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# Exports and firm-level efficiency in the UK food and drink industry

Francisco Requena Silvente

Departament of Applied Economics II
University of Valencia
Avda Tarongers s/n, 46022, Valencia, Spain
francisco.requena@uv.es
Tel 96 382 88 51
Fax 96 382 83 54

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**Abstract**
This paper uses firm-level panel data for the UK food and drink manufacturing sector to estimate the effect of export behavior on efficiency. Measures of firm-level efficiency using stochastic production frontier models are constructed for the period 1995 to 2002. Both parametric and non parametric analyses show that exporters are more efficient than non-exporters in the long run. But there is not evidence that, among exporters, greater export intensity leads to efficiency improvements in the short run. This result suggests that learning-by-exporting in this industry is simply the outcome of the presence in the export market.

**Keywords:** Efficiency, export activity, domestic competition, U.K. food and drink industry
**JEL:**

## 1. Introduction

There is an increasing number of research focusing around the question whether firm´s efficiency is significantly improved by the experience of competing in foreign markets. The underlying idea that motivates this research is that selling on the international markets should improve efficiency because of either the exploitation of economies of scale or the learning process through technology and knowledge spillovers. Most empirical studies find that exporting firms are superior to non-exporting firms both in size and in most measures of efficiency. However, the empirical evidence is not conclusive about the direction of causality between efficiency and exports. While some studies find that exporting status does not improve firm performance, other studies using the share of exports on total sales tend to find that greater export intensity improves firm performance significantly.

This paper attempts to investigate empirically whether export activity has a positive influence on technical efficiency improvement using a large panel of UK food and drink firms over the period 1994-2002. While domestic competition has received great attention in the UK as a mechanism that induces firms to improve performance (Nickell, 1996; Hay and Liu, 1997), foreign competition exposure has received no attention.

Our first aim is to find evidence of efficiency differences between firms with different export behavior. A non-parametric analysis of the distribution function of technical efficiency reveals the superior performance of exporters compared to non-exporters in the sample. The same appears to be true for *heavy* exporters compared to *light* exporters, although the difference is smaller than between exporting and non-exporting firms.

Next we estimate regressions of both long run efficiency levels and short run efficiency changes on a measure of export behavior. The parametric results confirm that being an exporter is an important determinant of long run efficiency, after controlling for other firm characteristics. However, we fail to find among the sample of exporting firms any evidence that greater competition in foreign markets makes firms to improve efficiency in the short run.

The rest of the paper is structured as follows. Section 2 presents the data and uses panel data techniques to examine a stochastic frontier production function that allows for the construction of a firm-specific time-variant technical efficiency index. Section 3 analyzes the efficiency index derived in the previous section using kernel density estimations. Section 4 undertakes regression analysis to deepen our understanding of the importance of exposure to foreign competition as determinant of efficiency both in the long and short run. Section 5 provides conclusions.

## 2. Theoretical and empirical background

A considerable literature has 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; 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. There are two explicative mechanisms in the literature underlying this view: the selection mechanism and the evolutionary mechanism.

The *selection* models (Jovanovic,1982; Hopenhyan, 1992) show that more efficient firms stay in business and less efficient firms, after learning about their relative inefficiency level, choose either not to enter or to exit the market. Dixit (1988) shows how the presence of sunk entry costs in export markets act as selection mechanism for weeding out the most inefficient firms. Since export markets have higher demand uncertainty, unexpected price fluctuations and entry sunk costs than domestic markets, exporters need to maintain higher efficiency levels relative to firms selling in the domestic market before entering the export market. Therefore, selection models claim that more efficient firms become exporters.

The *evolutionary* models (Leonidou and Katsikeas, 1996) argue that exporting is in itself a learning process. 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.

Recent empirical works have employed micro-level data to examine the direction of causality between exporting activity and productivity (efficiency) changes. In general, empirical researchers tend to agree that there is a positive relationship between exports and performance improvement.[1] One regularity in these studies seems to be that studies using the export status as a measure of export experience tend to find no learning effects (that is, exporting status does not improve firm performance significantly), while studies using the share of exports on total sales tend to find positive learning effects (that is, greater export intensity improves firm performance significantly).

[1] Using different empirical strategies due to the different nature of data in each country analyzed, Bernard and Wagner (1997), Kraay (1997), Clerides et al. (1998), Iscan (1998), Bernard and Jensen (1999), Beccheti and Santoro (2001), Castellani (2002) have attempted to sort out the direction of causality between export and productivity.

In the UK, Green and Mayes (1991, 1992) used the census of manufacturing firms in 1977 to study the determinants of the 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. Nickell (1996), Nickell et al. (1997) and Hay and Lai (1997) investigated the impact of domestic product market competition on productivity growth and efficiency change in the UK manufacturing industry over the period 1970-1989. They found that greater domestic competition improves firms´ efficiency but the importance of exposure to foreign competition on firms´ efficiency remained unexplored.

