability to export. The size of a firm is used as a proxy for past success, lower average costs, better information and easier access to financial external resources. Where fixed costs to exporting are important, the likelihood of exporting should increase with firm size. Large firms also benefit from economies of scale in production and marketing. Labour *productivity* and directors' *wages* are included as a proxy for labour quality and managerial skills, respectively. Again, it is expected that more productive firms or firms with a better managerial team will exhibit higher propensity to export. Finally, the *return on sales* is included to reflect the financial situation of the firm in each period.

The *age* of the company is expected to have a positive impact on the likelihood of exporting. The older the company the larger the accumulated experience in the product market. Two dummy variables are created. The first one takes a value of one for firm set up between 1970 and 1980, zero otherwise. The second dummy variable takes value of one for firms set up after 1980. As far as age captures experience, older companies should exhibit a larger propensity to export.

As we have emphasised previously, control over the decision to export in SMEs depends critically on *ownership* structure. We include two dummy variables for domestic-owned subsidiaries and foreign-owned subsidiaries, leaving domestic-owned independent firms as a benchmark. Decision makers in subsidiaries benefit from the interaction with other decision makers of the company group. Foreign-owned subsidiaries are the ones that more can benefit from the access to the resources that the parental firm has abroad. Therefore, we expect a positive impact of subsidiary ownership on export propensity, particularly among foreign-owned ones.

We also include a dummy for product *diversification* that takes value of one if the firm operates in more than one industry and zero otherwise. Product diversification may stimulate exports as strategy of market diversification. [9]

In addition to industry dummies we include as an explanatory variable the ratio of *foreign to domestic prices* to reflect the attractiveness of foreign markets relative to domestic markets. This index of export price competitiveness was obtained as the ratio between the unit value index of manufactured exports and the producer price index in UK manufacturing at four digit SIC92 industries. Export unit values over the period 1993-1998 are from "UK Markets" and "Product Sales and Trade" both published by ONS.

In Appendix 1.B we show that export status and firm performance are closely related, at least during the switching year. To avoid endogeneity problems between export status and firm performance, all the time varying characteristics have been lagged one period.

Our pre-sample information contains industry-level variables that measure *export spillovers, exchange rate shocks, foreign demand shocks and destination market uncertainty.* These extra variables are included in the "initial condition" equation to identify additional factors that may influence the firm decision to be exporter or non-exporter in years previous to our "observations window" 1994-1998. All the variables refer to the period 1990-1993. Motivated by the findings of Aitken et al. (1997) about the significant correlation between the decision to export and geographic spillovers in Mexico after trade liberalisation in 1985, we construct a measure of geographic concentration in a particular industry activity as the share of region-industry activity (measured by employment, E_{jk}) in national activity divided by the region share of ac-

[9] **In Chapter 2 we will pay special attention to the relationship between product diversification and market diversification.**

tivity in national activity. The region-industry concentration of employment E_{jk} is defined as $\frac{E_{jk}}{\sum_j E_{jk}} / \frac{\sum_k E_{jk}}{\sum_j \sum_k E_{jk}}$ where j is a region and k is a three-digit SIC80 industry in 1992. Note that we use an index of geographic concentration of activity concentration to capture concentration in export activity. To the extent that both indices are correlated and export spillovers matters, the export participation decision will be enhanced among small and medium sized companies in highly geographically concentrated industries.

We construct two industry-specific indicators of foreign demand conditions during the period 1990-1993 to capture positive shocks that may induce some firms to enter into foreign markets. The first one is the industry growth rate of exports. The second variable is a proxy for the extent of economic and political uncertainty of the destination markets using the CBI Industrial Trends Survey. One of the questions of the CBI Industrial Trends Survey for manufacturing exports is about the factors that firms perceive will limit their ability to export. Our explanatory variable is constructed as the percentage of responses claiming from question 15 of CBI Industrial Trends Survey that political and economic problems abroad are important factors constraining exporting. The CBI Survey data is available for 50 manufacturing industries. We use previous research by Temple and Urga (1997) for a correspondence with 81 three-digit SIC80 industries.

Finally, the export hedging literature suggests that higher volatility of the exchange rate rises expected profitability of exporting and stimulates exports (Ungern-Sternberg and Weizsacker, 1990). The volatility of the exchange rate was measured as the standard deviation of the industry monthly growth rate of the exchange rate between 1990 and 1992. The trade-weighted nominal value of the British pound is computed for 21 OECD countries using the average of monthly nominal exchange rates (Source: International Financial Statistics). The trade-weight is the 1992 share of 3-digit NACE industry exports in total UK exports for each destination country (Source: EUROSTAT).

1.4 Results

Table 1.4 reports the estimates of the dynamic probit model using the two-step estimation procedure. The first column reports the estimates of the initial condition equation. This is a static probit model of export decision including pre-sample information characteristics for the year 1993. Model 1 column 2 reports the estimates for the period 1994-1998 under the assumption of no correlation between the time-varying firm level covariates and the error term. Next, Model 2 column 3 reports the results of the specification with correlation between time-varying covariates and error term. In the columns 4 and 5 (Model 3 and 4) we re-estimate the model to check the robustness of the estimated parameters by selecting only a panel of the two extreme years, 1994 and 1998.

Our preferred specification is Model 2, which allows for correlation between the covariates and the error term. When testing for the endogeneity of the initial conditions, the null hypothesis of $\delta = 0$ is easily rejected by the data (t-statistic=20.3). We are also able to recover an estimate of $\rho = corr(\alpha_i, \eta_i)$ from the estimate of δ, the residual term in the initial condition probit, using the expression $\delta \left(\frac{1-r}{r}\right)^{1/2}$ (see the econometric section for more details). The estimate of ρ is 0.560 $(0.689 * \sqrt{\frac{1-0.602}{0.602}})$. [10]

After controlling for $corr(\alpha_i, \eta_i)$, the results indicate that the presence of unobservable firm heterogeneity is important. In all estimated models the variance of the unobservable heterogeneity as a proportion of total unexplained variance, r, lies between zero and one and it is statistically significant. Therefore, the pooled probit is rejected in favour of the random effect probit model.

State dependence

We interact the lagged export status variable with age, in order to investigate whether the relationship between previous and current export status is different for young, less experienced firms than for mature, well-experienced firms. The importance of state dependence is likely to

[10] It remains unsolved whether $\rho = 0.56$ in our preferred model is small enough to ensure consistent estimated parameters. We are quite confident since previous research by Arulampalam (1998) obtained the same estimated coefficients for all covariates using both Orme's two-step estimation approach and two-equation maximum likelihood estimation for an estimated ρ with value above 0.6.

vary with age. Case-studies have shown that young SMEs are more likely to receive unsolicited orders to export compared to mature, more experienced firms (Lautanen, 2000). If so young firms will find easy to entry-exit foreign markets without incurring in any "sunk" cost. By constrast, mature SMEs are more likely to have developed previous relationships abroad so they are more dependent on export sales. It is also possible that age differences in the magnitude of state dependence emerge as a result of differences in product markets conditions faced by young and more mature firms. New SMEs in the 1980s and 1990s are more export-oriented compared to older SMEs, which had more difficulties to start exporting in the 1970s so they have traditionally produced only for the domestic market. If so, we should expect to observe young SMEs trying to penetrate foreign markets, if necessary several times, in order to succeed as exporters. Alternatively, the greater ability of mature firms to enter or to exit foreign markets responding to current shocks would reveal the importance of experience and learning by doing in exporting.

The results in Table 1.4 show a positive and significant coefficient on the lagged export status variables, suggesting that there is state dependence in export activity for both young firms (aged less than 15 years) and mature firms (aged more than 15 years). In all the models there is little difference between the magnitude of the coefficients for young and more mature firms. Although the difference is small, the coefficients of the lagged export status for firms set up after 1980 is slightly larger than for companies set up before 1980.[11]

Observed firm heterogeneity.

Several observable firm characteristics seem to have a positive impact on the propensity to export. In Model 1, firm size, labour productivity and directors' wage (as proxy for managerial quality) have a positive and statistically significant impact on the decision to export. The indicator of financial performance, the rate of return on sales, has no effect on the decision to export.

[11] Various interactions of age with lagged export status were tried, including aged 10 and 20. Age 15 was chosen in the preferred specification based on the likelihood value. Since the models are estimated as probabilities, there is no restriction on the values of the coefficients on lagged export status. This is in contrast to time-series analysis, where the absolute value of the coefficient needs to be less than unity for stationarity.

The positive coefficient of subsidiary ownership reveals that foreign-owned subsidiaries are more likely to export than domestically-owned subsidiaries and independent companies. The negative sign of the coefficient of age suggests that young companies are less likely to export compared to mature companies. Industry diversification has a positive effect on the decision to export, but the coefficient is not statistically significant in most of the specifications. Time, regional and industry dummies were also included to pick up economy-wide trends. However, a joint test of significance was rejected for all three groups of dummies.

The export price variable has a positive effect on the decision to export but it is not significant. As pointed out by Roberts and Tybout (1997), this could be explained by the inclusion of time dummies that have already controlled for general movements in relative prices so industry-specific prices reflect simply deviations from the average trend. The exclusion of the time dummies in our regression did not change the sign and significance of the variable export prices. Another explanation is that the use of unit values to construct export prices indices introduced too much noise into the constructed variable.

When we control for the possible correlation between the covariates and the error term (Model 2), the only time-variant characteristic that remains statistically significant is firm size. The coefficients of ownership and age remain unaffected while the coefficient on diversification becomes weakly significant, suggesting that more diversified firms are more likely to export.

The initial conditions equation (Column 1) provides an additional list of industry-level explanatory variables on the propensity to export in 1993. Both geographic concentration of the manufacturing activity and exchange rate volatility are positively correlated with export participation, although the coefficient of the second variable is only significant at 10 percent. The two additional pre-sample variables, the growth rate of industry exports and an indicator of country-destination perceived instability by exporters, showed no effect on the decision to export in our sample. The rest of variables in the initial condition equation coincide in sign and significance with those in the random effect model.

1.4.1 State dependence, heterogeneity and export probabilities

The positive and significant coefficient on the lagged dependent variables suggest that there is a state dependence in the decision to export for both young and mature companies. Next we calculate various probabilities from our preferred estimated model (Model 2) and compare these to the raw aggregate probabilities, in order to see how much of the estimated export persistence probabilities are attributed to "true" state dependence. This calculations, carried out following Chamberlain (1984), are presented in Table 1.5. The first panel records of raw aggregate probabilities, and the other two panels record the predicted probabilites for the pooled probit model (incorrect specification) and the model with unobservable heterogeneity and endogenous initial condition (correct specification).

We take each firm and calculate the predicted probabilities of being an exporter conditional, first on being an exporter the previous period, and secondly on being a non-exporter in the previous period, and then we average over the sample members. Our calculations therefore keep firm characteristics constant. Our calculations indicate (for a randomly chosen firm from a particular age group, conditional on previous exporting status) the probability of observing this individual exporting in the current time period. Since each calculation is carried out for each individual by changing their previous export status the diference between probabilities gives the contribution due to true state dependence.

The main points to note about the predicted probabilities are the following. First, we find that, in the raw data, young firms show greater state dependence, although the difference is quite small. However, these raw calculations do not take into account that changes in observed and unobserved characteristics may influence the probability of being exporting at a particular point in time. Second, as expected, the models which treat the initial observation as endogenous and include unobservable heterogeneity, attribute a smaller percentage of the observed persistence to genuine state dependence (75 percent). This is in contrast to the pooled probit model that treat the initial observation as exogenous which attribute a very large percentage of the persistence effect to genuine state dependence (97 percent). This implies that one obtains a massively upward biased estimate of genuine state dependence if one does not adequately control for possible endogeneity of the initial state and unobservable heterogeneity.

Next we investigate the impact of unobservable firm heterogeneity on the probability of becoming an exporter. Table 1.6 reports the predicted probabilities for two "representative" SMEs. The first column describes the two types of firms. The first has "negative" attributes to be an exporter - independent, young, operating in only one industry and with low size, labour productivity and directors' remuneration. The second is a firm with "positive" attributes to be an exporter - that is, foreign subsidiary, mature, with diversified production, large size, higher productivity and greater directors' remuneration. The second column in Table 1.6 indicates the distance to the population mean of those unobservable firm attributes distributed randomly across firms that are relevant in the export participation decision. The benchmark is zero deviation so favourable unobservable attributes are measured as one or two positive standard normal deviations. The last two columns indicate whether the firm has previous export experience.

After controlling for observable firm characteristics and past export experience, we identify the marginal impact of unobservable heterogeneity across firms. Suppose that the distribution of the manager's attributes towards internationalisation of the firm is captured by our firm effect. Our results suggest that a firm with negative "attributes" and no previous export experience will have an increase of 6 percent in the probability of exporting if it recruits a manager with a pro-exporting attitude (from 0.06 to 0.12). Overall, the distribution of the unobservable component contributes to the probability to export among unexperienced exporters around 6 percent. For a firm with positive attributes and previous export experience, the increase in the probability to export is only 0.003 percent (from 0.996 to 0.999).

1.4.2 Robustness

In this section we discuss three issues: (1) the change in panel structure; (2) the importance of autocorrelated random shocks; (3) the predictive capacity of the model.

First we check whether our results are sensitive to the sample period. In the last two colums of Table 1.4 we report the results for the model for only two years (1994 and 1998).

Compared to Model 1 and 2, the results do not change for the variables capturing past experience, unobservable heterogeneity and endogenous initial conditions on the participation decision. However, time-invariant characteristics become statistically insignificant when we assume no correlation between the covariates and the error term (Model 3). Only the coefficients of firm size and foreign-owned subsidiary are robustly significant in the model with correlation between covariates and error term (Model 4).

Another important issue is whether the inclusion of autocorrelated shocks modifies previous findings about export persistence. For that purpose we have estimated a multiperiod dynamic probit model allowing for serial correlation in the error term. To simplify the estimation we have assumed that the initial conditions are exogenous and have reduced the number of estimates, relative to Model 2. The reason for a more parsimonious specification was the difficulties of computing the standard errors in the full model. We expect that the estimation is still valid to test for autocorrelation in the error term. Table 1.7 reports the results of our preferred estimation using 50 draws in the GHK simulator. The estimated coefficient for the autorregressive parameter in the error term -0.052 but it is not statistically different from zero. Therefore we are able to reject the hypothesis of permanent shocks as explanation for export persistence. This finding also ensures that the estimated coefficients in Table 1.4 are not inconsistent after allowing for the presence of serial autocorrelation in the error term.

To evaluate the goodness of fit of our model we compare the actual and predicted patterns of export market participation. We report the predicted export trajectories from Model 2 in Table 1.4. [12] Table 1.8 shows the distribution of the actual and predicted export status path over the period 1994-1998. Each path is composed by a sequence of {0,1}. For example {1,1,1,1,1} represents the sequence for an stable exporter and {0,1,0,1,0} for a firm that enters and exits the foreign market each year. The number of firms that change their export status more than

[12] An alternative approach is to carry out some simple test of our preferred model, such as the standard goodness of fit chi-squared tests (Chamberlain, 1984, Andrew, 1988). The approximate distribution of the test statistic is a chi-squared only if the expected frequencies that enter the denominator of the test statistic are at least 5. Unfortunately any combinations of cells is arbitrary, so we decide not to carry on with the calculations. Roberts and Tybout (1997) made groups of export trajectories to implement Andrew's omnibus test.

once is extremely reduced, only 2.5% of the total sample in a five-year period.[13] As it can be easily checked, our model overpredicts the number of regular exporters and non-exporters against those firms with irregular export behaviour. However, the model is still able to identify correctly a sixth of those firms switching export status over the period 1994-1998.

1.5 Conclusions

This paper provides the first empirical evidence on the export decision by UK firms. In doing so we estimate a dynamic probit model using a large panel of small and medium sized firms for the period 1992-1998. In that dynamic framework we consider the impact of previous export experience, individual firm characteristics and transitory shocks. We also control for the initial conditions problem that arises when the beginning of the observation period does not coincide with the beginning of the stochastic process generating fims exporting experiences. The estimation of the first period as a cross-section probit model requires the inclusion of additional factors affecting export decision: geographical spillovers, exchange rate volatility, growth of exports and perceived uncertainty of destination countries. After estimation the model is used to disentangle the effects of unobserved firm heterogeneity and true state dependence on observed export persistence.

The results suggest that both state dependence and firm heterogeneity are important in the export decision. The probability to export one year conditional on exporting the previous year, holding firm characteristics constant, is 75 percent. The importance of sunk costs falls with the age of the company, although the difference is very small. Older firms exhibit higher state dependence than young companies. The greater ability of older firms to enter or to exit foreign markets responding to current shocks reveals the important role played by experience and learning by doing in exporting. Although state dependence is high, firm heterogeneity among British SMEs also contributes to explain export persistence. Some SMEs export because only

[13] Roberts and Tybout (1997) find that only 5% of firms switch their export status more than once among all Colombian plants in a six-year period. Bernard and Jensen (1997) observe rates above 12% for US plants in a seven-year period. Bonaccorsi (1992) reports a rate of 40% for Italian plants in a ten-year period.

a few firms have the necessary characteristics to take advantage of favourable shocks. Firm size and foreign ownership are the most important observable characteristics dintinguishing exporters from non exporters.

We also test hypotheses about spillovers, exchange rate shocks, foreign demand shocks and perception of uncertainty about export destinations from the recent literature on trade and firms. We find a positive but weak role of geographic spillovers on the export decision by SMEs. In line with the export hedging literature, greater exchange rate volatility stimulates export participation decision. The rest of variables have no noticiable effects on exporting in our sample. The last results should be taken with caution since these industry-level variables are used in a static model of firm decision.

There are future lines of research. First, Roberts and Tybout (1997) found evidence of an uneven response of firm export participation in different industries to changes in exchange rates. As our dataset becomes larger in years and firms, we will investigate the sensitivity of the individual export participation and volume of exports to changes in exchange rates within industries. Second, a different response of export supply (participation vs value of exports) to changes in exchange rates will help to improve export promotion policies depending on the population target. If most of the effort has been paid on understanding the consequences of direct subsidies for stable exporters, little effort has received the effectiveness of export incentives such as access to information or learning on new exporters performance.

1.6 Appendix 1.A: Data description.

The empirical data used in the present study are mainly taken from FAME (Financial Analysis Made Easy). It is a financial database on CD-ROM containing major public and private companies from Jordan Watch and the Jordan Survey database. It is collected by Jordans and Bureau Van Dyck for commercial use and it includes balance sheet data, profit and loss statements and some complementary information on all UK firms that satisfy one or more of these criteria: Turnover greater than £700,000; Shareholder Funds greater than £700,000; Profits before tax greater than £40,000. This accounts for about 110,000 firms. It also contains a sample of 100,000 small-medium sized firms that satisfy one or more of these criteria: Turnover greater than £250,000; Current Assets or Liabilities greater than £250,000; profits before tax greater than £25,000.

We use the filters of FAME to select companies operating primarily in the manufacturing industry (SIC92 codes 1511 to 3663). FAME provided information for 25240 over the period 1992-1998, but some firms are repeated due to consolidated accounts (group accounts, holding accounts). In these cases we keep the individual and not the group. We have also eliminated repeated companies that changed legal status from limited company (LTD) to public limited company (PLC) during the period. The number of firms is reduced to 24115.

Our sample of firms is obtained after the following filters:

(i) companies with complete information for seven consecutive years (4759);

(ii) companies without measurement errors. The data was trimmed to eliminate possible outliers. Observations with total sales, employment, wages or tangible assets changing more than 150 percent in one year were excluded (4312);

(iii) companies classified in manufacturing activity before 1992 according to the 3 digit SIC80 classification (4168);

(iv) companies with less than 250 workers in 1992 (3023);

(v) firms that were set up after 1955 (2510);

(vi) firms operating in industries with export intensity above 10 percent in 1992 (1769);

The justification for the sample selection procedures (iv)-(vi) is twofold. We believe that this sample is valid to represent the population of firms that are more likely to suffer a change in their export status, that is, young small and medium sized companies competing in exporting industries. The final data set contains 7 annual observations for 1679 companies; a total of 11753 observations.

Firm-level variables

The following variables are obtained directly from FAME database

Name	Definition	FAME Code
Sales	Turnover	P&L 1
Home sales	UK Turnover	P&L 2
Exports	Export Turnover	P&L 3
Operative costs	Total expenses related to production activity	P&L 5
Profits	Profits before tax	P&L 14
Employment	Total number of employees	P&L 26
Wage	Total remuneration, including directors' remuneration	P&L 23
Directors' wage	Directors' remuneration	P&L 24
Tangible assets	Land, building, fixtures, plant & vehicles	Balance 31
Debt	Long term liabilities	Balance 85
Total Assets	Fixed assets plus current assets	Balance 70
Industry code	Four-digit SIC codes (up to ten); both SIC92 and SIC80	-
Age	Year of registration in Company House	-
Industry	Main activity by 4 digit SIC92 code	-
Diversification	Whether firm operates in more than one 3 digit SIC92 Code	-
Location	Region location according to postcode	-
Number of directors	Number of directors excluding Company Secretary	Director List
Subsidiary	Whether the company is subsidiary or independent	Shares List
Foreign owned	Whether parental firm of subsidiary is foreign	Shares List

Industry-level variables

Name	Definition	Source, period
Export prices	4 digit SIC92 export unit values index	UK Markets Report, 1993-94
		Product Sales&Trade,1995-98
Output prices	4 digit SIC92 output price index	Sector Review, 1993-1998
Region-industry	3-digit SIC80 share of region-industry	AES, 1992
concentration	in total employment	
Exchange Rate	3-digit SIC80 standard deviation of industry	IFS, EUROSTAT, 1990-93
volatility	monthly growth rate of exchange rate	
Export growth rate	4-digit SIC92 industry growth rate of exports	Sector Review, 1990-93
Export Uncertainty	Percentage of responses in Survey claiming	CBI Industrial Trends Survey
	political and economic problems abroad is an	1992
	important factor constraining export decision	

1.7 Appendix 1.B: Do changes in export status affect firm performance?

Tables 1.1 displays several features of the data after classifying each firm into five different export status: (1) new entrants, (2) exiters, (3) irregular exporters - firms that switch export status more than once- (4) stable exporters and (5) non-exporters. We distinguish three measures of performance: size, profitability and productivity. Total sales, employment and fixed assets capture the firm size evolution. We observe that exporters are larger than non-exporters, and that entrants and exiters are larger than non-exporters but smaller than regular exporters. New exporters show substantially high growth rates of sales, fixed assets and employment while exiters have significantly lower growth rates, compared to both stable exporters and non-exporters.

In order to measure profitability we use two standard corporate finance ratios, return on sales and return on assets. In addition, we include total debt-to-output as a measure of leverage. In levels, the three ratios are similar for all companies. However, the evolution of the ratios is particularly illustrative of the change that a firm observes when its export status changes. New entrants and exiters show a significant increase in the return rates compared to the other firms, while non-exporters and irregular exports suffer gradual deterioration in the return rates. The leverage ratio of all firms improved during the period.

Finally, we analyse the evolution of firm productivity, wage per worker, directors' wages and average operative costs. The best indicators correspond to new exporters. They show very high levels of labour productivity compared to the rest of firms. As a result, new entrants also show greater growth rates in wages.

The analysis of the measures of firm performance reveals that the transition from one export status to another matters to better understanding firm performance. Export decision affects the evolution of the main determinants of firm behaviour such as profitability, productivity or size, and therefore current success and future survival.

We can complement the descriptive analysis with a simple regression analysis to evaluate the impact of export status changes on firm performance. In several papers Bernard and his colleagues (referenced in Bernard and Jensen, 1999) have examined the differences between exporters and non-exporters using the regression equation $y_{it} = b_0 + b_1 x_{it} + b_2 z_{it} + u_{it}$ where the dependent variable y_{it} is an indicator of firm performance, x_{it} is a dummy variable for current export status and z_{it} is a vector of other firm characteristics. If the coefficient of the export-dummy is positive and significant, then an export premium for the firm characteristic exists. Here we measure the export premium effect by comparing the performance of entrants versus exiters in our sample of UK SMEs. The export decision is discrete and can change in only two ways. A non-exporter might decide to export one year, or an exporter might stop exporting one year or forever. We decompose the change in export status into indicators for entering into foreign market and leaving it, and examine the possibility that the two decisions do not have the same impact on firm performance measured by six variables: (1) $EMPL$: the log of number of employees (2) $DSAL$: the log of domestic sales, (3) $PDTV$: the log of labour productivity or total turnover per employee (4) $WAGE$: the log of wage per employee, (5) $DIRE$: the log of average director's wage, and (6) ROS: the return on sales as measure of profitability.

The empirical model of export premium on firm performance is

$$\Delta y_{it} = \beta_t \Delta x_{it} + \eta z_{it} + \Delta u_{it} \tag{1.26}$$

where y is the variable measuring performance, x is the indicator of export status and z is a vector of firm and industry covariates. We decompose the change in export status into the following:

$$\begin{aligned} ENTRY_t = 1 &\quad \text{if } x_t = 1 \text{ and } x_{t-1} = 0;\ 0 \text{ otherwise} \\ EXIT_t = 1 &\quad \text{if } x_t = 0 \text{ and } x_{t-1} = 1;\ 0 \text{ otherwise} \\ STAY_t = 1 &\quad \text{if } x_t = 1 \text{ and } x_{t-1} = 1;\ 0 \text{ otherwise} \end{aligned} \tag{1.27}$$

The last combination (which reflects the non-exporting decision) is absorbed into the intercept. We estimate then

$$\Delta y_{it} = \alpha_{1t} ENTRY_{it} + \alpha_{2t} EXIT_{it} + \alpha_{3t} STAY_{it} + \Delta u_{it} \tag{1.28}$$

where $\Delta y_{it} = y_{it} - y_{it-1}$ and Δu_{it} is defined similarly.[14]

Each coefficient gives the increase in annual growth rates for entrants, exiters and regular exporters, relative to non-exporters every year. First, we will test whether the coefficients are constant over time. Next, we test whether exporters in both years perform differently than non-exporters. Finally, we test whether the coefficient for a new exporter in one year is equal in

[14] An equivalent specification is

$$\Delta y_{it} = \gamma_{1t} x_{it-1} + \gamma_{2t} x_{it} + \gamma_{3t} x_{it} x_{it-1} + \eta z_{it} + \Delta u_{it} \tag{1.29}$$

where $a_{1t} = \gamma_{2t}$, $a_{2t} = \gamma_{1t}$, $a_{3t} = \gamma_{1t} + \gamma_{2t} + \gamma_{3t}$. Under the null hypothesis of no export performance premium $a_{1t} = -a_{2t} = \beta,\ a_{3t} = 0,\quad t = 2, ..., T$

absolute value but opposite in sign to the coefficient on the company that stops exporting that year. Each estimation allows for additional covariates such as age, firm size and lagged return on sales to enter freely into each change equation. In addition a set of industry and regional dummies are included.

The results of imposing time-invariant coefficients for each equation are reported in Table 1.2. In the first panel the restriction is that the coefficients do not change over time. For the variables employment, return on sales, wage per worker we reject the null hypothesis. For domestic sales, labour productivity and director's wage we accept that the coefficients are constant over time. In all the cases the coefficient of export switch for entrants is positive and the coefficient for exiters is negative. The second panel on the table constraints the coefficient on STAY to zero. The hypothesis that regular exporters perform equal than non-exporters is accepted for all the indicators except director's wage. Maintaining the hypothesis that the restriction $\alpha_{3t} = 0$ is correct, the last panel presents the results of constraining $a_{1t} = -a_{2t}$ $\forall t$ Again there is evidence in favour of the equal but opposite restriction on the coefficients of ENTRY and EXIT. It is strongly accepted in four cases - employment, domestic sales and productivity and director's wage. Thus there is evidence of symmetry in the decision to exit compared to the decision to entry impact on the firm performance.

We conclude that new exporters have a substantial increase in the growth rates in employment, wages, sales and productivity compared to non-exporters. On average the estimated coefficient varies from 5% in productivity to 1% in wages. Companies that decide to interrupt the exporting activity suffer significant losses in employment, employees' wage, director's wage, total sales and productivity. The negative estimated impact on the growth rates varies from -7% in director's wage to -3% in employment or productivity. We conclude that the bulk of the evidence is in favour of the restrictions $\alpha_{3t} = 0$ and $a_{1t} = -a_{2t}$. Akin with Bernard and Jensen findings for US, the results show that firms switching export status undergo dramatic contemporaneous changes in size, wage and productivity. Firms experiment a substantial improvement the year they switch from non-exporters to exporters while exiters have a quantitatively equivalent performance, but with opposite sign.

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Table 1.1: Trajectories of firm characteristics by export status.

EXPORTER STATUS	VARIABLE	Mean	Std. Dev.	Change
NEW EXPORTER	**Total sales (£000)**	8800	10135	151.30
Number firms=87	**Home sales (£000)**	8386	9953	129.81
Age=1977	**Exports (£000)**	414	1379	–
	Employment	78	82	59.65
	Total assets (£000)	5791	7263	66.91
	Return on sales (%)	0.03	0.12	4.53
	Return on assets (%)	0.07	0.15	6.73
	Debt-output ratio(%)	0.15	0.57	-6.96
	Average operative cost (£)	0.71	0.17	8.02
	Labour productivity (£000)	167	198	41.07
	Wage per worker (£)	18951	6608	31.86
	Average director's wage (£)	37586	26582	59.70
EXITER	**Total sales (£000)**	5707	5764	28.66
Number firms= 42	**Home sales (£000)**	5456	5635	39.37
Age=1976	**Exports (£000)**	251	581	–
	Employment	72	76	8.79
	Total assets (£000)	3490	3605	21.39
	Return on sales (%)	0.04	0.13	6.49
	Return on assets (%)	0.03	0.23	8.20
	Debt-output ratio(%)	0.08	0.30	-4.22
	Average operative cost (£)	0.71	0.16	7.47
	Labour productivity (£000)	127	154	-6.13
	Wage per worker (£)	19844	9633	22.85
	Average director's wage (£)	30691	19801	17.18
IRREGULAR EXPORTER	**Total sales (£000)**	6561	7130	64.93
Number firms: 86	**Home sales (£000)**	5925	5945	62.19
Age=1976	**Exports (£000)**	636	2882	–
	Employment	71	51	20.07
	Total assets (£000)	3955	4451	24.15
	Return on sales (%)	0.01	0.42	-3.78
	Return on assets (%)	0.06	0.15	-0.52
	Debt-output ratio(%)	0.07	0.16	-1.24
	Average operative cost (£)	0.75	0.32	3.74
	Labour productivity (£000)	147	305	24.20
	Wage per worker (£)	18073	9601	10.92
	Average director's wage (£)	32004	21928	22.57
STABLE EXPORTER	**Total sales (£000)**	10169	15311	57.05
Number firms: 996	**Home sales (£000)**	6681	10485	86.37
Age=1977	**Exports (£000)**	3487	8809	-7.78
	Employment	93	79	34.17
	Total assets (£000)	7191	12189	18.40
	Return on sales (%)	0.04	0.20	0.54
	Return on assets (%)	0.07	0.23	2.31
	Debt-output ratio(%)	0.08	0.19	-4.12
	Average operative cost (£)	0.71	0.20	7.05
	Labour productivity (£000)	144	227	14.67
	Wage per worker (£)	19712	8550	21.54
	Average director's wage (£)	46493	31195	84.97
NO EXPORTER	**Total sales (£000)**	5352	6471	58.22
Number firms=468	**Home sales (£000)**	5352	6471	58.22
Age=1976	**Exports (£000)**	0	0	0.00
	Employment	60	68	24.31
	Total assets (£000)	3510	5682	15.34
	Return on sales (%)	0.05	0.37	-1.57
	Return on assets (%)	0.08	0.99	-1.49
	Debt-output ratio(%)	0.25	1.32	-6.18
	Average operative cost (£)	0.73	0.26	1.41
	Labour productivity (£000)	142	376	22.47
	Wage per worker (£)	17800	7501	21.26
	Average director's wage (£)	36183	27133	46.26

Table 1.2: The effect of current entry/exit foreign markets on UK firm performance (1993-1998). [Dependent variables: Average annual growth rates]

	Employment	Domestic Sales	Sales per worker	Return on Sales	Wage per worker	Avg. director remuneration
Homogeneity restriction						
F-test (d.f.=15)	22.79 *	14.79	17.35	26.29 **	32.70 ***	8.91
Start	0.026	0.028	0.051	0.002	0.013	0.011
	[1.952]	[1.323]	[3.302]	[0.291]	[1.305]	[0.376]
Exit	-0.034	-0.017	-0.042	-0.037	-0.005	-0.079
	[2.305]	[1.695]	[2.402]	[3.277]	[0.444]	[2.122]
Stay	-0.001	-0.009	-0.005	-0.002	0.0009	0.017
	[0.387]	[1.632]	[1.620]	[0.973]	[0.412]	[2.254]
Adding restriction Stay==0						
F-test (d.f.=16)	23.56 *	17.45	19.79	27.23 **	32.87 ***	13.97
Start	0.026	0.035	0.055	0.004	0.013	0.024
	[2.087]	[1.637]	[3.639]	[0.440]	[1.255]	[0.814]
Exit	-0.033	-0.011	-0.038	-0.036	-0.005	-0.068
	[2.274]	[1.456]	[2.204]	[3.192]	[0.496]	[1.947]
Adding restriction Start=- Exit						
F-test (d.f.=17)	23.67	18.03	20.36	33.21 ***	33.12 **	14.97

Heteroscedasticity-robust t-statistics in brackets Specifications 3 to 6 allow to enter firm size, age, return on sales and dummies for industry and region. *** significant at 1% level , ** significant at 5% level and * significant at 10% level

Table 1.3: Firm raw transition rates in the UK export market, 1992-1998

Sample N=1679	Year t Year t+1	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	Average 1992-1998
Status	Status							
Export	Export	0.987	0.975	0.983	0.977	0.977	0.980	0.980
	No export	0.013	0.025	0.017	0.023	0.023	0.020	0.020
No export	Export	0.048	0.064	0.066	0.051	0.064	0.059	0.059
	No export	0.952	0.936	0.934	0.949	0.936	0.941	0.941

TABLE 1.4: Dynamic probit model of export participation

Variable	Random Effect Probit Model									
	Initial conditions Year: 1993		MODEL 1 Period: 1994-1998 (No correlation between covariates and error term)		MODEL 2 Period: 1994-1998 (With correlation between covariates and error term)		MODEL 3 1994 and 1998 only (No correlation between covariates and error term)		MODEL 4 1994 and 1998 only (With correlation between covariates and error term)	
Constant	-2.771 **	(0.384)	-5.734 **	(0.913)	-6.968 **	(1.112)	-4.533 **	(0.990)	-4.663 **	(1.089)
Lagged dependent variable										
Exported last year * (age>15)			1.390 **	(0.172)	1.315 **	(0.178)	2.786 **	(0.263)	2.781 **	(0.272)
Exported last year * (age<15)			1.643 **	(0.140)	1.588 **	(0.144)	2.907 **	(0.241)	2.910 **	(0.244)
Time-varying firm level variables										
ln(Capital Stock) (t-1)	0.144 **	(0.013)	0.439 **	(0.009)	0.309 *	(0.139)	0.275 **	(0.069)	0.292 **	(0.065)
ln(Productivity) (t-1)	0.102 **	(0.027)	0.394 **	(0.107)	0.121	(0.253)	0.212 **	(0.105)	0.252	(0.317)
ln(Directors' Wage) (t-1)	0.182 **	(0.025)	0.324 **	(0.095)	0.063	(0.162)	0.183 *	(0.105)	0.080	(0.252)
Return on sales (t-1)	-0.003	(0.075)	0.054	(0.574)	0.243	(0.776)	0.177	(0.667)	0.116	(0.987)
Time-invariant firm variables										
Subsidiary/domestic owned	0.317 **	(0.042)	0.249 *	(0.146)	0.503 **	(0.201)	0.132	(0.203)	0.141	(0.208)
Subsidiary/foreign owned	0.488 **	(0.068)	0.687 **	(0.242)	0.723 **	(0.267)	0.293	(0.234)	0.304 *	(0.182)
Set up between 1970 and 1980	-0.182 **	(0.052)	-0.342 **	(0.179)	-0.376 *	(0.195)	-0.170	(0.183)	-0.159	(0.189)
Set up after 1980	-0.214 **	(0.042)	-0.324 *	(0.196)	-0.345 *	(0.201)	-0.132	(0.197)	-0.137	(0.209)
Diversification	0.026	(0.044)	0.249	(0.183)	0.273 *	(0.169)	0.022	(0.180)	0.024	(0.186)
Relative export price	0.033	(0.040)	0.002	(0.090)	0.034	(0.239)	0.242	(0.647)	0.232	(0.238)
Industry dummies	No		Yes		Yes		Yes		Yes	
Regional dummies	No		Yes		Yes		Yes		Yes	
Year dummies	No		Yes		Yes		Yes		No	
Pre-sample information										
Regional industry concentration, 1992	0.025 *	(0.014)								
Growth rate of exports 1990-93	-0.001	(0.118)								
Country-destination instability 1992	-0.046	(0.225)								
Volatility exchange rate 1990-93	0.242 **	(0.102)								
Residual from initial condition probit			0.689 **	(0.058)	0.835 **	(0.041)	0.804 **	(0.171)	0.810 **	(0.178)
Variance of unobservable heterogeneity as % of total unexplained variance (r)			0.602 **	(0.101)	0.634 **	(0.102)	0.310 *	(0.164)	0.313 *	(0.168)
Log Likelihood	-2987.15		-930.32		-899.47		-407.58		-407.32	
Log Likelihood with r=0			-1152.89		-928.98		-411.54		-411.77	
Constant only log-likelihood	-3456.89									
Number of firms	1679		1679		1679		1679		1679	
Number observations	1679		8395		8395		3358		3358	

In parenthesis standard errors; ** significant at the 1% level; * significant at the 5% level

Table 1.5: State dependence - raw probabilities and predicted probability.

		Firm with age > 15 years [1]	Firm with age <15 years [2]
Raw Data Probabilities			
1 Exporting at t-1	Exporting at t	0.9776	0.9791
2 Non-exporting at t-1	Exporting at t	0.0612	0.0573
3 Non-exporting at t-1	Non-exporting at t	0.9388	0.9427
4 Exporting at t-1	Non-exporting at t	0.0224	0.0209
Predicted probabilities holding characteristics constant			
		Pooled Probit Model	
5 Keep same export status in t-1 and t		0.9617	0.9693
6 Change export status between t-1 and t		0.0721	0.0834
9 State dependence		0.8896	0.8859
10 As percentage of raw probability	[9/(3-4)]	**0.9707**	**0.9610**
		Random Effect Probit Model	
11 Keep same export status in t-1 and t		0.8953	0.8791
12 Change export status between t-1 and t		0.1166	0.1093
13 State dependence		0.7787	0.7698
14 As percentage of raw probability	[13/(3-4)]	**0.7497**	**0.7428**

Table 1.6: Predicted probability of exporting

Observable characterictics	Firm effect	No previous export experience	With past export experience
Independent	-2	0.000	0.770
Set up after 1980	-1	0.004	0.836
No-diversified	0	0.065	0.900
25th percentile of	1	0.123	0.940
time-variant characteristics	2	0.180	0.978
Foreign subsidiary	-2	0.041	0.969
Set up before 1970	-1	0.082	0.988
Diversified	0	0.149	0.996
75th percentile of	1	0.209	0.999
time-variant characteristics	2	0.275	0.999

The firm effect is one-time the standard deviation with respect to the mean.

Table 1.7: SML estimation of dynamic probit model of export

Variables	Coefficient		S.E.
Constant	-2.448	**	(0.079)
Lagged export status	3.583	**	(0.062)
Log(capital stock)	0.119	**	(0.022)
Return on sales	0.079		(0.128)
Set up after 1980	0.032		(0.058)
Diversification	0.055		(0.066)
Foreign-owned subsidiary	0.125	*	(0.067)
Export price	-0.001		(0.094)
RHO	0.239	*	(0.022)
AR1	-0.052		(0.043)
Industry dummies	Yes		
Year dummies	Yes		
Log-likelihood	944.86		
Number of firms	1679		
Number of observations	8395		

For estimation we use the GAUSS program SSML, kindly provided by Vassilis Hajivassiliou. Note that the specification of the model is more parsimonious than the one estimated using the random probit model without autocorrelated error term (Model 2). The excluded variables are directors' wage, labour productivity, dummy for set up before 1970 and a dummy for domestic subsidiaries

"Rho" represents the variance of the unobservable heterogeneity as percentage of the total explained variance.

Table 1.8: Goodness of fit. Actual and predicted export trajectories

Export Sequence	Actual probability	Predicted probabilities	Export Sequence	Actual probability	Predicted probabilities
00000	28.36%	31.15%	00111	0.81%	0.15%
00001	0.98%	0.30%	01011	0.12%	0.07%
00010	0.17%	0.15%	01101	0.06%	0.00%
00100	0.12%	0.00%	01110	0.17%	0.07%
01000	0.12%	0.07%	10011	0.12%	0.00%
10000	0.35%	0.00%	10101	0.00%	0.00%
00011	0.92%	0.45%	10110	0.00%	0.00%
00101	0.00%	0.00%	11001	0.12%	0.00%
00110	0.12%	0.07%	11010	0.29%	0.00%
01001	0.00%	0.00%	11100	0.40%	0.07%
01010	0.06%	0.00%	01111	1.61%	0.30%
01100	0.12%	0.00%	10111	0.29%	0.00%
10001	0.00%	0.00%	11011	0.00%	0.00%
10010	0.12%	0.00%	11101	0.52%	0.00%
10100	0.12%	0.00%	11110	1.10%	0.45%
11000	0.58%	0.07%	11111	62.31%	66.54%

Table 1.9: Statistical summary of variables

Variables	Mean	Std. Dev.	Minimum	Maximum
Export status	0.689	0.462	0	1
Lagged export status*setup<1980	0.274	0.446	0	1
Lagged export status*setup>1980	0.414	0.492	0	1
ln(Capital Stock) (t-1)	6.420	1.281	2.302	10.612
ln(Productivity) (t-1)	4.229	0.733	2.542	8.045
ln(Wage) (t-1)	4.696	0.734	2.771	7.425
Return on sales (t-1)	0.024	0.113	-0.781	0.484
Subsidiary/domestic owned	0.510	0.500	0	1
Subsidiary/foreign owned	0.190	0.392	0	1
Set up between 1970 and 1980	0.281	0.449	0	1
Set up after 1980	0.415	0.493	0	1
Diversification	0.719	0.433	0	1
Relative export price	0.814	13.05	44.3	140.93
Pre-sample information				
Regional industry concentration, 1992	1.197	1.005	0.001	12.20
Growth rate of exports 1990-93	12.96	25.71	-48.52	55.29
Country-destination inestability 1992	0.301	0.146	0.045	0.731
Volatility exchange rate 1990-93	2.975	0.312	2.147	3.688

Chapter 2

Internationalisation and export diversification: A semi-parametric approach.

2.1 Introduction

While Chapter 1 looked at the export participation decision, the next two chapters examine the marketing strategy of exporting firms. Chapter 2 investigates how different firms approach the international market place in terms of the number of products they sell and the number of countries they export to. In Chapter 3 we will search what factors determine which markets firms export to.

Export diversification of a single-product firm can be defined as the degree of spread of sales over different foreign markets. There is a common belief that increased involvement in exporting encourages diversification to a larger number of countries. This can be attributed to several reasons. First corporate resources increase as the firm moves to more advanced levels of exporting, allowing a broader market focus. Second, the market spreading strategy minimises risks and exploits opportunities better than a concentrated strategy. Third, the problems in managing business in different foreign markets tend to diminish as the firm acquires more export experience. However, it is unclear what the limits of diversification are. Note first that the number of countries is not the only dimension that matters with respect to export diversification. Exporting firms diversify not only in destination but also in the products that they sell abroad. Exporters might become more diversified across markets because they produce more than one product and different products have different markets. Alternatively, large firms tend to be multiple-product so they may expand exports through product dispersion. Moreover, it is not completely clear why firms should always become more diversified as they become more export dependent. If international trade theories predict that comparative advantage forces stimulate industry specialisation, why not expect to see firms becoming more specialised in their export activities? If diversification as a strategy for risk-spreading ensures a stable cash flow in international markets, concentration of exports can be viewed as a strategy of firm internationalisation by achieving economies of scale in production and distribution.

If the number of empirical studies about industry diversification has increased rapidly in recent years, there is a lack of research on export diversification. Most studies about firm export activity have focused on the determinants of export participation and export intensity due to the fact that export diversification at firm level is very data demanding. In this chapter we use the complete distribution of export sales by product and country for a large sample of manufacturing Spanish exporters in 1988. With such a detailed information we can answer some unsolved questions about export diversification. (1) Does export diversification always increase with firm internationalisation?; (2) Is there any difference between market diversification and product diversification as firms become more export-orientated?; (3) Besides the firm export/sales ratio, which other firm or industry characteristics have a significant impact on export diversification?

To test the hypothesis whether more export-orientated firms exhibit higher product and market dispersion of sales, we proceed in two steps. First, we contruct indices of export diversification by destination and by product, separately, which increase with the number of markets (products), the uneven distribution of the value of sales, and the extent of heterogeneity between markets (products). Second, we use semi-parametric regression techniques to analyse the internationalisation-diversification relationship. After controlling for firm and industry characteristics that may affect the internationalisation-diversification profile, we represent graphically the export diversification trajectory of a representative firm, as it becomes more export-orientated.

In our application to the Spanish case, we find that exporters opt for a strategy of market diversification in the early stages of internationalisation. Light exporters begin selling to few markets. As they become more export-orientated they explore new destinations, exhibit a more even distribution of sales across destinations and/or choose a sample of more heterogeneous countries. After reaching a certain level of exports as proportion of total sales, the number of destinations is fixed, the selection of destinations is more homogenous and the distribution of export value tends to be more concentrated in few destinations. Thus there is not a linear relationship between market diversification and firm internationalisation. Finally, we find a negative correlation between product diversification and firm internationalisation in almost all the analysed industries. The findings suggest that the success of export-orientated exporters relies heavily on product specialisation.

In Section 2 we explain the methodology used in the rest of the chapter. Section 3 describes the data and Section 4 examines the determinants of market and product diversification of Spanish manufacturing exports, with special attention to the role of firm internationalisation. A summary of the major findings and conclusions is reported in Section 5.

2.2 Research approach.

Our first step is to measure export diversification. Traditionally, product diversification has been defined as the spread of sales across different industries, and market diversification as the spread of exports across different destinations. With available information about products and markets, the optimal strategy seems to be the construction of two indices of export diversification, one by markets (the geographic diversification index) and another by products (the product diversification index). The indices are based on the work by Gollup and Mohanan

(1991). The indices are designed so that they are sensitive to the number of distinct markets (products) that the firm exports to, the changes in the distribution of export value to these markets (products), and the extent of heterogeneity among the markets (products). When Gollup and Mohanan compared their index with the standard Herfindahl-based index, they found that the diversification index that accounts for heterogeneity doubled when the unit of production was the firm instead of the establishment. Therefore, it is important to control for heterogenity when we use firm-level data.

The geographic diversification index (GDI) of exports is equal to one minus the Herfindahl index, corrected by a measure of heterogeneity,

$$GDI = \frac{1}{2}\left[\left(1 - \frac{1}{n}\right) + \sum_i \left(\frac{1}{n^2} - s_i^2\right) + \sum_i \sum_{j \neq i} s_i s_j \sigma_{ij}\right] \tag{2.1}$$

where n is the total number of destination markets measured by countries, s_i is the share of sales in a country i over the total exports and σ_{ij} is a "distance" function quantifying the heterogeneity between markets i and j.[1] Appendix 2.1. describes the properties of the index in detail.

The first term in GDI identifies the effect of changing the number of markets on the index. It varies directly with the number of export markets. The second term focuses on market distribution of sales and it is based on the maintained hypothesis that diversification decreases as sales shift more and more to a single destination. Holding the number of markets fixed, the index GDI decreases as a firm adopts a more uniform market distribution. The index posits that a firm exporting to n markets having a $1/n$ share in the firm's total exports is more diversified that another firm exporting to the same number of markets but with one representing, say, 90% of firm sales. The third term captures the notion of "heterogeneity" among destinations. If two countries share common characteristics (i.e. proximity, same economic or geographic area,

[1] Note that the first two terms can be expressed as one minus the Herfindahl index $1 - H = 1 - \sum_i s_i^2 = (1 - \frac{1}{n}) + \sum_i (\frac{1}{n^2} - s_i^2)$

and similar level of development), they should be treated as one single market. Dissimilarity between destinations should contribute positively to the index of diversification. The distance function σ_{ij} is constructed as

$$\sigma_{ij} = \frac{d_{ij} - \min\left[d_{ik}, d_{jk}\right]}{\max\left[d_{ik}, d_{jk}\right] - \min\left[d_{ik}, d_{jk}\right]} \tag{2.2}$$

where d_{ik}, d_{jk} is the physical distance (in kilometers) between the capitals of country i(j) and any other country in the world k to where the firm exports. σ_{ij} takes a maximum value of 1 if $d_{ij} = \max(d_{ik}, d_{jk})$, that is, the largest possible distance between two countries, and takes value of 0 if $d_{ij} = \min(d_{ik}, d_{jk})$. We also calculated the heterogeneity component using the absolute difference in income per capita between pairs of countries. Although both measures of heterogenity were highly positive correlated ($\rho = 0.83$), we prefer the use of distance as indicator of heterogeneity since it embodies the concepts of "Geography" and transport costs.

Summarising, ceteris paribus, GDI is an increasing function of the number of destinations, varies directly with an increasing equal distribution of sales by markets, and increases with greater dissimilarity between destinations.

The index of product diversification (PDI) of exports is constructed in a similar way. Here s_i takes the value of the exports of the distinct i four-digit Combined Nomenclature product as percentage of the total exports of the firm. The distance function is constructed as

$$\sigma_{ij} = \begin{cases} 0 & \qquad CN3_i = CN3_j \\ 0.5 \quad if & CN2_i = CN2_j, CN3_i \neq CN3_j \\ 1 & \qquad CN2_i \neq CN2_j \end{cases} \tag{2.3}$$

where $CN2$ and $CN3$ stand for the Combined Nomenclature product group aggregated at two and three digit, respectively. When a firm exports two products belonging to the same three digit product group, both products are treated as homogenous ($\sigma_{ij} = 0$), and if they belong to two different two digit industry codes there are treated as heterogeneous products ($\sigma_{ij} = 1$).

For the intermediate case we assign an arbitrary value of one-half.

After constructing the two indices, the next step is to analyse the relationship between internationalisation and diversification. Aw and Batra (1998) have investigated whether market diversification, through exports, can be viewed as an alternative for product diversification. They showed that small sized firms in Taiwan prefer market diversification to product diversification. They also found that large single-product companies are domestic-orientated while large exporters are also multiple-product firms. In some way we extend their empirical research by examining the determinants of export diversification by product and destination.

While there is strong evidence of a positive relationship between size and diversification, the internationalisation- diversification profile of the exporting firm remains unsolved. To analyse this relationship we use semi-parametric regression techniques. The advantage of this econometric technique is that we do not have to impose any ad hoc parametric form between the dependent variable, the diversification index, and the explanatory variable of interest, the export/sales ratio. There are four reasons that justify our approach: the past empirical evidence is unclear, there is a lack of theoretical framework, our data set is very large, and the technique is particularly useful for inter-industry comparisons.

Past empirical evidence is scarce and mixed. Hirsh and Lev (1971) used firm-level survey data to analyse the determinants of export geographical diversification in three countries. They found that the export/sales ratio was positively associated with diversification in Israel, negatively in Denmark and there was no correlation in Netherlands. For Spain, Alonso y Donoso (1994) found that statistically the relationship between export propensity and destination diversification was non-lineal. So far we do not know any other studies that analyse the strategy of diversification of exporting firms, and no study has dealt with product diversification.

Marketing strategy theories provide reasons for export diversification to increase or decrease with the process of internationalisation of the firm. Once a firm becomes an exporter, it must choose between spreading its efforts among numerous products or markets and concentrating on a small number of products or markets. The decision can be viewed as being dependent on a trade-off between profitability and risk in the export activity. Total risk is reduced by increasing the number of products or markets whenever there is no strong correlation between risks facing firms in production or in different markets (Hirsch and Lev, 1971). This kind of investment is not cost-free. Foreign entry involves sunk costs that reduce profits. Moreover, if there are economies of scale in marketing, concentration will yield higher total returns than when the effort is spread thinly over several products and markets (Basevi, 1970). It is expected that diversification and firm size have a positive relationship, while firm size and export/sales ratio have a non-linear relationship. We may expect export/sales ratio and diversification to be positively correlated in early stages of internationalisation but it becomes unclear how the relationship evolves as the export sales ratio approaches to one. The use of semi-parametric regression techniques eliminates the impact of firm size on both the diversification and export/sales profile before drawing the profile between these two variables.

Empirically, the use of Kernel functions is not recommended when the number of observations is small because of the asymptotic bias in the estimation. Since our data set consists of 5229 firms, the use of this technique is adequate. Finally, cross-industry differences may be very important to characterise the export/sales-diversification profile. In our application, semi-parametric regression techniques make inter-industry comparisons easier due to the use of graphs.

2.3 Export diversification in Spain.

Recent studies have analysed the pattern of industry diversification of Spanish manufacturers in the eighties and nineties, but there is no research on the pattern of export diversification. Suarez (1993) and Merino and Rodriguez (1998) find that, on average, 70 percent of large sized firms and 90 percent of small sized firms do not diversify, without noticeable changes over time. Second, there is a strong association between firm size and number of industries in which the firm operates, but a weak relationship between firm size and diversification intensity. Finally, the portfolio diversification varies substantially with the primary industry activity of the firm.

To investigate the determinants of export diversification in Spain we use an original data set which contains information on the value of exports and imports, broken down by product and country destination, for all Spanish exporters of manufactures that employ more than 20 staff and export above one million pesetas (~3000 ECU) in 1988. The data is based on firm records from Spanish Customs. A private marketing company called CAMERDATA completed the original data with information about total sales, employment by size range, foreign capital participation in ownership, industry activity (3 digit NACE) and geographic localisation by province. The final number of firms with complete information is 5229.[2] For each company exports are classified according to the four-digit Combined Nomenclature codes (Eurostat, 1991). Firm-level data is complemented with industry-level data obtained from Spanish Industrial Census, 1988. Geographic distribution of manufacturing employment activity is available for 30 aggregated industries and 50 provinces. The national-industry level variables from the Industrial Census are (3 digit NACE) industry concentration, advertising expenditure, and R&D expenditure data.[3]

We start describing briefly the extent of internationalisation and export diversification by Spanish manufacturers in 1988. The average export/sales ratio by size group is presented in Table 1. There is a U-shaped relationship between firm size and export/sales ratio. Firms with less than 100 workers and firms with more than 5000 have export/sales ratios above average, while medium sized firms have export/sales ratio below average. Our findings are very similar to those reported by Bonaccorsi (1992) using Italian manufacturing census data.

Table 2 displays the frequency of export diversification. Each cell contains the percentage

[2] The selection of firms was affected not only by missing information (mainly on sales and ownership structure), but also by the exclusion of countries and products:

-Exports/imports to/from Andorra;

-Exports/imports classified to/from "special destinations" (destination codes 899-999);

-Exports/imports corresponding to non-manufacturing activities according to "Table of Correspondence CN-NACE" (Eurostat, 1991).

Although we had no access to the original data of all manufacturing exporters, there is not reason to think against the representativity of the sample.

[3] The correspondence between the Industrial Census codes and NACE codes is straightforward. The NACE codes are mapped with the CN codes using EUROSTAT, Table of Correspondence CN-NACE (1991). A complete description of the statistical sources of the data, the construction of the variables, and the correspondence between industrial codes can be obtained from the following authors: Castillo (1994) for CAMERDATA data set; Callejón and Costa (1996) for province-industry employment data in the Industrial Survey; Gil and Máñez (1996) for R&D and advertising data in the Industrial Survey; and Requena (1996) for the industry concentration indices in the Industrial Survey.

of firms within a size group or export/sales ratio segment exporting certain number of products or exporting to some number of countries. Above 74% of firms exported more than one product and 82% exported to more than one country. Looking at the firm characteristics, there is a positive correlation between firm size and the number of products and markets of exports, while the relationship between the export/sales ratio and diversification is unclear.

Table 2 only exploits one dimension of diversification, the number of products or markets that a firm exports, but it does not give us any guidance about how diversification changes with the distribution of export sales or with the heterogeneity of the products and markets. For example, instead of using numbers of markets (products), we could say that a firm is diversified if the percentage of exports in secondary markets (products) is above 10 percent. Table 3, column 1 and 3, shows the percentage of firms whose main product (market) represents less than 90 percent of total exports. Column 2 and 4 indicate the average proportion of export sales in secondary products (markets), among diversified exporters. Again, the frequency of diversification is quite high. The number of diversified exporters increases with both firm size and internationalisation. A diversified exporter, on average, has 35 percent of export sales in secondary products and 45 percent in secondary markets.

Table 4 presents the mean values of GDI and PDI using the Herfindahl index and the Gollop and Mohanan index. The value of all the indices varies between zero and one. By construction the correction proposed by Gollop and Monahan always reduces its values relative to the Herfindahl index.

For the full sample, the Herfindahl GDI index varies between 0 and 0.95 with average value of 0.42, while the Gollop and Mohanan GDI index varies between 0 and 0.55 with average value of 0.24. The Herfindahl PDI index varies between 0 and 0.94 with average value of 0.24, while the Gollop and Mohanan PDI varies between 0 and 0.65 with average value 0.17. Although the use of different correction terms for GDI and PDI makes comparisons difficult, heterogeneity seems to be greater in the product portfolio than in the geographical portfolio.

The same indices are calculated for five selected industry groups, which account for 82 percent of the total sample. The industries are (1) Food and drink, (2) Textile, clothing and footwear, (3) Metal, ceramic and glass products, (4) Chemical, rubber and plastic, and (5) Engineering products. Cross-industry comparison reveals that heterogeneity in firm characteristics among exporters of different industries is quite substantial. For example, compared to the engineering industry, exporters in the textile industry are smaller, less export-dependent, less geographically diversified, and more production diversified. The next section explores econometrically the relationship between export diversification and firm internationalisation, after controlling for other firm and industry characteristics. To account for such inter-industry differences, we perform our econometric analysis of the determinants of export diversification for each industry group separately.

2.4 Semi-parametric regression analysis

We investigate the relationship between export/sales ratio and diversification (PDI and GDI) using the semi-parametric estimation techniques, following Robinson (1988). The econometric model is

$$y = x'\beta + \theta(z) + u \tag{2.4}$$

where y is the index of diversification (PDI or GDI) and x is a $n \times k$ vector of exogenous characteristics that affect the dependent variable linearly. The variable, z, the ratio between exports and total sales, is the non-parametric component of the model, that is, $\theta(\cdot)$ is unknown. The error term u has mean zero and finite variance, and $E[u\,|x, z] = 0$. The estimation procedure has two steps. In the first step we estimate the vector of parameters β using OLS after transforming the model (2.4) in

$$y - E(y\,|z) = (x - E(x\,|z))'\beta + u \tag{2.5}$$

where $E(y|z)$ and $E(x|z)$ are non-parametric estimations of $E_N(y|z)$ and $E_N(x|z)$ using Kernel function. We use a high-order Kernel function to reduce the asymptotic bias in the estimation and the "bandwidth" parameter is chosen following the least square cross-validation method (Lee, 1998).[4] In the second step, to obtain the relationship between internationalization, measured by export/sales ratio (z), and the extent of diversification we estimate the non-parametric kernel regression

$$E(y - x\hat{\beta}|z) = \theta(z) \tag{2.6}$$

where $\widehat{\beta}$ is the OLS estimated parameters.

The parametric variables in x are all firm specific: size, foreign ownership, import activity and an indicator of province-industry concentration of employment in manufactures. When the equations are estimated industry by industry the vector x includes three additional variables: an index of industry concentration and two indicators of product differentiation based on R&D and advertising spending. The expected sign of the relationship between the vector x of explanatory variables and the measures of export diversification is discussed briefly. Table 5 presents some statistical descriptive of the variables.

One stylised fact about diversification is the non-negative relationship between firm size and industry diversification. [5]. Firm size may affect export diversification in various ways. As firms grow they find it more difficult to increase their share in the domestic market, so in order to grow further firms have to look for foreign markets. Moreover, large firms usually possess enough resources to access several foreign markets simultaneously. Furthermore, many large firms are multiple-product so they expand exports through product dispersion. Firm size is therefore expected to be positively associated with any strategy of export diversification. In the regresion analysis we use a set of four dummy variables for size, measured by number of

[4] We use a programme written in GAUSS to run the regressions.

[5] See, among others, Grinyer and Yasai-Ardekani (1981), Gollop and Monahan (1991), Aw and Batra (1998), Merino de Luca and Rodriguez (1999)

employees ([21-50], [51-100], [101-200] and [>200]). The smallest sizeband is ommited to avoid the multicollinearity problem.

Our second explanatory variable is foreign-ownership. For Spain, Castillo (1994) and Merino and Salas (1996) show that foreign-owned firms have significantly higher export participation and export propensity than domestic-owned firms in the manufacturing industry. Among exporting firms, we expect that foreign-owned firms will have higher product and market diversification than domestic-owned firms do. Foreign-owned firms face lower cost in the introduction of new products or presence in new foreign markets due to their advantageous access to new products, process techniques and management practices developed by the parent firm. In the empirical model, the variable foreign-own firm takes a value equal to one if the firm has more than 25 percent of foreign capital, and zero otherwise.

Our third explanatory variable is the import activity of the firm. In our sample 43% of firms did some imports in 1988. Although the import activity of a manufacturing firm may be closer related to the input requirements of the production function, Castillo (1994) and Merino and Salas (1996) observe that firms with high export propensity also have greater import propensity. If firms learn through their import activities about opportunities to sell new products or enter into new countries, we should expect a positive correlation between firm's import/sales ratio and export diversification. The import ratio is measured as the value of total imports divided by total sales.

It is interesting to ask whether firms that are competing abroad are located in such a way that localisation economies may help them to explain their export performance. Aitken et al. (1997) show that the presence of multinationals in some regions of Mexico induced local firms in this region to become exporters over the period 1985-1989. Bechetti et al. (2000) find positive effects of industrial districts on export intensity of small and medium sized firms in Italy. If localisation externalities generate more availability of specialised inputs and facilitate the diffusion of information and know-how about export products and markets, then industry-province activity concentration will stimulate export diversification. We measure geographical concentration of an industry as the percentage of employment of this industry in the province.

Industry R&D and marketing as percentage of industry sales are introduced to control for product differentiation. Export diversification may occur because firms become so specialised in their products than local markets are not large enough. Product diversification and specialised market segmentation is more likely among firms whose main activity is in industries intensive in R&D and marketing (Teece, 1980; Jovanovic, 1993; Willing, 1993). Concentration in the domestic market is measured as the four largest firms' sales concentration ratio adjusted by the import penetration ratio to take into account foreign competition in the domestic market. Firms in industries with strong domestic competition will have a less diversified production and marketing strategy in order to concentrate effort in a better defence. On the other hand, firms operating in oligopolistic industries may enjoy market power in the domestic market so they can employ more resources in product and market diversification abroad.

2.5 Results

We first investigate the relationship between geographical diversification and internationalisation, putting an special emphasis on how such a relationship is affected by the extent of product diversification. Table 6 reports the semi-parametric regression of GDI on export ratio by number of product-lines. The sample is split-up into three groups of firms: single product firms, firms selling less than 5 products, firms selling more than 5 products. The industry effects have been netted out through the use of three-digit industry dummies. Interestingly, the results show important differences between single-product and multiple-product firms. The size of the firm seems not to have a significant impact on the firm export/sales ratio-GDI relationship for single-product exporters. In opposition to our expectations, the coefficient on firm import activity is negative on market diversification in all the product segments, although it is only significant for single-product firms. Firms that depend heavily on imports for production tend to be more domestic-orientated, especially among single-product firms. As expected, the foreign ownership variable is positively related to market diversification in the three estimations, although the coefficient in only significant among firms exporting more than 5 different products. Finally, province sales concentration is also positively related to geographical export diversification, but the coefficient is only significant for multiple-product firms with less than five products.

Figure 1 summarises the non-parametric results of the export/sales ratio-GDI profile by the number of product-lines after controlling for firm and industry characteristics. For each group of firms, the export/sales ratio is on the x-axis and the geographic diversification index on the y-axis. At any given value of firm export/sales ratio, the graph indicates an average of the values of the index of diversification for observations within the kernel. As far as different products are more likely to be demanded by specific countries, multiple-product firms will export to more countries. In addition, the distribution of sales across destinations will be proportional to the production of each good, and markets will be more dissimilar due to production heterogeneity. The graph confirms this hypothesis. The GDI-export ratio profile shifts upward as firms export more products.

The GDI-export/sales ratio profiles are quite steep in the early stages of internationalisation of the firm. The maximum value of market diversification varies with the export/sales ratio: Around 32 percent for single-product firms, 26 percent for firms producing less than five products, and 49 percent for firms producing more than 5 products. After reaching the critical threshold, market diversification falls slowly but continuously for the three groups of firms.

To deepen our understanding of the relationship between export diversification and the export/sales ratio we analyse GDI and PDI separately for five groups of industries in order to identify possible industry differences masked by aggregation. Table 7 reports the results of the semi-parametric regression of GDI on export/sales ratio. The most significant firm characteristic affecting the firm export ratio-GDI relationship in all the industries is the size of firm, suggesting that large companies tend to export to more countries than small companies. The foreign ownership variable is also positively related to market diversification in all industries except engineering equipment. The two industry-level variables measuring product differentiation, R&D and marketing, are positively related to market diversification in most industries, suggesting that the close link between investment in technology, product quality and product diversification is also valid for market diversification. However, the coefficients of these two variables are only statistically significant in engineering equipment. As expected, province-industry concentration of economic activity is also positively related to geographical diversification, confirming that expansion of exports towards new markets is stimulated by the proximity of other competitors. However, here the relationship was not statistically significant in the textile, clothing and footwear industry. The coefficient on firm's import ratio showed a negative sign but was not significantly different from zero in all but one industry. Finally, we find no relationship between industry concentration and GDI.

The estimation results of the regression of PDI on export/sales ratio are reported in Table 8. Firm size has a positive impact on product diversification of exports only among very large firms (>200 workers), except in engineering equipment in which no coefficient is significant. Foreign ownership still shows a positive impact on PDI but it is only statistically significant in the engineering and chemical industries. The industry characteristics of R&D spending and marketing expenditure show no correlation with PDI, while the signs of the coefficients of industry concentration on PDI are negative although they are only statistically significant in textile and chemicals. In contract to the GDI regressions, the import activity of the firm has a positive and statistically significant positive correlation with PDI in all industries except textiles. As in the GDI regression, the spatial concentration of industry export activity has a positive effect on product diversification, although the correlation is only statistically significant for the food and chemical industry.

The panels in Figure 2 summarise the non-parametric results of the export intensity-GDI profile and export intensity-PDI profile for the five industries, after controlling for firm-specific characteristics and market characteristics. By comparing the shape of the graphs in each of the five industries, the general impression is that there is not a clear positive relationship between export diversification and export/sales ratio. In fact the data shows that product diversification falls when firm's export/sales ratio increases in all industries but food. The GDI-export ratio profile is positive and quite steep for all firms with an export ratio up to 20 percent. In the food and chemical industry the profile continues up, in the textile industry the GDI-export ratio profile becomes flat, and in the metal and engineering industry the GDI-export ratio profile falls. The empirical evidence has revealed a number of interesting features in the pattern of export diversification of Spanish manufacturing firms. First, the positive relationship between export diversification and firm internationalisation is only valid for market diversification but not for product diversification. Firms tend to be more specialised in their production as they are more internationalised. Therefore, product specialisation arises as a key characteristic of heavy export-orientated companies. Second, in the early stages on internationalisation firms tend to diversify in destination very quickly, but when these firms achieve certain levels of export dependence, the positive relationship between market diversification and exports/sales ratio disappears, and it becomes negative in some industries.

2.6 Conclusion

This paper deals with the international marketing strategy of exporters. In particular, we investigate the relationship between export diversification and firm internationalisation. Since theory and previous empirical evidence are unclear about the internationalisation-diversification profile, we make use of semi-parametric regression techniques to explore such a relationship without imposing any a priori functional form in the estimation. We construct two indices of export diversification, one for markets and another for exported products. The indices are sensitive to the number of markets (products), distribution of the value of sales, and the extent of heterogeneity between markets (products). Internationalisation is defined by the export/sales ratio.

Our research exploits the information about export values by product and destination of Spanish manufacturing exporters in 1988. The results show that there is an inverted U-shaped relation between firm export/sales ratio and the geographical diversification of exports. Although multi-product firms have their exports more geographic diversified compared with single-product firms, the shape of the inverted U-shaped relation is not altered.

In almost all the industries analysed, the results show that firms tend to be more specialised in production and marketing as they become heavily export dependent. On the one hand, firms with a low export ratio opt for quick market diversification, mainly through an even spread of sales across several countries. This strategy is in line with the portfolio theory of diversification that predicts diversification is used to reduce the risk of operating in markets under uncertainty. On the other hand, the group of firms with high export ratio tend to concentrate efforts in a few product lines and market destinations. Although the number of products and markets still increases, the distribution of sales is more concentrated in few homogenous destinations and products. This strategy suggests that there are some advantages such as scale economies associated to sell most of the exports in few destinations. Summarising, diversification is crucial in the first stages of firm internationalisation, but specialisation arises as a key factor of success in the marketing strategy of heavily export-orientated firms.

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2.7 Appendix 2.1. The Gollup-Mohanan Index of Diversification.

A standard measure of dispersion is the Herfindahl-based index, defined as $H = 1 - \sum_i s_i^2$, where s_i is the share of *ith* product in total firm sales. The index of diversification proposed by Gollup and Monahan (1991) is a generalisation of the Herfindahl-based index to make it sensitive to a continuous measure of product (market) heterogeneity.

$$D = \frac{1}{2}\left[1 - \sum_i s_i^2 - \sum_i \sum_{j \neq i} s_i s_j \left(z_{ij} - \sigma_{ij}\right)\right] \tag{2.7}$$

where z_{ij} is a corrective term to avoid an upwards bias by any disaggregation of a homogenous output bundle into artificially distinct product groups. $z_{ij} = 1$ if products i and j are identical, and 0 otherwise. σ_{ij} is an index of dissimilarity between products. Gollup and Mohanan (1991) proposed a continuous function

$$\sigma_{ij} = \left(\sum_k \frac{|w_{ik} - w_{jk}|}{2}\right)^{1/2} \tag{2.8}$$

where $w_{ik}\,(w_{jk})$ is the input cost share k in product $i(j)$. If we assume that within each industry group products are identical, z_{ij}=1 for product pairs (i,j) within a common industry group and z_{ij}=0 for product pairs (i,j) belonging to different industry groups. The results of this simplifying restriction is

$$D = \frac{1}{2}\left[1 - \sum_i s_i^2 + \sum_i \sum_{j \neq i} s_i s_j \sigma_{ij}\right] \tag{2.9}$$

The Gollup and Monahan index satisfies the five desired properties of an index of diversification:

1) It varies directly with the number of products produced or (markets supplied).

2) It varies inversely with increasingly unequal distribution of sales across product lines (destination markets).

3) it varies directly with dissimilarity or heterogeneity of products (markets).

4) It can be scope, applyed equally to firms, plants or industries.

5) It is bounded between zero and one.

2.8 Appendix 2: Choosing Smoothing Parameter and Kernel in the Semi-Linear Model.

The semi-linear model is $y = x\acute{}\beta + \theta(z) + u$. In order to estimate β consistently, we use the kernel estimators

$$E_N(y\,|z_o) = \sum_i K\left((z_i - z_o)\,|h\right).y_i / \sum_i K\left((z_i - z_o)\,|h\right) \tag{2.10}$$

$$E_N(x\,|z_o) = \sum_i K\left((z_i - z_o)\,|h\right).x_i / \sum_i K\left((z_i - z_o)\,|h\right) \tag{2.11}$$

Although Silverman (1986) shows that the choice of K(.) is not crucial, the selection of a "high-order" Kernel function may reduce the asymptotic bias in the estimation. We use a third-order Kernel based on N(0,1) density $\phi(z)$,

$$K = \frac{3}{2}\phi(z) - \frac{1}{2}z^2\phi(z) \text{ such that } \int z^2 K(z)dz = 0 \tag{2.12}$$

The choice of the smoothing parameter h is more important than the choice of K(.). We can choose h by minimising the Mean Integrated Square Error (MISE) - for example, the rule of thumb $N^{1/5}SD(z)$- or by the least squares cross validation. This chapter uses the data-driven method. Define the "leave-one-out" kernel estimator for $E_N(y\,|z_j)$ (the same applies for $E_N(x\,|z_o))$

$$E_N(y\,|z_j) = \sum_{i \neq j} K\left((z_i - z_j)\,|h\right).y_i / \sum_{i \neq j} K\left((z_i - z_j)\,|h\right) \tag{2.13}$$

Then we choose h by minimising the cross-validation criterion

$$(1/N) \sum_{j} (y_j - E_N(y\,|z_j))^2 \tag{2.14}$$

Table 2.1: Distribution of Spanish exporters by size, in 1988

Employment Interval	Number firms	Export/sales ratio (%)
21-50	1064	21.73
51-100	1826	21.15
101-200	1157	18.60
201-500	821	17.52
501-750	143	15.36
751-1000	93	16.80
1001-2000	78	14.20
2001-5000	29	15.35
5001-	18	20.11
Total	5229	19.76

Table 2.2. Frequency of export diversification by firm size and export/sales ratio.

		PRODUCT DIVERSIFICATION				GEOGRAPHIC DIVERSIFICATION			
		one CN code (1252)	between 2 and 4 CN codes (1866)	between 5 and 9 CN codes (1209)	more than 10 CN codes (902)	one country (947)	between 2 and 4 countries (1482)	between 5 and 9 countries (1355)	more than 10 countries (1445)
Firm size (number of workers)									
[21,50]	(1064)	0.08	0.08	0.03	0.01	0.06	0.07	0.05	0.03
[51,100]	(1826)	0.10	0.14	0.07	0.04	0.07	0.11	0.09	0.07
[101,200]	(1157)	0.04	0.08	0.06	0.04	0.03	0.07	0.06	0.07
>200	(1182)	0.02	0.05	0.07	0.08	0.02	0.04	0.06	0.11
Export/sales ratio (%)									
<10	(2634)	0.15	0.19	0.09	0.06	0.14	0.19	0.12	0.06
[11,25]	(961)	0.03	0.06	0.05	0.04	0.01	0.04	0.06	0.07
[26,50]	(970)	0.03	0.07	0.05	0.04	0.01	0.04	0.05	0.09
>51	(664)	0.02	0.05	0.04	0.03	0.01	0.03	0.04	0.06

Each cell contains the proportion of firms over the total of 5229. CN stands for Combined Nomenclature.

Table 2.3: Distribution of firms and sales in secondary export activities, by firm size and export/sales ratio

		Product diversification		Market diversification	
Size (workers)		(% firms)	(% sales)	(% firms)	(% sales)
[21,50]	(1064)	39.85	34.66	61.94	43.30
[51,100]	(1826)	38.72	35.08	65.33	45.61
[101,200]	(1157)	53.50	36.65	74.76	48.23
>200	(1182)	60.11	38.59	85.45	51.39
Export ratio (%)					
<10	(2634)	46.74	37.75	57.25	42.96
[11,25]	(961)	50.05	36.35	82.83	49.86
[26,50]	(970)	48.14	34.41	86.80	51.19
>51	(664)	49.25	32.63	87.50	49.60

Columns 1 and 3 indicate the percentage of firms whose main product or export market represents less than 90 percent of total exports. Columns 2 and 4 indicate the average proportion of export sales in secondary products or markets, among diversified exporters.

Table 2.4: Characteristics of exporting firms in manufacturing industry, 1988.

	Number of firms (Total)	Sales (average in mll.pts)	Export ratio (average)	GDI Herfindahl index	GDI Mohanan Gollup	PDI Herfindahl index	PDI Mohanan Gollup
Total sample of firms	5229	2604	19.85	0.422	0.243	0.240	0.169
Industry groups							
Food & drinks	752	3347	21.52	0.401	0.226	0.186	0.129
Textile, clothing & footwear	903	1095	16.90	0.309	0.214	0.274	0.190
Chemical, plastic, rubber	961	3593	15.11	0.465	0.254	0.321	0.218
Metal, ceramic & glass	1141	2655	22.87	0.438	0.241	0.211	0.152
Engineering products	624	2884	23.86	0.461	0.265	0.250	0.176

Food & drinks (NACE 41, 42); Textile & clothing (NACE 43, 44, 45); Metal, ceramic & glass products (NACE 247, 248, 31); Quemical, plastic and rubber (NACE 25, 48); Engineering products (NACE 32, 33, 34, 37). GDI is the geographic diversification index and PDI is the product diversification index. The Herfindahl index is $1-\sum_i s_i^2$ and the Mohanan and Gollup index is $\frac{1}{2}\left[\left(1-\frac{1}{n}\right)+\sum_i(\frac{1}{n^2}-s_i^2)+\sum_i\sum_{j\neq i}s_i s_j \sigma_{ij}\right]$

Table 2.5: Descriptive statistics

Variable name	Mean	Std. Dev.	Min	Max
GDI	0.240	0.17	0.00	0.56
PDI	0.169	0.17	0.00	0.66
Export/sales ratio	0.198	0.23	0.00	1.00
Size[21-50]	0.203	0.40	0.00	1.00
Size[51-100]	0.349	0.48	0.00	1.00
Size[101-200]	0.221	0.42	0.00	1.00
Size[>200]	0.226	0.42	0.00	1.00
Foreign owner	0.094	0.30	0.00	1.00
Import ratio	0.114	0.20	0.00	0.724
Province concentration	0.175	0.18	0.000	0.745
Industry concentration	0.185	0.14	0.036	0.810
R&D/sales	0.005	0.01	0.001	0.083
Advertising/sales	0.009	0.06	0.001	0.086

Table 2_6: Geographic diversification index of exports by number of exported products. Semi-parametric regression.

	# products=1		1<# products<5		# products>5	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Size [50-100 workers]	0.002	(0.26)	0.024 **	(2.83)	0.027	(1.20)
Size [100-200 workers]	0.006	(0.49)	0.036 **	(3.75)	0.078 **	(3.48)
Size [>200 workers]	0.014	(1.01)	0.068 **	(6.56)	0.117 **	(5.44)
Foreign Ownership	0.040	(1.54)	0.032	(1.52)	0.180 **	(3.15)
Firm import ratio	-0.040 **	(3.18)	-0.043	(1.18)	-0.053	(1.87)
Province concentration	0.088 *	(2.01)	0.037 **	(3.17)	0.006	(1.45)
Industry dummies	F(66)=4.76 [0.000]		F(68) =3.35 [0.000]		F(68)=2.32 [0.000]	
Number of firms	1209		2272		1748	

Numbers in parenthesis are standard errors. (**) significant at 1%, (*) significant at 5%. Foreign ownership: dummy that takes value of one if more than 25% of capital of the firm is foreign and zero otherwise. Firm import ratio is the value of imported goods divided by sales of the firm. Province concentration is the share of industry-province employment in national industry employment.

Table 2.7: Geographic diversification index of exports by industry. Semiparametric regression.

	food & drinks	textile & clothing	metals & ceramic,glass	enginnering equipment	chemical, rubber & plastics
Size [50-100 workers]	0.019	0.010	0.038 **	0.038 *	0.018
	(1.03)	(0.72)	(3.15)	(2.22)	(1.17)
Size [100-200 workers]	0.027	0.055 **	0.082 **	0.062 **	0.045 **
	(1.73)	(3.39)	(5.97)	(3.28)	(2.80)
Size [>200 workers]	0.069 **	0.143 **	0.108 **	0.076 **	0.096 **
	(3.57)	(9.32)	(8.00)	(3.99)	(6.33)
Foreign Ownership	0.189 **	0.045 **	0.049 **	0.030	0.056 **
	(3.24)	(2.94)	(3.31)	(1.88)	(4.85)
Firm import ratio	-0.022	-0.037	-0.012	-0.044 *	-0.008
	(0.82)	(1.72)	(0.71)	(2.31)	(0.51)
Market concentration	0.187	-0.235	-0.026	-0.001	-0.062
	(0.79)	(1.36)	(0.47)	(0.01)	(0.84)
Industry R&D	0.030	0.151	0.261	1.297 **	0.754
	(0.59)	(0.09)	(0.43)	(3.09)	(0.99)
Industry Marketing	0.189 **	0.023	0.046	0.793 **	-0.015
	(3.23)	(1.01)	(0.77)	(3.23)	(0.66)
Province concentration	0.048 *	0.038	0.161 **	1.600 **	0.111 **
	(2.24)	(0.69)	(5.94)	(2.68)	(3.58)
Number of firms	752	927	1145	624	946

Numbers in parenthesis are standard errors. (**) significant at 1%, (*) significant at 5%. Foreign ownership: dummy that takes value of one if more than 25% of capital of the firm is foreign and zero otherwise. Firm import ratio is equal to the value of imported goods divided by sales of the firm. Industry concentration is the four-largest firm concentration index, adjusted by import penetration. Industry R&D and industry marketing are the ratio of expenditures on R&D and marketing divided by sales, respectively. The variables are available at the three-digit CNAE level. Province concentration is the share of industry-province employment in national industry employment.

Table 2.8: Product diversification index of exports by industry. Semiparametric regression.

	food & drinks	textile & clothing	metals & ceramic,glass	enginnering equipment	chemical, rubber & plastics
Size [50-100 workers]	0.009	-0.025	0.015	-0.006	0.013
	(0.57)	(1.75)	(1.22)	(0.30)	(0.70)
Size [100-200 workers]	0.039	0.053 **	0.032	-0.019	0.038
	(1.31)	(3.09)	(1.11)	(0.96)	(1.64)
Size [>200 workers]	0.062 **	0.108 **	0.069 **	0.017	0.052 **
	(3.69)	(6.22)	(4.43)	(0.79)	(2.69)
Foreign Ownership	0.04	0.023	0.030	0.024 *	0.041 **
	(1.57)	(1.34)	(1.65)	(2.19)	(2.66)
Firm import ratio	0.105 **	0.027	0.088 **	0.074 **	0.079 **
	(3.69)	(1.27)	(4.44)	(3.37)	(4.11)
Market concentration	-0.165	-0.433 *	0.041	0.028	-0.237 **
	(1.23)	(2.34)	(0.69)	(0.35)	(2.98)
Industry R&D	0.320	0.517	-0.123	0.633	0.321
	(0.18)	(1.35)	(0.18)	(0.67)	(0.41)
Industry Marketing	0.036	0.313	-0.070	0.376	0.038
	(0.82)	(1.29)	(1.09)	(1.88)	(1.40)
Province concentration	0.173 **	0.014	0.081	0.024	0.091 *
	(3.00)	(0.63)	(1.02)	(0.49)	(2.55)
Number of firms	752	927	1145	624	946

See footnote in Table 7 for details.

Figure 2.1: GDI-export/sales ratio profile, by number of products.

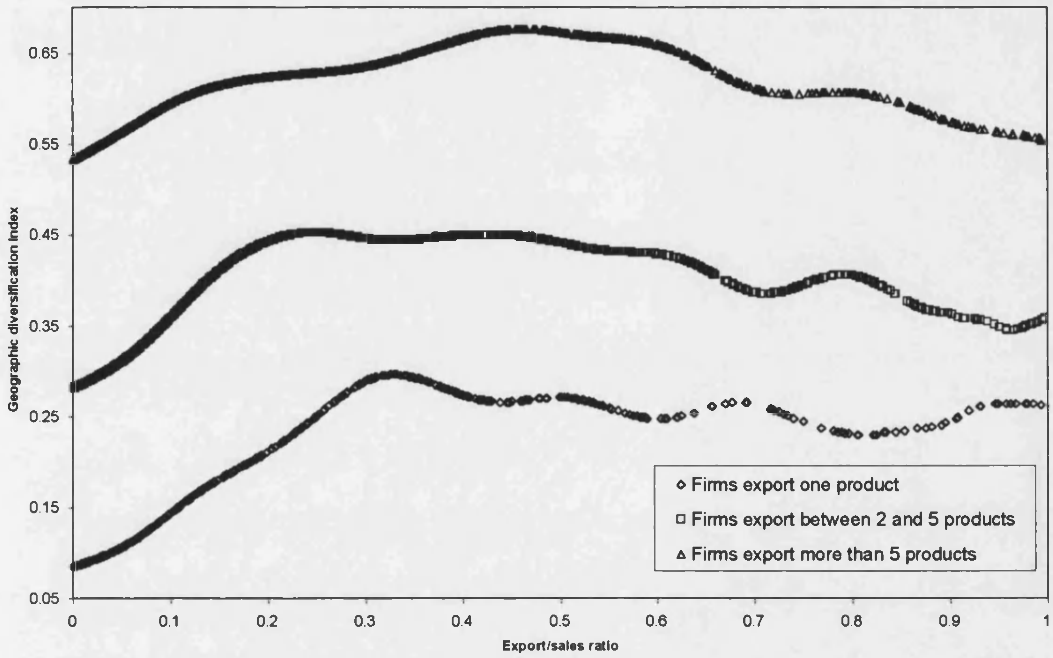
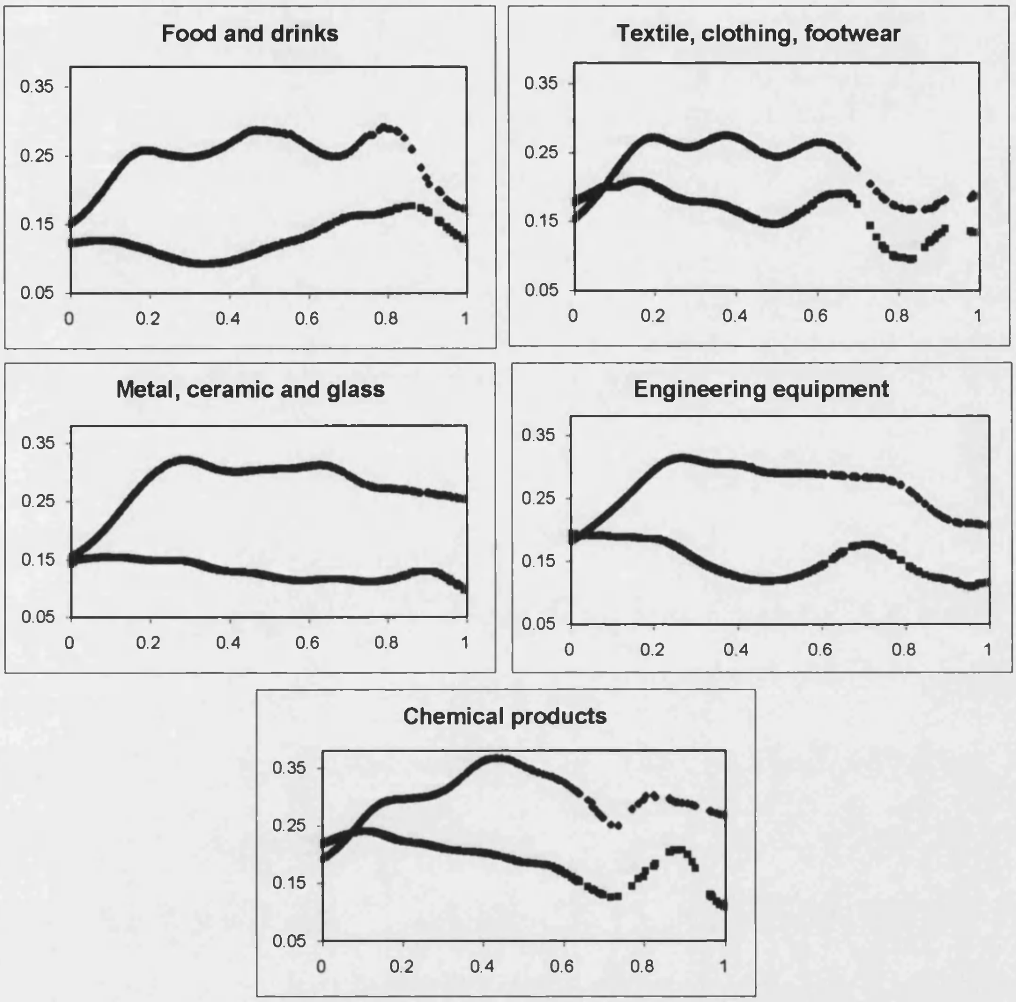


Figure 2.2: GDI, PDI and internationalisation profile, by industry.



The export/sales ratio is in the x-axis and GDI and PDI in the y-axis. The upper line is for GDI, while the lower line is for PDI.

Figure 2.1: GDI-export/sales ratio profile, by number of products.

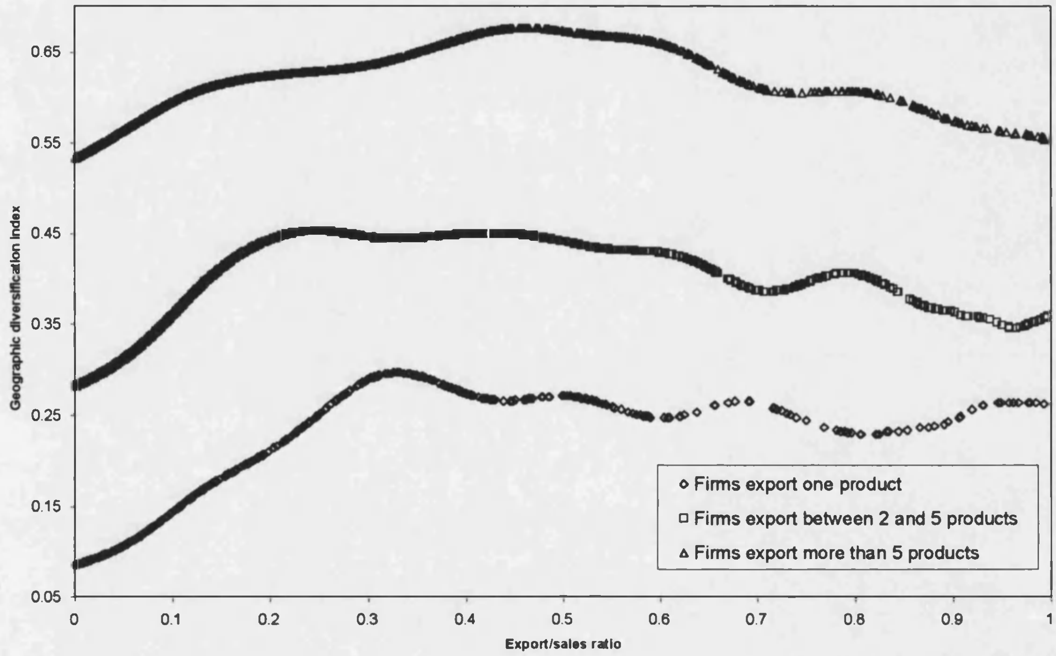
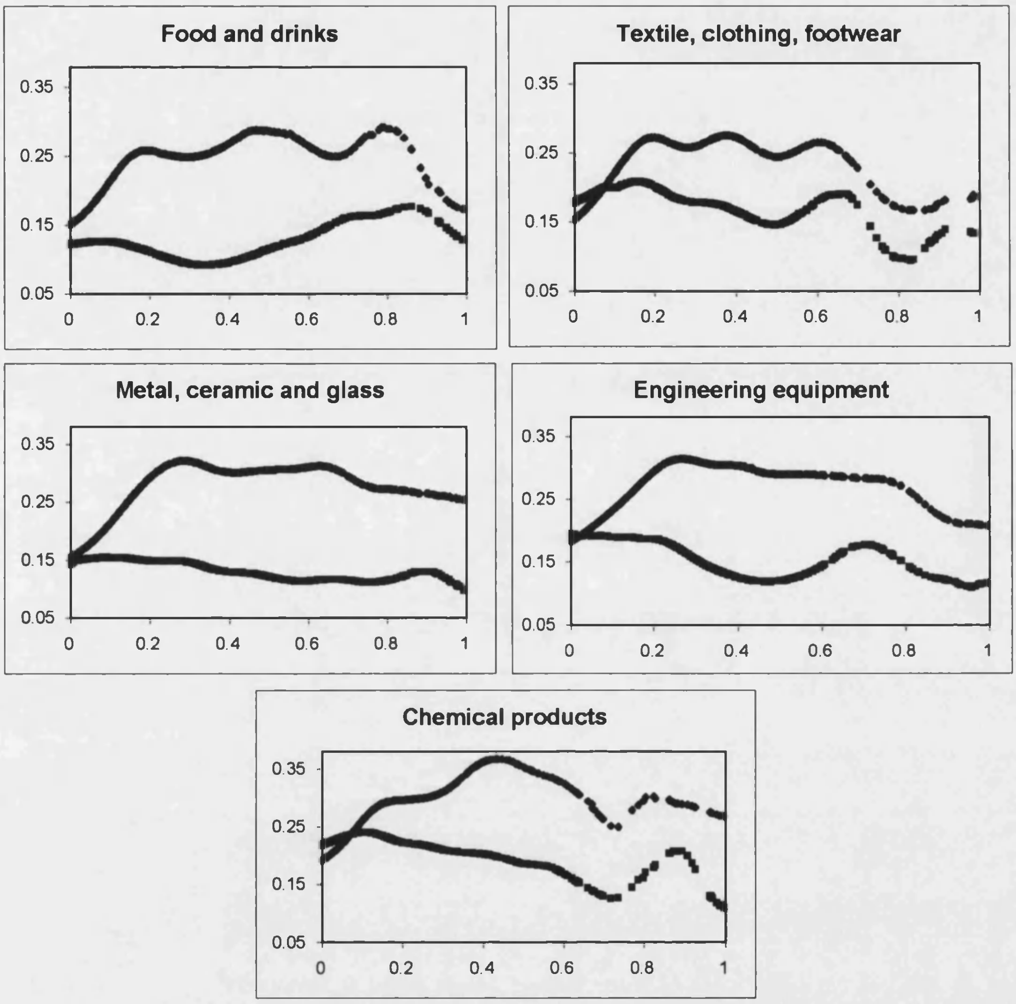


Figure 2.2: GDI, PDI and internationalisation profile, by industry.



The export/sales ratio is in the x-axis and GDI and PDI in the y-axis. The upper line is for GDI, while the lower line is for PDI.

Chapter 3

Information spillovers and the choice of export destination

3.1 Introduction

Which countries do firms export to? Trade traditional theory predicts that firms will export to countries that have a comparative disadvantage with respect to the domestic country. Empirical gravitational models find that firms tend to export more to countries that have a similar level of development or are geographically close to the domestic market. Finally, anecdotal evidence and several case studies show that entrepreneurs start exporting after observing other firms exporting similar products or through an idea that came from another domestic firm. With the same micro-data used in Chapter 2 to examine the pattern of export diversification in Spain, here we investigate the factors behind the firm's decision concerning the destination choice of exports. In particular, we aim to identify the source and quantify the effect of information spillovers generated by other local firms in the individual choice of export location.

From the firm perspective, export activity can be viewed as a learning process, wherein firms gradually became familiar with overseas markets and operations. Acquisition of sufficient information on foreign markets and operations is crucial for a firm's export decision (Leonidou and Katsikeas, 1996). Beside macroeconomic conditions, the high uncertainty surrounding international markets compared to the domestic market is due to firm's limited knowledge regarding international business and overseas market characteristics. Case studies show that firms start exporting to close destinations and they export to more distant destinations as they accumulate more experience (Weidersheim-Paul et al., 1978; Tesar and Tarleton, 1982). However, the physical proximity to certain markets can be altered by destination characteristic or firm-specific factors. A firm may bypass several geographically close countries because their size does not justify the amount of investment required to initiate export operations (Dalli, 1994). Moreover, light exporters are more likely to choose "soft" countries with relatively low entry barriers and more stable macroeconomic environment (Bonacorssi, 1992). Finally, inter-firm communication or personal contacts may change the perception about the profitability and risk of some geographically remote destinations (Reid, 1984).

The theoretical literature has only partially analysed the positive effects of information spillovers obtained from the geographical concentration of industries. The empirical literature has assessed the importance of agglomeration on firms' decision to export (Chapter 1), the degree of internationalisation of the firm and the pattern of export diversification (Chapter 3). However, any measurement of geographical concentration captures more than one possible source of externalities. Marshall's analogy that the cotton permeating the air of Manchester was akin to the transfer of ideas is an evocative one, but information spillovers of the forms he described are rarely of such a tangible form. While it is intuitively obvious that such forms of externalities may affect firm export behaviour, and that they are frequently invoked in anecdotal evaluations, the empirical researcher evaluating such spillovers faces considerable conceptual difficulties and problems of how to measure them directly. The recent empirical literature on exports and information spillovers has dealt with the decision to export and how much to export.[1] Here we investigate the destination choice of exports, since we believe that entrepreneurs not only exchange generic information about the export activity but also share specific information about which particular countries are more profitable and less risky. If we cannot reject the hypothesis that firms located in a geographically agglomerated area tend to

[1] See, among others, Aitken et al (1997), Becchetti et al. (2000), Malmberg et al. (2000) and Lautanen (2000).

export to the same destinations, this can be interpreted as direct evidence of the importance of information spillovers in export activity.

We estimate a multinomial logit model for the probability that a profit maximising firm chooses to export to a particular destination. We test whether firms tend to export to countries where other local exporters have previous experience as information is cheaper and more reliable, to more developed countries in order to enhance the scale of production, and to close countries to reduce transport costs. In addition, we try to identify the type(s) of firms that generate the information externalities in the export activity: domestic exporters producing the same good (localisation economies), multinationals, or any other domestic exporters, whatever the industry activity that they have (urbanisation economies).

Our study is based on a unique data set including the export sales by country of destination for some 5229 Spanish manufacturing firms in 1988. Our regression analysis is done for a subsample of 437 small firms (less than 100 workers) selling only one product to one foreign country. Besides the econometric issues discussed below, small firms are more likely to benefit from information spillovers since research about opportunities in foreign markets can be very expensive for firms with limited resources.

To anticipate the findings, there is evidence that geographical agglomeration of exporting firms selling to a particular destination significantly increases the probability of small firms exporting to the same destination. The source of information spillovers is localisation externalities, that is, geographical concentration of domestic exporters of the same industry. There is no evidence that the presence of multinationals or urbanisation economies significantly affect the choice of destination of small exporters. The results are robust to different measures of geographical agglomeration. The significance of localisation economies also persists in spite of controls, which show how the probability to export to one particular destination is also (positively) affected by conventional gravitational factors such as the level of development and the physical proximity of the destination country, and firm characteristics in the form of size and export intensity.

The paper is organised as follows. Section 3.2 briefly reviews the literature on information spillovers and export activity. Section 3.3 characterises the data and provides descriptive evidence from the sample on the destination choice by Spanish exporters. Section 3.4 accesses the results of an econometric analysis on the effects of information spillovers on the decision about where to export. Section 3.5 concludes.

3.2 Agglomeration economies and export activity.

Pioneering work by Marshall (1920) suggests that firms in the same industry may be drawn to the same location because proximity generates positive externalities. Firms tend to concentrate in specialised areas since this reduces production costs due to the sharing of certain resources (notably social and physical infrastructures and skilled labour), access to transportation facilities and proximity to both customers and suppliers. Recent advances in Economic Geography have formalised, in general equilibrium models, the different types of source generating positive spillovers: pool of specialised labour, linkages, diffusion of information and technology (Krugman, 1991; Fujita et al., 1999; Henderson et al., 1995; Glaeser et al. 1992).

It has been argued that in industrial areas where there is a high density of one or few sectors the degree of co-operation is intensive. There is a high level of communication and of interpersonal relationships among entrepreneurs, so that information is diffused by word-of-mouth. In such an environment, information spillovers may have direct or indirect effects on the decision of a firm about what to produce, where to locate production, and which markets to target. Two factors, related to firm neighbourhood, play a major role in reducing the barriers to export: information and imitation.

Managerial attitudes toward exporting, risk perception and risk-aversion are key to explain export behaviour (Bilkey and Tesar, 1975). Interpersonal communication reduces the perception of risk and positively influences expectations about profitability of exports. Entrepreneurs start exporting because they learn about experiences from other firms that have adopted exporting as a viable growth alternative. Perception of risk is greatly reduced because first-hand information is available about opportunities in a particular foreign market, the trends of demand, and major problems about exporting. Entrepreneurs strongly prefer personal and direct sources of information when they have to decide where to export. For example, Bonaccorsi (1992) observes that many new Italian firms are set up by people with previous experience as employees, who often receive support from their former employer who are in contact with foreign intermediaries. When demand in a particular foreign market is increasing, entrepreneurs feel that they can give information on export markets even to their local competitors, with the expectation that it will be reciprocated in the future, when needed. Proximity to other exporting firms also reduces the need for information gathering and processing, since face-to-face contacts with other colleagues are perceived as a reliable and inexpensive information source.

Knowledge about foreign markets can be transmitted through other channels. Even without direct interpersonal communication about exporting experience, the high density of firms in a concentrated area leads to a high transparency in the behaviour of individual firms. When an innovative firm makes the decision to export, many imitators will follow within a short time period. Imitators will target the same market destinations where the innovative firm has already conducted the research on potentially profitable foreign markets (Lautanen, 2000).

The two factors referred to above, information and imitation, lead us to formulate the following hypothesis: ceteris paribus, if information spillovers are important, firms located in the same region will have similar export experience. We define "similar" export experiences in terms of same destination of exports and we aim to identify the source of information spillovers that induce firms to share the same export destinations. Our approach follows Head et al. (1995) and Aitken et al. (1997) by separating various types of exporters located in the same area. The geographic concentration of export activity to one particular destination is split into three terms: province concentration of local exporters in the same industry, province concentration of multinationals in the same activity, and province concentration of the rest of export activities. The first is related to localisation economies (or industry-specific economies); the second captures economies generated by the proximity to a multinational company; the third reflects urbanisation economies (or agglomeration of firms irrespective of sector origin). We discuss each source of information spillovers in more detail.

Localisation economies

Similar firms tend to benefit from being located close to each other. The gains comes from reductions in transaction costs between firms and their trading partners, as well as from the speed with which communication can take place between firms. The central mechanism is that the concentration of many firms in related industries tends to enhance firm competitiveness by triggering not only flexibility and dynamics in general, but innovation and learning in particular. In regions with many firms in the same industry, there is a greater chance of contact with early adopters of a new technology, more rapid circulation of information about specific technologies, potential markets, and so on. The literature on industrial-districts is particularly interesting in this context (Pyke and Sengenberger, 1992, for an overview) since the specific source of externalities is the concentration of very small sized firms of the same activity in well-defined geographic areas.

Multinationals economies

Multinational (MNEs) may act as a "hub firm" in a large-firm dominated hub-and-spoke industrial area. Aitken et al. (1997) describe two channels used by domestic firms that want to export to benefit from the export activity of multinational enterprises. First MNEs have multi-market presence so they have better information than domestic exporters about foreign markets, foreign consumers and foreign technology. Second, MNEs provide inputs not available in local markets, and arrange subcontracts or licences with neighbouring local firms that directly or indirectly link these firms to foreign buyers.

Urbanisation economies

Whereas localisation economies are defined as the effect of an agglomeration of firms active in the same industry, urbanisation economies accrue from the agglomeration of firms irrespective of sectoral origin. The main difference may be that urbanisation economies are seen as being more related to the benefits of sharing basic assets, resources and institutions, which are regarded as public goods, while localisation economies have traditionally leaned more toward the increase of efficiency of economic transactions when carried out between firms located close to each other. In areas where similar firms are not close one to each other, cities may have a central position in the system of information circulation facilitating access to specialised information.

Recent empirical literature has found that agglomeration economies play an important role in regional and urban growth (Nakamura, 1985; Glaeser et al, 1992; Henderson et al., 1995; Hanson, 1996), location decision, particularly by multinationals (Head et al. 1995, Devereux and Griffith, 1998) and in the export performance of local firms. While most empirical research finds that geographical agglomeration has a positive effect on economic performance at the aggregate, regional and firm levels, there is no consensus about the type of agglomeration behind such benefits.[2] In the trade literature, Lautanen (2000) analyses the reasons that generate interest for exporting among managing directors of small exporting firms in Finland. He finds that the major stimulus comes from inter-firm transmission of information, but not always from firms producing the same goods. Becchetti et al.(2000) find strong evidence of the positive impact of industrial districts (or localisation economies) on the probability to export and the export intensity of Italian small-medium sized firms in 1995. In contrast, Malmberg et al. (2000) observe that localisation economies are not important among Swedish exporters in 1990, while urbanisation economies have a large positive effect on the firms' volume of exports. Finally, Aitken et al.(1997) show that the export decision of local Mexican firms is positively affected by the specific export activities of multinationals, while there is no evidence of spillovers from the geographical concentration of local export activity.

This paper uses data on Spanish exporters to analyse the impact of information spillovers on export activity. Our approach differs markedly in a number of important respects from previous research. First, we examine the destination choice decision, instead of the export participation decision or export performance (e.g. export sales or export/sales ratio). Second, we concentrate our attention on small firms since the lack of a sophisticated marketing team makes it more likely they will be dependent on local information spillovers than their large more

[2]While some authors find a positive and significant effect on regional growth from urbanisation economies (Nakamura, 1985; Glaeser et al, 1992), other have found evidence emphasising the importance of localisation externalities (e.g. Henderson et al., 1995; Hanson, 1996). In Spain the evidence also is mixed. The results in Callejón and Costa (1996) support urbanisation economies as determinant of province output growth rates over the eighties. However, Goicolea et al (1996) find weak evidence of urbanisation economies and strong evidence of localisation economies using regional data.

complex counterparts. Third, we aim to identify the source of spillovers: domestic exporters in the same industry (localisation economies), multinational enterprises, domestic exporters from any other sector (urbanisation spillovers).

3.3 The destination choice of Spanish exporters

We analyse empirically the decision about where to export using a multinomial logit model. Consider a firm that produces one good in the local market and sells part of the production abroad. There are several alternative markets and the firm has to decide on one market to export to. [3] We assume that the expected profits (Π_{ij}) of selling to country j by firm i is a linear function of factors affecting the destination choice,

$$\Pi_{ij} = \theta_j + \alpha' I_{-ij} + \beta_j' x_i + \gamma' z_{ij} + \varepsilon_{ij}, \text{ i=1,..., I; j=1,...,J} \tag{3.1}$$

where θ_j is a constant specific to the location, which captures unobservable fixed effects associated with the location perceived as identical by all the exporters; I_{-ij} measures the "mass" of information that other exporters located close to firm i have about destination j, x_i is a vector of firm-specific characteristics, z_{ij} is a vector of attributes of the destination-country (that may be perceived differently by each firm i), and ε_{ij} is a random term denoting the unobservable (by the researcher) unique profit advantage to the ith firm from selling in the jth country.

An exporter will choose to export to a particular country if it will earn the highest possible profit. Formally, the jth country is chosen as the destination of exports if

$$\Pi_{ij} = \max(\Pi_{ik}, k = 1, ..., K) \tag{3.2}$$

If random, firm-specific random terms $(\varepsilon_{i1}, \varepsilon_{i2}, ...\varepsilon_{iK})$ are independently distributed, each

[3]For the moment let assume firms export only to one destination and model their choice. However, firms usually choose more than one export destination. This issue wiil be discussed below and in the next section.

with an extreme value (Weibull) distribution, McFadden (1974) showed that the probability of a firm i to choose a destination k is

$$P_{ik} = \Pr ob[y_i = k] = \Pr ob(\Pi_{ik} > \Pi_{il},\ k \neq l) = \frac{\exp(\theta_k + \alpha' I_{-ik} + \beta_k' x_i + \gamma' z_{ik})}{\sum_j \exp(\theta_j + \alpha' I_{-ij} + \beta_j' x_i + \gamma' z_{ij})} \qquad (3.3)$$

where P_{ik} is the population relative frequency of exporting to destination k. The estimates are obtained by maximising the likelihood function, $L(\theta_j, \beta_j, \gamma) = \Pi_j P_{ij}$. Two econometric issues should be mentioned. The estimation of a single multinomial logit model requires the assumption of the "independence of irrelevant alternatives (IIA)", which would imply that the probability of choosing between two destinations is independent of the characteristics of a third destination. In the next section we test for IIA by selecting different sub-samples to check for consistency of the estimates.[4] Another problem is that our specification does not permit choosing to export to more than one country. However, in practice some firms do so. As it is difficult to allow for this possibility, we estimate parameters using firms that export to only one destination and assume that these estimates are also valid for firms that export to several countries. We conduct an indirect test of this assumption by estimating a binary logit model for the choice of whether or not to export in each country, and compare the results of the group of firms that export to only one destination with those that export to more than one destination.

The data used in our empirical exercise is the same as in chapter 2: 5229 Spanish manufacturing firms with more than 20 workers and exports above one million pesetas (~3000ECU) in 1988. For each company the value of exports is broken down by product and country. Trade data is classified by four digits Combined Nomenclature codes (Eurostat, 1991). The data set includes information on total sales, employment by size range, percentage of foreign equity participation in the firm, and geographic localisation by province. It is worth stressing that more than 55 percent of the firms employ less than 100 staff and that 9 percent of the firms have positive (>25%) foreign capital participation.

[4]The alternative approach is the use of specification tests for the multinomial logit model (Hausman and McFadden, 1984).

Table 3.1 shows the distribution of total export value by geographic area in 1988. The first half of the table demonstrates the preference of Spanish firms for EU countries since 68 percent of firms' exports were marketed to the EU. Of the remaining market areas, North America has some significance for exporters (8.3 percent). The remaining geographic areas have less than 6 percent of Spanish exports each. The last two columns in Table 3.1 show the distribution of Spanish exports to those countries whose share in total Spanish exports was above 1 percent. The ranking of countries matches expectations: France, Germany, Italy, UK and USA are the five largest market destinations (65 percent of total firm's exports). The concentration of exports value by destination is significant since the first 10 countries represent 80 percent of total export value. Table 3.2 shows the preferences of 5229 Spanish firms towards several export destination markets. The choice of *first* destination by export value is quite selective. France is the first destination chosen by both domestic-owned and foreign-owned firms. The next most frequent first destination is Portugal among domestic exporters while Germany seems to be preferred by multinationals. In our sample, 50 percent of firms choose France, Germany or Portugal as a first destination.

We have selected our analysis to those firms that are domestic-owned, export only one good (major product represents above 95% of the exports value), employ less than 100 workers, and export to only one destination. The number of firms is 494 out of 5229 firms. On the one hand, as we explained above, this is motivated by the econometric specification of the model. On the other hand, we reduce the heterogeneity of the sample (only small sized firms) and ease the calculations of the geographic concentration indicators (single-product exporters). The comparison between column 1 and column 3 in Table 3.2 points out some differences in the distribution of number of firms by first destination between all domestic-owned firms and the subsample of single-product SMEs. Saudi Arabia was one of the preferred destinations in the full sample but it disappears from the list of favourite destinations by SMEs. Portugal, Morocco, Tunisia and Algeria gain positions in the ranking, which suggests that the geographic proximity of the destination country is important for SMEs. Again the destination choice is quite selective: 437 out of 494 SMEs chose among only 12 countries in 1988.

Next we provide a description of the explanatory variables in the empirical model (I_{-ij}, x_i, z_{ij}) and the hypotheses related to each of them. The source of information available in one province about market opportunies abroad (I_{-ij}) is captured by three types of agglomeration economies. Each of them is identified by the kind of firms providing the information about the profitability of exporting to one particular market: domestic firms operating in the same industry, multinationals, and firms from different industries.

> $H_0(1)$: *Localisation economies.* The probability that a firm exports to a particular destination increases with the level of export concentration by other domestic exporters of the same product to this destination.
>
> $H_0(2)$: *Multinational enterprises* (MNEs). The probability to export to a particular destination increases with the concentration of export activity by MNEs in the province.
>
> $H_0(3)$. *Urbanisation economies.* The probability to export to a particular destination increases with the total number of firms in the province exporting to this particular destination, independent of the exported product.

A problem in the analysis of agglomeration by province is that the export value is not always registered by the plant where the production actually took place, but in the place where the legal unit (that is, the firm) is registered. In the case of multilocational firms, this means that certain provinces acquire a higher export value and other regions a lower export value than they should. When we compare the distribution of export values between our 5229 exporting firms in 1988 and government's aggregate figures using ESTACOM (ICEX) in 1993, the correlation indices were very high (0.71 across 48 provinces and 0.98 across 81 two-digit Combined Nomenclature codes). The main difference between the two data sets was the high concentration of export activity in Madrid; 40% of total export value according to CAMERDATA and 12% of total export value according to official statistics. Since the gap is mainly caused by a few large multiple-plant exporters whose legal unit is located in Madrid, we choose firm counts instead of export values in the construction of agglomeration measures.

We measure LOCALISATION economies as the logarithm of one plus the number of domestic-owned firms in the province operating in the same industry and exporting to the same destination. In the calculations, we exclude the firm on which the observation is taken. MNE economies are equal to the logarithm of one plus the number of foreign-owned firms in the province operating in the same industry and exporting to the same destination. URBANISATION economies are equal to the logarithm of one plus the number of firms in the province exporting to the same destination. However, other local export firms in the same industry have been included in the localisation economies. Therefore, in order to avoid double counting, these have been excluded from the urbanisation economies.

If the "home base" of the firm is the correct locus for the origin of export spillovers, as this is normally where the main development work takes place (Porter, 1990), we can still use export values to construct a conventional indicator of LOCALISATION economies (Henderson et al, 1995) as

$$\frac{\frac{\text{industry-province exports to country K}}{\text{industry exports to country K}}}{\frac{\text{province exports}}{\text{national exports}}} \tag{3.4}$$

Indicators of MNE economies and URBANISATION economies are constructed in a similar way using export values of MNEs and export firms outside the industry of the firms in focus, respectively.

The other two destination-specific variables included in the regression analysis are level of development and distance. Gravity models of trade show that the volume of trade between partners is directly proportional to their level of economic development and inversely proportional to the geographic distance between them. The level of economic development of the destination country is measured by its income per capita (Source: World Penn Tables) and it is expected that domestic exporters will tend to sell more where the demand is higher. As rich countries will demand more manufacturing products than poor countries, the choice decision should be positively affected by the per capita income of the destination country. However, the geographic proximity of some foreign markets may contribute to change the perception towards these markets. For example, firms located near the frontier will treat neighbouring countries similar to other domestic regions. Indeed, transportation costs may be lower or similarities in demand stronger across neighbouring countries than within a country in some industries. Given the important role of distance, we undertook a detailed analysis of the transportation routes for firms in relation to their provincial location. The calculation of distance with trading partners is as follows: France, Portugal, Morocco, Tunisia and Algeria, we calculate the distance by road between the capital of each province to the corresponding frontier. For other European destinations [Germany, UK, Italy, Netherlands, Belgium], we use the road distance in kilometres from the capital of the province and the capital of the destination country. For USA and Mexico, we use the geographical distance between Madrid and the capital of these countries. Measuring distance in that way takes into account borderline effects between some countries and some Spanish provinces.[5]

> $H_0(4)$: *Geographic proximity.* The probability to export to a particular destination decreases with the physical distance from the production province to the destination country.
>
> $H_0(5)$: *Level of Development.* The probability to export to a particular destination increases with the level of development of the destination country.

Unlike other studies on spillovers and localisation, our model allows for firm-specific characteristics to have different impacts on the choice of export destination. The presence of different firm characteristics might make some of their choices closer substitutes in the eyes of certain exporters than other choices. The inclusion of firm-specific characteristics interacting with the destination-specific constant terms also contributes to reducing the risk of violation of the Independence of Irrelevant Alternatives assumption (Train, 1986). For example, some firms must

[5] Sources: http://shellintenational.org for distance between Spanish cities and European destinations; http://Haveman.org for distance between capitals. We consider Cádiz the closest port to Morocco. For Argelia and Tunisia we add 800km and 1200km, respectively, to the original distance (approximately the distance Cádiz-Algiers and Cádiz-Tunis).

attain a minimum size in order to export. We can carry this argument further and specify the relationship between conditions of foreign entry and the minimum size which must be attained by firms to enter a specific foreign market. Some destinations may require a level of previous investment or knowledge such that only few firms may have enough resources to export to them. The requirements needed by a firm to supply a particular market may be directly related to its size and the level of internationalisation, measured by its export/sales ratio. If we do not include information about firm characteristics, then the choice of destination could be dependent on firm heterogeneity.

> $H_0(6)$: *Firm heterogeneity.* The probability that a firm will export to a particular destination is affected by the interaction between the country-specific characteristics and the firm-specific characteristics.

3.4 Estimation results

Our final sample is reduced to 437 single-product small-medium sized firms (SMEs), producing in 1050 (four digits Combined Nomenclature) industries, located in 48 provinces[6], and exporting to 12 possible choices (France, Portugal, Germany, UK, Italy, USA, Morocco, Netherlands, Belgium, Mexico, Argelia and Tunisia).[7] The indices of geographic concentration of exports are constructed using data on the rest of domestic firms and foreign-owned firms, and excluding in the calculation the firm of reference. As firms export, on average, 6 different product lines to 8 different countries, we count each product line-country pair as a separate observation. As a result, we use more than 120000 observations for calculating the relevant concentration variables. Table 3.3 presents some descriptive statistics of the explanatory variables used in our estimation.

The results of the regression analysis using firm counts to measure agglomeration are dis-

[6] Firms located outside of the peninsula (Baleares, Canarias, Ceuta and Melilla) were excluded.

[7] We have constrained the number of countries to 12 since the rest of the destinations are chosen by three or less firms. Given the independence from irrelevant alternatives assumption built into the logit specification, the reduction in the choice set should not affect the other parameter estimates.

played in Table 3.4. In the first three columns, the impact of each measure of spatial concentration of exporters is investigated in isolation from each other. If the error term is an independently drawn disturbance, the coefficient of each agglomeration measure shows the impact of information spillovers on the destination choice. All the columns include 12 country-specific constants. The high value of the reported chi-square statistics suggest that there are significant unobservable differences across the 12 destination characteristics. In Column 1 the coefficient on LOCALISATION is positive and significant. That is, SMEs choose those destinations in which a relatively large number of other local exporters in the same industry are exporting. Column 2 shows that the presence of MNEs in the same province exporting to one particular destination has a negative impact on the destination choice by domestic SMEs, but the coefficient is not statistically significant. In column 3 the coefficient of spatial concentration of firms from other industries selling to a particular destination is not statistically significant on the choice decision of SMEs. When we put the three measures of export concentration together in column 4 the coefficient on LOCALISATION remains positive and significant, while the coefficients on MNE and URBANISATION economies are not statistically significant. The results are reasonably stable across columns 5 and 6 when we add the other explanatory variables in the model, firm-specific characteristics (size and export/sales ratio) interacting with the destination-specific constants and the gravity variables (distance and income per capita). The chi-square test rejected the hypothesis that firm-specific variables interacting with the destination-specific constants have no explanatory power.[8] The coefficient of the distance to the destination shows a negative and significant impact on firms' choice decision as we expected, but the coefficient of per capita income has an unexpected negative sign although it is not statistically significant. The inclusion of additional variables has little effect on the three measures of export concentration: the coefficient on LOCALISATION economies remains positive and significant, while that on MNE and URBANISATION remains insignificant. There are benefits of being near other firms exporting to the same destination. However, the results indicate these

[8] The hypothesis of equal coefficients for size and export/sales ratio across destinations was also strongly rejected by the data.

benefits are only generated by other domestic firms operating in the same industry. Neither the proximity of MNEs nor the concentration of firms in other industries exporting to one particular destination has a significant impact on the decision of SMEs.

The coefficients presented in Tables 3.4 are the marginal impact on odds ratios. A more intuitive interpretation of the magnitudes of the effects is given by considering the marginal effects or the probability elasticities. Since explanatory variables are expressed in logs, the elasticity of the probability of a particular exporter j choosing destination k with respect to any explanatory variable can be calculated as

$$E_{jk} = \frac{\partial \ln P_{jk}}{\partial \ln X} = \widehat{\beta}(1 - P_{jk}) \tag{3.5}$$

Summing overall the choices and firms we obtain the relationship between average probability elasticities and the coefficient estimate, $\widehat{\beta}$:

$$E = \sum_{j}^{J} \sum_{k}^{K} E_{jk} = \widehat{\beta}\frac{K-1}{K} \tag{3.6}$$

Since K, the number of choices, equals 12 in the estimations, elasticities can be obtained by multiplying the estimated coefficient by 0.916. Using the estimates of Column 6 in Table 3.4, the average probability elasticity indicates that for the average province, a 10 percent increase in the number of firms in some industry exporting to one particular destination would increase the likelihood of choosing this destination by other exporters in the same industry by 16 percent. Thus, we have shown that the coefficient that we interpret as evidence of export spillovers is highly statistically significant and seems to affect the choice decision of small firms by a large percentage.

Three final remarks about our findings. First, our results are obtained using a sample of small single-product firms. If we assume that small firms have less resources to finance searching for new market opportunities, information from other firms could be the only available way to learn about profitable opportunites abroad, compared with large firms that may obtain extra resources more easily. If the benefits from information spillovers decrease with firm size, the estimated coefficients should be smaller for a sample including medium-large sized firms. However, when we augment the sample with large single-product firms the new estimated coefficients did not change significantly. Second, we attribute the positive effect of geographic agglomeration on export activity to information spillovers between local firms. However, another source of information could be a sector of specialised export services in the local area created by the central or regional government or wholesale industry. Unfortunately, it is difficult to control for such an alternative source of positive externalities without extra information. Finally, the findings could be also interpreted using the traditional trade theories. Due to factor abundance or superior technology, Spain will have a comparative cost advantage in the production of some goods relative to its importing countries. At the same time some regions may have a comparative advantage in the production of those goods in which Spain shows a comparative cost advantage abroad. The result will be that most firms producing these goods will be located in specific locations and will export to the same destinations in which Spain has a comparative cost advantage. The main criticism of this explanation is that technology and factor endowments are not so heterogenous across Spanish regions, particularly in the manufacturing industry.

3.5 Robustness issues

In this section we discuss three issues. First, we check the robustness of the results by changing the way we measure agglomeration. Second, we test for the violation of the independence of irrelevant alternatives (IIA) assumption by changing the number of possible destinations. Third, we test whether the results obtained for single-destination firms apply for multi-destination exporters.

Table 3.5 presents the results of estimating the multinomial logit using as explanatory variables the quotient index in expression (3.4). The results are very similar to those in Table 7 using firm counts to measure agglomeration. Again, in all the specifications, the coefficient on LOCALISATION economies is positive and significant, while the coefficients on MNE and

URBANISATION are not significant. We conclude that the hypothesis of information and imitation spillovers in the export activity among domestic firms operating in the same industry is robust for alternative measures of agglomeration. In Column 6 the coefficient on per capita GDP of the destination is now positive and significant, confirming the importance of including gravity variables in this type of model of export destination decision.

Multinomial logit estimations rely on the assumption of identical independent error terms. If these assumptions are not meet in the data, a violation of the independence of irrelevant alternatives (IIA) property will lead to biased estimates. The IIA property implies that the relative probability of choosing two alternatives does not depend on the availability or characteristics of other alternatives. Although the inclusion of firm-specific characteristics interacting with the alternative-specific constant terms might contribute to reduce the risk of violation of IIA, the coefficient estimates still depend critically on the sample of firms and destination choices. To investigate whether the results in Table 7 are robust, we re-estimate the model with different sub-samples. We have selected three groups of destinations from the sample: all destinations but France, European destinations only, and border destinations only. Since France concentrates nearly half of the total first destination choices, we check whether France itself has certain characteristics that could lead to violations of the IIA assumption. Second, we remove non-European destinations since they have in common larger transportation costs. Finally, we select the three border destinations (France, Portugal and Morocco) to check whether our estimates change when we control for borderlines.

The results of estimating the model with the restricted samples are shown in Columns 1 to 3 in Table 3.6. The baseline specification is column 6 of Tables 3.4. The estimates on SPECIALISATION are robust through each sub-sample. The coefficients are always positive and statistically significant. While the coefficient on MNE is again not significant in any sub-sample, the coefficient on URBANISATION is positive and significant in the sub-samples of European destinations and destination borders.

An additional problem is the difficulty in dealing with firms that choose more than one destination within the context of the econometric framework used here. Consider the possible extension that includes firms that export to two destinations. It is difficult to assess which variables should be used to investigate choices such as France-UK and Germany-Portugal relative to the choice of each destination separately. We therefore investigate this issue using a different approach. We follow the procedure of Grubert and Mutti (1996) and Devereux and Griffith (1998) of estimating a binary choice model (in our case logit) of the choice facing a firm as to whether or not to export to a given market, independent of whether the firm exports to other countries. [9] Thus, the dependent variable y_c^i

$$y_c^i = 1 \text{ if firm i exports to country } c; \quad y_c^i = 0, \text{ otherwise} \tag{3.7}$$

The observations for the 12 destinations are stacked together, so that the 437 observations used above reflect 5244 choices in this framework. The results of estimating this model on the sample of single-destination exporters are presented in column 5. The presence of other domestic firms in the same industry exporting to one particular destination has a significant impact on the destination choice of small exporters, while the presence of MNEs has no impact no the destination decision. The coefficient on distance is negative and significant, and the per capita GDP of the destination is not significant. Surprisingly, the coefficient on URBANISATION is negative and statistically significant. Since it is independent of the choice for any other country, this model can be applied to firms which choose more than one location. Column 6 presents the results of estimating the model on all firms that export to more than one country in our selection of 12 destinations. Because we can now include firms choosing more than one destination this yields 1201 firms and 14424 possible choices. The results in column 6 are the same as those in column 5 suggesting that the hypothesis of spillover effects can be extended to firms selling in more than one destination. Of equal interest, the results indicate that small firms at best do not benefit from being close to multinational firms, at least in their choice

[9] As we saw in chapter 2, the probability of exporting to more markets was positively related to the extent of firm internationalisation. Here what we are saying is that the choice of exporting to Germany, for example, is independent of whether the firm is exporting to UK, France or Portugal.

decision about exports.

3.6 Conclusions

This paper investigates the impact of information spillovers on firms' choice of export destination. Although case-studies indicate that new exporters take into account the destination chosen by other exporters, there is no econometric evidence on this area. If information/imitation is important in the firm's decision about where to export, an interesting issue is to identify the source of these externalities. There are three sources of externalities generated by the location of firms in the same geographic area: pooled specialised labour, linkages and information spillovers. A further classification distinguishes between externalities generated by the concentration of firms of the same industry in the same area and externalities generated by the location in the same area of firms from several industries. This paper investigates whether the geographical concentration of different types of exporters selling to a particular destination stimulates other firms to export to this destination. These benefits from the concentration of exporters selling to a particular destination are more likely to be be generated by information spillovers and less likely to be generated by a skilled labour pool or by demand and supply linkages.

We have divided the sources of externalities generated by geographical concentration of exporting firms in three: localisation (firms operating in the same industry), multinationals, and urbanisation (heterogeneity of firms). Our research uses data on exports destination of a sample of 5229 Spanish exporting manufacturers with more than 20 workers in 1988. The results confirm the hypothesis that local exporters in the same industry affect positively the destination choice of small size exporters. There is no evidence of any influence from from multinationals or agglomeration of local firms belonging to other industries. We also quantify the importance of "information spillovers" on the export decision. Our estimates suggest that for a province increasing the number of firms exporting one product to one particular destination by 10 percent would increase the likelihood of choosing this destination by other small exporters in the same industry by 16 percent. Localisation economies also emerge as a major mechanism of transmission of information about export markets after controlling for firm-specific characteristics (size, export/sales ratio) and gravity factors (distance, level of economic development).

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Table 3.1: Distribution of Spanish exports sales, by geographic destination, in 1988.

Geographic Area	Percentage	Major destinations	Percentage
Developed countries	82.8	France	23.1
EU-12	67.8	Germany	14.4
Rest West Europe	4.1	UK	11.9
North America	8.3	Italy	9.2
Other	2.5	USA	6.6
		Portugal	5.5
Developing countries	17.1	Netherlands	3.8
Eastern Europe	2.1	Belgium	2.0
Africa	4.9	Morocco	1.7
LatinAmerica	3.0	Canada	1.1
Asia	6.2	Sweden	1.0

Own calculations using CAMERDATA. The developed countries include Japan, Australia, New Zealand and South Africa.

Table 3.2: The *first* destination by sales value of Spanish firms. N=5229.Year=1988.

Domestic-owned companies			Foreign-owned companies			Single-destination SMEs		
	# exporters	Ranking		# exporters			# exporters	
France	1289	(1)	France	119	(1)	France	163	(1)
Portugal	568	(2)	Germany	95	(3)	Portugal	75	(2)
Germany	492	(3)	UK	68	(4)	Germany	47	(3)
UK	403	(4)	Netherlands	44	(7)	UK	36	(4)
Italy	365	(5)	Italy	40	(5)	Italy	34	(5)
USA	354	(6)	Portugal	33	(2)	USA	29	(6)
Netherlands	127	(7)	Belgium	24	(8)	Morocco	17	(10)
Belgium	99	(8)	USA	23	(6)	Netherlands	12	(7)
Arabia Saudi	78	(9)	Denmark	19	(18)	Belgium	9	(8)
Morocco	64	(10)	Japon	16	(16)	Mexico	6	(11)
Mexico	56	(11)	Sweden	11	(15)	Algeria	5	(12)
Argelia	42	(12)	Canada	8	(24)	Tunez	4	(20)
First 12 destinations	3937		First 12 destinations	465		First 12 destinations	437	
All firms	4733		All firms	496		All firms	494	

Foreign-owned firms are companies with positive foreign equity participation. The sample in the third column includes only domestic-owned SMEs (less than 100 workers) selling one major product in a single destination (a major product line equals at least 95 percent of total exports).

Table 3.3: Basic statistics of the explanatory variables

Variable	Mean	Std. Dev.	Min	Max
firm export/sales ratio	0.075	0.178	0.0001	1
log firm size (sales)	5.502	1.512	0.693	10.542
log (1+distance province-destination)	7.022	1.227	0	9.166
log (per capita GDP in destination)	9.055	0.601	7.577	9.715
Destination export concentration [log(1+number of firms)]				
Localisation	0.743	1.059	0	4.788
MNE	0.127	0.333	0	2.197
Urbanisation	4.333	1.811	0	7.286
Destination export concentration [quotient index]				
Localisation	0.059	0.745	0	47.162
MNE	0.021	0.119	0	3.245
Urbanisation	0.013	0.016	0	0.029

Table 3.4: Estimation of multinomial logit model of decision about where to export.

	(1)	(2)	(3)	(4)	(5)	(6)
Localisation	**1.750**			**1.772**	**1.761**	**1.757**
	(0.148)			(0.149)	(0.151)	(0.148)
MNE		-0.151		0.234	0.261	0.241
		(0.207)		(0.232)	(0.234)	(0.233)
Urbanisation			0.183	0.292	0.302	0.328
			(0.239)	(0.241)	(0.242)	(0.230)
Distance to destination						**-0.163**
						(0.056)
GDP per capita of destination						-0.294
						(0.426)
Specific-alternative constant	65 (11)	294 (11)	115 (11)	46 (11)	45 (22)	37 (22)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Number firms	437	437	437	437	437	437
Number of choices	12	12	12	12	12	12
Log-Likelihood	-740.77	-837.42	-837.43	-739.12	-724.25	-728.63
Pseudo-Rsq	0.262	0.167	0.167	0.265	0.281	0.275

Concentration indicators are constructed using number of exporters and formula log(1+n). Column (1) to (4) include country specific constants. Column (5) and (6) are estimated with firm-specific characteristics (size, export/sales ratio) interacted with country specific constants. Standard errors in parenthesis. Bold figures indicate "significant at 5% critical level".

Table 3.5: Estimation of multinomial logit model of decision about where to export.

	(1)	(2)	(3)	(4)	(5)	(6)
Localisation	**0.231**			**0.230**	0.233	0.186
	(0.113)			(0.112)	(0.140)	(0.153)
MNE		0.764		0.742	0.740	0.756
		(1.405)		(0.526)	(0.528)	(0.540)
Urbanisation			-0.131	-0.461	-0.914	-0.423
			(3.765)	(3.780)	(3.825)	(0.438)
Distance to destination						**-0.320**
						(0.050)
GDP per capita of destination						0.079
						(0.182)
Specific-alternative constant	296 (11)	297 (11)	295 (11)	289 (11)	257 (22)	130 (22)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Number firms	437	437	437	437	437	437
Number of choices	12	12	12	12	12	12
Log-Likelihood	-927.99	-929.82	-930.12	-927.84	-910.25	-887.56
Pseudo-Rsq	0.262	0.260	0.259	0.262	0.275	0.294

Concentration indicators are constructed using export values and the quotient index. Column (1) and (4) include country specific constants. Column (5) and (6) are estimated with firm-specific characteristics (size, export/sales ratio) interacted with country specific constants. Standard errors are in parenthesis. Bold figures indicate "significant at 5% critical level".

Table 3.6: Specification tests for the choice of destination.

	Excluding France (1)	European Destinations (2)	Border destinations (3)	Binomial logit model (4)	(5)
Localisation	**1.586**	**2.048**	**1.371**	**0.452**	**0.327**
	(0.168)	(0.199)	(0.230)	(0.055)	(0.032)
MNE	0.154	0.264	0.343	-0.108	0.091
	(0.287)	(0.275)	(0.429)	(0.184)	(0.115)
Urbanisation	0.313	**0.849**	-0.617	**-0.176**	**-0.108**
	(0.253)	(0.313)	(1.462)	(0.039)	(0.027)
Distance to destination	**-0.157**	**-0.179**	**-0.336**	**-0.269**	**-0.396**
	(0.075)	(0.068)	(0.093)	(0.047)	(0.060)
GDP per capita of destination	-0.271	-0.548	**1.496**	-1.882	-2.244
	(0.446)	(0.737)	(0.634)	(1.125)	(1.524)
Number firms	275	370	246	437	1202
Number of choices	11	7	3	12	12
Log-Likelihood	-482.53	-485.96	-171.41	-1331.1	-3695
Pseudo-Rsq	0.201	0.326	0.388	0.254	0.054

The baseline specification is Table 4, column 6. Column (1) to (3) are estimated with firm-specific characteristics (size, export/sales ratio) interacted with country specific constants. Column (4) and (5) includes firm-specific characteristics interacted with country specific constants and a set of 10 two-digit Combined Nomenclature industry dummies. European destinations are France, Germany, UK, Italy, Portugal, Belgium, and Netherlands. Border countries are France, Portugal, and Morocco.

Chapter 4

Price discrimination and market power in the ceramic tile export industry.

4.1 Introduction

The oligopolistic behaviour of exporters in international markets has been examined using three main approaches developed from the New Industrial Organisation literature. First, Knetter (1989) tested for third degree price-discrimination and pricing-to-market behaviour using a single equation of export price-adjustment to exchange rate changes. Second, Goldberg and Knetter (1999) successfully applied a residual demand elasticity technique to measure the extent of competition of German beer and US kraft paper in the international markets. Third, several authors have estimated a system of demand and supply of exports to identify what factors explain a positive market power in the industry. [1] This paper combines the three empirical approaches in order to characterise the market structure and conduct of the ceramic tile export industry.

Over the past decade, ceramic tile production for exports have been concentrated in two

[1] Among others, Aw (1993), Bernstain (1994), Yerber (1995), Bughin (1996) and Steen and Salvanes (1999).

regions, Emilia-Romagna in Italy and Castellon de la Plana in Spain. In 1996 these two regions constituted above 60 percent of the world export value of glazed ceramic tiles. Moreover, in many countries imports represent more than 50 percent of the national consumption. Finally, while Italian and Spanish manufacturers exported more than 50 percent of their production, other major producers such as China, Brazil, and Indonesia exported less than 10 percent.

Although it is widely accepted that competition is very aggresive in the home markets, it is not clear how much competition there is between Italian and Spanish exporter groups in the international markets. Market segmentation and lack of information may have prevented domestic competition to be the same in the export destinations. In addition, leadership position might allow some producers to act as monopolists in some destinations. But the increasing presence of both exporter groups in all the destinations may have eroded the market power of these exporters.

As far as we aware, this is the first time international markups have been estimated with data for two groups of exporters that clearly dominate all the the major import markets. Our investigation aims to combine previous empirical techniques to obtain a "complete picture" of the case with two source-countries/multiple destinations.

We propose a three-step approach to evaluate the extent of competition in the ceramic tile export industry. In the first step, we test for price discrimination and pricing-to-market as signals of imperfect competition. In the second step, we identify in which markets exporters have some market power and how the extent of market power changes with the presence of other competitors. In the third step, we examine the effect of demand, costs and conduct on market power in a dynamic framework, in order to distinguish long-run from short-run market power.

One of the main problems in the identification and measurement of firm markup is the access to information about production inputs. Our approach avoids this problem by estimating directly the marginal cost of both Italian and Spanish exporter groups. Once we know the cost structure of each exporter group, the measurement of market power can be obtained using cross-section techniques (estimation of the residual demand elasticity) or time-series techniques (estimation of a dynamic system of demand and supply).

Our findings show that the tile export industry had enjoyed substantial market power over the period 1988-1998. However, there are indicators suggesting that the export market was becoming more competitive over time. Summarising, we found that:

1.- There is strong evidence of market segmentation and pricing-to-market in the tile export industry. Producers try to adjust markups to stabilise import prices in the European destinations, while they apply a constant-markup export price policy in non-European markets. We attribute this finding to the greater price transparency of the European destinations.

2.- The results using cross-section techniques show a positive price-above-marginal cost in half of the largest destination markets. In our attempt to relate the extent of each exporter group's markup to the existence of "outside" competition in each destination market, we found that only Spanish markups are sensitive to Italians' market share. Both Spanish and Italian markups seems to be insensitive to the market quota of domestic rivals.

3.- We use time-series techniques to analyse whether market power has been sustainable over the period 1988-1998. For France, the third largest import market of ceramic tiles, we find that only Italian exporters have market power in the short run. Neither Italian or Spanish exporters have market power in the long run. The finding that positive markups are not sustainable in the long run during the nineties suggests that the export ceramic tile industry has become more and more competitive, at least within Europe.

The structure of the paper is as follows. Section 4.2 describes the tile export industry. Section 4.3 introduces the theoretical framework and the different empirical applications. Section 4.4 examines the data, specification issues and the results. Section 4.5 concludes.

4.2 The glazed ceramic tile export industry

Ceramic tiles are an end product that is produced by burning a mixture of certain non-metal minerals (mainly clay, silica sand or kaolin, feldspars and quartz sand) in very high temperatures. Basically, ceramic tiles have standardised sizes and shapes. However, ceramic tiles come in different physical qualities, especially in terms of surface hardness (for public building or for households). Ceramic tiles as a building material has two principal sources of demand. First, the construction sector, and especially the development of non-residential property such as office buildings, shopping centres, hotels, and apartment blocks. A secondary source of demand for ceramic tiles is the retail market composed of households. The types of ceramic products that are produced on a large-scale basis are wall tiles, floor tiles, and roof tiles.

Italy, the world leader, produced 572 million square metres in 1997, compared with only 200 million square metres in 1973. Over the same period exports rose too, from 30% to 70% of total production. Overall Italy's tile industry accounts for 20% of global output and 50% of the world export market. In his book "The Competitive Advantage of the Nations", Porter (1992) attributes the success of the Italians' tile producers in the international markets to fierce domestic competition plus the gains generated by the interaction between tile makers and machinery engineers. [2]

Tile makers elsewhere are catching up with the Italians. [3] In 1987 Italy was clearly the largest producer and exporter of ceramic tiles in the world. Spanish production started competing against Italian producers in the late 1970s, although the technological and marketing superiority of Italian producers was notorious. Graph 4.1 shows the evolution of Spanish and Italian production over the period 1977-1998. In 1977 the Spanish production was equivalent to one-third that of Italy. In 1987 Spain's production was only one half that of Italy, however by 1997 the production was about 85% the Italian's.[4] In the same year exports represented 52% of total production. The success of Spanish producers may be attributed to the use of high quality clay and pigments to create a new market niche in large floor tiles, and the control of marketing subsidiaries by manufacturing companies.

The abundant supply of basic materials, low labour costs and the sheer size of population

[2] Porter analysed the domestic characteristics of the Italian tile industry over the period 1977-1987 in order to explain the success of tile producers abroad. Our study starts in 1988, year in which Spain and other large producers start gaining market quota to Italy in most export markets.

[3] "On the Tiles", an article in "The Economist" (99/2) emphasises the challenge that Italian exporters are facing due to an increasing competitive world marketplace.

[4] ASCER Annual Report (1998) estimated that the Spanish production could achieve the Italian production level in the year 2004.

are among the most important factors that led to the expansion of the ceramic tile industry in China, Brazil, Turkey and Indonesia. However, these countries are strongly oriented to the domestic market. In 1996 China's production was already as large as Italy's but its exports were only 5% of its production. Brazil, Indonesia and Turkey exported 14%, 12% and 11% of its production, respectively. Moreover their destination markets are mainly neighbour countries.

High quality ceramic tiles with the logos "Made in Italy" and "Made in Spain" add value to what is basically nothing more than cooked mud. The best example is the porcelain ceramic tile. A porcelain ceramic tile is a ceramic tile that is homogenous, meaning that every part of it is made from the same mixture of materials. The surface of a porcelain ceramic tile is glazed. Since it has to be homogenous and strong, a porcelain ceramic tile has to be made from high-quality materials. Porcelain ceramic tiles look like marble and granite, but are lighter and cheaper than the real thing. Among the advantages of marble/granito ceramic tiles over the regular products are that the former are more solid and less water-absorbent than the latter. This means that marble/granito ceramic tiles are more resistant to impact and scratches than a regular product. In addition, the colour of a marble/granito ceramic tile is also more durable than that of a regular product. This is the market segment in which Italian and Spanish exporters are the absolute world leaders.

The industrial and geographic composition of the tile industry is displayed in Table 4.1. Medium-and-small sized firms dominate the production. Over the nineties 75 percent of firms had less than 100 workers. There are more producers in Italy than in Spain, mainly due to the existence of a large number of family business. Industrial production is strongly concentrated in two provinces, Modena in Italy and Castellon de la Plana in Spain. The regional concentration ratio in both countries is about 70% if it is measured by number of firms, and it rises to about 90% in terms of production.

The strong export orientation of the Italian and Spanish tile industry is evident looking at Table 4.2. In 1997 Italy and Spain exported 70 and 52 percent of their production, respectively. Together they represent 68 percent of the world export market. Table 4.2 also displays the distribution of the ceramic tile exports among the 20 largest destinations (~77% of world import market). Three features are relevant for our purposes. First, for most countries imports represent more than 60% of the total domestic consumption and in some countries the import/consumption ratio is above 85%. Second, in all but one market (Hong Kong), Italy and Spain are the first and second major exporters. In all the destinations, Italian and Spanish products are above 50% of total imports and, in some cases the ratio is above 95% (Greece, Israel, Portugal). Third, in almost every market Italian and Spanish exporters face competition from a neighbour country of the importer. Germany has a notable market share in Netherlands, Austria and Switzerland. Turkey has a significant presence in Greece and Saudi Arabia. Some of these features have important implications on the empirical sections below, in particular in the analysis of the residual demand.

Glazed ceramic tiles are physically homogenous products. It is very unlikely to guess the origin (Italian or Spanish) of the product without looking the reverse of the tile. Trade restrictions appear not to be important in any country destinations: tariffs have been low and stable over the nineties and the ceramic tile industry is not subject to non-tariff barriers.

4.3 The theoretical framework

The demand of ceramic tiles in a market k can be described as

$$X_k = D(P_k, Z_k) + \varepsilon_k \tag{4.1}$$

where X is exported quantity, P is price and Z is a vector of exogenous variables (e.g. income) affecting demand. The supply of the production by a firm j is given by the equilibrium output condition, that marginal revenue equals marginal cost,

$$P_{jk} = \left(\frac{\epsilon_k}{\epsilon_k - 1}\right) e_k M_j \tag{4.2}$$

where P_{jk} is the product price (in source country currency), ϵ_k is the price elasticity of demand curve facing all firms in market k, M_j is the marginal cost of production, and e_k is the exchange rate (expressed as source country currency in terms of the destination currency). The technology of each ceramic tile exporter j supplying any destination market is assumed to be represented by the marginal cost function,

$$M_j = mc(W_j) \tag{4.3}$$

where W_j represents a set of input factors (labour, capital, energy, and raw materials).

4.3.1 Step 1: The pricing-to-market equation (Sullivan, 1985; Knetter, 1993)

Suppose, as it is our case, that we have no information about each single exporter but industry-level data is available for each export destination over a period of time. Equation (4.2) for cross-section time series data may be written as

$$P_{kt} = \left(\frac{\epsilon_k}{\epsilon_k - 1}\right) e_{kt} + M_t\Psi = \beta_k e_{kt} + \theta_k + \lambda_t + u_{kt} \tag{4.4}$$

where k refers to each of the destination markets, t refers to time, and u_{kt} is a random disturbance term. The export price to a specific market becomes a function of: (1) the bilateral exchange rate in foreign currency units per domestic currency the exchange rate (e_{kt}); (2) a destination-specific effect (θ_k) capturing time-invariant institutional features; and, (3) a time-varying effect (λ_t) reflecting primarily the marginal costs of exporter group. Finally, a random disturbance term u_{kt}. is added to account for unobservable factors (by the researcher) or for measurement error in the dependent variable.

The conditions under which the use of industry-level data can be used to made inferences about (4.2) are: (a) The industry has no influence over the exchange rate. (b) The variation of the perceived elasticity of demand and the variation in marginal costs across firms selling in the same destination are small. (c) No arbitrage opportunity exists across destinations. The three conditions are satisfied in the tile export industry. First, exchange rate variation is exogenous to the export industry. Second, the marginal cost condition is strongly supported by the fact that cost of production differences across exporters are likely to be small since ceramic tiles are produced in a single region of the country with a standard technology. Unfortunately little can said about demand elasticity differences since firm data are not available. Third, segmentation of the international markets and product characteristics make arbitrage very unlikely. Therefore, monopoly power would give tile manufacturers an incentive to charge different prices in countries and years on the basis of exchange rate differences.

Under the assumption of *common* marginal costs for ceramic tiles across destination markets, three different market structure hypotheses can be tested using equation (4.4). Under the null of perfect competition, both θ_k and β_k equal zero since λ_t captures all marginal cost effects over time. Under the alternative hypothesis of imperfect competition with constant elasticity of demand, θ_k can be non zero since markups can change across markets but β_k still equals zero. Lastly, under the null of imperfect competition with non constant elasticity of demand both β_k and θ_k can be non zero.[5]

In addition to the statistical significance of the parameters β_k and θ_k, the parameter β_k can be interpreted economically in terms of the exchange rate pass-through effect. On the one hand, a zero value for β_k implies that the markup to a particular destination is unresponsive to fluctuations in the value of the exporter's currency against the buyer's. On the other hand, the response of export prices to exchange rate variations in an imperfect competition setting depends on the curvature of the demand schedule faced by firm. As a general rule, when the demand becomes more elastic as local currency prices rise, the optimal markup charged by the exporter will fall as the importer's currency depreciates. Negative values of β_k imply that exporters capable of price discrimination try to offset relative changes in the local currency induced by exchange rate fluctuations. Thus markups adjust to stabilise local currency prices.

[5] Knetter (1989) shows that there are no estimation problems even though there is correlation between factors that affect exchange rate and demand shocks in the traded goods markets.

Positive values of β_k suggest that exporters amplify the effect of exchange rate fluctuations on the local currency price.

The advantage of the pricing-to market equation as an indicator of imperfect competition is its simplicity and clear interpretation of the results. First, if $\theta_k \neq 0$ we can reject the null hypothesis of perfect competition in the export industry; and, if $\beta_k \neq 0$ firms may adjust markup as demand elasticities varies with respect to its local currency price. Second, we can look for similarities in the price behaviour between exporter groups in different source-countries by comparing β coefficients across destinations. A third advantage of using the pricing-to market equation is that we can obtain an estimate of the marginal cost λ_t of both exporter groups over the entire period. Once we know the cost structure of the competitors, the following steps are to measure the intensity of competition in the export industry and to identify which factors determine positive markups.

4.3.2 Step 2: The residual demand elasticity equation (Baker and Bresnahan, 1988; Goldberg and Knetter, 1999)

As we said above, how exchange rate shocks are passed through to prices in itself reveals little about the nature of competition in product markets. Indeed, the interpretation of the pricing-to market coefficients depends critically on the market structure of the product market. Our next step explains how to measure directly the elasticity of the residual demand curve of exporter groups to assess the importance of market power in the export industry.

The "residual demand curve" measures the relationship between the exporter group's price and quantity, taking into account the supply response of all other rivals. The residual demand curve is derived as the difference between the market demand and the supply curves of all other exporter groups outside the export source country. This approach was first developed by Baker and Bresnahan (1988) to avoid the complexity in the estimation of multiple cross-price and own-price demand elasticities in product differentiated markets. Instead, the residual demand elasticity approach summarises in a unique statistic the degree of market power of one exporter group in a particular destination market.

Consider two groups of exporters (I) and (S) selling in a particular foreign destination market (we will use the letter J for S or I indistinctively). We rewrite equation (4.1) as the inverse demand including the export price of the other competitor

$$P_I = D_I(X_I, P_S, Z) \tag{4.5}$$

$$P_S = D_S(X_S, P_I, Z) \tag{4.6}$$

where $X_J = \sum x_j$ stands for the total quantity exported by the J exporter group, P stands for price expressed in destination currency, and Z is a vector of exogenous variables affecting demand for exports. For each firm j within an exporter group J, the optimal sales are achieved when the perceived marginal revenue is equal to the marginal cost,

$$P_I + x_i D_{II}\left[\frac{dX_I}{dx_i}(1 + \frac{dD_I}{dP_S}\frac{dD_S}{dP_I})\right] = e_I M_i \quad , \quad i \in I \tag{4.7}$$

$$P_S + x_s D_{SS}\left[\frac{dX_S}{dx_s}(1 + \frac{dD_S}{dP_I}\frac{dD_I}{dP_S})\right] = e_S M_s \quad , \quad s \in S \tag{4.8}$$

where $D_{JJ} = \frac{dD_J}{dX_J}$. We rewrite the both expressions as follows

$$P_I = e_I M_i - x_i \lambda_i \psi_I D_{II} \quad , \quad i \in I \tag{4.9}$$

$$P_S = e_S M_s - x_s \lambda_s \psi_S D_{SS} \quad , \quad s \in S \tag{4.10}$$

where λ_j is the j firm's conjecture term relating the output of the exporter group J to a change in its own output $\left(\frac{dX_I}{dx_s}\right)$, and ψ_J captures the competitive interaction between both groups of exporters $\left(1 + \frac{dD_I}{dP_J}\frac{dD_J}{dP_I}\right)$. In order to obtain an industry-level expression we use firm's market share ms_j within each export group. Taking the market share-weighted sum over all firms and defining industry-level marginal cost as $M_J = \sum_j ms_j M_j$, exporter group exported quantity as $X_J = \sum_j ms_j x_j$, and industry conduct as $\lambda_J = \sum_j (ms_j)^2(\lambda_j)$, we can transform equations (4.9) and (4.10) into industry-level expressions

$$P_I = e_I M_I - [D_{II} \lambda_I \psi_I] X_I \quad (4.11)$$

$$P_S = e_S M_S - [D_{SS} \lambda_S \psi_S] X_S \quad (4.12)$$

The estimation of the market power of each exporter group requires the estimation of the system of Eqs (4.5),(4.6),(4.11) and (4.12). Here we explain how to estimate a single equation for each exporter group to measure the extent of market power, the so-called residual demand equation. For exposition purposes let us derive the residual demand curve for the exporter group (I). After substituting (4.5),(4.6) in (4.12) the first order condition for exporter group (S) becomes

$$P_S = e_S M_S - D_{SS}(X_S, D_I(X_I, P_S, Z\ ), Z)\,[\lambda_S \psi_S]\, X_S \quad (4.13)$$

In expression (4.13) the optimal price of exporter group (S) becomes a function of the quantity exported by the rival exporter group (I), cost factors, demand shifters in destination market, and conduct parameters,

$$P_S^* = P_S^*(X_I, e_S M_S, Z, \lambda_S \psi_S) \quad (4.14)$$

Now we write the residual demand for the exporter group (I) as follows

$$P_I = D_I(X_I, P_S^*, Z\ ) = R_I(X_I, e_S M_S, Z, \lambda_S \psi_S) = R_I(X_I, e_S M_S, Z)\varepsilon_S \quad (4.15)$$

and solving in the same way for exporter group (S) we obtain

$$P_S = D_S(X_S, P_I^*, Z\ ) = R_S(X_S, e_I M_I, Z, \lambda_I \psi_I) = R_S(X_S, e_I M_I, Z)\varepsilon_I \tag{4.16}$$

The residual demand curve has three observable arguments (the quantity produced by the exporter group, demand shifters and the rival exporter group cost shifters) and one unobservable argument (the rivals' conduct parameters). The slope of the residual demand is the slope of the demand curve facing each export group, taking into account the competitive interaction of the other rival exporter group(s). The system of two equations of residual demand is identified as cost shifters for each exporter group are excluded arguments in their own residual demand function; i.e. e_I and M_I from (4.15) and e_S and M_S are excluded from (4.16). In each expression the only endogenous variable is the exported quantity X_J. We can use both e_J and M_J as instruments since both variables affect the exported supply of the exporter group in a particular destination independently of the other exporter groups competing in the same destination.

We obtain the residual demand elasticity by differentiating (4.15) and (4.16) with respect to X_J. For export group I, the (inverse) demand elasticity is

$$\eta_I^R = \frac{\partial \ln R_I}{\partial \ln X_I} = \frac{\partial \ln D_I}{\partial \ln X_I} + \frac{\partial \ln D_I}{\partial \ln P_S^*}\frac{\partial \ln P_S^*}{\partial \ln X_I} \tag{4.17}$$

Note first that η_I^R estimates the degree of market power, but not its source. The estimation method only reflects the joint impact on market power through the slope of the residual demand curve but we cannot separately estimate each of the demand, cost and behavioural parameters affecting market power. In addition, the residual demand elasticity is equal to the Lerner index $\left(\frac{P_I - e_J M_J}{P_J}\right)$ if and only if $\frac{\partial \ln D_I}{\partial \ln P_S^*}\frac{\partial \ln P_S^*}{\partial \ln X_I} = 0$, that is, the residual and the actual demand faced by the exporter group coincides. This may limit the use of the residual demand elasticity to specific industries. Baker and Breshanan (1988) numerate the following cases: Stackelberg leader, dominant firm model with competitive fringe, perfect competition, and extensive product differentiation. These four markets have one characteristic in common: the role of strategic interaction is not important.

Although in other oligopoly models the markup measured by the Lerner index and the estimated residual demand elasticity are not equal, one would expect that the estimated slope of the residual demand is still correlated with the true measure of market power. In other words, an steep residual demand curve is likely to be a valid indicator of high market power. An alternative interpretation of the estimated residual demand elasticity is that it summarises the intensity of "outside competition" faced by each exporter group in a particular destination country. An elastic schedule would reflect the presence of close substitutes and intense competition from outside the exporter group. In the empirical section, we look for evidence of the sensitivity of the estimated markups of one exporter group with respect to the market share of other competitors in each destination market. [6]

4.3.3 Step three: The demand-supply equation system

As we noted before the residual demand elasticity η_I^R estimates the degree of market power, but it cannot separately estimate each of the demand, cost and behavioural parameters affecting market power. This task only can be achieved if we estimate a complete system of demand and supply. A brief description of the methodology to estimate both a static and dynamic structural model of demand-supply is contained in this section. [7]

The static model (Bresnahan, 1982; Aw, 1992)

Consider again the system of equations (4.5),(4.6),(4.11) and (4.12) for a particular market rewritten in a linear form

[6] The "inside" competition among Spanish and Italian producers within each source country is fierce, but it is difficult to evaluate whether the "inside" competition by each exporter group is severe in the international markets. The residual demand elasticity measures the extent of "outside competition" faced by each source-country exporter group in each destination market.

[7] See Bresnahan (1989) for a complete discussion of the NIO empirical methods.

$$X_I = \alpha_{Io} + \alpha_{I1} P_I + \alpha_{I2} P_S + \alpha_{I3} Z + \alpha_{I4} P_I P_S + \alpha_{I5} P_I Z + \epsilon_I \quad (4.18)$$

$$X_S = \alpha_{So} + \alpha_{S1} P_S + \alpha_{S2} P_I + \alpha_{S3} Z + \alpha_{S4} P_I P_S + \alpha_{S5} P_I Z + \epsilon_S \quad (4.19)$$

$$P_I = \beta_{I0} + \beta_I M_I - \theta_I D_{II}^{-1} X_I + \eta_I \quad (4.20)$$

$$P_S = \beta_{S0} + \beta_S M_S - \theta_S D_{SS}^{-1} X_S + \eta_S \quad (4.21)$$

where $D_{JJ}^{-1} = \left(\frac{\partial X_J}{\partial D_J}\right)^{-1}$ and thus $P_J + \theta_J D_{JJ}^{-1} X_J$ is the marginal revenue perceived by each exporter group J in each export market. The parameter $\theta_J = \lambda_J \psi_J$ can be interpreted as a summary statistic of the degree of market power measuring directly the percentage of monopoly marginal revenue perceived.

The parameter θ is identified, i.e. we can distinguish between $P = MC$ and $MR = MC$, provided that at least one of the elements of the vector of exogenous variables affecting demand causes both a rotation and a shift in the demand curve. The identification problem arises from the simultaneity relationship price-quantity in the supply-demand product market: $\theta_J D_{JJ}^{-1} = \frac{1}{\alpha_{J1}}$. Starting from an equilibrium situation rotations of the demand curve caused by a change in own quantity will not affect the exporter group equilibrium price. Only a joint rotation and shift of the demand curve caused by a change in price(quantity) will affect both price and quantity, allowing us to identify the extent of the behavioural impact on exporters' group market power. A sufficient condition for identification of θ is that at least one demand shifter interacts with the exporter group's price(quantity). If changes in the rivals price and/or income conditions affect both the position and the slope of the export group demand curve, the identification problem is solved as $D_{JJ}^{-1} = \frac{1}{\alpha_{J1} + \alpha_{J3} P_A + \alpha_{J5} Z}$ so $\theta_J D_{JJ}^{-1} \neq \frac{1}{\alpha_{J1}}$. Now the supply relation is given by

$$P_I = \beta_{I0} + \beta_I M_I - \theta_I \, X_I^* + \eta_I \quad (4.22)$$

$$P_S = \beta_{S0} + \beta_S M_S - \theta_S X_S^* + \eta_S \quad (4.23)$$

where $X_J^* = \frac{X_J}{\alpha_{J1}+\alpha_{J3}P_A+\alpha_{J5}Z}$. By treating the parameters of demand as known, the parameters measuring market power θ_I and θ_J are identified. The model needs to be estimated as a system of simultaneous equations. As far as the vector of demand shifters Z in the demand equations and the vector of cost shifters M in the supply equations contain at least one exogenous variable the system is identified.

It remains a question: what are the gains from estimating a multiequational system compared to the easy-implemented residual demand elasticity equation to measure market power. First, solving the simultaneous equation model we obtain complete information about own price and cross price elasticities of demand. Second, as we will show, the linear demand-supply model can be extented to a dynamic framework to examine whether market power is sustainable in the long run. As markets are intrinsically dynamic, the market structure of an industry changes over time. This is particularly applicable to the case of the tile export industry. Until 1987 Italy was the world leader. From 1988 new large producers appear on the world (China, Brazil, Indonesia, Spain). In particular, Spain has continuously gaining market share in all the international markets. The recent, quick changes in the export ceramic industry has opened the question whether the market power of a dominant exporter group is affected by the dynamic interaction between the dominant exporter group and the new competitors. Our third step thus offers another way of studying the relationship between market power and "outside" competition in the export industry.

The dynamic model (Steen and Salvanes, 1999)

Here we extend the monopoly version of Steen and Salvanes (1999) to a duopoly setting. A structural demand-supply system can be re-formulated in an Error Correction Model framework. The starting point is that any linear demand-supply system can be re-formulated as an autoregressive distributed lagged model (ADL). Next the ADL model can be formulated as an error-correction model (ECM) such that the stationary solution of the ADL coincides with long run solution of the ECM (see Steen and Salvanes (1999) for the proof).

The demand functions in (4.18) and (4.19) have the following dynamic formulation

$$\Delta X_{Jt} = \alpha_{J0} + \sum_{i=0}^{k-1} \alpha_{J1i} \Delta X_{Jt-i} + \sum_{i=1}^{k-1} \alpha_{J2i} \Delta P_{Jt-i} + \sum_{i=0}^{k-1} \sum_{v=3}^{V} \alpha'_{Jvi} \Delta R_{vt-i} +$$
$$\gamma_J^{LR} \left[X_{Jt-k} - \varphi_{J2} P_{Jt-k} - \sum_{v=2}^{n} \varphi'_{Jv} R_{vt-k} \right], \quad J = I, S \tag{4.24}$$

where Δ is the lag operator and R_{vt} is a vector of demand variables including the price of the rival and at least one additional variable interacting with the variable own price P_{Jt-k} in the stationary long-run relationship. If α_{Jv}^{LR} is the vector of long-run demand parameters, it can be shown that $\varphi_{Jv} = \frac{\alpha_{Jv}^{LR}}{\gamma_J^{LR}}, v = 2, ..., V$.

In the same way, the linear supply can be written in a dynamic formulation,

$$\Delta P_{Jt} = \beta_{J0} + \sum_{i=1}^{k-1} \beta_{J1i} \Delta P_{Jt-i} + \sum_{i=0}^{k-1} \theta_{Ji} \Delta X^*_{Jt-i} + \sum_{i=0}^{k-1} \beta_{Ji} \Delta M_{Jt-i}$$
$$+ \Psi_J^{LR} \left[P_{Jt-k} - \lambda_J^* X^*_{Jt-k} - \phi_{Ji} M_{Jt-k} \right], \quad J = I, S \tag{4.25}$$

where M_{Jt} is a vector of contemporaneous and lagged marginal costs (expressed in destination currency) and $X_J^* = \frac{X_J}{D_{JJ}^{-1}(P_J, R_J)}$. As in the demand system, if we define θ_J^{LR} and ϕ_J^{LR} as the long-run supply parameters, then $\theta_J^{LR} = \frac{\lambda^*}{\Psi_J^{LR}}$ and $\phi_J^{LR} = \frac{\phi_J}{\Psi^{LR}}$. The ECM provides then a short-run measure of market power, $\sum_{i=0}^{k-1} \theta_{Ji}$, and a long-run measure of market power, θ_J^{LR}. If intertemporal changes in competition matter, we should expect some difference in the estimates of the short-run and long-run market power parameters.

4.4 Data, estimation and results

4.4.1 The Data

We use quarterly observations from 1988:I to 1998:I (41 observations) on the values and quantities of ceramic tiles exports (CN Code 690899) from Spain and Italy to the largest market destinations. The price of exports are measured using fob unit values. As far as we are aware, no country produces bilateral export price series, which is probably the main justification for the use of unit value to measure bilateral export prices. The drawbacks of using unit values as an approximation for actual transaction prices are well known. The most serious problems are the excessive volatility of the series and the effect on prices of changes in product quality over time (Aw and Roberts, 1988). However, any purely random measurement error introduced by the use of unit values as a dependent variable will only serve to reduce the statistical significance of the estimates.

The analysis includes sixteen export destinations (>60 percent of world import market): Germany, USA, France, United Kingdom, Greece, Hong-Kong, Belgium, Netherlands, Singapore, Australia, Israel, Austria, Portugal, Canada, South Africa and Switzerland. Spanish and Italian exports represented between 48 and 99 percent of total imports in each of these markets in 1996.

The destination-specific exchange rate data refer to the end-of-quarter and is expressed as units of the buyer's currency per unit of the seller's (unit of destination market currency per home currency). Adjusted nominal exchange rate is nominal exchange rate divided by the destination market wholesale price level.

As we explained above, the exporter's marginal cost function for ceramic tiles is obtained directly from the estimation of the pricing-to-market equation. Demand for ceramic tiles in each destination market is captured by two variables: building construction and real private consumption expenditure. [8] All the series in the empirical analysis are seasonally adjusted. The Appendix contains more details about the construction and source of the variables.

4.4.2 Evidence of Pricing-to-Market Behaviour

In order to assess the potential for price discriminating behaviour on the part of Italian and Spanish exporters, we start by comparing the response of export prices to exchange rate variations in each of the major destination markets. For a comparable export product, differences in prices across export markets should be attributable to segmented markets. If the null of

[8] When consumption data was not available we used real GDP.

perfect competition is rejected, price discrimination is possible so exporters may enjoy market power in some destinations. The general empirical model of export price adjustment estimated for the tile export industry in Spain and Italy as source countries can be written as follows:

$$p_{kt}^{J} = \lambda_t^J + \beta_k^J e_{kt}^J + \theta_k^J + u_{kt}^J, \quad \text{J=Italy, Spain} \tag{4.26}$$

where $k = 1, ..., 15$ and $t = 1, ..., 41$, p_{kt}^J is the log of price in national currency of k's exports to country J at time t, e_{kt}^J is the log of bilateral exchange rate, λ_t is a time effect reflecting common marginal costs across destination markets , θ_k is a destination market effect, and the error term, u_{kt}^J, is assumed to be jointly normally distributed with mean zero and constant variance-covariance matrix.

The model is estimated with two different exchange rate measures, the nominal exchange rate in foreign currency units per home currency and the nominal exchange rate adjusted by the wholesale/producer price index in the destination market. The exchange rate adjustment is made, because the optimal export price should be neutral to changes in the nominal exchange rate that correspond to inflation in the destination markets. Estimates of θ_k reveal the average percentage difference in prices across markets during the sample period, conditional on other controls for destination-specific variation in those prices. In practice, only (N-1) separate values of θ_k can be estimated in the presence of a full set of time effects. Consequently, we will normalise our model around West Germany, the world largest import market, and test whether the fixed effects for the other countries are significantly different from zero.

Equation (4.26) is estimated by Zellner's Seemingly Unrelated Regression technique to improve on efficiency by taking explicit account of the expected correlation between disturbance terms associated with separate cross-section equations. Results for the two source-countries, Italy and Spain, are reported in Table 4.3. For each destination the table reports the estimates of the country effects (θ_k), and the coefficient on the exchange rate (β_k).

Using either exchange rate measures, the country effects are significantly different from zero in almost all the cases. [9] This is evidence against the hypothesis of perfect competition. Looking at the estimated β_k, the regression with nominal exchange rates indicates that 7 export markets for Italy and 8 export markets for Spain violate the invariance of export prices to exchange rates implied by constant-elasticity model. The regression with adjusted exchange rates increases the number of exports markets to 12 for both source-countries. There is evidence of imperfect competition with constant elasticity of demand ($\theta_k \neq 0$ and $\beta_k = 0$) for most non-European markets (USA, Canada, Hong-Kong, Singapore, Australia) in one or another source-country . In most European destinations, tile exporters perceive demand schedules to be more concave than a constant elasticity of demand ($\theta_k \neq 0$ and $\beta_k < 0$) revealing that exporters capable of price discriminate try to offset the relative price changes in the local currency price induced by exchange rate fluctuations. A plausible explanation is that tile exporters have some incentives for price stabilization in the local currency in the European markets while there is a lack of significant stabilisation across non-European markets. In other words, European destinations are more competitive than non-European ones in the export tile industry. Theories explaining PTM behaviour such as large fixed adjustment costs differences across destinations or concerns for market share that varies with the size of the market seem unlikely explain this dichotomy in price behaviour. An alternative explanation could be the greater price transparency in the European markets over the period 1988-1998, together with the fact that the number of firms selling in the European markets is larger than in the non-European markets (this interpretation coincides with the predictions of the Cournot oligopoly model; see Dornbush (1987).

A surprising feature of our results is that destination-specific markup adjustment is very similar across source country for each destination country. In order to examine in more detail the pattern of price discrimination across destinations we reestimate equation (4.26) under the assumption that the β_k is the same across destination markets (Knetter, 1993). Table 4.4 displays the estimated value of β_k for each source-country when it is assumed to be the same

[9] F-tests for the exclusion of the country effects are overwhelmingly significant: 3486 for Italy and 4970 for Spain.

across destination markets. The t-statistics (reported in parentheses) indicate that pricing-to-market coefficients are significantly different from zero for both exporter groups. The second row in Table 4.4 offers a test of whether the identical PTM behaviour is supported across only the European destinations. In this regression each non-European market coefficient is unconstrained and a common β is estimated for all the European markets. The reported F-statistic reveals that the null hypothesis of identical PTM behaviour across destination markets is rejected at the 5 percent level. The last column of Table 4 offers pooled regression results. In it, the constrained coefficients across destination markets for each source country are additionally constrained to be the same for both source countries. The reported F-statistic reveals that the null hypothesis of identical PTM behaviour across source countries cannot be rejected at the 5 percent level for the tile export industry. We conclude that export price-adjustment behaviour is different across destination for each source country but on aggregate both source countries have similar export price-adjustment behaviour.

Finally, Figures 4.2 and 4.3 plot the index of the estimated time effects from the regression with price-level adjusted exchange rates for Italy and Spain. For comparison we also plot the wholesale price indices in both countries (dotted line). As argued by Knetter (1989) "...there is no reason to think that they are biased measures of marginal cost, only noise ones".

As a conclusion the export price-adjustment in response to exchange rate variations is on average 30 percent. This means that more than a half of the exporter's currency appreciation or depreciation are passed through to the import prices (after controlling for country-specific effects and time effects). The low sensitivity of domestic currency prices to changes in exchange rates provides indirect evidence of the existence of positive markups in the export tile industry. The next two questions are how much market power each tile producers have and what is the extent of competition in the industry. These questions are accessed in the following section.

4.4.3 Estimating the Residual Demand Elasticities

In this section we estimate the slopes of the residual demand curves facing Italian and Spanish exporters in each destination market. Our data includes two source-countries, Italy and Spain, and 16 destination markets. For destination k a system of two equations can be written

$$\ln P_{Ikt} = \lambda_{Ik} + \eta_I \ln X_{Ikt} + \gamma \ln Z_{kt} + \beta \ln e_{Skt} + \gamma \ln M_{St} + \epsilon_{Ikt} \quad (4.27)$$

$$\ln P_{Skt} = \lambda_{Sk} + \eta_S \ln X_{Skt} + \gamma \ln Z_{kt} + \beta \ln e_{Ikt} + \gamma \ln M_{It} + \epsilon_{Skt} \quad (4.28)$$

The demand shifters Z_{kt} consists of a combination of construction index, real private consumption, the nominal exchange rate of a third competitor and a time trend. The cost shifter M_{Jt} is the estimated marginal cost of each exporter group derived from the pricing-to-market equations in the previous section. Each equation is in double log form so that the coefficients are elasticities. It is easy to check that the system is identified due to exclusion of the cost shifter and exchange rate of the source-country in its own equation.

If the exported quantity X_{Jkt} is endogenously determined with its price through the residual demand function, then OLS will be biased and inconsistent. Three-stage least squares (3SLS) is employed to estimate separately each of the 16 systems of two equations. The exogeneity assumption of the exported quantity is testable by comparing the 3SLS and seemingly unrelated regression (SUR) estimates using the Hausman-Wu test statistic (Hausman, 1978). The choice of an appropriate instrument in the 3SLS is a crucial step. We need a set of instrumental variables that are correlated with the exported quantity but not with the error term of the residual demand function in each equation. The ideal candidates are the cost shifters and exchange rate of the source-country, as they have been excluded from each equation as regressors.

Results of our preferred specifications by 3SLS appear in Table 4.5. The last column reports the p-value of the Hausman-Wu test for the null hypothesis of exogeneity of log quantity after estimating the model with (3SLS) and without instrumental variables (SUR). The null hypothesis is rejected in about half of the specifications at 10 percent significant level, suggesting that IV techniques are necessary to control for endogeneity in the equation system. The R-square and Durbin-Watson statistics vary substantially across destinations and source countries.

The coefficient on log quantity directly estimates the residual demand elasticity. If we interpret the η_i parameters as estimates of exporter's group markup of price over marginal cost, Italy had a significant market power over the sample period in 9 destinations while Spain had significant market power in 6 destinations. For example, the residual demand elasticity for Italy in the three largest markets is 0.362 (Germany), 0.460 (US) and 0.363 (France) which corresponds to a markup over marginal cost between 36 and 46 percent. Although Spain shows no market power in Germany, its residual demand elasticity for US and France are 0.372 and 0.135, respectively. Looking at the rest of the destinations, Italy's markup over marginal cost was on average 40 percent while in Spain was about 10 percent.

The interpretation of the rest of the coefficients in each equation is unclear since they may reflect both direct effects on demand and indirect effects through the adjustments of a rival exporter's group. Columns 3 and 4 in Table 4.5 display the estimated coefficients of the rival's adjusted exchange rate and marginal costs. A positive sign of the coefficients reflects the significant role of "outside" competition in constraining the market power of a particular exporter group. In general, the coefficients of the other exporter group's exchange rate and marginal costs are positive (and for some destinations significant), indicating that the market power of one or another exporter group in most destination markets is constrained by the presence of the other exporter group.

The conclusions drawn from estimating the equation system (4.27)-(4.28) are summarised in Table 4.6. Destination countries are ranked from the highest to the lowest residual demand elasticities for each source country. If the market demand elasticities are not very different across destinations, the residual demand elasticities measure the degree of "outside" competition in each destination: the lower (in absolute value) the elasticity, the stronger the competition that each exporter group faces from each . In the previous section the PTM analysis showed that demand elasticities were constant for non-European destinations and convex across European destinations. The rank correlations between the market power of one exporter group and the market share of the other exporter group are clearly negative with values of -0.34 for Italy and -0.51 for Spain, suggesting that the presence of competitors reduces the market power of the other export group. A weaker correlation was also found between the market power of one exporter group and the domestic market share. In our regression analysis, the coefficient of

Italian market share in the Spanish market power regression is negative and significant, while the coefficient of Spanish market share in the Italian market power regression is negative but not significant. The coefficient of domestic market share is negative but not significant in both samples. Hence, Italian exports are strong substitutes of Spanish tiles while the evidence is weaker in the opposite direction. Finally, domestic tiles seem to be poor substitutes for both Italian and Spanish tiles.

4.4.4 Estimating of the structural model

So far we have ignored the dynamic interactions between exporter groups and their impact on the market power. If market structure changes with competition, then market power in the short run and market power in the long run may be different. To investigate whether there have been changes in competition in the tile export industry, we estimate a structural system of demand and supply. We start by specifying a linear static model,

$$X_J = \alpha_{J0} + \alpha_{J1}P_J + \alpha_{J2}P_R + \alpha_{J3}Y + \alpha_{J4}P_J P_R + \alpha_{J5}P_J Y + \epsilon_J^{demand} \quad (4.29)$$

$$P_J = \beta_{J0} + \beta_{J1}M_J + \lambda_J X_J^* + \epsilon_J^{supply} \quad (4.30)$$

where the subscripts J and R represent the source-country and the rival exporter group, respectively. Apart from the quantity exported and its destination-currency per unit price, the rest of variables are: Y is the construction index, M is the estimated marginal cost and X^* is a function of X_J, P_R and Y such that $X_J^* = \frac{X_J}{D_{JJ}^{-1}(P_J, R_J)} = \frac{X_J}{\alpha_{J1} + \alpha_{J4}P_{Rt-k} + \alpha_{J5}Y_{t-k}}$.

Using equations (4.29) and (4.30) the specification of the dynamic empirical model as an error correction model is given by

$$\Delta X_{Jt} = \alpha_{I0} + \sum_{i=0}^{k-1} \alpha_{J1i}\Delta X_{Jt-i} + \sum_{i=1}^{k-1} \alpha_{J2i}\Delta P_{Jt-i} + \sum_{i=1}^{k-1} \alpha_{J3i}\Delta P_{Rt-i}$$
$$+ \sum_{i=0}^{k-1} \alpha_{J4i}\Delta Y_{t-i} + \sum_{i=1}^{k-1} \alpha_{J5i}\Delta(P_{Jt-i}P_{Rt-i}) + \sum_{i=0}^{k-1} \alpha_{J6i}\Delta(P_{Jt-i}Y_{t-i})$$
$$+\gamma_J^{LR}[X_{Jt-k} - \varphi_{J1}P_{Jt-k} - \varphi_{J2}P_{Rt-k} - \varphi_{J3}Y_{t-k}$$
$$-\varphi_{J4}P_{Jt-k}P_{Rt-k} - \varphi_{J5}P_{Jt-k}Y_{t-k}] + \epsilon_{Jt}^{demand} \quad (4.31)$$

$$\Delta P_{Jt} = \beta_{J0} + \sum_{i=1}^{k-1} \beta_{J1i}\Delta P_{Jt-i} + \sum_{i=0}^{k-1} \lambda_{Ji}\Delta X^*_{Jt-i} + \sum_{i=0}^{k-1} \beta_{J2i}\Delta M_{Jt-i}$$
$$+\Psi_J^{LR}[P_{Jt-k} - \phi_J M_{Jt-k} - \lambda_J^* X^*_{Jt-k}] + \epsilon_{Jt}^{supply} \quad (4.32)$$

where the subscripts J and R represent the source-country and the other exporter group. An important fact is that X^* is still a function of X_J, P_R and Y such that $X_J^* = \frac{X_J}{\varphi_{J1}+\varphi_{J4}P_{Rt-k}+\varphi_{J5}Y_{t-k}}$. To calculate X_J^* we use the estimated parameters in the error correction term of the demand functions.

The steps for solving the simultaneous equation system are: (a) Selection of the destination market. (b) Cointegration test for long-run relationship between the variables of interest in each equation of the system. (c) Test of identification conditions in the demand functions. (d) Estimation of the model. (e) Significance test for long-run market power. We examine steps (a)-(e) in turn.

(a) Selection of the destination country: Integration test.

Due to the complexity in estimating a structural model of demand and supply, we choose one destination. Our choice is France. This is motivated by two reasons. First, France is the closest destination market for both exporter groups. In fact Spain and Italy share borders with France. It is the third largest import market of tiles in the world, with a ratio of imports to consumption above 60 percent. Italy has ~38 percent of the total market and Spain has

~10 percent. Second, when we analyse the integration order of the price, quantity, and other demand variables using the Augmented Dickey-Fuller unit root test (Dickey and Fuller, 1979), the series for France were non-stationary in levels but stationary in first differences at reasonable significance levels. The integration tests are presented in Table 4.7. As the data is quarterly, it was natural to perform the ADF test up to four lags. All the variables in first differences capturing the short run dynamics in the demand equations are stationary. On the supply side the variables in first differences for Italy are stationary, but not for Spain.

(b) Long run equilibrium: Co-integration test.

We need to ensure the existence of a long-run solution in the demand functions and in the supply functions. Johansen and Juselius (1990) propose two different tests, the "trace" test and the "maximal eigenvalue" test.[10] The vector of variables in the demand functions are y_I={X_I,P_I, P_S, Y , $P_I P_S$, P_IY}, y_S={X_S, P_S, P_I, Y, $P_S P_I$, P_SY} for Italy and Spain, respectively. The vector of variables in the supply functions are $y_I = \{P_I, X_I^*, M_I\}$ and $y_S = \{P_S, X_S^*, M_S\}$ where $X_J^* = \frac{X_J}{\alpha_{J1}+\alpha_{J4}P_{Rt-k}+\alpha_{J5}Y_{t-k}}$ are the estimates of the demand function of $J = I, S$. To account for the possible simultaneity problem between quantity and prices, the VAR system includes in the demand functions the marginal cost estimates for both exporter

[10] We can write the VAR system in error correction form

$$\Delta y_t = \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \Pi_p y_{t-p} + Bx_t + \epsilon_t$$

where $\Gamma_i = -I + \Pi_1 + ...\Pi_i$, $i = 1, ..., p-1$, and Π_p is the long-run "level solution". If y_t is a vector of I(1) variables, the left hand side and the first (p-1) elements of the VAR system are I(0), and the second elements, as linear combination of I(1) variables, is I(0). If $\Pi_p y_{t-p}\tilde{} I(0)$ either y_t contains a number of cointegration vectors, or Π_p must be a matrix of zeros. Johansen's method estimates the Π_p matrix in an unrestricted form and tests whether we can reject the restrictions implied by the reduced rank of Π_p. The rank of Π_p, r, determines how many linear combinations of y_t are stationary. If $r = N$, the variables in levels are stationary; if $r = 0$, $\Pi_p = 0$ and none of the linear combinations are stationary; hence the variables are non-cointegrated; finally, if $0 < r < N$, there are r cointegration vectors or r stationary linear combinations of y_t.. In the last case one can factorize $\Pi_p : -\Pi_p = \alpha\beta'$ where β contains the cointegrating vectors and α the speed adjustment parameters.

The "trace" test is a likelihood test for *at most r* cointegrating vectors: $\eta_r = -T\sum_{i=r+1}^{N} \ln\left\{1-\widehat{\lambda}_i\right\}$ where T is the number of observations and $\widehat{\lambda}_i$ is the eigenvalues that solve the iegenvalue problem. The "maximal eigenvalue" test is a test of the *relevence of column r+1* in β: $\xi_r = -T\ln\left\{1-\widehat{\lambda}_{r+1}\right\} = \eta_r - \eta_{r+1}$. The critical values for both statistic tests are tabulated in Osterwald and Lenum (1992).

groups and the exchange rate France-Germany as predetermined variables. For the supply functions, the selection of predetermined variables comes from the construction indices and real private consumption in the destination country and the source countries.

Table 4.8 displays the cointegration tests for each source country. There is clear evidence of cointegration in all the demand and supply functions. Both the trace test and the maximal eigenvalue test indicate one cointegration vector for the demand functions and two cointegration vectors in the supply functions. Therefore, the expressions in brackets in equations (4.31) and (4.32) can be interpreted as stationary long-run solutions.

(c) The identification condition: Separability test.

We can use the exclusion tests of Johansen and Juselius (1990) to test the identification condition in the demand functions. According to our empirical specification, the parameter λ^* in the supply function is only identificable if the demand function is not separable in P_R and/or Y, that is, the price set by the each exporter group (P_J) interacts with the other exporter group P_R and/or with the income variable Y. Exclusion tests are imposed as null-restrictions on the long-term parameters of $P_J P_R$ and $P_J Y$ in the $\widehat{\varphi}$ long-run coefficients found in the demand functions (Table 4.12). Hence, if the interaction term can be excluded from the long-run relation the demand function is separable in P_R and Y. Table 4.8 indicates that there is only one cointegration vector in the demand equation of Italy and Spain. Thus the null-hypothesis of separability is $H_{J0} : \widehat{\varphi}_{J4} = \widehat{\varphi}_{J5} = 0,\ J = I, S.$ [11] Table 4.9 shows that the null hypotheses of separability in each demand function are rejected at 5 percent significance level. The demand functions are not separable in P_R and Y, so we can use $P_J P_R$ and $P_J Y$ to identify λ^* in the supply relations of both source-countries.

[11] The null restrictions on the parameters in $\widehat{\varphi}$ are tested using a likelihood ratio test. First we estimate the unrestricted model and solve the eigenvalue problem. Then the model with the restriction(s) imposed are estimated and the restricted eigenvalues $\widehat{\lambda}_1^* > ... > \widehat{\lambda}_r^*$ are calculated. The test statistic are calculated as: $LR^*\left[r(N-s)\right] = T\sum_{i=1}^{r} \ln\left\{1 - \widehat{\lambda}_i^* / 1 - \widehat{\lambda}_i\right\}$. The test statistic has an asymptotic chi-square distribution with $r(N-s)$ degrees of freedom, where s is the number of independent cointegration parameters in the restricted model.

(d) Estimation of the static model

The parameter estimates of the static model (4.29) and (4.30) are presented in Table 4.10 and Table 4.11. First, the demand function is not separable in P_S in the Italian regression and is not separable in Y in the Spanish regression. The model satisfies the condition of identification of the parameters reflecting the degree of competitiveness, and confirms the significance of the separability test implemented in the previous section using the ECM model. The average price elasticity of demand is calculated using the formula $\left[\frac{\overline{P_J}}{X_J}\right]\left(\alpha_{J2} + \alpha_{J5}\overline{P_R} + \alpha_{J6}\overline{Y}\right)$ where the upper bar stands for average values over the whole sample. In the same way, the average cross-price elasticity is calculated as $\left[\frac{\overline{P_R}}{X_J}\right]\left(\alpha_{J3} + \alpha_{J5}\overline{P_J}\right)$ and the average income elasticity is $\left[\frac{\overline{Y}}{X_J}\right]\left(\alpha_{J4} + \alpha_{J6}\overline{P_J}\right)$. The elasticities are quite similar between source-countries. The own-price elasticity varies between -0.61 and -0.79, revealing that the demand for tiles in France is moderate inelastic. The values for the cross-price elasticities, -0.05 for Italy and -1.10 for Spain, are quite surprising since they suggest that Spanish tiles are poor substitutes for like tile produced in Italy and Italian tiles are very poor substitutes for like tiles produced in Spain. The complementarity of the tile price by source country is an unexpected result. The income elasticities are 0.61 for Italy and 0.58 for Spain, suggesting that tiles in both source-countries are perceived as normal goods.

Table 4.11 displays the estimates of the static specification of the supply equation. The index of competitiveness is measured by the parameter of $\lambda(X^*)$. The parameter value should be negative, and between -1 and 0. This is the case for Spain (λ_0 =-0.012) but not for Italy (λ_0 =0.003). Since the variables are not stationary it is difficult to make any inference about the accuracy of λ_0. As in the demand equation, the supply equation has problems of specification. The R^2 is quite low and the Q-statistics detect autocorrelation.

Overall, the results of the static model are very poor. First, although there are not previous studies on the ceramic tile export industry, the economic interpretation of the estimated parameters does not coincide with what was expected a priori (positive cross price elasticity and high income elasticities). Second, there is a statistical problem of autocorrelation due possible to the non-stationarity of the variables. In the demand functions the Q-statistics are

Q(4)=4.00 for Italy and Q(4)=17.85 for Spain. In the supply functions the Q-statistics are Q(4)=11.73 for Italy and Q(4)=7.61 for Spain. The significance of the Q-statistics indicate that the model is mis-specified. For these reasons we estimate a dynamic model of demand and supply.

(e) Estimation of the dynamic model

Demand equations

Examining the equations (4.31) and (4.32), it is noteworthing that the ECM is non-linear. The model can still be estimated by OLS after factoring in the ECM term, and recovering the long run parameteres using the so-called Bardsen (1989) transformation.[12] The model is estimated by two-stage least squares (2SLS). In the demand equations, export prices, export quantities and the export price of the other exporter group are treated as endogenous variables. The construction index in France and the estimated marginal costs of Italy and Spain are treated as exogenous. The variables used as instruments in the demand equation are all the exogenous variables in the system as well as the construction indices in Italy and Spain, real consumption in Italy and Spain, and the exchange rates of Germany/France. To test the validity of the instruments, we used the Sargan test.[13]

The results for the demand functions are displayed in Table 4.12. The lag length of the ECM was determined using the Ljung-Box Q-statistics to avoid higher-order autocorrelation (Ljung and Box, 1979). For Italy the number of lags was k=1 and for Spain the number of lags was k=2. In both equations the Q-statistics for no-autocorrelation are not significant (Q(4)=0.9 for Italy and Q(4)=3.08 for Spain.). Although most parameters are insignificant, the model fits well with $R^2 = 0.72$ for Italy and $R^2 = 0.86$ for Spain. Since the correlations

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[12] The variance of $\widehat{\theta}_j = -\frac{\beta^*_{jn}}{\alpha^*_k}$ is computed from the matrix of variance-covariance of the OLS estimates using the delta method.

$$\widehat{V}(\widehat{\theta_j}) = (\widehat{\alpha}^*_k)^{-2}\left[\widehat{V}(\widehat{\beta}^*_{jn}) + \widehat{\theta_j}^2\widehat{V}(\widehat{\alpha}^*_k) + 2\widehat{\theta}_j\widehat{cov}\left(\widehat{\beta}^*_{jn}, \widehat{\alpha}^*_k\right)\right]$$

See Kmenta (1986, pag. 486)

[13] The Sargan validity of instruments test is $\frac{\widehat{\pi}'(Z'Z)\widehat{\pi} - \widehat{\beta}'_{IV}\left(X'Z(Z'Z)^{-1}Z'X\right)\widehat{\beta}_{IV}}{\widehat{u}'_{IV}\widehat{u}_{IV}/n} \sim \chi^2_{df}$ with Z=set of instruments and $\widehat{\pi} = (Z'Z)^{-1}Z'Y$ and degrees of freedom equal to the number of instruments minus the number of endogeneous variables plus one.

between the right side variable are very high and the model has a high explanatory power, we have a standard problem of multicollinearity.[14] After calculating the long-run coefficients we obtain the long run elasticity predictions. Comparing with the results of the static model, the three elasticities do not change sign but are greater (in absolute value), suggesting that the dynamic model has the same difficulties of interpretation of the elasticities as the static model.

The long-run own-price elasticity is -0.83 for Italy and -1.11 for Spain, so tiles are found to be weakly own-price elastic. This result is consistent with those in Table 4.5, where the (inverse) residual demand elasticity for France was -0.35 for Italy and -0.14 for Spain. Ceteris paribus, the greater the perceived sensitivity of demand to changes in own price, the lower the capacity to set prices in the long-run.

The cross-price elasticity lies between [-4.38, -5.58], and suggests, surprisingly, that Italian and Spanish tiles are strong complementary products in the international markets. We do not find a economic rationale for such a result in general. Finally, the income elasticities are 2.70 for Italy and 0.90 for Spain. In contrast to the results in the static demand equation, the difference between coefficients in the dynamic specification suggests that French consumers perceive Italian tiles as a luxury product.

Summarising, tiles exports are found to be weakly own-price elastic and strong demand complements. The income elasticity is high in Italy (luxury product) and low in Spain (normal product).

The next parameter is the adjustment parameter γ_J^{LR}. If $\gamma_J^{LR} = 0$ no error correction takes place, if $\gamma_J^{LR} = -1$ the deviation from the long run equilibrium is adjusted instantly. The estimate of the adjustment parameter γ_J^{LR} has the expected negative sign. The value -0.855 for Italy and -0.175 for Spain reveals that only Italian exporters adjust to deviations from the stationary long-run equilibrium quite instantly.

Supply equations

The results for the supply function using the dynamic specification are displayed in Table

[14] In the correlation matrix of the five variables included in the demand function of Italy and Spain the coefficients are never lower than 0.48.

4.13. Again we use the Ljung-Box Q-statistics to determine the lag length of the ECM to avoid high order auto-correlation. The optimal lag for Italy was k=1 and for Spain was k=3. In both equations the Q-statistic for no-autocorrelation are not significant (Q(4)=1.73 for Italy and Q(4)=1.52 for Spain.). The supply side of the model fits well with $R^2 = 0.57$ for Italy and $R^2 = 0.64$ for Spain. Again, due to multicollinearity problems, several parameters are insignificant. In both countries, the adjustment parameters Ψ_J^{LR} lies in the interval [-1,0] and is statistically significant; $\Psi_I^{LR} = -0.448$ for Italy and $\Psi_S^{LR} = -0.584$ for Spain, indicating that both countries adjust quite fast to deviation from the stationary long-run equilibrium.

Looking directly at the parameter λ_J in the supply functions we can test for differences in market power in the short run. The short run market power parameter should be negative, and between -1 and 0. If λ is -1 the exporter group uses all its potential market power with respect to its residual demand curve. The parameter that measures the extent of competition in the short run is $\lambda_0 = -0.147$ for Italy and $\lambda_0 = 0.007$ for Spain. The estimates suggest that only Italy exercises a moderate level of market power in the short run. The null hypothesis of market power in the short run ($H_0 : \lambda_0 = 0$) is rejected for Italy at 5 percent significance level, but it cannot be rejected for Spain at any reasonable significance level.

The next question is whether the result also holds in the long-run. The measure of long run market power is $\theta^* = \frac{\lambda^*}{\Psi^{LR}}$. The long run measure of market power is $\theta^* = -0.24$ for Italy and $\theta^* = 0.04$ for Spain (last row in Table 4.13). The null hypothesis of no market power in the long run ($H_0 : \theta^* = 0$) cannot be rejected for both Italy and Spain at 5 percent significance level.

Our finding of a positive market power by Italian exporters only in the short run is similar to the one found by Steen and Salvanes (1999) for the Norwegian salmon exporting industry in the EU. They argue that some market power in the short run is justified by the scarcity of fresh wild-caught salmon in some periods of the year, which allows for seasonal price discrimination in the short run, but it is not enough to prevent competition in the long-run. They also suggested an alternative explanation, which is more plausible in the case of the export tile industry. The short-run-long-run result can be due to the historical change that has happened in the industry during the eighties. It is very likely that Italy had some market power at the beginning of the eighties, given its worldwide leadership position. As Spain entered the international market, Italian's market power disminished, and finally dissapeared. According to this explanation the long-run estimate of market power in the ECM model captures the present situation in the industry, and the short-run estimate of market power is capturing the historical role of Italians and Spaniards at the beginning of the period analysed.

4.5 Conclusions

Before 1987 Italian exporters were the absolute world leaders. After 1988 the international market structure of the export industry has changed. China and Brazil becames large producers. Moreover Spanish producers have been gaining gradually market quota in the international export market.

In order to characterise the market structure of the tile export industry, we use three different techniques borrowed from New Industrial Organisation. First, we measure the sensitivity of local currency prices of exported tiles to different countries with respect to exchange rate changes. The so-called pricing-to-market equation permits one to identify the existence of price discrimination and the similarity in the price behaviour of Italian and Spanish across destination markets. Second, we measure the response of one exporter group's price to changes in the quantity supplied, taking into account the supply response of the other rival exporter group. The so-called residual demand elasticity equation allows us to identify the extent of competition in the international tile market by quantifying the sensitivity of the positive markups of an exporter group across destinations with respect to the market share of its rivals. Third, we investigate whether increasing competition in the industry has affected the market power of competitors during the eighties. An Error Correction Model of demand-supply is estimated for France, the third largest import market, in order to account for dynamic factors such as changes in demand preferences and adjustment costs for the producers. The estimates distinguish between short-run market power and long-run market power.

Using the pricing-to-market equation we found that the export price-adjustment in response to exchange rate variations is on average 30 percent. We also observe that both Spanish and Italian exporters set different prices in domestic currency to different destination markets. The evidence of market segmentation is weaker for European destinations compared to non-European destinations, which could be explained by the price transparency effects of economic integration within Europe.

In order to measure the degree of competition in the export tile industry. The estimation of the residual demand elasticity for each exporters' group revealed that, across destinations, both Italian and Spanish exporters have enjoyed positive market power during the eighties. On average Italian markups are 30 percent and Spanish markups are 10 percent. The results also reveal that Italian markups are less sensitive to Spanish competition, while the historical leadership of Italian exporters has a depressive effect on Spanish markups in many destinations.

Finally, a time-series analysis of the changes in competition for France revealed that neither Italian or Spanish exporters enjoy positive markups in the long run. The findings of positive markups by Italian exporters in some periods is attributed to its historical leadership in the tile market over the eighties, but in the long run this positive markup tends to dissapear.

While the above findings are most relevant to researchers studying ceramic tile industry, the methodology developed contributes more generally to the literature testing market power in export markets. A major problem in estimating market power in an industry is to collect information on the determinants of marginal costs such as input quantities or prices. We propose a simple solution to this problem by estimating the marginal cost for each exporter group directly from the pricing-to-market equation. We also show that techniques developed in one-source-country/multiple-destination can be implemented to multiple-source-countries/multiple-destinations. Finally we compare the results obtained by two different approaches, the residual demand elasticity estimated using cross-section data and a structural model of demand and supply estimated using an ECM framework. Our future research is to explicitly model the strategic behaviour between exporter groups for a better understanding of the export pricing policies in different periods of time, in a similar way as Kadayali (1997) did for the US photographic film industry or Gross and Schmitt (2000) did for the Swiss automobile industry.

4.6 Appendix 1. Description of data.

Export quantity and price.

Price and quantity of ceramic tiles exported to the largest market destinations from 1988 to 1998 is from national customs, who collect data on the total number of squared metres and the total national currency value of exports of ceramic tiles to each destination country. Data was kindly provided by ASSOPIASTRELLE and ASCER, the two national entrepreneur associations. To ensure homogeneity in the product we selected the product registered as "CN Code 690899" from the EUROSTAT-COMEXT Customs Cooperation Council Nomenclature: "Glazed flags and paving, hearth or wall tiles of stone ware, earthenware or fine pottery,..., with a surface of $>7cm^2$" (Eurostat, 1988). The price of exports is measured using unit values. Data does not include the cost of shipping and the other transportation charges. Tariff levies are not included in the value. The study covers the period 1988:I-1998:I (41 observations).

Unit values are quarterly average prices constructed dividing the value by the quantity of trade flows. Monthly data was available for all European destinations, but Italian series for non-European destinations are quarterly. For the monthly series unit values for each quarter were calculated as the mean average of the corresponding three months. We reduce the volatility of the unit values series by eliminating potential outliers. We exclude in our calculations the monthly prices five times larger or smaller the standard deviation of the annual average in the corresponding year.

Export markets.

The eligible destination markets are those that satisfy the following conditions. First, the destination countries are the largest import markets over the entire period since large destinations improve the accuracy of the unit values as a measure of prices. Second, country destination currencies fluctuate in value against the exporter's currency since exchange rates are the critical variable which rotate the industry supply schedule in the source country. Three large destination markets, Poland, Saudi Arabia and Russia, were excluded from our analysis due to data limitations. The analysis includes sixteen export destinations (>60 percent of world import market): Germany, USA, France, United Kingdom, Greece, Belgium, Hong-Kong, Netherlands, Singapore, Australia, Israel, Austria, Portugal, Canada, South Africa and Switzerland.

Exchange rates and demand variables.

The data on exchange rate and wholesale price was collected from IFS publication of the International Monetary Fund. The destination-specific exchange rate data refer to the end-of-quarter and are expressed as units of the buyer's currency per unit of the seller's (unit of destination market currency per home currency). Adjusted nominal exchange rate is nominal exchange rate divided by the destination market wholesale price level.

We use quarterly data on "new building construction permits" as an indicator of building construction demand. Data was obtained from DATASTREAM and the original sources are OECD and National Statistics. When the series were not available we look for alternatives. We use for Italy and South Africa "Construction in GDP", for Hong Kong and Austria "Work put in construction", and for Israel "Construction production index". Real private consumption expenditures were used for the household demand of ceramic tiles. When the data was not available it was replaced by gross domestic production. The data was obtained from IMF, International Financial Statistics. All the series in the paper are seasonally adjusted.

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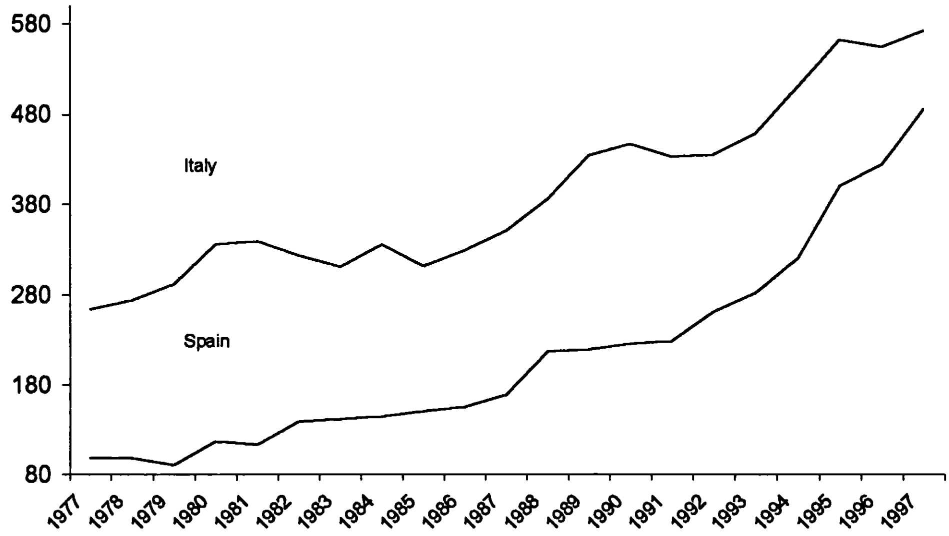
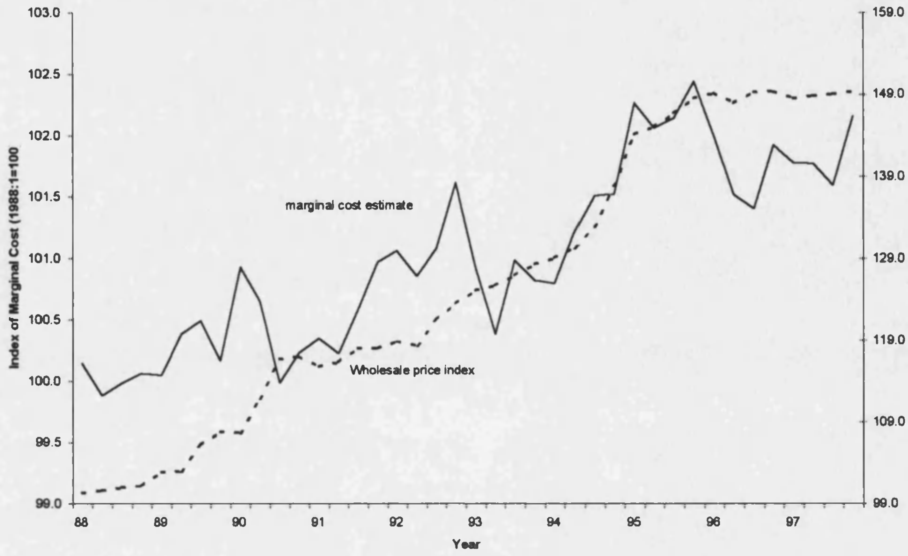
Appendix of Graphs and Tables

Graph 4.1: Evolution of production of ceramic tiles in Italy and Spain (million m-square). Period 1977-1998



Graph 4.2: Estimated marginal cost for Italy



Graph 4.3. Estimated marginal cost for Spain

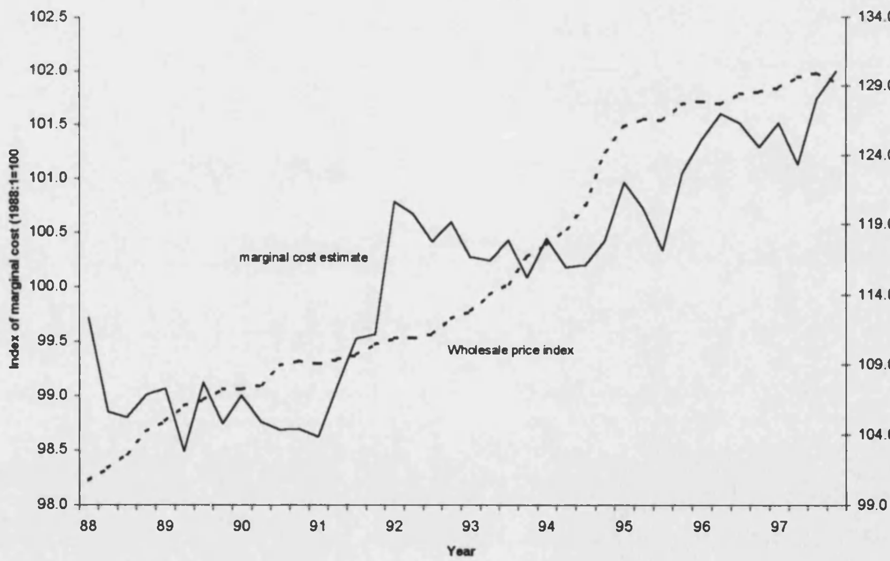


Table 4.1. Industrial structure of ceramic tile industry in Italy and Spain. Distribution of firms by size.

	1987		1991		1996	
Number of employees	**Italy**	**Spain**	**Italy**	**Spain**	**Italy**	**Spain**
<25	92	58	115	49	93	41
>25 - <100	185	144	157	123	145	132
>100 - <200	50	16	50	20	40	30
>200	28	15	29	14	42	20
Total	355	212	351	206	320	223
Regional concentration	69%	75%	68%	76%	69%	81%

Source: Assopiastrelle and ASCER. The regional concentration ratio is constructed as the percentage of firms located in the provinces of Modena and Reggia-Emilia for Italy and Castellon de la Plana for Spain.

Tabla 4.2. Ceramic tile industry. Import shares and main exporters in the largest destination markets (1996)

Country	Imports (thous. m2)	Consumption (thous. m2)	Imp/Cons (%)	1st exporter	(%)	2on exporter	(%)	3rd exporter	(%)	4th exporter	(%)
Germany	145.159	186.825	77,7	**Italy**	67,7	**Spain**	8,5	France	7,2	Turkey	7
USA	87.743	145.883	60,1	**Italy**	31,8	Mexico	23,5	**Spain**	17,6	Brazil	10,3
France	75.674	119.711	63,2	**Italy**	61,2	**Spain**	15,3	Germany	5,5	Netherland	5,4
Poland	32.262	50.474	63,9	**Italy**	55,2	**Spain**	27,7	Chech Rep.	9,4	Germany	3,5
UK	29.382	37.439	78,5	**Spain**	38,3	**Italy**	20,5	Turkey	12,4	Brazil	7,2
Greece	27.577	30.453	90,6	**Italy**	62,1	**Spain**	32,8	Turkey	2,3	Others	2,7
Hong Kong	27.008	29.168	92,6	China	33,0	**Spain**	29,3	**Italy**	20,0	Japan	10
Belgium	22.518	23.000	97,9	**Italy**	52,8	**Spain**	14,1	Netherland	10,2	France	8,3
Netherlands	20.453	26.358	77,6	**Italy**	38,8	**Spain**	18,1	Germany	15,6	Portugal	4,3
Singapure	19.422	19.474	99,7	**Italy**	34,4	**Spain**	30,5	Malaysia	17,0	Indonesia	7,3
Saudi Arabia	19.276	24.671	78,1	**Spain**	61,1	Turkey	11,1	**Italy**	10,0	Libanon	6,2
Australia	17.703	21.118	83,8	**Italy**	54,4	**Spain**	10,9	Brazil	6,6	Indonesia	5,4
Israel	17.009	23.013	73,9	**Spain**	54,8	**Italy**	34,2	Turkey	4,3	Others	6,7
Austria	16.963	17.215	98,5	**Italy**	79,3	Germany	8,7	**Spain**	3,8	Chech Rep.	2,8
Portugal	15.083	54.557	27,6	**Spain**	97,3	**Italy**	1,9	Others	0,8		
Russia	14.044	66.931	21,0	**Spain**	26,6	**Italy**	24,0	Turkey	13,6	Germany	4,5
Canada	13.450	15.318	87,8	**Italy**	43,1	Turkey	13,6	Brazil	12,3	**Spain**	10,7
South Africa	12.418	21.600	57,5	**Italy**	43,1	**Spain**	17,4	Taiwan	12,6	Brazil	9,8
Switzerland	10.485	12.050	87,0	**Italy**	69,2	Germany	10,2	**Spain**	6,2	France	5,1

Source: Own elaboration using data from ASCER and Assopiastrelle

Table 4.3. Estimation of price discrimination across export markets. SUR estimation. N=41.

Source country: Italy.	**Nominal Exchange Rate**		**Foreign Price Adjusted Nominal Exchange Rate**	
Source destination	a_i	b_i	a_i	b_i
Germany		-0,590 (0,127) *		-0,530 (0,117) *
United States	-0,338 (0,037) *	0,155 (0,150)	-0,320 (0,031) *	0,119 (0,127)
France	-0,092 (0,032) *	-0,896 (0,132) *	-0,143 (0,028) *	-0,710 (0,104) *
United Kingdom	-0,036 (0,032) *	-0,252 (0,230)	-0,050 (0,029) *	-0,263 (0,123) *
Greece	-0,409 (0,030) *	-0,536 (0,161) *	-0,348 (0,048) *	0,082 (0,110) *
Hong-Kong	-0,448 (0,037) *	-0,074 (0,148)	-0,447 (0,030) *	-0,032 (0,132)
Belgium	-0,117 (0,032) *	-0,226 (0,125)	-0,107 (0,030) *	-0,230 (0,124) *
Netherland	-0,080 (0,032) *	-0,568 (0,126) *	-0,091 (0,030) *	-0,578 (0,131) *
Singapore	-0,331 (0,037) *	-0,068 (0,180)	-0,336 (0,046) *	0,028 (0,163)
Australia	-0,161 (0,033) *	-0,001 (0,168)	-0,145 (0,029) *	-0,100 (0,131)
Israel	-0,513 (0,030) *	-0,402 (0,121) *	-0,623 (0,044) *	-0,374 (0,095) *
Austria	-0,046 (0,032)	-0,569 (0,127) *	-0,093 (0,050)	-0,555 (0,127) *
Portugal	-0,369 (0,030) *	-0,351 (0,246)	-0,394 (0,032) *	-0,176 (0,081) *
Canada	-0,293 (0,040) *	1,029 (0,261) *	-0,206 (0,028) *	0,693 (0,161) *
South Africa	-0,340 (0,033) *	-0,028 (0,137)	-0,286 (0,036) *	-0,346 (0,134) *
Switzerland	-0,017 (0,032)	-0,217 (0,114) *	-0,031 (0,030)	-0,238 (0,122) *

Source country: Spain.	**Nominal Exchange Rate**		**Foreign Price Adjusted Nominal Exchange Rate**	
Source destination	a_i	b_i	a_i	b_i
Germany		-0,688 (0,130) *		-0,681 (0,111) *
United States	-0,291 (0,034) *	0,206 (0,137)	-0,275 (0,027) *	0,076 (0,112)
France	-0,043 (0,030) *	-0,839 (0,134) *	-0,099 (0,024) *	-0,801 (0,095) *
United Kingdom	-0,011 (0,029)	-0,702 (0,183) *	-0,069 (0,025) *	-0,597 (0,107) *
Greece	-0,453 (0,028) *	-0,118 (0,117)	-0,445 (0,043) *	0,031 (0,101)
Hong-Kong	-0,415 (0,034) *	0,044 (0,136)	-0,411 (0,026) *	-0,034 (0,116)
Belgium	0,027 (0,030)	-0,238 (0,128) *	0,043 (0,026)	-0,431 (0,118) *
Netherland	0,105 (0,030) *	-0,560 (0,128) *	0,116 (0,026) *	-0,720 (0,124) *
Singapore	-0,246 (0,033) *	0,198 (0,158)	-0,294 (0,039) *	0,304 (0,136) *
Australia	-0,140 (0,030) *	0,339 (0,148) *	-0,115 (0,025) *	0,028 (0,116)
Israel	-0,135 (0,027) *	0,605 (0,091) *	-0,269 (0,038) *	0,725 (0,083) *
Austria	0,194 (0,030) *	-0,565 (0,129) *	0,203 (0,026) *	-0,724 (0,121) *
Portugal	-0,113 (0,028) *	-0,105 (0,293)	-0,165 (0,028) *	-0,295 (0,073) *
Canada	-0,139 (0,036) *	-0,391 (0,222)	-0,171 (0,025) *	-0,368 (0,141) *
South Africa	-0,242 (0,029) *	0,919 (0,109) *	-0,221 (0,032) *	0,813 (0,127) *
Switzerland	0,026 (0,029)	0,063 (0,112)	0,038 (0,027)	0,091 (0,115)

* Indicates significance at the 5% level. Heteroskedasticity robust standard errors in parenthesis. Exchange rate series are expressed as destination market currency per source country currency and normalised to 1.0 in 1994:1. Wholesale price are used to adjust exchange rates.

Table 4.4: Testing for identical Pricing-to-Market behaviour across destination

	ITALY b_i	Std error	SPAIN b_i	Std error	Pooled b_i	Std error
Constrained-b_i	-0,256 (0.063) *		-0,304 (0.067)*		-0,292 (0.045)*	
(all destinations)	F(15,584)= 21.52 *		F(15,584)= 11.57 *		F(1,599)= 0.46	
Constrained-b_i	-0,281 (0.072) *		-0,401 (0.064)*		-0,337 (0.038)*	
(Europe only)	F(8,584) = 8.41 *		F(8,584)= 11.94 *		F(1,592)= 2.14	

F-statistic tests the null hypothesis that PTM coefficient is the same across export destinations. For the pooled regression F-statistics test the null that PTM coefficient is the same for both source countries. * indicates significance at the 5% level. Heteroskedasticity robust standard errors in parenthesis.

Table 4.5: Measuring the residual elasticity of demand in ceramic tile export industry.

SOURCE COUNTRY: ITALY						Hausman-Wu
Destination	**lq_italy**	**le_spain**	**lcost_spain**	R^2	**D-W**	**P-value**
Germany	**-0.362 (0.105)**	0.518 (0.319)	**-6.496 (2.177)**	0.37	1.75	0.12
United States	**-0.460 (0.196)**	**0.533 (0.280)**	5.686 (4.194)	0.49	2.31	**0.00**
France	**-0.363 (0.132)**	**0.582 (0.251)**	**9.408 (3.027)**	0.63	1.71	0.40
United Kingdom	-0.885 (1.833)	1.632 (1.011)	26.706 (19.763)	0.05	1.63	**0.01**
Greece	**-0.417 (0.077)**	0.655 (0.402)	4.342 (3.736)	0.91	1.93	**0.08**
Hong-Kong	**-0.718 (0.379)**	-0.309 (0.271)	7.960 (7.921)	0.73	1.90	**0.00**
Belgium	-0.428 (0.423)	**1.792 (0.999)**	0.895 (2.600)	0.12	2.05	0.20
Netherland	**-0.317 (0.130)**	**0.981 (0.285)**	**11.235 (3.980)**	0.45	2.22	**0.01**
Singapore	-0.472 (0.355)	0.830 (0.318)	1.154 (6.955)	0.21	2.03	0.12
Australia	-0.042 (0.111)	1.190 (0.235)	**4.995 (1.822)**	0.71	2.30	**0.06**
Israel	-0.231 (0.179)	0.455 (0.620)	11.391 (7.923)	0.68	1.44	0.18
Austria	**-0.409 (0.237)**	-0.014 (0.221)	-1.602 (4.948)	0.12	1.67	0.38
Portugal	-0.099 (0.073)	**0.753 (0.395)**	-0.839 (2.167)	0.45	1.87	0.54
Canada	**-0.782 (0.338)**	**-1.352 0.354**	3.017 (2.321)	0.45	1.87	**0.05**
South Africa	-0.662 (1.835)	0.120 (1.923)	-14.298 (18.207)	0.02	1.71	0.17
Switzerland	**-1.139 (0.615)**	**2.510 (0.861)**	**11.404 (5.365)**	0.49	1.72	0.16

SOURCE COUNTRY: SPAIN						Hausman-Wu
Destination	**lq_spain**	**le_italy**	**lcost_italy**	R^2	**D-W**	**P-value**
Germany	0.412 (0.723)	0.854 (0.972)	8.848 (11.480)	0.04	1.25	0.12
United States	**-0.372 (0.134)**	**0.483 (0.250)**	**8.180 (2.927)**	0.69	1.73	**0.00**
France	**-0.135 (0.066)**	**0.718 (0.161)**	**11.432 (2.799)**	0.73	2.26	0.40
United Kingdom	0.019 (0.081)	**0.720 (0.282)**	**12.44 (2.771)**	0.67	1.24	**0.01**
Greece	-0.060 (0.278)	0.518 (0.884)	-1.615 (4.179)	0.58	1.64	**0.08**
Hong-Kong	**-0.259 (0.124)**	**-0.704 (0.175)**	3.914 (3.143)	0.74	2.18	**0.00**
Belgium	0.111 (0.377)	0.883 (0.677)	**11.172 (5.929)**	0.29	1.40	0.20
Netherland	-0.466 (0.430)	0.478 (0.682)	4.410 (4.087)	0.25	1.61	**0.01**
Singapore	**-0.713 (0.447)**	**0.597 (0.338)**	3.044 (9.333)	0.61	2.15	0.12
Australia	0.068 (0.056)	1.530 (0.139)	**7.262 (2.539)**	0.84	1.41	**0.06**
Israel	**-0.136 (0.078)**	0.399 (0.533)	6.890 (10.93)	0.74	2.10	0.18
Austria	0.106 (0.286)	0.369 (0.328)	2.124 (2.053)	0.00	2.28	0.38
Portugal	**-0.192 (0.073)**	-0.079 (0.156)	-1.353 (2.511)	0.75	2.20	0.55
Canada	-0.063 (0.063)	-0.341 (0.419)	**2.259 (7.084)**	0.05	1.57	**0.05**
South Africa	-0.145 (0.092)	**0.678 (0.251)**	3.032 (5.763)	0.60	1.57	0.17
Switzerland	-0.009 (0.132)	**1.174 (0.243)**	**14.265 (5.144)**	0.65	1.52	0.16

Each destination is estimated jointly for Italy and Spain using 3SLS estimator. Standard errors are reported in parenteses. Dependent variable: log-price of exports expressed in local currency. (Reported) Independent variables are log-quantity of exports, log-exchange rate between destination country and the direct rival country, and marginal cost of direct rival country. Additional exogenous variables are a construction index, log-real private consumption, time trend, and log-neighbour rival exchange rate.

Table 4.6: Relationship between residual demand elasticity and rivals' market share

Source country ITALY	Residual demand	Spain market share	Domestic share	Source country SPAIN	Residual demand	Italy market share	Domestic share
Switzerland	**-1.139**	6.2	13.0	Singapore	**-0.713**	34.4	0.3
United Kingdom	-0.885	38.3	21.5	Netherland	-0.466	38.8	22.4
Canada	**-0.782**	10.7	12.2	United States	**-0.372**	31.8	39.9
Hong-Kong	**-0.718**	29.3	7.4	Hong-Kong	**-0.259**	20.0	7.4
South Africa	-0.662	17.4	42.5	Portugal	**-0.192**	1.9	72.4
Singapore	-0.472	30.5	0.3	South Africa	-0.145	43.1	42.5
United States	**-0.460**	17.6	39.9	Israel	**-0.136**	34.2	26.1
Belgium	-0.428	14.1	2.1	France	**-0.135**	61.2	36.8
Greece	**-0.417**	32.8	9.4	Canada	-0.063	43.1	12.2
Austria	**-0.409**	3.8	1.5	Greece	-0.060	62.1	9.4
France	**-0.363**	15.3	36.8	Switzerland	-0.009	69.2	13.0
Germany	**-0.362**	8.5	22.3	United Kingdom	0.019	20.5	21.5
Netherland	**-0.317**	18.1	22.4	Australia	0.068	54.4	16.2
Israel	-0.231	54.8	26.1	Austria	0.106	79.3	1.5
Portugal	-0.099	97.3	72.4	Belgium	0.111	52.8	2.1
Australia	-0.042	10.9	16.2	Germany	0.412	67.7	22.3
Spearman correlation		-0.15	-0.33	Spearman correlation		-0.64	0.26
Pearson correlation		-0.34	-0.30	Pearson correlation		-0.51	0.09
Regression analysis		b_Spain	b_home	Rsq=0.30		b_Italy	b_home
Rsq=0.13		-0.003	-0.002			-0.007	-0.003
		(0.004)	(0.004)			(0.003)	(0.003)

Figures are obtained form Table 2 and Table 5. Market shares are for the year 1996. In the regression analysis, standard errors are in parenthesis.

Table 4.7: Integration test. Destination country: France.

Source	Country/ variable	I(0)	lag	I(1)	lag
xit	Italy quantity	-2.19	0	-5.92 **	2
pit	Italy price	-3.53	1	-5.81 **	2
xsp	Spain quantity	-0.92	2	-6.56 **	3
psp	Spain price	-1.79	3	-10.25 **	1
Y1	France construction	-1.84	0	-6.46 **	1
Z1	France consumption	-2.40	1	-9.04 **	0
Z2	DM/Fr Exch. Rate	-2.18	0	-5.86 **	1
Z3	Italy construction	-2.41	1	-2.91	0
Z4	Spain construction	-1.53	0	-7.61 **	0
M_Italy	Italy marginal cost	-2.50	0	-6.53 **	1
M_Spain	Spain marginal cost	-1.82	1	-2.81	1

Zs are the additional instruments used in the estimation, M_Italy and M_Spain are the estimated coefficients in the pass-through exchange rate equation.

Table 4.8: Cointegration Analysis. Destination country: France

ITALY		Trace	[95%]	Maximal	[95%]
DEMAND	r = 0	47.17**	39.4	121.8**	94.2
	r = 1	30.24	33.5	74.61*	68.5
	r = 2	20.49	27.1	44.37	47.2
	r = 3	12.64	21	23.88	29.7
	r = 4	9.163	14.1	11.24	15.4
SUPPLY	r = 0	54.38**	39.4	141.9**	94.2
	r = 1	34.62*	33.5	87.51**	68.5
	r = 2	24.59	27.1	52.89*	47.2
	r = 3	16.93	21	28.3	29.7
	r = 4	9.805	14.1	11.37	15.4
SPAIN		**Trace**	**[95%]**	**Maximal**	**[95%]**
DEMAND	r = 0	46.59*	42.5	109.1*	104.9
	r = 1	26.76	36.4	62.51	77.7
	r = 2	15.44	30.3	35.75	54.6
	r = 3	14.54	23.8	20.31	34.6
	r = 4	3.809	16.9	5.769	18.2
SUPPLY	r = 0	52.59**	39.4	143.5**	94.2
	r = 1	45.17**	33.5	90.89**	68.5
	r = 2	16.69	27.1	45.72	47.2
	r = 3	14.43	21	29.03	29.7
	r = 4	13.8	14.1	14.6	15.4

* Significant at 1% level , ** significant at a 5% level. Critical values are from Osterwald-Lenum (1992). The lag length in each equation is k=1 (demand, Italy), k=1 (supply, Italy), k=2 (demand, Spain), k=3 (supply, Spain).

Table 4.9: Test for Separability in demand

SEPARABILITY TEST	H_0: $\varphi^*_4=\varphi^*_5=0$
ITALY	LR-test (2)=10.98 *
SPAIN	LR-test (2) =7.26 *

* significant at a 5% level. In parenthesis the degrees of freedom.

Table 4.10: Estimated parameters of linear demand equation. Method: TSLS. Destination country: France. Period 1988:1-1998:1

	ITALY		SPAIN	
Variable	Parameter	Std. Error.	Parameter	Std. Error
α_0 (CONST)	-75485	88494	45663	20854**
α_1 (P)	1731.6	1801.6	-1031.7	864.3
α_2 (Z)	1177.1	1087.5	-357.6	261.6
α_3 (Y)	410.0	501.3	-257.0	208.9
α_4 (PZ)	-52.5	22.519**	7.079	4.99
α_5 (PY)	-7.4	10.13	6.263	2.38**
R^2	0.41		0.63	
Sargan Test				
[p-value]	[0.63]		[0.17]	
Q(4)	4.00		17.85	
Q(8)	17.35		24.67	
Elasticities				
Own price	-0.61		-0.79	
Cross-price	-0.05		-1.10	
Income	0.61		0.58	

Dependent variable: q (Exported quantity to France). Instrument variables: estimated marginal costs, exchange rate France-Germany. The variable Z stands for price of the rival and Y for construction index in France.

Table 4.11: : Estimated parameters of linear supply equation. Method: TSLS. Destination country: France. Period 1988:1-1998:1

	ITALY		SPAIN	
Variable	Parameter	Std. Error.	Parameter	Std. Error
β_0 (CONST)	-0.877	12.833	17.85	8.895**
β_1 (M)	1.418	0.564**	0.393	0.387
λ (x*)	0.003	0.013	-0.012	0.014
R^2	0.26		0.34	
Sargan Test				
[p-value]	[0.83]		[0.48]	
Q(4)	11.73		7.61	
Q(8)	15.68		12.36	

Dependent variable: p (Export price to France). Instrument variables: Construction index in France, construction index in source country and a linear trend.

Table 4.12: Estimated parameters of dynamic demand equation. Method: TSLS. Period 1988:1-1998:1. Destination country: France. Number of lags: k=1.(Italy); k=2 (Spain).

	ITALY			SPAIN	
Variable	Parameter	Std. Error.	Variables	Parameter	Std. Error
CONSTANT	24842.00	85321.00	CONSTANT	46595	1910
α_{00} (Δx_{-1})	-0.59	0.21**	α_{00} (Δx_{-1})	-0.39344	0.213*
α_{10} (ΔP)	-786.46	1381.5	α_{01} (Δx_{-1})	-0.68746	0.234**
α_{11} (ΔP_{-1})	322.59	1552.30	α_{10} (ΔP)	-694.85	282.39**
α_{20} (ΔZ)	86.40	1022.00	α_{11} (ΔP_{-1})	-768.57	501.41
α_{21} (ΔZ_{-1})	195.18	103.30*	α_{12} (ΔP_{-2})	-1079.4	564.35
α_{30} (ΔY)	-311.64	373.41	α_{20} (ΔZ)	-245.72	273.56
α_{31} (ΔY_{-1})	-103.79	473.92	α_{21} (ΔZ_{-1})	-447.18	352.89
α_{40} (ΔPZ)	-2.18	21.99	α_{22} (ΔZ_{-2})	-502.64	383.15
α_{41} (ΔPZ_{-1})	-7.89	24.94	α_{30} (ΔY)	-211.6	111.0**
α_{50} (ΔPY)	17.26	7.90**	α_{31} (ΔY_{-1})	-114.26	120.37
α_{51} (ΔPY_{-1})	1.322	9.737	α_{32} (ΔY_{-2})	-235.64	143.39
γ^* (x_{-1})	-0.855	0.204**	α_{40} (ΔPZ)	4.9016	6.126
φ^*_1 (P_{-1})	184.69	1175.90	α_{41} (ΔPZ_{-1})	9.9708	8.1203
$\varphi\delta^*_2$ (Z_{-1})	-257.67	1125.90	α_{42} (ΔPZ_{-2})	10.777	8.735
φ^*_3 (Y_{-1})	110.47	472.58	α_{50} (ΔPY)	4.4639	2.3992**
φ^*_4 (PZ_{-1})	-15.17	27.31	α_{51} (ΔPY_{-1})	2.7582	2.5501
φ^*_5 (PY_{-1})	2.84	9.4192	α_{52} (ΔPY_{-2})	5.0575	2.9036
			γ^* (x_{-1})	-0.17511	0.14458
			φ^*_1 (P_{-1})	-1052.2	661.71
			φ^*_2 (Z_{-1})	-409.91	366.73
			φ^*_3 (Y_{-1})	-245.6	172.08
			φ^*_4 (PZ_{-1})	8.4286	8.1528
			φ^*_5 (PY_{-1})	6.155	2.7205**
R^2	0.72			0.86	
Sargan Test					
[p-value]	[0.07]			[0.30]	
Q(4)	0.90			3.08	
Q(8)	6.33			11.27	
LR parameters					
θ_1	215.96	1361.7		-6008.79	6347.97
θ_2	-301.30	1336.0		-2340.87	2925.34
θ_3	129.18	551.2		-1402.55	1531.64
θ_4	-17.73	31.2		48.13	62.83
θ_5	3.32	11.1		35.15	33.06
LR Elasticities					
Own price	-0.83			-1.11	
Cross-price	-4.38			-5.58	
Income	2.70			0.90	

Dependent variable: q(exported quantity). Instrumental variables are: Estimated marginal costs in Italy and Spain, German/France nominal exchange rate and a linear trend. Standard errors are calculated using the Taylor series expansion (Kmenta, 1971, pag. 444)

Table 4.13: Estimated parameters of dynamic supply equation. Destination country: France. Method: TSLS. Period 1988:1-1998:1. Number of lags: k=1.(Italy); k=3 (Spain)

	ITALY			SPAIN	
Variable	Parameter	Std. Error.	Variables	Parameter	Std. Error
CONSTANT	**24.389**	**29.632**	CONSTANT	**-23.111**	**37.325**
β_{11} (Δp_{-1})	**-0.148**	**0.219**	β_{11} (Δp_{-1})	**-0.738**	**0.240**
β_{20} (ΔM)	**-0.687**	**2.035**	β_{12} (Δp_{-2})	**-0.596**	**0.322****
β_{21} (ΔM_{-1})	**-0.969**	**1.505**	β_{13} (Δp_{-3})	**-0.353**	**0.356***
λ_0 (Δx^*)	**-0.147**	**0.075****	β_{40} (ΔM)	**0.039**	**0.642**
λ_1 (Δx^*_{-1})	**-0.004**	**0.077**	β_{41} (ΔM_{-1})	**0.714**	**0.669**
ψ^*	**-0.448**	**0.221****	β_{42} (ΔM_{-2})	**-0.386**	**0.720**
ϕ^*_1 (M_{-1})	**-0.835**	**0.593**	β_{43} (ΔM_{-3})	**-0.661**	**0.702**
λ^* (x^*_{-1})	**-0.109**	**0.068**	λ_0 (Δx^*)	**0.007**	**0.025**
			λ_1 (Δx^*_{-1})	**-0.017**	**0.032**
			λ_2 (Δx^*_{-2})	**-0.006**	**0.039**
			λ_3 (Δx^*_{-3})	**0.029**	**0.047**
			ψ^*	**-0.584**	**0.297 ****
			ϕ^*_1 (M_{-1})	**-0.0005**	**0.001**
			λ^* (x^*_{-1})	**0.025**	**0.066**
R^2	**0.57**			**0.64**	
Sargan Test					
[p-value]	**[0.62]**			**[0.80]**	
Q(4)	**1.73**			**1.52**	
LR estimate of Market power	**-0.24**	**0.20**		**-0.043**	**0.118**

Dependent variable: p(export price in source-country currency). Standard errors are calculated using the Taylor series expansion (Kmenta, 1971, pag. 444)

Chapter 5

Export Activity and Efficiency: An Empirical Analysis of the UK Manufacturing Industry, 1992-1998

5.1 Introduction

In the previous chapters we have examined the decision to export, the export marketing strategy and the competition in export markets. In the final chapter we want to examine how the export activities affect firms' performance. In Appendix 1.2 of Chapter 1, we showed that firm performance experienced a substantial change during the year that a firm decided to start exporting or stop exporting. While performance indicators such as size, labour productivity or directors' wage improve for new exporters, firms that exit the export market experienced a deterioration of the same indicators.

This chapter focuses on the performance differences between regular exporters and regular non-exporters. For that purpose, we investigate whether UK exporting firms are more efficient than their domestically-orientated counterparts operating within the same industry using a sample of 2,279 UK manufacturing firms in 45 selected industries over the period 1992-1998. In particularly, we focus on two inter-related issues and literatures: (1) is the exports-efficiency relationship affected by industry-specific characteristics? (2) is the exports-efficiency relationship affected by the share ownership structure of the firm?

A considerable literature has been developed arguing that if market competition reduces firm's inefficiency, then the more competitive is an industry the stronger will be the relationship between efficiency and firm performance and hence the greater the incentives for managers to pursue efficiency (Hart, 1983; Scharfstein, 1988; Hermalin, 1992; Horn et al, 1995; Schmidt, 1997). It is generally accepted that, although export markets are not necessarily perfectly competitive, they are more competitive than the domestic markets. Therefore, we should expect that exporters will have fewer opportunities for inefficient operations compared to their domestic rivals. Export activity forces firms to behave more efficiently in those products in which competition abroad is fiercer than in the local market. There is a number of competing and complementary mechanisms in the literature underlying this view.

The first mechanism, which was previously discussed in Chapter 1, is associated with the separate but complementary analyses of Dixit (1988) and Baldwin (1989) concerning the entry and exit decision of exporters. Both models emphasize that entry into international markets is determined by the entrant's response to above normal profitability, but that potential entrants are deterred by barriers to entry. In the context of firm efficiency that literature implies that since export markets have higher demand uncertainty and entry sunk costs than domestic markets, exporters will need to maintain higher efficiency levels relative to firms selling in the domestic market before entering the export market. The minimum entry cost in export markets therefore acts as selection mechanism for weeding out the most inefficient firms.

A second mechanism associated with the managerial literature focuses on firm's internationalisation. That literature has emphasised the argument that exporting is in itself a learning process (see Leonidou and Katsikeas, 1996 for a typical example from this literature). The relative efficiency of firms at the time of entry is not considered to be the key efficiency inducing mechanism for firms but rather their ability to make progress in reducing the gap between incumbents and themselves after entry. While managerial and labour skills may not be equally distributed before entry, there is an opportunity to learn and to improve performance. Export activity can be viewed as an innovation, which modifies management practices and attitudes in a step-by-step process. The evolutionary learning approach implies that efficiency improves as export activity promotes contact with superior managerial and production techniques employed abroad. As firms gradually become more familiar with overseas markets and operations, they also become more efficient.

The two mechanisms described above to explain the better performance of exporters have been formalised in the Industrial Organisation literature using selection and evolutionary adaptation mechanisms. The participation in export markets can be viewed as a entry decision. Entry involves at least two different types of learning – one comes from selection, the other is more evolutionary in nature. In the first case, entrants may physically have to be present to learn about their abilities to manage, to master technologies, to engender labour skills and to solve the myriad of other problems that are a pre-requisite for success. Entrepreneurs differ in capabilities and are unsure of their own capabilities before committing resources to the new activity, that is, they do not have precise information on what their costs will be relative to their potential competitors. Industry dynamics models by Jovanovic (1982) or Hopenhyan (1992) explain the selection of firms in the market as a function of factors of production and a random variable, which can be interpreted as a persistent productivity shock that is uncorrelated across firms. Firms have an initial distribution of efficiency levels and potential entrants have to incur sunk entry costs. Selection models show that more efficient firms stay in business and less efficient firms, after learning about their relative inefficiency level, choose to exit.

A third mechanism is found in a well developed literature examining the pro-efficiency effects of competition in product markets that place a pivotal role on ownership structure. Leech (1987) argues managerial discretion may be reduced by product market competition, but it can also be reduced by having a major shareholder who can exercise control. If ownership is widely dispersed there is no individual (or group) with either the voting power or the incentive to exercise control and enforce profit maximisation. Moreover, the effect of product market competition on efficiency may be different for firms with differing types of ownership structure. For example, Aghion and Howitt (1996) show that the positive effect of product market competition on firm growth is stronger among firms with the major shareholders not having direct control over managerial decisions (manager controlled firms). The impact of ownership structure on the relationship between exports and efficiency has not as yet been integrated into the export-efficiency literature, a deficit this paper seeks to amend.

At the empirical level, studies employing micro-data find that imports enhance performance (Levinsohn,1991; McDonald,1994), and macro-studies support the link between exports and economic growth (Edwards, 1998). Direct evidence from studies utilising micro-data on the relationship between exports and performance is mixed. Several studies have compared firm performance before and after trade liberalisations to evaluate the effects of foreign competition.[1] Although there is some evidence that increased export activity enhances efficiency at the firm level, the more substantive sources of efficiency gains were found to be at the industry level resulting from the reduction in the market power of large domestic incumbents and the shake-out of small high-cost domestic firms. Unfortunately, such natural experiments occur very occasionally and tend to be concentrated in Less Developed Countries. An alternative way to test whether export activity stimulates productivity and efficiency is to compare the performance of exporters with non-exporters. To date, the evidence suggesting that exporting firms exhibit superior productivity or efficiency is mainly based on cross-sectional firm-level data (Aw and Hwang, 1995; Chen and Tang, 1987), while studies providing more rigorous firm-level panel techniques have obtained mixed results (Kraay, 2000; Tybout and Westbrook, 1995).

A recent strand of the empirical studies has analysed the direction of causality between exports and productivity: the self-selection hypothesis (good companies become exporters) vs learning-by-exporting hypothesis (exporting improves firm performance). Bernard and Jensen (1999) and Bernard and Wagner (1997) examine this issue using manufacturing firm data for the U.S. and Germany, respectively. They find that successful companies become exporters and the benefits of exporting are less clear since productivity performance grows slowly after firms become exporters. For Colombia, Mexico, and Morocco Clerides et al. (1998) find that the

[1] See, among others, Handoussa et al. (1986), Tybout et al. (1991), Harrison (1994) and Pavcnik (2000).

causality between success and exports runs from good performance to exports rather than the other way. For Taiwan, Aw et al. (2000) and Liu et al (1999) reinforce the evidence in favour of the self-selection hypothesis by finding that Taiwanese firms with higher productivity tend to enter the export market and exporters with low productivity tend to exit over the eighties and nineties. Aw et al. (2000) find that stable exporters experience relative productivity improvement in several industries compared to non-exporters. In contrast, Liu et al. (1999) do not find that exporting itself provides performance gains among stable exporters in the electronic industry.

There has also been a small body of empirical work focused on the UK. Green and Mayes (1991, 1992) used the census of manufacturing firms in 1977 to study the determinants of the UK industry technical efficiency. The results suggested that technical efficiency across industries was positively related to greater competition in the domestic market but, surprisingly, negatively related to greater exposure to competition in the international markets. [2]

Finally as was noted there are, as far as we are aware, no papers that provide a direct a link between ownership and export activity. There are however numerous empirical studies that find a significant majority of owner controlled firms outperformed manager controlled firms.[3] In the literature that specifically examines the UK, Leech and Leahy (1987, 1991) found that owner controlled firms perform better than manager controlled firms among large-sized companies in the eighties. Nickell et al (1997) investigated the interaction between ownership structure and product market competition in the evolution of productivity growth in UK manufacturing industry over the period 1985-1994. They found that dominant external shareholders have a positive impact on productivity growth, but dominant internal shareholders have no effect.

In contrast to the significant body of empirical literature concerning the long run relationship examined above there has been no empirical work examining the short run export-efficiency relation.[4] Consistent with our desire to understand the impact of product competition on

[2]Since the seventies manufactures account for about 80 percent of exports of goods in the UK. Exports as percentage of total manufacturing sales has increased continuously from 1970 to 1998.

[3]Short (1994) provides a comprehensive summary of the literature.examining ownership and competition.

[4]A paper that does examine short efficiency is Hay and Lai (1997) who, using a large panel of UK firms, found that short run declines in domestic market share induced firms to improve efficiency over the period 1975-1991.

efficiency improvements by groups of firms with different type of ownership structure we provide a similar analysis over the short run. Of the mechanisms provided by the theoretical literature above, with the exception of evolutionary selection models that are clearly only applicable over the long-run, all make a consistent claim that exporters are more efficient than their domestically-orientated counterparts in the short-run operating within the same industry.

To anticipate the results, we show that exporting firms are more technically efficient than no-exporters, based on their long-run relative position to the industry frontier. We find that, on average, exporters are 4 percent closer to the frontier than non-exporters. However, the efficiency differences seems to be substantially reduced between heavy exporters and light exporters.[5] We thus conclude that the source of efficiency gains comes directly from the decision to export rather than the intensity of the export activity. When we examine if the strength of the export-efficiency relationship is affected by the trade-orientation of the industry, the results show a stronger impact of export activity on long-run efficiency among those industries in which UK reveals comparative disadvantage. This finding suggests that firm competitiveness factors play an important role in overcoming industry comparative disadvantage factors. In the analysis of the determinants of short run efficiency changes among exporting firms, the results indicate that competition in the domestic market is more important as a "disciplinary device" in reducing technical inefficiency than competition in the export market. This finding is robust to different samples of firms with different ownership characteristics.

We adopt a three stage methodology which determines the format of remainder of this paper that is structured as follows. Section 4.2 defines how the data is constructed. In the first stage (Section 4.3) we use panel data techniques to examine a stochastic frontier production function that allows for the decomposition of total factor productivity (TFP) constructing a firm-specific time-variant technical efficiency index. In Section 4.4 we analyse the efficiency index derived in the previous step using kernel density estimations to compare the efficiency index between

However, Hay and Lai do not examine the link between efficiency and export status that is the focus of this paper. The fact that they do not control for firms' export activity is somewhat surprising since exports today represent 40 percent of total sales in the UK manufacturing industry.

[5] Heavy exporters being those firms whose average export/sales ratio above 25%, while light exporters are classified as exporters whose average export/sales ratio below 25%.

domesticly orientated and exporting firms, and between firms with different export intensity derived in the first step. Section 4.4 examines the third stage where we undertake regression analysis to deepen our understanding of the determinants of efficiency over both the long and short runs. Section 4.6 provides conclusions.

5.2 Construction of the Data

The trade classification of UK manufacturing industries over the period 1993-1998 uses two recent publications from ONS, UK Markets Reports (1993-1994) and Product Sales and Trade (1995-1998). Each publication contains information about value and volume of imports and exports by destination (EU and NON-EU) for 4,500 products within 200 four-digit SIC92 industries. We combine two different methods to classify the trade data: positive/negative net exports and horizontal/vertical intra-industry trade (IIT). The intuition behind introducing an IIT measure is that the division of industries using only the revealed comparative advantage classification (positive/negative net exports) may be distorted by firms specific effects. In particular it is widely recognised that product differentiation may change the relative importance of industry comparative advantage forces against firm competitive advantage forces (Porter, 1990, and Ab-el-Raham, 1991). For example, firm-specific characteristics become very important in industries whose trade is based in the exchange of varieties of similar price (horizontal intra-industry trade) since cost difference between trading partners is not the major driven-force of trade. On the other hand, firm-specific characteristics may be less important in industries whose trade is based on exchange of varieties of different price (vertical intra-industry trade) since quality differences are based on cost differences, so that traditional comparative advantage forces become important again.

For each industry we calculate the average net export flow and the extent of intra-industry trade. Following Greenaway, Hine and Milner (1994), we decompose the proportion of intra-industry trade that corresponds to horizontal and vertical differentiated products. The key assumption is that quality is reflected in price and price can be proxied by unit vales. The intra-industry trade (IIT) index for an industry j, defined as the share of overlapping trade in total trade, can be disentangle into horizontal (HIIT) and vertical (VIIT),

$$IIT_j = HIIT_j + VIIT_j \tag{5.1}$$

Each term in the right-hand side is obtained according to the formula,

$$\frac{\sum_i \left| x_{ij}^k - m_{ij}^k \right|}{\sum_i \left(x_{ij}^k + m_{ij}^k \right)} \tag{5.2}$$

where i refers to a product in a given j industry, and k refers to horizontally or vertically differentiated products. Each product i is allocated in group k according to the formula

$$\begin{array}{lll} k \in HIIT_j & \text{if} & 1-\alpha \leq \frac{UV_{ij}^x}{UV_{ij}^m} \leq 1+\alpha \\ k \in VIIT_j & \text{if} & \frac{UV_{ij}^x}{UV_{ij}^m} \leq 1-\alpha \;\; or \;\; \frac{UV_{ij}^x}{UV_{ij}^m} \geq 1+\alpha \end{array} \tag{5.3}$$

where UV_m and UV_x stands for unit values of imports and exports and α is a the dispersion factor. The price gap is justified on possible distortions in the unitary values of imports and exports because of transport cost, tariffs and other duties. In our calculations we use a dispersion factor of 20 per cent.[6]

Table 5.1 displays the list of sectors, the value of net exports, the intra-industry trade ratio (IIT), and the decomposition of IIT into horizontal (HIIT) and vertical (VIIT). Net exports are for the year 1993 and IIT, HIIT and VIIT are averages over the period 1993-1998. The results indicate the percentage of UK trade classified as intra-industry trade is quite large. Although the figures for some industries may be upwardly bias due to aggregation, our main interest here is not the extent of intra-industry trade but its composition. The intra-industry trade seems to be dominated by exchange of varieties of products of different quality, reflected in the price

[6] The literature that has followed Greenaway, Hine and Milner (1994) uses a value of α between $[0.15, 0.25]$ and have found that the index is highly robust within these parameter values. Our calculations use an intermediate value of $\alpha = 0.2$.

dispersion of the imported and exported varieties. In that sense, our results are in line with Greenaway et al. (1994). The analysis of industries in which UK reveals a comparative advantage or disadvantage also confirms with expectations. Traditional industries (food, textiles, footwear, glass and wood-made products) are dominant among the manufacturing sectors in which UK reveals comparative disadvantage (negative net exports). UK reveals comparative advantage in more advanced technological industries (pharmacy, vehicles, aircrafts, electronic apparatus, precision instruments). The high level of disaggregation of our data allows us to determine other industries in which UK has comparative advantage or disadvantage: in industries dominated by horizontal differentiated trade UK reveals comparative disadvantage in the plastic and rubber industry (plastic in primary form, rubber tyres and plastic tubes); in industries dominated by vertical differentiated trade UK reveals comparative disadvantage in the production of specialised machinery for agriculture and manufacturing industry.

The first column of Table 5.1 highlights the 45 industries that we have selected for the calculation of the firm technical efficiency.[7] The fact that most industries have high vertical IIT is in line with the fact that most trade flows across UK industries are of this type.

In order to examine firm and industry characteristics we match two sets of data, one at firm-level and one at industry-level. Our first data set is based on firm-level panel data constructed from balance sheets provided by Financial Analysis Made Easy (FAME). The firm level data comes from a sample contains 2,279 firms distributed in the previously selected 45 manufacturing industries. The firm-level data were taken from FAME and were based on published Profits and Loss account and balance sheets of UK manufacturing companies.[8] The industry

[7] The rules for selection of the industry selection rules are (i) industries with export as percent of industry sales and imports as percent of home sales both above 10 percent; (ii) industries with a Grubel Lloyd index of intra-industry trade above 50% (with the exceptions of [1513] Meat and Poultry products (IIT=0.23) and [1533] Fruit and vegetables nec (IIT=0.35) that are included to provide a representation of the Food industry so that all SIC92 are included in the analysis) (iii) industries with more than two product categories; (iv) there is a sufficient large number of firms in the firm data set (see next section). 29 out of 45 industries have negative net exports in 1993 and 30 have high vertical IIT.

[8] Firms were selected according to the following criteria: (i) complete information to estimate the production function over the period 1992-1998; (ii) the number of employees is above 6 (every year); total assets and turnover are above £100.000 every year over the period 1992-1998; (iii) the value of tangible assets does not suffer any revaluation or substantial adjustment (doubles or halves) over the entire period; (iv) the number of firms in each industry is above 20 prior to eliminating outliers.

level data on output growth and price indices is from Sector Review, Manufacturing (ONS). The data covers the period 1992-1998.

In order to examine the effects of ownership on the relationship between exporters and efficiency we classify firms by ownership into two groups: independent privately owned companies, and subsidiary companies. *Independent private-owned* companies are firms whose major shareholder is a single individual or family. Within this group of firms we can distinguish between firms with a dominant major shareholder who has direct control over managerial decisions (owner controlled), and firms with several major shareholders with or without participation in the managerial decisions (manager controlled). *Subsidiary* companies are those firms whose major shareholder is another company. To divide independent private companies into owner-controlled firms and manager-controlled firms we follow Cubbin and Leech (1983) who measured "ownership control" as function of both the importance of the largest shareholders and the degree of dispersion of all the shares of the firm. Suppose that N shareholders are ordered in decreasing size with percentage holding defined as $P_0, P_1, ..., P_N$ such that $\sum P_i = 100$. If we define the Herfindahl index as $H = \sum P_i^2$, it can be shown that the degree of control of the shareholder with the largest percentage of shares, P_0, is defined as $\alpha_0 \cong \Phi\left(\frac{P_0}{(H-P_0^2)^{1/2}}\right)$ where $\Phi(\cdot)$ is the standard normal distribution. This index accounts for the fact that a large dispersion of other shareholders helps the largest shareholder to win control over the firm in case of a hypothetical contest in which each shareholder votes independently.

Among subsidiary companies, we distinguish between domestic and foreign-owned subsidiaries. Here the major shareholder is an outsider, whose main concern is with the performance of the company. However, the degree of managerial discretion may vary with nationality (domestic vs foreign).

In our sample, details of managers (name and position) and shareholders (names and sizes of holding) are obtained from FAME. Table 5.3 summarises the distribution of companies by ownership-type in our sample. In the sample of 2,279 firms, we identified 807 firms as independent private companies. On the basis of the probability of control by the leading shareholder higher than 90% (i.e. $\alpha_0 > 0.9$), more than a half of the companies (458) are classified as owner-controlled. Of the 1,472 subsidiary companies, 792 companies have as a major shareholder a domestic-owned company and 680 companies are subsidiaries of foreign firms.[9]

5.3 Measuring firm technical efficiency

This section describes the calculation of the index of firm technical efficiency by econometric estimation of production functions. Productivity varies across firms within the same industry, for example due to differences in technology, scale of production or product diversity. It is possible that after controlling for these three factors, productivity differences still persist due to firms obtaining different levels of output from the same levels of inputs. This last idea, formalised first by Farrell (1957), is termed technical efficiency. *Technical efficiency* refers to the firms' ability to produce the maximum possible output from their input bundles and technology, regardless input prices and output market conditions.[10]

The index of technical efficiency is measured as the ratio of the observed output of a firm to the maximal potential output possible or *frontier* output by that firm given its production capacity. The reliability of this index, therefore depends on accurately estimating the maximal potential output of a firm. The most general of the alternative methods for the derivation of an efficiency frontier and the computation of a technical efficiency measure is the econometric estimation of a stochastic frontier production function (SFPF).[11] The main drawback of using SFPFs is that they assume a parametric technology to estimate the maximum potential output from a given combination of inputs for each company in the same industry. If real output is a function of the real capital stock and employment, measured in efficiency units, the stochastic

[9] The largest percentage of foreign subsidiaries is from USA (41%). Germany, Japan, France and Switzerland are the other major countries with subsidiaries in UK.

[10] Efficiency is conventionally divided into two conceptual distinct forms: technical and allocative efficiency. Allocative efficiency results in utilisation of inputs in the correct proportions in order to minimise the production costs, given input prices is not the subject of analysis in this paper.

[11] The alternative approach, a non-parametric technique called Data Envelopment Analysis (DEA), uses linear programming techniques to restrict all observations to lie on or below the frontier. Conceptually this deterministic technique is the closest representation of what a frontier is. It, however, is more sensitive to errors in observations compared to the stochastic techniques. For a survey of the literature, see Aigner and Schmidt (1980).

frontier production for a firm i over the period $t = 1, ..., T$ is given by

$$Y_{it} = \exp(A_{it}) f(\overline{K_{it}}, \overline{L_{it}}) \exp(Z_{it}) \exp(v_{it}) \tag{5.4}$$

where $\overline{K_{it}} = K_{it} \exp(-u'_{kit})$ and $\overline{L_{it}} = L_{it} \exp(-u'_{lit})$. The error term u'_{jit}, $j = k, l$ measures technical inefficiency associated directly with each input (i.e. capital-vintage, labour work stoppages, material bottlenecks). Technical progress is assumed to be Hicks-neutral. Since output changes may occur through firms eliminating (increasing) excess capacity due to demand booms (slowdowns), the term $\exp(Z_{it})$ includes industry-level and firm-specific factors to control for cyclical movement in demand or capacity utilisation affecting firm's production. The error term v_{it} captures random variations in the economic environment that are not directly controlled by the firm reflecting factors such as luck, weather, machine breakdown, random variation in workers' productivity, or measurement and reporting errors in the firm data.

The term $\exp(A_{it})$ is an index of total factor productivity (TFP), which varies across firms and over time,

$$\exp(A_{it}) = a_{it} = a_i + b_t - u''_{it} \tag{5.5}$$

The first term, a_i, measures long run efficiency of the firm relative to the frontier. It reflects firm-specific characteristics that affect internal efficiency (managerial organisation) and competitive ability of firms in the product market (experience, expertise, quality factors, location, fast adoption of the latest technologies). The second term, b_t, represents time-specific efficiency effects or shift of the frontier. The change in b_t is a measure of the rate of technical change. The last term, $-u''_{it}$, is a random term which reflect "unobserved" technical inefficiency or short run deviations with respect to the "best practice" of the firm. Substituting (5.5) in (5.4), we write the standard SFPF equation in logarithm form

$$y_{it} = a_i + b_t + f(k_{it}, l_{it}) + \sum_h \xi_h z_{hit} + v_{it} - u_{it} \tag{5.6}$$

The last term $u_{it} = -u''_{it} - u'_{kit} - u'_{lit}$ is a firm-specific, time-varying inefficiency effect. It reflects the shortfall of the firms relative to their "own best practice" in each period, where the best practice for the firm is determined by the time invariant efficiency coefficient, a_i.

Since the selection of the production function is made *apriori*, the translog form is the clear choice due to its inherent flexibility, [12]

$$f(k_{it}, l_{it}) = \alpha_1 l_{it} + \alpha_2 k_{it} + \alpha_3 l_{it}^2 + \alpha_4 k_{it}^2 + \alpha_5 l_{it} k_{it} \tag{5.7}$$

and substituting equation (5.7) into equation (5.6) and expressing the resulting equation in per-capita terms gives

$$(\frac{y_{it}}{l_{it}}) = a_i + b_t + \gamma l_{it} + \beta\left(\frac{k_{it}}{l_{it}}\right) + \delta\left(\frac{k_{it}}{l_{it}}\right)^2 + \sum_h \xi_h z_{hit} + v_{it} - u_{it} \tag{5.8}$$

The specification of equation (5.8) is made for convenience in order to reduce both multicollinearity and heteroscedasticity problems. The parameters (γ, β, δ) are $\gamma = \alpha_1 + \alpha_2 - 1$, $\beta = \alpha_2$ and δ is obtained after imposing the restrictions $\alpha_4 = -\alpha_3; \alpha_5 = 0$. γ is a convenient measure of the extent to which the industry production differs from constant return to scale, while the joint significance of the parameters (β, δ) test for the translog versus the Cobb-Douglas specification. We assume the error term v_{it} is normally distributed with mean zero and variance σ_v^2.[13]

[12]The Translog function is a second order approximation to the CES function which does not impose any a priori assumption about the Allen partial elasticity of substitution or separability, or else homotheticity (Bernt and Christensen, 1973).

[13] Three alternative distribution forms of u_{it} have been assumed traditionally in the literature. Two pioneering papers in SFPF, Aigner, Lowell and Schmidt (1977) and Meeusen and van den Broeck (1977) assume half-normal and exponential residuals distribution, respectively. The main objection to these distributions to depict inefficiency is that the modal level of inefficiency is zero. Stevenson (1980) proposes a more general form in which the elements of u_{it} are distributed as a truncated-normal, with the mode determined by the data. The three distributions are one-side normal. Eq. (5.8) is estimated by maximum likelihood. Since the measure of firm-specific efficiency depends on the estimates of the variance of u_{it} and v_{it}, the left skew of the distribution of residuals is necessary to calculate the standard deviation of u_{it} and v_{it}. A positive skew of the residuals means that the longer tail of the distribution lies outside rather than inside the frontier; as a consequence, $\sigma_u < 0$. Three potential reasons could explain the *wrong* skew of the residuals distribution: (1) the presence of "outliers", (2) our initial distribution assumption (i.e. truncated normal) of u_{it} is incorrect , (3) the specification of the model is inappropriate. Estimation had to proceed by eliminating "extreme" outliers in the data, by switching the distribution of u_{it}, and by using a more parsimonious functional specification of the production function.

To estimate the production function for each industry, we first utilise a Least Square Dummy Variable (LSDV) estimation of equation (5.8) omitting the error term u_{it}. This is followed by a battery of specification tests: Cobb-Douglas vs CES model, fixed effect error model (Hausman test), heteroscedasticity (Breush-Pagan test) and first-order correlation (Durbin-Watson test). We then use maximum likelihood estimation of our "preferred" specification of equation excluding outliers (5.8).[14] We test for the correct form of the SFPF using $H_0 : \lambda = \frac{\sigma_u}{\sigma_v} = 0$; $\mu = 0$ for the truncated normal distribution,$H_0 : \lambda = \frac{\sigma_u}{\sigma_v} = 0$ for the half-normal distribution and $H_0 : \lambda = \frac{\theta}{\sigma_v} = 0$ for the exponential distribution. We then obtain the residual u_{it} from the "preferred" distribution of u_{it}.

As we explained above, the efficiency index is measured as the ratio of the observed output of a firm to its frontier output. For n firms in the industry, the estimation of the stochastic production function provides $(n-1)$ negative values of $\widehat{a}_i$ which reflect deviations with respect to the most efficient firm (the constant term, $\max(a_i)$).[15] In addition, where we obtained n positive estimates of u_{it}, these reflect deviations with respect to firm's best practice every period. Since the firm's efficiency level was calculated across firms within the same sector, we define the estimated relative technical efficiency index (RTE) as

$$RTE_{it} = \frac{Y_{it}}{Y_{it}^*} = \exp\left(\frac{a_i - u_{it}}{\max(a_i)}\right) \tag{5.9}$$

This index has the advantage of being comparable not only across fims within the same sector, but also across different sectors. By construction the index is equal to or less than 1. As RTE_{it}

[14] When the skewness of the residuals is wrong (failure in the estimation), we delete those extreme points whose DFITS is above $5\sqrt{\frac{k}{n}}$ (k=number of regressors, n=number of observations), and repeat the estimation. In case of new failure, we use $4\sqrt{\frac{k}{n}}$ and so on. DFITS can be interpreted as the scaled difference between predicted values for the ith case when the regression is estimated with and without the ith observation. DFITS combines both the size of the residuals - studentised residuals (r_i) - and the size of the leverage (h_i), $DFITS_i = \frac{r_i}{\sqrt{\frac{h_i}{(1-h_i)}}}$, so large values of r_i and h_i increase the value of DFITS. Belsley et al. (1980) identify "potential" outliers as observations with DFITS greater than $2\sqrt{\frac{k}{n}}$,where k is the number of regressors and n is the number of observations.

[15] We identified the most efficient firm using LSDV estimation. In each regression an arbitrary firm was omitted until the rest of estimated firm- effect coefficients were negative.

approaches to 1, the firm is closer to the frontier.

We estimate equation (5.8) using Aigner, Lovell and Schmidt Maximum Likelihood estimation with time and firm dummies (ALS-DV ML).[16] The value of total turnover is used as the measure of output. Capital stock is approximated by the book value of tangible assets (i.e. the sum of land, building, machinery and equipment).[17] Total number of full-time workers measures employment. Output and capital are expressed in real terms using the corresponding output price index and capital price index at the corresponding four-digit and two-digit SIC level, respectively. Two additional variables were included in the regression. The first variable, real growth rate of industry output, is included to reflect changes in product demand conditions. The second variable is the ratio between finished-good inventories (stock) divided by total sales at the end of the previous period. This variable is transformed into deviations from trend to reflect unexpected changes in demand/capacity that may affect production decisions in the next period. We use instrumental variables to correct for possible simultaneity between output and inputs (capital and labour) in the production function using one-period lagged variables as instruments. The estimation thus covers the period 1993-1998 with six observations per firm.

Table 5.2 displays the estimation of the production functions. The following features summarise the results:

(i) The firm-specific time-invariant effect, a_i, picks up the relative efficiency of firms, identifying their positions relative to the frontier. This parameter varies across firms in the same industry, capturing differences in quality of management, in ability to adopt new technologies

[16] Hay and Liu (1997) use the same estimation technique. ALS-DV ML estimation allows us to examine time-variant firm-specific inefficiency as compared to LSDV technique which assumes that $u_{it} = u_i$ (Schmidt and Sickles, 1984). See Cornwall et al. (1993) and Kumbhakar (1990) for alternative ways to measure technical inefficiency over time. ALS-DV MLE estimation is not exempt of criticism. We impose one-sided normal distribution assumptions on u_{it} to estimate deviations with respect to the firm's "best practice" over time and assume that the elements of the variance-covariance matrix of the error term are independence over time.

[17] An alternative to total turnover is value-added. The value added can be measured as the sum of total wages, profits before tax, depreciation and interest payments. When we experimented with value-added as endogenous variable, the results were quite similar to those using turnover. However, we prefer to use turnover in the estimation as it is well known the limitations of using accounting profits as component of value-added (Nickell, 1996). Regarding the capital stock, FAME does not provide information on new investment in capital so we cannot calculate any measure of capital stock as the sum of investment flows minus depreciation following the perpetual inventory formula.

or in inherited capital stock or technologies. In all the sectors the estimated coefficients of a_i are significant as a group, reflecting the persistence of efficiency differences between firms.

(ii) The time dummies b_t reflect the movements of the sectoral production frontier over time. The sign and statistical significance of the coefficients changes from industry to industry, although in most cases the frontier seems to shift upward every year. Behind that result may stand the favourable years for the UK economy after the recession period 1991-1993.

(iii) The time-variant firm-specific efficient term u_{it} measures the shortfall of the firms relative to their own "best practice" in each period. In 30 out of 45 industries, the specification tests on one of the distributions of the residuals confirm the presence of significant time-variant firm inefficiency.

(iv) The translog specification (that included a quadratic term in the log of the capital-labour ratio) was statistically rejected in only nine industries. The coefficient on the labour variable is a convenient measure of the extent to which the industry differs from constant returns to scale. The null hypothesis of constant returns of scale is not rejected in 15 out of forty-five industries, while the rest of industries but one shows decreasing returns to scale. Only the "paperboard" industry shows strongly increasing returns. The effect of the capital-labour ratio on output is mixed. In 5 industries the effect is linear and positive. In 13 of the industries the relationship is an strong inverted-U shape while in other 12 the relationships take a U-shape form. In the rest of industries there is not significant effect.

(v) Finally, the two control variables for cyclical conditions affecting production are the annual growth rate of industry sales (DEMAND) and the ratio inventories/total sales (STOCK). The annual change in industry sales was dropped in some industries due to multicollinearity problems with the time dummies which complicates the interpretation. For the other variable, in 33 industries the coefficient of deviation of stocks/sales to the trend has a negative coefficient (only 12 of them are significant) reflecting that in several industries firms adjust their current production in response to an excess of finished goods stock.

5.4 Export activity and Efficiency: Non-parametric Analysis

In this section we compare the RTE indices calculated in the previous section between exporters and non-exporters, and between regular exporters with different export intensity. Unfortunately not all firms in our sample of 2,279 report information about exports every year over the period 1993-1998 (see Table 5.4). Some 1,997 out of 2,279 firms report at least one year information about exports and 1,712 firms report exports value during six consecutive years. With this type of data, we could define an exporting firm as a firm that exports at least once over the period 1993-1998. However, this definition includes firms that export a very small proportion of total production or export irregularly. To avoid including these firms as "regular" exporters, we prefer to define an exporting firm as a firm that exports every year and sells abroad more than 2.5 percent of total sales. The selection of exporting and domestic-orientated firms is made for the subsample of 1,924 firms with at least three consecutive years of information about exports. There are 1,402 regular exporters and 522 domestic-orientated firms. Among "regular" exporters, we split the sample into 741 heavy exporters (average export/sales ratio above 25%) and 861 light exporters (average export/sales ratio below 25%).

We compare the cumulative distribution functions of efficiency levels that correspond to groups of firms with experience in the export market to those with no experience. We denote a dummy variable, D, that categorise firms into groups and then calculate the density function of the RTE index of firm i at time t, z, that is obtained from a gaussian kernel density estimators $\widehat{f}(z\,|t, D)$.[18] Formally,

$$\begin{aligned} \widehat{F}(z\,|t, D) &= \int_{-\infty}^{z} \widehat{f}(x\,|t, D)dx \\ D &= 1 \text{ for exporting firms} \\ D &= 0 \text{ for domestic orientated firms} \end{aligned} \tag{5.10}$$

[18]The smoothing parameter for the kernel estimate is $h = 0.9n^{-1/5}A$, where $A = \min(SD, riq/1.34)$, SD denotes the standard deviation and riq the interquartile range (according to the recommendation in Silverman, 1986).

Figure 5.1 reports the kernel estimators of the density functions of the RTE index for exporting and domestically-orientated firms. Since the RTE index takes value of one in the frontier, the left skewness of the density function of exporting firms (straight line) suggests a higher level of efficiency.

Table 5.5 summarises efficiency differences between exporting firms and domestic-orientated firms for the quartiles of both cumulative distributions. The efficiency cumulative distributions are higher for exporting firms for all the quartiles. In particular, the median efficiency level of exporting firms is 5 percent higher than the efficient level of domestic-orientated firms. The efficiency differences at the lower part of the distribution are 5% in favour of exporting firms at the lower quartile, and 4% in favour of exporting firms at the upper quartile. The dispersion of the distribution of exporting firms, measured by the interquartile range, is similar to the one of domestic-orientated firms.

Next we test whether the cumulative distributions are equal,

$$H_o : \sup \left| \widehat{F}(z\,|t, D=0) - \widehat{F}(z\,|t, D=1) \right| = 0 \tag{5.11}$$

and whether the sign of the differences between compared distributions is as expected (i.e. a superior performance for exporting firms),

$$H_o : \sup \left[\widehat{F}(z\,|t, D=0) - \widehat{F}(z\,|t, D=1) \right] \leq 0 \tag{5.12}$$

which can be tested using the Kolmogorov-Smirnov statistics of equal distribution and stochastic dominance for two independent samples. [19] Note that the tests are implemented for each time period.

[19] Smirnov (1939) shows that the corresponding statistic to test for equality of cumulative distributions and differences in cumulative distribution is, respectively,

$$\widehat{\eta}_{n+m} = \left(\frac{n.m}{n+m} \right)^{1/2} \sup \left| \widehat{F}(z) - \widehat{G}(z) \right| \tag{5.13}$$

The lower part of Table 5.5 shows the test statistics for both hypotheses. First, the null hypothesis of equality of both distributions can be rejected at the 0.01 level for all years. Second, the null hypothesis of stochastic dominance of exporting firms cannot be rejected at any conventional significance level.

Our previous findings indicated higher levels of technical efficiency for exporting firms relative to domestically-orientated firms. Now, we want to investigate whether the RTE index for exporting firms increases with the export intensity. For this purpose, we have classified firms into two groups according to their export intensity distribution, i.e. light exporters and heavy exporters. The threshold of 25 percent is quite close to the actual median of the distribution (21%).

Figure 5.2 displays the density kernel functions of efficiency performance according to firms export intensity. Descriptive statistics are displayed in the right hand side of Table 5.5. The statistics of stochastic dominance cannot be rejected at any significant level. However, the magnitude of the efficiency differentials is smaller than for the aggregate distribution of exporters and domestically-orientated firms. The findings suggest that export status matters more than export intensity in order to distinguish groups of firms by their efficiency differences.

5.5 Exports and Efficiency: Regression Analysis.

This section is divided into two parts: (1) is the exports-efficiency relationship affected by industry-specific characteristics? (2) is the exports-efficiency relationship affected by the share ownership structure of the firm?

(1) Long-run analysis of the efficiency-export relationship.

To probe whether the relationship between export activity and efficiency is sensitive to the

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$$\widehat{\eta}_{n+m} = \left(\frac{n.m}{n+m}\right)^{1/2} \sup\left(\widehat{F}(z) - \widehat{G}(z)\right) \tag{5.14}$$

where n and m are the number of firms and domestic-orientated exporters, and $\widehat{F}(.)$ and $\widehat{G}(.)$ are their estimated cumulative distribution functions.

industry trade orientation, we analyse the determinants of long-run efficiency. Standard with the literature on technical efficiency, firm *size*, *age*, and *ownership* may affect long run efficient position of a firm (Pitt and Lee,1981; Haddad and Harrison, 1991). We add to this our key variable of interest: the export status of the firm at the beginning of the period (i.e. 1993). Our dependent variable is RTE index in 1998. Since the dependent variable lies between zero and one we apply the logistic transformation to the dependent variable and estimate the following model

$$\log \frac{RTE_{i98}}{1 - RTE_{i98}} = f(EXPORT_{i,93}, SIZE_{i,93}, AGE_{i,93}, OWNERSHIP_{i,93}) \qquad (5.15)$$

where the sub-index 98 and 93 refer to years 1998 and 1993. The variable *size* is measured by the sales value (£m), *age* is equal to the number of years since registration in Company House, and *foreign* is a dummy that takes value of one if the firm is foreign-owned subsidiary, zero otherwise. The expected relation between the explanatory variables and technical efficiency are as follows. Larger firms are usually to be more efficient than smaller firms because they are thought to have superior organisation or technical knowledge. Older firms both because they have gained experience from past operations, and the fact o9f their survival may reflect their efficiency should exhibit a positive relation with efficiency. Finally, if there are differences in efficiency between foreign-owned and domestically-owned firms, this may indicate differences in the organisation of production, input usage, or technology access suggesting a positive relationship between foreign ownership and efficiency.

Row 1 in Table 5.6 shows the results of equation (5.15) for a sample of 1,902 firms with complete information in the year 1993. The positive and statistically significant coefficient on the export status supports the earlier results that export activity exhibit less deviation from the best-practice efficiency levels relative to domestic-orientated firms. The positive and significant coefficient on size also suggests that larger firms are more likely to achieve higher levels of efficiency. The positive and significant coefficient on foreign-owned subsidiary suggests a smaller deviation from maximum efficiency levels in firms with foreign ownership. This result is similar to that obtained by Griffith and Simpson (2000), who observe higher labour productivity between foreign-owned and domestic-owned establishments in Britain over the period 1980-1996. Finally the coefficient on age is not statistically significant.

Rows (2) and (3) test the sensitivity of the results by splitting the sample into industries that are net importers and industries that are net exporters. The sign and significance of the coefficients on size, age and ownership does not change. The coefficient on export status is positive and statistically significant in net importing industries, but it is not significant in exporting industries. This result is in line with our hypothesis that exporters are more efficient than domestically-orientated firms in industries with comparative disadvantage since exporters have to overcome unfavourable country-wide conditions. Rows (4) and (5) repeat the regression for the subsample of industries with high horizontal intra-industry trade. Again the coefficient on export status is positive and statistically significant in net importing industries, but it is not statistically significant in exporting industries. These findings confirm that the relationship between firm-specific factors and export supply is stronger in industries with comparative disadvantage, while it is not so strong in industries with comparative advantage. Therefore, the positive impact of export status on firm efficiency is greater in industries where firms have to overcome national comparative disadvantages to compete successfully abroad. Rows (6) and (7) include industries with high vertical intra-industry trade. The coefficient on export status is positive but not significant in both net importing industries and net exporting industries. A possible explanation for this result is that comparative advantage forces are still important in industries with high vertical intra-industry trade so firm-specific attributes are less important than they are in industries with high horizontal intra-industry trade.

Our results support the hypothesis that long-run industry comparative advantage forces affect the relationship export activity-technical efficiency. In industries with comparative disadvantage the presence of firm-specific competitive advantage factors appears to be necessary to compete successfully in the international markets. The relationship between export activity and unobservable firm-specific factors having a positive impact on efficiency becomes stronger in industries with comparative disadvantage, while it is not strong in industries with comparative advantage.

(2) Short-run analysis of the efficiency-export relationship.

We now turn to the determinants of shifts in the efficiency of firms over the short run analysing a subsample of 832 "regular" exporters with complete information over the period 1993-1998. The selection of only exporting firms allows us to separate the impact of competition in the domestic product market and competition in the export markets on efficiency performance. We use the same empirical approach as Hay and Liu (1997) for comparison purposes but we introduce the novelty that each equation is run for subsamples of firms classified according to different types of ownership and control.

$$\Delta RTE_{it} = g(\Delta RTE_{it-1}, \Delta RTE_{-it-1}, \Delta\pi_{it-1}, \Delta MS_{it-1}, \Delta XS_{it-1}) \qquad (5.16)$$

In the relative efficiency index (RTE_{it}) the term u_{it} provides an indicator of the failure of the firm i to achieve its own best efficiency in period t. As the long-run efficiency component $(a_i - \max(a_i))$ is constant over time, deviations within firms efficiency frontier between periods $\Delta u_{it} = -(u_{it} - u_{it-1})$ capture short run efficiency changes. A positive value indicates that the firm is becoming more efficient. A negative value that the firm is allowing its short run efficiency to slip.

What factors are more likely to stimulate firm performance improvements each period? Firms performing badly, in particular losing domestic market share, export sales or facing falling profits, will have an incentive to improve its short run efficiency. The explanatory variables we examine are of two kinds reflecting the differing sorts of competition that the firm may face. The first type is competition by comparison, which assumes that the "product market rivalry" acts as an information mechanism (Bertoletti and Polletti, 1997). Yardstick competition will put more pressure on a firm to improve its own efficiency if rival firms are more efficient. The comparative efficiency aspect is addressed by introducing the change in efficiency of all other firms in the sector (Δu_{jt}). The coefficient is expected to be positive since if rival firms in the sector are becoming more efficient there is increased pressure on the firm to improve its efficiency. The second type of competition is in the product market where changes in domestic market share or export sales will have incentive effects if the firm interprets falling domestic sales or exports as a signal of loss of competitiveness and reacts to improve its performance (Nickell, 1996). Therefore, the expected sign of the coefficient on lagged change in domestic market share and lagged change in export/sales ratio is negative. A fall in cash flow might spur the firm to improve efficiency so we also introduce the change in gross profits lagged one period in the model. The empirical equation is completed by introducing (up to 20) two-digit SIC industry dummies and three year dummies. The inclusion of year dummies should pick up any cyclical effects, though it should be noted that the estimating equations for the u_{it} from the stochastic frontier production functions have already controlled for these effects with year dummies, via sectoral demand changes and unexpected firm stock/sales deviations that were designed to proxy the effects of capacity utilisation.

Two further points merit comment. First, Δu_{it} is a first differences in logs so the explanatory variables are also expressed as such. Second, the dependent variable Δu_{it} is itself an estimate derived from the stochastic frontier production function, so may be affected by a problem of correlation. In addition we include the contemporaneous rival change in efficiency as a regressor. To control for endogeneity of the regressors we instrument the variables Δu_{it-1} and Δu_{jt} for $\Delta u_{it-2}, \Delta u_{jt-1}$ and Δu_{jt-2}.

In order to examine the effects of differing ownership between companies whose major shareholder is a single individual or family (*Independent private-owned firms)*, and companies whose major shareholder is another company (*Subsidiary firms*) we utilise the separated sample for ownerships type, which is further disaggregated into owner-controlled and manager-controlled firms, and, for the subsample of subsidiaries into domestic-owned and foreign-owned firms (the construction of these variables was previously detailed in Section 5.2). The regression results are given in Table 5.7. The sign and statistical significance of the estimates varies across the different types of firms classified by ownership, underlining the importance of delineating between ownership structures. The only variable that behaves predictably across all the firm groups is lagged profits whose negative coefficient is interpreted as reflecting the effect of falling profits motivating improvements in current efficiency. Contemporaneous efficiency improvements by rivals have a strong positive effect on efficiency in all firms except owner-controlled private firms. Loss of market share in the previous period has a strong positive effect on efficiency among independent private companies, but the coefficients are not significant among subsidiary companies. Past changes in the export/sales ratio have a positive impact on short run efficiency changes, but the coefficients are not statistically significant. Finally, neither industry nor year fixed effects are significant. The absence of year fixed effects in the regression confirms that the frontier production function estimates have successfully distinguished the Δu_{it} from cyclical effects.

To sum up, there is a strong link between past financial losses and efficiency improvements. There is also some support for the hypothesis that short run efficiency of the firm is affected by competition. On the one hand, competition with rivals improves efficiency among the group of subsidiary firms. On the other hand, competition in the product market, captured by losses in domestic market share, seems to have a strong disciplinary effect on independent private companies. Finally, the effect of a large exposure to competition in foreign markets, captured by an increase in the previous year export intensity, has a positive impact on efficiency, although none of the coefficients are significant for any type of firm.

5.6 Conclusions

This chapter has examined the relationship between technical efficiency and export activity using a large sample UK manufacturing firms over the period 1992-1998 drawn from FAME databank. The paper has aimed to address two questions: (1) is the exports-efficiency relationship affected by industry-specific characteristics? (2) is the exports-efficiency relationship affected by the share ownership structure of the firm?

Our results can be summarised as follows. First, the data provide robust evidence that exporters enjoy higher levels of efficiency relative to domestically-orientated firms. Second, firms that export a small fraction of their sales only have marginally lower efficiency levels that firms with high propensity to export. This indicates that the superior efficiency performance of exporters is mainly driven by export status, not by export intensity of sales. Third, the econometric analysis confirms that export activity has a positive impact on the long run efficiency performance, after controlling for firm size, age and foreign participation in capital assets. Moreover, we show that the link between export activity and long-run efficiency is stronger among firms operating in import competing industries. This finding suggests firm-specific attributes such as managerial quality or internal organisation play an important role in the exporting firms' performance in sectors with comparative disadvantage compared to sectors in which exporting firms benefit from the comparative advantage forces in the country to compete abroad. Fourth, competition abroad has a weak impact on short run efficiency, compared to other sources of competition such as yardstick competition or competition in the domestic market. In general, controlling for ownership does not change the results concerning the lack of impact of competition in export markets on short run efficiency improvements.

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Table 5.1: Trade orientation of UK manufacturing industries.

sic92_4	Sector Name	Net exports 1993	ITT avg 93-98	HIIT avg 93-98	VIIT avg 93-98
1511	Production and preserving of meat	22	0.44	0.32	0.11
1512	Production and preserving of poultry meat	-160	0.53	0.05	0.48
1513**	Meat and poultry products	-237	0.23	0.17	0.06
1520	Processing and preserving of fish	-26	0.40	0.19	0.21
1531	Processing and preserving potatoes	-96	0.32	0.02	0.30
1532	Fruit and vegetable juice	-190	0.24	0.13	0.11
1533**	Fruit and vegetables not elsewhere classified	-678	0.35	0.20	0.16
1541	Crude oils and fats	-532	0.13	0.06	0.07
1542	Refined oils and fats	-82	0.56	0.29	0.27
1543	Margarine and similar edible fats	-15	0.59	0.59	0.00
1551**	Milk, butter, cheese and other milk products	90	0.57	0.44	0.13
1552	Ice-cream	-41	0.86	0.86	0.00
1561	Grain milling and cereals	311	0.38	0.14	0.24
1562	Starches and starch products	-181	0.30	0.06	0.24
1571	Manufacture of prepared feeds for farm animals	33	0.87	0.00	0.87
1572	Pet foods	4	0.89	0.00	0.89
1581	Bread, fresh pastry and cakes	35	0.88	0.51	0.37
1582**	Biscuits, preserved pastry and cakes	109	0.67	0.02	0.65
1583	Sugar	-480	0.22	0.00	0.22
1584**	Cocoa, chocolate and confectionary	92	0.60	0.29	0.31
1585	Macaroni, noodles and similar	-67	0.26	0.06	0.20
1586	Tea, coffee and substitutes	131	0.48	0.06	0.42
1587	Condiments	-60	0.81	0.74	0.07
1588	Homogenesed and dietetic food	-50	0.42	0.39	0.03
1589	Soups & other products nec	-247	0.67	0.04	0.63
1591	Destilled potable alcoholic beverages	2122	0.13	0.06	0.07
1592	Ethyl alcohol from fermented materials	33	0.27	0.00	0.27
1593	Wine	-946	0.10	0.03	0.07
1594	Cider and perry	-17	0.97	0.97	0.00
1595	Other non-destilled fermented beverages	-131	0.51	0.00	0.51
1596**	Beer	64	0.78	0.78	0.00
1597	Malt	-21	0.35	0.02	0.33
1598	Mineral water and soft drinks	470	0.46	0.38	0.08
1600	Tobacco	-129	0.28	0.00	0.28
1710**	Textile fibres, silk	-776	0.56	0.42	0.14
1720**	Textile weaving	-21	0.64	0.24	0.40
1740**	Soft furnishings, household textiles	-9	0.55	0.07	0.48
1751	Carpets and rugs	-201	0.63	0.02	0.60
1752	Cordage, rope,twine, netting	2	0.72	0.07	0.65
1753	Nonwovens articles, except apparel	-53	0.63	0.33	0.30
1754**	Lace and other textiles n.e.c	27	0.82	0.67	0.15
1760	Knitted and crocheted fabrics	6	0.50	0.02	0.48
1771	Knitted and crocheted hosiery	-63	0.69	0.00	0.69
1772	Knitted and crocheted pullovers and cardigans	-327	0.60	0.00	0.60
1810	Leather clothes	-69	0.48	0.48	0.00
1821	Workwear	-4	0.63	0.09	0.55
1822**	Other outwear	-748	0.65	0.05	0.59
1823	Underwear	-948	0.57	0.20	0.38
1824**	Other wearing apparel & accessories nec	-217	0.58	0.07	0.51
1830	Fur; articles of fur	25	0.95	0.95	0.00
1910	Tanning and dressing leather	68	0.67	0.18	0.49
1920	Luggage, handbags, harness	-253	0.44	0.00	0.44
1930**	Footwear	-814	0.47	0.02	0.44
2010	Sawmilling and planning wood	-1030	0.05	0.01	0.04
2020	Panels, boards and similars	-522	0.26	0.05	0.21
2030	Builder's carpentry	-118	0.40	0.25	0.15
2040	Wooden containers	-2	0.65	0.00	0.65
2051**	Other wood products	-94	0.53	0.21	0.32
2052	Articles of cork and straw	-37	0.12	0.00	0.12
2112**	Pulp, paper & paperboard	-1809	0.54	0.22	0.32
2121	Corrugated paper and paperboard	-40	0.75	0.75	0.00

Source: Own calculations using UK Markets Reports (1993-1994) and Product Sales and Trade (1995-1998)

Table 5.1: [continuation]

2122	Households and sanitary goods	-84	0.47	0.32	0.14
2123**	Paper stationary	-102	0.77	0.57	0.20
2124	Wallpaper	141	0.25	0.00	0.25
2125	Other articles of paper	2	0.83	0.00	0.83
2211	Publishing books, newspapers	672	0.70	0.00	0.70
2214	Publishing of sound recordings	102	0.86	0.74	0.13
2411	Industrial Gases	-38	0.53	0.00	0.53
2412	Dyes and pigments	330	0.73	0.16	0.56
2413**	Other inorganic basic chemicals	145	0.62	0.20	0.41
2414	Other organic basic chemicals	974	0.55	0.08	0.27
2415	Fertilizers and nitrogen componends	-179	0.43	0.41	0.02
2416**	Plastic in primary form	-623	0.41	0.20	0.20
2417	Synthetic rubber in primary form	60	0.65	0.13	0.53
2420	Pesticides and agro-chemistry	397	0.56	0.23	0.32
2430**	Paints, ink and mastics	250	0.72	0.38	0.33
2441**	Basic pharmaceutical products	300	0.71	0.00	0.71
2442	Prepared pharmaceutical products	1399	0.61	0.35	0.26
2451	Soaps and detergents	192	0.72	0.64	0.09
2452	Perfumes and toilet preparations	346	0.64	0.06	0.58
2462	Glues adn gelatine	-30	0.85	0.00	0.85
2463	Essential oils	58	0.65	0.50	0.15
2464	Photographic chemistry	155	0.89	0.00	0.89
2465	Prepared unrecorded media	-272	0.78	0.00	0.78
2466**	Other chemical products n.e.c.	718	0.68	0.11	0.57
2470	Man-made fibres	25	0.66	0.35	0.31
2511	Rubber tyres and tubes	-35	0.77	0.69	0.09
2512	Retreating, rebuilding of rubber tyres	16	0.12	0.01	0.11
2513**	Other rubber products	-4	0.76	0.24	0.52
2521	Plastic plates, sheets, tubes , profiles	-64	0.69	0.49	0.20
2522	Plastic packing goods	-136	0.76	0.27	0.49
2523	Plastic floor and builder' ware of plastic	2	0.61	0.10	0.50
2524**	Other plastic products	-341	0.80	0.18	0.61
2611**	Flat glass	-133	0.67	0.02	0.65
2613	Hollow glass	-60	0.61	0.30	0.31
2614	Glass fibres	16	0.71	0.30	0.41
2615	Other glass techniques	-31	0.71	0.32	0.39
2621	Ceramic household	161	0.40	0.00	0.40
2622	Ceramic sanitary fixtures	14	0.62	0.00	0.62
2623	Ceramic insulators	27	0.51	0.00	0.51
2626	Refractory ceramic products	170	0.40	0.00	0.40
2630	Ceramic flags and tiles	-84	0.22	0.14	0.08
2640	Bricks, tiles and construction products	24	0.43	0.00	0.43
2650	Cement, lime, plaster	-16	0.95	0.88	0.08
2661	Concrete products for construction	4	0.53	0.00	0.53
2666	Other articles of concrete, plaster, cement	21	0.34	0.14	0.20
2681**	Abrasive products	5	0.69	0.00	0.69
2682	Asbestos and other non metallic products n.e.c.	13	0.66	0.41	0.24
2721	Cast iron tubes,Steel tubes	66	0.45	0.19	0.27
2731	Cold drawing	14	0.55	0.40	0.15
2732	Cold rolling of narrow strip	-10	0.73	0.08	0.65
2733	Cold forging	5	0.59	0.00	0.59
2734	Wire drawing	65	0.70	0.48	0.22
2741	Precious metal production	-10	0.51	0.23	0.28
2742**	Aluminium	-552	0.58	0.54	0.03
2743	Lead, zinc and tin	-144	0.54	0.08	0.46
2744	Copper	-392	0.75	0.56	0.19
2745	Other non-ferreous metal production	-164	0.59	0.23	0.36
2811	Metal structures and parts of structures	221	0.64	0.17	0.47
2812	Builers' carpentry and joinery	-11	0.85	0.85	0.00
2821	Tanks and metal containers	-1	0.82	0.61	0.22
2822	Central hetaing radiators and boilers	-95	0.44	0.00	0.44
2830	Steam generators	58	0.38	0.05	0.33
2861	Cutlery	-7	0.42	0.06	0.36
2862**	Tools	-40	0.70	0.37	0.33

Table 5.1: [continuation]

2863**	Locks and hinges	-200	0.62	0.39	0.23
2871	Steel drums and similar containers	6	0.87	0.00	0.87
2872	Light metal packaging	56	0.73	0.00	0.73
2873	Wire products	-36	0.80	0.67	0.13
2874**	Fasteners, screw, chain and springs	-108	0.71	0.07	0.64
2875**	Other fabricated metal products n.e.c.	-99	0.80	0.38	0.41
2911	Engines and turbines, except aircraft and vehicles	356	0.93	0.93	0.01
2912**	Pumps and compresors	108	0.67	0.02	0.65
2913	Taps and valves	55	0.88	0.20	0.68
2914	Bearings, gears, driving elements	-54	0.82	0.28	0.54
2921	Furnaces and furnace burners	97	0.61	0.23	0.38
2922**	Lifting and handling equipment	127	0.74	0.52	0.23
2923	Non-domestic cooling and ventilation equipment	-11	0.70	0.46	0.23
2924**	Other general purpose machinery	163	0.77	0.34	0.44
2931	Agricultural tractors	414	0.43	0.05	0.37
2932**	Other agricultural and forestry machinery	-150	0.61	0.24	0.37
2940**	Machine tools	-11	0.69	0.12	0.57
2951	Machinery for metallurgy	50	0.37	0.17	0.20
2952**	Machinery of mining, quarrel, construction	645	0.64	0.22	0.42
2953	Machinery for foof, beveradge and tobacco	-16	0.65	0.24	0.41
2954	Machinery for textile, apparel and leather	88	0.65	0.07	0.57
2955	Machinery for paper and paperboard	-15	0.70	0.26	0.44
2956	Machienery for other special purposes	-157	0.85	0.28	0.57
2971**	Electric domestic appliances	-434	0.55	0.14	0.41
2972	Non-electric domestic appliances	-35	0.72	0.18	0.53
3001	Office machinery	19	0.73	0.29	0.44
3002**	Computers & information processing equipment	-1439	0.75	0.14	0.61
3110**	Electric motors,generators and transformers	130	0.59	0.05	0.54
3120	Electrical distribution and control apparatus	-202	0.79	0.44	0.34
3130	Insulated wire and cable	-35	0.69	0.34	0.36
3140	Accumulators, primary cells and batteries	-169	0.53	0.14	0.39
3150	Lighting equipment and electric lamps	-75	0.81	0.27	0.53
3161	Electrical equipment for engines and vehicles	-36	0.60	0.32	0.27
3162**	Other electrical equipment	106	0.79	0.09	0.70
3210**	Electronic valves and tubes	-163	0.76	0.26	0.50
3220**	TV and radio Transmiters etc	-256	0.86	0.00	0.86
3230	Television and radio receiver, sound and video	-322	0.69	0.15	0.54
3310	Medical, surgical, orthopaedic appliances	171	0.73	0.28	0.45
3320**	Non-industrial instruments for measuring, testing	417	0.77	0.28	0.49
3340	Optical instruments;Photographic equipment	-222	0.50	0.08	0.42
3350	Watches and clocks	-286	0.59	0.09	0.50
3410**	Motor vehicles	-3155	0.80	0.74	0.07
3420**	Bodies for motor vehicles; trailers	84	0.67	0.14	0.52
3430	Parts and accesories for motor vehicles	-2160	0.66	0.15	0.51
3512	Leisure craft	133	0.50	0.34	0.16
3530**	Aircraft and spacecraft	1904	0.76	0.44	0.33
3541	Motorcycles	-114	0.27	0.19	0.07
3542	Bicycles	-108	0.45	0.00	0.45
3543	Invalid Carriages	10	0.75	0.16	0.59
3550	Other transport equipment	157	0.98	0.00	0.98
3611**	Chairs and seats	-148	0.56	0.06	0.50
3612	Other office and shop furniture	-21	0.55	0.17	0.38
3613	Other kitchen furniture	-25	0.78	0.00	0.78
3614**	Other furniture	-199	0.68	0.40	0.28
3615	Mattresses	2	0.37	0.00	0.37
3620	Striking coins & medals; Jewellery	-285	0.50	0.00	0.50
3630	Musical instruments	-56	0.34	0.00	0.34
3640	Sports goods	-131	0.72	0.13	0.60
3650	Games and toys	-814	0.56	0.14	0.42
3661	Imitation jewellery	-27	0.75	0.16	0.59
3662	Brooms and brushes	-29	0.79	0.37	0.41
3663	Other miscellaneous goods	-133	0.66	0.21	0.45

Table 5.2: Estimation of Stochastic Frontier Production Functions

Industries [SIC92 classification]			PARAMETERS									
			Constant	L	K/L	K/L^2	Demand	Stock	y1995	y1996	y1997	y1998
[1513] (H)	Pork industry	LSDV	6.620*	-0.042 (0.8)	-0.105 (0.6)	0.047 (1.9)	-0.002 (0.2)	0.119 (1.1)	0.041	0.086*	0.139*	0.083*
		ALSDV	6.741*	-0.048 (1.3)	-0.105 (0.7)	0.048 (2.1)	0.003 (0.1)	0.122 (0.8)	0.026	0.082*	0.143*	0.092*
[1533] (H)	Preserved fruit & vegetables	LSDV	7.749*	-0.222 (5.6)	0.194 (5.2)	--	0.002 (1.3)	0.096 (2.4)	0.078*	0.109*	0.001	0.106*
		ALSDV	7.785*	-0.223 (5.8)	0.194 (6.1)	--	0.009 (1.2)	0.095 (2.5)	0.078*	0.109*	-0.001	0.106*
[1551] (H)	Milk& derivates	LSDV	8.355*	0.006 (0.1)	-1.500 (2.6)	0.244 (2.7)	0.003 (1.2)	-0.002 (1.4)	-0.004	-0.091	0.086*	0.081
		ALSDV	8.476*	0.002 (0.0)	-1.517 (3.1)	0.249 (3.3)	0.002 (0.8)	-0.010 (1.2)	-0.009	0.095	0.074	0.058
[1582][1584] (V)	Confectionary	LSDV	6.643*	-0.050 (0.8)	-0.251 (1.0)	0.072 (2.3)	0.003 (0.3)	0.151 (2.5)	0.008	0.002	-0.015	0.021
		ALSDV	6.671*	-0.050 (1.1)	-0.241 (1.3)	0.072 (2.4)	0.003 (0.3)	0.151 (2.5)	0.008	0.002	-0.015	0.022
[1596] (H)	Beer	LSDV	10.885*	-0.649 (1.7)	-0.476 (0.9)	--	0.593 (1.8)	-0.114 (1.6)	0.001	0.132	0.376*	0.406*
		ALSDV	10.079*	-0.596 (1.6)	-0.321 (0.7)	--	0.499 (1.8)	-0.078 (1.4)	0.025	0.154*	0.359*	0.385*
[1710] (H)	Preparing textile fibre	LSDV	4.556*	-0.207 (1.6)	0.090 (0.8)	0.019 (2.0)	0.003 (0.1)	0.005 (0.2)	0.131*	0.175*	0.162*	0.227*
		ALSDV	4.420*	-0.179 (1.8)	0.065 (0.7)	0.031 (1.9)	0.004 (0.1)	0.046 (0.2)	0.092*	0.151*	0.129*	0.224*
[1720] (H)	Weaving industry	LSDV	2.312*	0.069 (0.5)	0.283 (1.4)	0.001 (0.1)	0.025 (0.2)	-0.078 (1.7)	0.123*	0.140*	0.177*	0.143*
		ALSDV	3.210*	-0.104 (0.7)	0.340 (1.6)	-0.020 (0.5)	-0.055 (0.4)	-0.049 (1.6)	0.119*	0.124*	0.194*	0.151*
[1740] (H)	Housing textiles	LSDV	4.562*	-0.184 (1.3)	0.256 (2.6)	--	--	-0.047 (1.6)	0.054	0.062	0.145*	0.201*
		ALSDV	4.462*	-0.120 (0.8)	0.208 (2.1)	--	--	-0.053 (1.8)	0.052	0.056	0.137*	0.216*
[1754] (H)	Lace, narrow, embroidery, wadding	LSDV	0.440	0.087 (1.3)	1.935 (1.5)	-0.379 (1.4)	--	-0.131 (1.3)	0.094	0.136*	0.220*	0.269*
		ALSDV	0.498	0.087 (1.3)	1.935 (1.2)	-0.379 (1.2)	--	-0.131 (1.2)	0.094	0.136*	0.220*	0.269*
[1822] (V)	Outwear excl. workwear	LSDV	6.656*	-0.142 (3.1)	0.108 (3.0)	0.032 (3.0)	-0.004 (1.3)	0.437 (2.9)	0.110*	0.096*	0.051	0.005
		ALSDV	6.690*	-0.143 (3.2)	0.108 (2.3)	0.033 (2.2)	-0.005 (1.3)	0.437 (2.3)	0.110*	0.096*	0.053	0.005
[1824] (H)	Hats and other apparel accessories	LSDV	6.921*	0.017 (0.2)	0.267 (4.4)	--	-0.007 (1.6)	0.425 (2.4)	0.152*	0.089*	0.076	0.087*
		ALSDV	8.096*	0.017 (0.1)	0.267 (4.3)	--	-0.007 (1.5)	0.425 (2.3)	0.152*	0.089*	0.076	0.087*
[1930] (V)	Footwear	LSDV	7.720*	-0.387 (3.8)	-0.366 (2.1)	0.153 (2.8)	-0.002 (0.4)	0.199 (1.2)	0.074	0.010	0.127*	0.149*
		ALSDV	7.798*	-0.387 (3.4)	-0.364 (1.9)	0.152 (2.7)	-0.003 (0.4)	0.196 (1.3)	0.071	0.004	0.130	0.149*
[2051] [H)	Other wood products, nec	LSDV	6.630*	-0.188 (3.2)	0.079 (2.2)	--	-0.001 (0.1)	0.191 (0.3)	0.060*	0.086	-0.021*	-0.204*
		ALSDV	6.709*	-0.190 (3.6)	0.818 (2.0)	--	-0.001 (0.3)	0.191 (0.5)	0.059*	0.065	-0.021*	-0.188*

CONTINUATION TABLE 5.2

[2112] (V)	Paper & Paperboard	LSDV	6.515*	-0.106 (2.0)	0.051 (0.4)	-0.004 (0.3)	0.003 (2.0)	0.027 (0.8)	-0.101*	0.006	-0.281*	-0.242*
		ALSDV	6.599*	-0.107 (2.2)	0.051 (0.3)	-0.003 (0.2)	0.003 (1.8)	0.028 (0.9)	-0.094	-0.004	-0.273*	-0.239*
[2123] (H)	Other paper products	LSDV	5.903*	-0.161 (2.2)	-0.157 (0.8)	0.048 (1.3)	0.005 (0.3)	0.078 (1.3)	-0.044	-0.010*	-0.191*	-0.147*
		ALSDV	5.977*	-0.162 (2.5)	-0.16 (0.9)	0.048 (1.4)	0.004 (0.3)	0.077 (1.0)	-0.044	-0.010*	-0.198*	-0.151
[2413] (V)	Inorganic quemical	LSDV	8.706*	-0.189 (4.1)	0.146 (1.3)	-0.017 (1.1)	0.030 (3.8)	0.092 (0.5)	-0.174*	0.542*	0.475*	-0.101
		ALSDV	8.820*	-0.191 (4.7)	0.151 (1.6)	-0.016 (1.2)	0.025 (3.3)	0.095 (0.4)	-0.136*	0.465*	0.419*	-0.055
[2416] (H)	Plastic in primary form	LSDV	5.504*	-0.170 (1.3)	0.632 (1.8)	-0.130 (1.8)	-0.002 (2.7)	-0.064 (1.5)	0.015	-0.092*	-0.049	0.151*
		ALSDV	5.636*	-0.181 (1.4)	0.637 (2.1)	-0.129 (2.3)	-0.001 (2.6)	-0.064 (1.4)	0.014	-0.092*	-0.051	0.151*
[2430] (H)	Paints & inks	LSDV	9.206*	-0.726 (3.7)	0.155 (0.3)	-0.016 (0.2)	--	0.111 (1.5)	0.095*	0.129*	0.057	0.139*
		ALSDV	7.007*	-0.512 (2.4)	0.388 (0.7)	-0.052 (0.4)	--	0.076 (1.0)	0.124*	0.161*	0.099*	0.175*
[2441] (H)	Basic Pharmaceutical Products	LSDV	6.503*	-0.188 (2.9)	-0.479 (2.4)	0.107 (3.5)	0.009 (2.3)	0.150 (1.1)	-0.054	0.479*	0.105	0.496*
		ALSDV	7.949*	-0.188 (3.1)	-0.479 (2.8)	0.107 (4.2)	0.009 (2.4)	0.149 (1.3)	-0.057	0.477*	0.102	0.498*
[2466] (V)	Quemicals for final consumption n.e.c.	LSDV	6.964*	-0.327 (3.4)	-0.698 (2.7)	0.127 (2.6)	--	-0.007 (0.2)	0.032	0.006	0.056*	0.02
		ALSDV	7.108*	-0.329 (3.7)	-0.680 (2.1)	0.122 (2.1)	--	-0.100 (0.4)	0.017	-0.058	0.035	0.01
[2513] (V)	Rubber products excl. tyres	LSDV	5.268*	-0.316 (2.8)	-0.102 (0.9)	0.070 (2.5)	--	-0.082 (1.6)	0.091*	0.112*	0.120*	0.194*
		ALSDV	5.422*	-0.319 (3.2)	-0.143 (1.3)	0.079 (3.1)	--	-0.078 (1.8)	0.088*	0.104*	0.111*	0.198*
[2524] (V)	Plastic products n.e.c.	LSDV	3.856*	-0.167 (1.7)	0.518 (1.7)	-0.169 (3.2)	0.005 (2.1)	-0.094 (2.2)	0.052*	-0.002	0.041	0.090*
		ALSDV	3.856*	-0.237 (2.5)	0.907 (3.4)	-0.151 (3.3)	0.005 (2.2)	-0.081 (1.8)	0.050*	0.001	0.044	0.152*
[2611] (V)	Flat glass	LSDV	9.091*	-1.094 (2.4)	-0.495 (1.2)	0.198 (1.9)	--	-0.081 (2.1)	0.074	0.113*	0.208*	0.07
		ALSDV	9.170*	-1.089 (2.0)	-0.504 (1.0)	0.191 (1.5)	--	-0.081 (2.2)	0.074	0.115*	0.211*	0.072
[2681] (V)	Abrasive products	LSDV	8.692*	-0.205 (1.4)	-2.508 (2.3)	0.441 (2.5)	0.090 (1.5)	0.127 (1.8)	0.166*	0.144*	0.135*	-0.116*
		ALSDV	8.764*	-0.215 (1.6)	-2.490 (2.0)	0.437 (2.2)	0.090 (1.5)	0.131 (1.5)	0.131*	0.161*	0.144*	-0.118*
[2742] (H)	Aluminium	LSDV	7.439*	-0.153 (2.8)	0.103 (2.1)	--	-0.095 (3.6)	0.057 (1.5)	-0.614*	1.758*	0.574*	0.061*
		ALSDV	7.526*	-0.138 (2.6)	0.138 (2.7)	--	-0.082 (3.1)	0.061 (1.4)	-0.512*	1.508*	0.480*	0.068
[2860] (H)	Cutlery and tools	LSDV	7.229*	-0.371 (5.9)	-0.318 (2.2)	0.071 (2.6)	-0.005 (0.3)	-0.043 (1.7)	0.069	0.117*	-0.159*	-0.221*
		ALSDV	7.325*	-0.377 (8.6)	-0.301 (2.1)	0.704 (2.6)	-0.004 (0.8)	-0.240 (1.5)	0.066	0.109*	-0.163*	-0.203*
[2874] (V)	Fasteners, screw, chain and springs	LSDV	4.881*	-0.241 (2.4)	0.156 (1.9)	-0.011 (1.4)	--	-0.030 (0.7)	0.104*	0.113*	0.128*	0.108*
		ALSDV	5.285*	-0.275 (3.1)	0.170 (2.5)	-0.023 (2.9)	--	0.045 (1.1)	0.040	0.094*	0.068*	0.086*
[2875] (H)	Metal products n.e.c.	LSDV	3.494*	-0.103 (1.8)	0.458 (2.3)	-0.057 (1.7)	--	-0.008 (0.5)	0.075*	0.102*	0.095*	-0.065*
		ALSDV	4.056	-0.124 (2.5)	0.169 (2.3)	-0.001 (1.2)	--	-0.012 (0.8)	0.051*	0.082*	0.080*	-0.084*

CONTINUATION TABLE 5.2

[2912]	Pums & compressors	LSDV	5.385*	-0.208 (4.9)	0.019 (1.3)	0.009 (0.6)	0.006 (2.5)	0.179 (3.7)	0.089*	0.085*	-0.094*	-0.057*
(V)		ALSDV	5.470*	-0.211 (5.3)	0.019 (1.2)	0.01 (0.7)	0.007 (2.4)	0.187 (4.6)	0.083*	0.093*	-0.093*	-0.062*
[2922]	Lifting & handling	LSDV	7.031*	-0.561 (4.9)	0.001 (0.1)	0.013 (0.3)	--	-0.001 (0.1)	0.066*	0.153*	0.162*	0.027
(H)	machinery	ALSDV	7.814*	-0.615 (6.7)	-0.218 (1.4)	0.044 (1.3)	--	-0.003 (0.1)	0.025*	0.063*	0.088*	-0.065
[2924]	General purpose	LSDV	6.225*	-0.143 (3.7)	-0.088 (1.1)	0.031 (1.7)	0.007 (1.5)	0.063 (1.2)	0.063	0.099*	-0.088*	-0.119*
(V)	machinery	ALSDV	6.388*	-0.143 (3.6)	-0.061 (1.5)	0.03 (1.5)	0.002 (1.8)	0.103 (1.6)	0.029	0.090*	-0.109*	-0.111*
[2932]	Agricultural	LSDV	5.827*	-0.188 (2.1)	0.939 (3.4)	-0.159 (3.1)	0.006 (1.6)	0.316 (1.8)	0.004	-0.019	-0.214*	-0.262*
(V)	mach. excl. tractors	ALSDV	5.926*	-0.201 (2.2)	0.927 (3.7)	-0.152 (3.6)	0.004 (1.3)	0.329 (1.6)	0.037	-0.004	-0.221*	-0.248*
[2940]	Machinery for tools	LSDV	6.365*	-0.184 (4.1)	-0.053 (1.4)	0.053 (2.2)	0.006 (0.5)	0.096 (2.8)	0.079*	0.140*	-0.091*	-0.115*
(V)		ALSDV	6.549*	-0.191 (3.8)	-0.153 (1.5)	0.048 (2.1)	0.004 (0.4)	0.088 (2.4)	0.079*	0.141*	-0.088*	-0.113*
[2952]	Mining & earth	LSDV	7.059*	-0.247 (3.3)	-0.018 (0.1)	0.013 (0.4)	-0.024 (2.3)	0.087 (0.8)	0.577*	0.634*	0.319*	0.372*
(V)	machinery	ALSDV	7.098*	-0.247 (2.6)	-0.018 (0.1)	0.013 (0.4)	-0.024 (2.0)	0.087 (0.7)	0.577*	0.634*	0.319*	0.372*
[2971]	Electric domestic appliances	LSDV	5.668*	-0.364 (2.0)	0.581 (1.3)	-0.111 (0.3)	--	-0.028 (2.0)	0.096*	0.052	0.052	0.019
(H)		ALSDV	5.464*	-0.376 (1.9)	0.795 (1.2)	-0.147 (0.4)	--	-0.027 (2.1)	0.105	0.065	0.031	0.02
[3002]	Computers	LSDV	7.586*	-0.170 (3.3)	-0.216 (1.4)	0.042 (1.5)	0.005 (1.5)	0.116 (3.6)	0.168*	0.225*	0.495*	0.512*
(V)		ALSDV	7.622*	-0.170 (3.5)	-0.216 (1.2)	0.042 (1.8)	0.004 (1.5)	0.112 (3.5)	0.168*	0.225*	0.495*	0.512*
[3110]	Electric motors,	LSDV	7.749*	-0.269 (4.8)	-0.152 (1.3)	0.017 (0.6)	-0.009 (0.6)	0.038 (0.8)	0.057	0.102	-0.089*	-0.092*
(V)	generator, transformers	ALSDV	7.856*	-0.270 (5.9)	-0.139 (1.2)	0.015 (0.5)	-0.004 (0.3)	0.043 (1.0)	0.041	0.089*	-0.105*	-0.100*
[3162]	Electric equipment	LSDV	6.781*	-0.094 (2.9)	0.052 (1.8)	--	0.001 (2.5)	0.041 (1.2)	0.071*	0.081*	-0.092*	-0.076*
(V)	for engines	ALSDV	6.894*	-0.098 (3.3)	0.054 (1.9)	--	0.001 (2.7)	0.046 (1.6)	0.061*	0.067*	-0.090*	-0.082*
[3210]	Electrical valves &tubes	LSDV	5.566*	-0.164 (1.8)	-0.241 (0.7)	0.077 (2.0)	--	0.010 (0.3)	0.130*	0.197*	0.207*	0.367*
(V)		ALSDV	5.720*	-0.016 (2.0)	-0.242 (0.6)	0.078 (1.9)	--	0.012 (0.3)	0.129*	0.192*	0.204*	0.368*
[3220]	Electronic capital goods	LSDV	6.406*	**-0.015 (0.2)**	-0.051 (0.5)	0.003 (0.1)	0.003 (1.2)	0.005 (1.4)	0.005	-0.059	0.070*	0.068*
(V)		ALSDV	6.605*	**-0.031 (0.5)**	-0.04 (0.4)	0.005 (1.2)	0.003 (1.5)	0.075 (2.3)	-0.083	0.044	0.016	0.045*
[3320]	Instruments for testing	LSDV	5.923*	**-0.146 (0.5)**	0.126 (2.6)	-0.014 (1.3)	-0.003 (1.8)	1.120 (4.2)	0.085*	0.120*	0.093*	0.021*
(V)	checking, measuring	ALSDV	5.677	**-0.161 (0.7)**	0.151 (2.5)	-0.016 (1.2)	-0.017 (1.1)	1.121 (4.3)	0.036	0.102*	0.108*	0.009
[3410][3420]	Motor vehicles	LSDV	8.016*	-0.259 (3.7)	0.119 (1.2)	-0.006 (0.3)	-0.002 (1.2)	0.205 (3.3)	0.110*	0.111*	-0.009	-0.02
(H)		ALSDV	8.052*	-0.259 (3.9)	0.119 (1.2)	-0.006 (0.3)	-0.002 (1.1)	0.206 (3.0)	0.110*	0.111*	-0.009	-0.02
[3530]	Aircraft and spacecraft	LSDV	6.132*	**-0.075 (1.4)**	0.117 (1.8)	0.035 (2.3)	-0.002 (0.3)	0.113 (3.7)	0.074*	0.080*	-0.001	0.057
(V)		ALSDV	6.243*	**-0.075 (1.3)**	0.116 (1.4)	-0.035 (1.8)	0.004 (0.5)	0.110 (2.8)	0.054	0.068*	-0.031	0.029
[3611]	Seats & chairs	LSDV	3.301*	**-0.172 (1.1)**	0.055 (1.3)	-0.077 (1.3)	-0.001 (1.8)	0.138 (2.0)	-0.066	-0.107*	-0.066	-0.285*
(H)		ALSDV	3.346*	**-0.174 (1.2)**	0.058 (1.3)	-0.078 (1.4)	-0.001 (1.9)	0.139 (2.0)	-0.066	-0.107*	-0.066	-0.285*
[3614]	Furniture, excl. office,	LSDV	8.909*	-0.732 (5.3)	-0.425 (2.7)	0.028 (2.1)	0.001 (2.0)	0.015 (0.5)	-0.0001	0.072*	-0.197*	-0.150*
(V)	shop and kitchen	ALSDV	9.064*	-0.740 (5.8)	-0.419 (2.8)	0.023 (2.3)	0.002 (1.7)	0.012 (0.3)	0.0003	0.810*	-0.175*	-0.163*

Table 5.2.B: Stochastic Frontier Production Functions

Industries [SIC92 classification]		SPECIFICATION TESTS										
		LSDV					ALS-LSDV					
		Firm effects	Hausman (fixed vs random)	Breush Pagan (heterosc.)	Durbin Watson (AR1)	R^2 adjusted	Lambda	Sigma	Mu/Varv (T) Varv (E)	Theta	Distribution of u	# observ [firms]
[1513] (H)	Pork industry	71.04 [0.00]	15.3 (9) [0.08]	15.59 [0.01]	2.08	0.95	1.843 [4.14]	0.19 [3.89]	0.563 [0.29]	--	T	312 [52]
[1533] (H)	Preserved fruit & vegetables	79.49 [0.00]	85.3 (8) [0.00]	26.21 [0.00]	2.05	0.94	0.433 [1.76]	0.113 [2.55]	--	--	H	348 [58]
[1551] (H)	Milk& derivates	44.85 [0.00]	13.1 (9) [0.15]	102.1 [0.00]	2.02	0.93	--	--	0.064 [3.86]	8.487 [5.70]	E	138 [23]
[1582][1584] (H)	Confectionary	64.17 [0.00]	24.4 (9) [0.00]	62.9 [0.00]	2.17	0.97	--	--	0.091 [6.36]	36.72 [1.49]	E	222 [37]
[1596] (H)	Beer	16.40 [0.00]	64.4 (8) [0.00]	21.12 [0.00]	2.19	0.94	1.412 [1.86]	0.168 [6.82]	--	--	H	162 [27]
[1710] (H)	Preparing textile fibre	35.17 [0.00]	9.69 (9) [0.28]	42.54 [0.00]	1.99	0.92	--	--	0.017 [0.21]	6.918 [18.14]	E	492 [82]
[1720] (H)	Weaving industry	12.79 [0.00]	5.92 (9) [0.74]	8.45 [0.48]	1.93	0.80	--	--	0.074 [4.90]	7.899 [7.73]	E	198 [33]
[1740] (H)	Housing textiles	30.56 [0.00]	9.05 (8) [0.33]	14.47 [0.01]	2.31	0.88	--	--	0.087 [7.25]	10.55 [5.08]	E	192 [32]
[1754] (H)	Lace, narrow, embroidery, wadding	13.91 [0.00]	4.37 (8) [0.82]	11.12 [0.03]	2.36	0.76	0.569 [1.24]	0.147 [1.70]	--	--	H	114 [19]
[1822] (V)	Outwear excl. workwear	90.88 [0.00]	21.6 [9] [0.01]	60.07 [0.00]	1.95	0.96	--	--	0.133 [11.35]	29.12 [1.77]	E	372 [62]
[1824] (H)	Hats and other apparel accessories	75.94 [0.00]	503.4 (8) [0.00]	134.25 [0.00]	2.05	0.96	2.33 [2.74]	0.248 [2.70]	0.442 [0.21]	--	T	144 [24]
[1930] (V)	Footwear	14.14 [0.00]	24.05 (9) [0.00]	16.64 [0.00]	1.98	0.86	0.884 [1.23]	0.156 [1.64]	0.154 [0.02]	--	T	198 [33]
[2051] (H)	Wood containers	74.45 [0.00]	43.8 (8) [0.00]	10.42 [0.31]	2.14	0.96	1.351 [1.53]	0.120 [1.75]	0.163 [0.03]	--	T	192 [32]

CONTINUATION TABLE 5.2.B

[2112] (V)	Paper & Paperboard	65.84 [0.00]	47.48 (9) [0.00]	16.14 [0.05]	2.19	0.96	1.131 [1.64]	0.112 [1.60]	0.229 [0.05]	--	T	270 [45]
[2123] (H)	Other paper products	21.03 [0.00]	19.4 (9) [0.02]	31.96 [0.00]	2.2	0.89	0.911 [1.50]	0.137 [1.83]	0.225 [0.03]	--	T	156 [26]
[2413] (V)	Inorganic quemical	142.9 [0.00]	10.3 (9) [0.00]	40.69 [0.00]	1.96	0.97	2.125 [4.10]	0.179 [3.26]	0.515 [0.28]	--	T	432 [72]
[2416] (H)	Plastic in primary form	17.08 [0.00]	49.3 (9) [0.00]	33.21 [0.00]	2.16	0.91	1.088 [1.99]	0.198 [1.78]	0.234 [0.04]	--	T	402 [67]
[2430] (H)	Paints & inks	24.74 [0.00]	13.14 (8) [0.10]	1.15 [0.89]	2.04	0.9	--	--	0.086 [3.95]	7.123 [3.34]	E	126 [21]
[2441] (H)	Basic Pharmaceutical Products	52.62 [0.00]	27.65 (9) [0.00]	43.84 [0.00]	1.94	0.92	0.544 [0.34]	0.175 [1.03]	0.029 [0.001]	--	T	372 [62]
[2466] (V)	Quemicals for final consumption n.e.c.	15.15 [0.00]	19.94 (8) [0.01]	4.25 [0.48]	2.03	0.8	2.098 [3.58]	0.233 [2.60]	0.525 [0.23]	--	T	432 [72]
[2513] (V)	Rubber products excl. tyres	17.8 [0.00]	15.72 (8) [0.04]	25.13 [0.00]	2.02	0.82	1.701 [2.05]	0.158 [1.82]	0.264 [0.06]	--	T	216 [36]
[2524] (V)	Plastic products n.e.c.	10.84 [0.00]	15.95 (8) [0.04]	--	1.99	0.74	--	--	0.003 [0.03]	5.991 [22.6]	E	588 [98]
[2611] (V)	Flat glass	15.35 [0.00]	5.11 (8) [0.74]	9.35 [0.06]	2.29	0.83	0.861 [0.29]	0.155 [0.46]	0.06 [0.001]	--	T	102 [17]
[2681] (V)	Abrasive products	31.03 [0.00]	5.86 (9) [0.64]	1.51 [0.87]	204	0.91	--	--	0.087 [4.96]	20.77 [1.46]	E	96 [16]
[2742] (H)	Aluminium	124.07 [0.00]	24.16 (8) [0.00]	243.7 [0.00]	1.93	0.97	1.951 [2.93]	0.248 [2.52]	0.522 [0.19]	--	T	258 [43]
[2860] (H)	Cutlery and tools	54.25 [0.00]	15.71 (9) [0.07]	59.55 [0.00]	2.1	0.93	1.659 [2.52]	0.159 [1.99]	0.381 [0.11]	--	T	246 [41]
[2874] (V)	Fasteners, screw, chain and springs	29.19 [0.00]	14.63 (8) [0.06]	17.94 [0.01]	2.05	0.87	--	--	0.069 [6.05]	10.11 [6.91]	E	192 [32]
[2875] (H)	Metal products n.e.c.	15.23 [0.00]	21.63 (8) [0.00]	--	1.96	0.81	1.133 [4.84]	0.156 [4.44]	0.417 [0.17]	--	T	750 [125]

CONTINUATION TABLE 5.2.B

[2912]	Pums & compressors	46.67	16.24 (9)	87.6	2.01	0.9	0.857	0.147	0.321	--	T	450
(V)		[0.00]	[0.06]	[0.00]			[3.70]	[4.00]	[0.07]			[75]
[2922]	Lifting & handling machinery	10.44	28.33 (8)	2.49	1.98	0.68	78.82	1.140	5.59	--	T	366
(H)		[0.00]	[0.00]	[0.31]			[0.44]	[0.97]	[0.46]			[61]
[2924]	General purpose machinery	85.4	1.91 (9)	45.5	2.2	0.82	1.891	0.199	--	--	H	402
(V)		[0.00]	[0.99]	[0.00]			[3.22]	[12.7]				[67]
[2932]	Agricultural	41.22	21.96 (9)	40.98	2.18	0.94	1.331	0.169	--	--	H	150
(V)	mach. excl. tractors	[0.00]	[0.00]	[0.00]			[1.68]	[6.22]				[25]
[2940]	Machinery for tools	78.52	17.99 (9)	11.97	2.16	0.94	1.456	0.184	--	--	H	402
(V)		[0.00]	[0.03]	[0.21]			[2.75]	[9.58]				[67]
[2952]	Mining & earth equipment	86.52	9.20 (9)	24.77	2.10	0.95	--	--	0.127	25.82	E	138
(V)		[0.00]	[0.41]	[0.00]					[4.35]	[0.37]		[23]
[2971]	Electric domestic appliances	7.95	16.04 (8)	5.98	1.96	0.73	--	--	0.161	20.34	E	150
(H)		[0.00]	[0.04]	[0.21]					[4.81]	[1.41]		[25]
[3002]	Computers	39.47	52.1 (9)	14.87	2.16	0.92	0.277	0.167	0.0006	--	T	300
(V)		[0.00]	[0.00]	[0.09]			[1.04]	[0.04]	[0.01]			[50]
[3110]	Electric motors,	93.64	31.3 (9)	41.59	2.12	0.94	1.182	0.186	0.264	--	T	312
(V)	generator, transformers	[0.00]	[0.00]	[0.00]			[2.36]	[2.71]	[0.07]			[52]
[3162]	Electric equipment	43.54	1197 (8)	66.35	2.05	0.79	1.21	0.17	0.563	--	T	822
(V)	for engines	[0.00]	[0.00]	[0.00]			[7.87]	[7.15]	[0.31]			[137]
[3210]	Electrical valves & tubes	33.18	19.72 (8)	14.16	2.18	0.9	0.557	0.147	0.069	--	T	468
(V)		[0.00]	[0.01]	[0.10]			[1.87]	[2.15]	[0.006]			[78]
[3220]	Electronic capital goods	42.05	3.70 (9)	69.82	1.99	0.89	2.25	0.248	0.804	--	T	288
(V)		[0.00]	[0.93]	[0.00]			[4.89]	[3.83]	[0.43]			[48]
[3320]	Instruments for testing	13.81	15.21 (9)	--	1.98	0.75	1.262	0.216	0.653	--	T	552
(V)	checking, measuring	[0.00]	[0.05]				[6.28]	[5.30]	[0.31]			[92]
[3410][3420]	Motor vehicles	13.16	19.20 (9)	3.33	1.85	0.79	0.318	0.149	--	--	H	354
(H)		[0.00]	[0.02]	[0.44]			[1.11]	[1.98]				[59]
[3530]	Aircraft and spacecraft	53.85	17.9 (9)	30.07	2.18	0.93	1.481	0.169	0.297	--	T	324
(V)		[0.00]	[0.03]	[0.00]			[2.89]	[2.97]	[0.11]			[54]
[3611]	Seats & chairs	9.97	16.79 (9)	7.19	1.99	0.85	3.622	0.142	--	--	H	240
(H)		[0.00]	[0.04]	[0.10]			[1.11]	[1.62]				[40]
[3614]	Furniture, excl. office,	12.24	38.0 (9)	12.03	1.92	0.71	1.998	0.245	0.659	--	T	312
(V)	shop and kitchen	[0.00]	[0.00]	[0.02]			[3.84]	[2.87]	[0.27]			[52]

Notes for Tables 5.2.A and Table 5.2.B

Table 5.2.A (split into three pages) presents the estimates of the coefficients of the model and Table 5.2.B (split into three pages) presents the specification tests. In Table 4.2.B "lambda" stands for λ,sigma stands for $(\sigma_v^2 + \sigma_u^2)$, mu/varv stands for μ/σ_v, and varv stands for σ_v.

The model is $(\frac{y_{it}}{l_{it}}) = a_i + b_t + \gamma l_{it} + \beta\left(\frac{k_{it}}{l_{it}}\right) + \delta\left(\frac{k_{it}}{l_{it}}\right)^2 + \theta g_{it} + \psi f_{it} + v_{it} - u_{it}$

where y_{it}=log(output), l_{it}=log(employment), k_{it}=log(capital), g_{it}=real growth rate of industry output, f_{it}= stock over total sales (in deviations with respect to the trend), a_i=firm-specific dummies, b_t=time dummies.

LSDV are least squares dummy variables estimators, with dummies for time periods (b_t) and firm fixed effects (a_i). ALSDV are Aigner, Lovell and Schmidt maximum likelihood estimators, with time period and firm specific dummies. No dummies are included for the years 1993 and 1994, which are subsumed in the constant.

* indicates that estimates are significant at at least 5% level. Values in parenthesis are t-statistic.

LSDV statistics. For the Wald tests (χ^2) the values in brackets are the associated probabilities. The fixed effect test is for joint significance of firm dummies; The Hausman test is for specification (fixed vs random effect model); the Breush-Pagan test is for heteroscedasticity; and, the Durbin-Watson statistic is for first order autocorrelation.

ALSDV statistics. The null hypothesis of time-variant inefficiency is based on the significance of λ, $(\sigma_v^2 + \sigma_u^2)$, θ, σ_v under different distribution assumptions. For the truncated normal (T) distribution of the u_{it} the relevant statistics are λ, $(\sigma_v^2 + \sigma_u^2)$ and μ/σ_v; for the half normal (H) , λ and $(\sigma_v^2 + \sigma_u^2)$; and for the exponential distribution (E) θ and σ_v. If the appropiate statistics are not significant, then the null hypothesis of the u_{it} being zero is not rejected. Estimations were carried using LIMDEP v.7.0. See Greene (1993) for further detail about these techniques.

Table 5.3. Distribution of firms by ownership in the sample (Number of firms=2229)

SIC92 code	Name sector	private independent companies Number	owner-control (%)	subsidiary companies Number	foreign-control (%)
[1513]	Pork industry	23	56.5	29	13.8
[1533]	Preserved Fruit&vegetables	23	73.9	34	52.9
[1551]	Milk& derivates	12	41.7	11	45.5
[1584]	Confectionary	13	84.6	22	36.4
[1596]	Beer	16	31.3	10	10.0
[1710]	Preparing textile fibre	47	68.1	34	17.6
[1720]	Weaving industry	17	41.2	16	31.3
[1740]	Housing textiles	17	70.6	15	20.0
[1754]	Lace,narrow,embroidery,wadding	8	37.5	11	27.3
[1822]	Outwear excl. workwear	37	37.8	25	24.0
[1824]	Hats & other apparel accessories	9	44.4	15	33.3
[1930]	Footwear	19	31.6	14	28.6
[2051]	Other wood products	22	50.0	9	44.4
[2112]	Paperboard	14	35.7	31	51.6
[2123]	Other paper products	14	42.9	12	66.7
[2413]	Inorganic quemical	13	38.5	59	54.2
[2416]	Plastic in primary form	16	56.3	49	46.9
[2430]	Paints & inks	4	25.0	16	62.5
[2441]	Basic Pharmaceutical	11	45.5	51	72.5
[2466]	Quemicals for final consumption	13	46.2	58	50.0
[2513]	Rubber products excl. tyres	15	46.7	21	28.6
[2524]	Plastic products n.e.c.	27	48.1	71	29.6
[2611]	Flat glass	6	50.0	10	30.0
[2681]	Abrasive products	8	87.5	9	66.7
[2742]	Aluminium	14	35.7	29	51.7
[2860]	Cutlery and tools	12	58.3	29	62.1
[2874]	Fasteners, screw,chain &springs	14	42.9	18	44.4
[2875]	Metal products n.e.c.	40	62.5	85	31.8
[2912]	Pums & compressors	15	73.3	60	55.0
[2922]	Lifting&handling machinery	29	62.1	32	59.4
[2924]	General purpose machinery	15	73.3	52	50.0
[2932]	Agricultural mach. Excl. tractors	14	50.0	11	45.5
[2940]	Machinery for tools	28	60.7	39	53.8
[2952]	Mining&earth machinery	5	80.0	18	66.7
[2971]	Electric domestic Appliances	11	45.5	14	57.1
[3002]	Computers	15	33.3	34	67.6
[3110]	Electric motors,generators	16	75.0	36	55.6
[3162]	Electric equipment for engines	41	73.2	96	53.1
[3210]	Electrical valves &tubes	24	62.5	54	61.1
[3220]	Electronic capital goods	10	80.0	38	65.8
[3320]	Instruments for testing, measuring	22	45.5	70	47.1
[3410]	Motor vehicles	22	86.4	37	67.6
[3530]	Aircraft and spacecraft	16	68.8	37	24.3
[3611]	Seats & chairs	17	70.6	22	0.0
[3614]	Furniture excl office,shop, kitchen	23	56.5	29	20.7

Source: Own elaboration using data from FAME. Owner-controlled private independent companies have a dominant shareholder with a 90 percent chance of wining a vote.

Table 5.4: Distribution of firms by number of years with information about exports, 1993-1998

Years	Firms
0	232
1	57
2	66
3	57
4	62
5	93
6	1712
N	2279

Table 5.5. Efficiency distributions.

Descriptive statistics	Exporting firms	Domestic-orientated firms	Heavy exporters	Light exporters
Lower quartile	0.74	0.69	0.74	0.72
Median	0.78	0.73	0.79	0.77
Upper quartile	0.85	0.81	0.86	0.84
Interquartile range	0.11	0.12	0.12	0.12
Hypothesis test	Equality of distribution	Stochastic dominance	Equality of distribution	Stochastic dominance
Year	Statistic	Statistic	Statistic	Statistic
1993	4.35	0.00	3.37	0.00
1994	3.97	0.00	3.21	0.00
1995	3.08	0.00	2.55	0.00
1996	5.23	0.00	4.77	0.00
1997	6.88	0.00	5.19	0.00
1998	3.26	0.00	3.23	0.00

Exporters have an export/sales ratio above 2.5%; domestic-orientated exporters have an export/sales ratio below 2.5%.

Heavy exporters have an export/sales ratio above 25%; light exporters have an export/sales ratio below 25%.

Table 5.6: The determinants of technical efficiency levels in UK manufacturing. 1993-1998.

	Constant	Size	Age	Foreign	Exporter	N	R-sq
All industries	-1.343 (38.40)	0.0008 (5.93)	0.0003 (0.04)	0.491 (11.06)	0.086 (2.24)	1902	0.577
Import industries	-1.206 (28.32)	0.0008 (3.78)	0.0005 (0.52)	0.437 (7.13)	0.109 (2.37)	1094	0.556
Export industries	-1.522 (25.00)	0.0007 (4.94)	-0.0007 (0.74)	0.543 (8.65)	0.049 (0.74)	808	0.591
Horizontal IIT industries							
Import industries	-1.468 (18.27)	0.0007 (1.28)	-0.0001 (0.93)	0.403 (3.28)	0.251 (2.17)	336	0.488
Export industries	-1.739 (14.20)	0.0008 (3.55)	0.0005 (2.08)	0.511 (3.21)	0.178 (1.65)	153	0.523
Vertical IIT industries							
Import industries	-1.072 (21.04)	0.0009 (3.52)	0.0001 (1.34)	0.450 (6.42)	0.075 (1.35)	738	0.555
Export industries	-1.446 (20.48)	0.0006 (3.02)	-0.0002 (2.52)	0.547 (8.17)	0.004 (0.05)	675	0.612

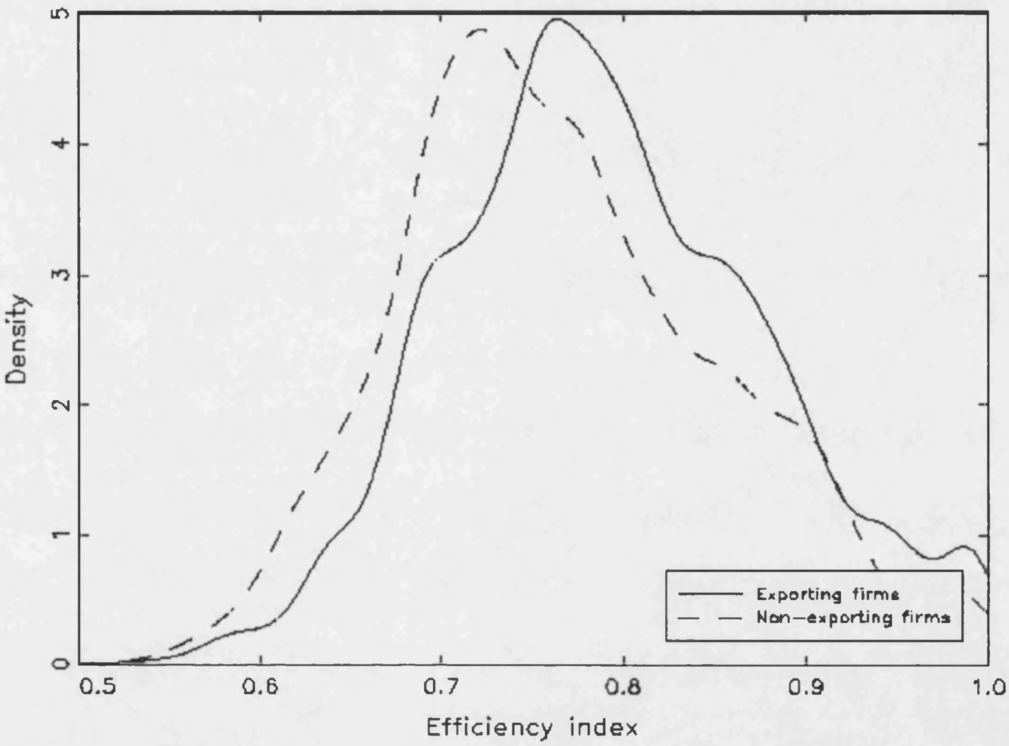
Dependent variable is the firm-specific time-invariant efficiency level, exp(a(i)).
Observations with value of zero and one are not included in the logistic model
(i.e. the 45 "best practice" firms in each industry)
In brackets heterokedastic-robust t-statistics. Regression includes industry dummies.
Explanatory variables: Size=sales, age=number of years since registration in Company House,
foreign=dummy that takes value of one if the firm is foreign-owned subsidiary, zero otherwise;
Exporter=dummy that takes value of one if the firm is a regular exporter
(positive sales abroad with export/sales ratio above 2.5% every year)

Table 5.7: The determinants of changes in Short-Run Efficiency, 1996-1998

	Independent-private firms			Subsidiary firms		
	all firms	owner controlled	manager controlled	all firms	domestic owned	foreign owned
lagged short-run efficiency	0.368	0.336	0.375	0.228	0.118	0.241
	(2.50)	(1.31)	(2.18)	(1.14)	(0.33)	(1.72)
rival firm efficiency	0.368	-0.223	0.196	1.092	1.299	1.029
	(0.86)	(0.68)	(1.75)	(2.62)	(1.71)	(2.55)
lagged market share	-0.095	-0.065	-0.141	-0.008	-0.009	-0.007
	(3.56)	(2.91)	(2.48)	(0.93)	(0.64)	(0.81)
lagged profits	-0.265	-0.202	-0.319	-0.137	-0.205	-0.108
	(2.37)	(1.61)	(1.91)	(2.25)	(1.28)	(2.28)
lagged export/sales	0.021	0.038	0.014	0.074	0.124	0.038
	(1.40)	(1.68)	(1.42)	(1.62)	(1.71)	(1.18)
industry dummies (p-value)	0.98	0.98	0.98	0.99	0.99	0.99
year 1997	-0.015	-0.021	0.012	-0.024	-0.004	0.005
	(0.57)	(0.48)	(1.20)	(0.19)	(0.66)	(0.63)
year 1998	0.018	0.032	0.022	0.003	0.006	0.003
	(0.64)	(0.20)	(1.35)	(0.65)	(0.58)	(0.21)
Adjusted R-squared	0.11	0.14	0.09	0.08	0.12	0.07
Number of observations	714	420	294	1335	882	453

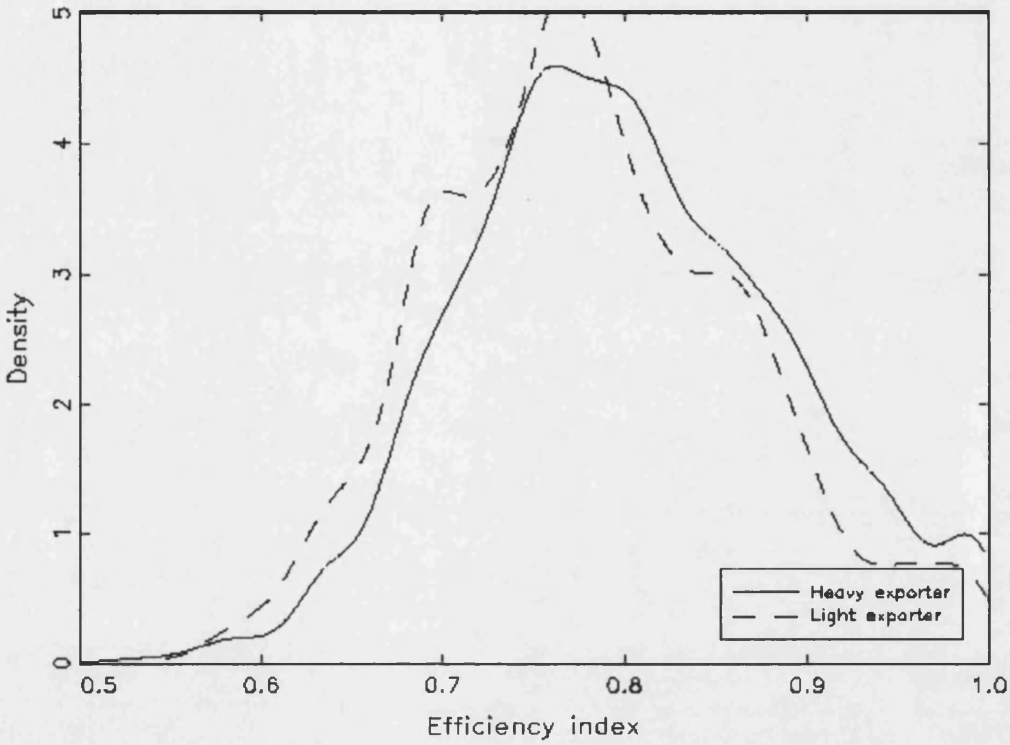
Dependent variable is $-(u_{it} - u_{it-1})$. Lagged dependent variable Δu_{it-1} and contemporaneous rival firm efficiency Δu_{jt} are instrumented by Δu_{it-2} and $\Delta u_{jt-1}, \Delta u_{it-2}$,respectively. Regression includes (ommitted) 20 two-digit SIC industry dummies.

Figure 5.1: **Kernel density functions of RTE index according to export status.**



Exporters have an export/sales ratio above 2.5%
Domestic-orientated firms have an export/sales ratio below 2.5%.

Figure 5.2: Kernel density functions of RTE index according to export intensity.



Heavy exporters have an export/sales ratio above 25%.

Light exporters have an export/sales ratio below 25%.