Three recent empirical papers using UK firm-level data (Bleaney and Wakelin, 2002; Gourlay and Seaton, 2003; Barrios et al., 2003) have investigated how productivity affects export activity. Compared to other studies for US and Germany, they find little evidence of a strong impact of firm productivity on both export probability and export intensity. However, as far as we know, there are no empirical studies that examine how export activity affects productivity (efficiency) in the UK at firm level. This is quite surprising as nowadays exports represent above 40 percent of total UK manufacturing output.

Following Bernard and Jensen (1999), among others, we will run regress our measure of time-varying technical efficiency on measures of export behavior (export status and export intensity). In the long run analysis of efficiency levels, we will control for other individual characteristics; in the short run analysis of efficiency changes, we will also control for other forms of competition such as *yardstick* competition and domestic product competition.

## 3. Data and the construction of a measure of efficiency

*Data*

The food and drink manufacturing industry was the single largest manufacturing sector in the UK in 2002, accounting for 14.4% of the total manufacturing turnover (£66.1bn) and employing 13.1% of the manufacturing workforce (500.000 workers). Total exports in 2002 for food and drink accounted for 13.4% of total turnover (£8.9bn).

Although Britain has had historically comparative disadvantage in the food and drink manufacturing in the international markets, its exports/output ratio has increased continuously over the period 1970-1992 (Proudman and Redding, 1998). Moreover, the rise in the export/output ratio has continued over the period 1993-2002 (9.6% in 1993 to 13.4% in 2002)[2]. This fact makes the industry an interesting example to search for the impact on performance of greater exposure to competition in foreign markets.

We match two sets of data, one at the firm-level and the other at the industry-level. The first data set is based on firm-level panel data constructed from published profit and loss accounts and balance sheets provided by Financial Analysis Made Easy (FAME). The industry level data on output growth and price indices is from *ONS Sector Review: Food, Drink and Tobacco* and Product Sales and Trade (ONS). The data covers the period 1994-2002.

Table 1 presents the distribution of firms in the sample. There are 501 firms distributed in 10 selected food and drink industries. The sub-industry selection was based on a minimum of 30 firms with completed information to construct the efficiency indices.

One limitation of the dataset is that some firms do not report their export status. For that reason I adopt a two stage estimation procedure. Since firm efficiency is measured with respect to the industry frontier, in the first stage I use all the firms in the sample to estimate the stochastic frontier production functions. This is done industry by industry so the efficiency index is constructed for firms operating under the same technological conditions. In the second stage, I use the sample of firms with full information about export behavior (331 out of 501 firms) to investigate the relationship efficiency-exports.

Table 1 also describes the distribution of firms according to its export behavior. An *exporting firm* is a firm that exports at least once during the period. A *regular exporter* is a firm that exports every year and sells abroad more than 2.5 percent of total turnover. Finally, among regular exporters, a *heavy exporter* is a firm that exports every year above 25% of its total turnover.

[2] Until 1992 National Statistics are based on SIC-80 classification. From 1993 the statistics are based on SIC-92 classification.

*Measuring firm technical efficiency*

This section describes the calculation of the index of firm technical efficiency by econometric estimation of production functions. 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 the index, therefore, depends on accurately estimating the maximal potential output of a firm.

In line with Hay and Liu (1997), we estimate the following stochastic frontier production function (SFPF) for the derivation of an efficiency frontier and the computation of a technical efficiency measure:

$$\ln(y/l)_{it} = a_i + b_t + \alpha \ln(y/l)_{t-1} + \gamma l_{it} + \beta \ln\left(\frac{k_{it}}{l_{it}}\right) + \delta \ln\left(\frac{k_{it}}{l_{it}}\right)^2 + v_{it} - u_{it} \qquad (1)$$

where the dependent variable is the (log) output per worker of firm i in period t, which is a function of two production factors, labor and capital. The introduction of lagged adjustment of output as an explanatory variable captures the dynamic adjustment process and also serves to alleviate any bias caused by the possible exclusion of explanatory variables other than capital and labour. The term $a_i$ measures long run efficiency of the firm relative to the frontier. It reflects firm-specific characteristics that affect internal efficiency (managerial organization) and competitive ability of firms in the product market (such as experience, expertise, quality factors, location, fast adoption of the latest technologies). The term $b_t$ represents time-specific efficiency changes and measures the rate of technical change. The first error term, $v_{it}$, captures random variations in the economic environment that are not directly controlled by the firm. The second error term, $u_{it}$, captures "unobserved" (to the econometrician) technical inefficiency or short run deviations with respect to the "best practice" of the firm. We assume the error term $v_{it}$ to be normally distributed with mean zero and variance $\sigma_v^2$ and the error term $u_{it}$ to have a truncated distribution.[3]

The rest of parameters in eq. (1), that is ($\gamma, \beta, \delta$), are directly related to the technology used in the production function. The parameter $\gamma$ provides a convenient

[3] We test for three alternative truncated distributional forms of $u_{it}$ in the SFPF: the truncated normal distribution, the half-normal distribution and the exponential distribution. See Greene (1997) for details about each distribution.

measure of the extent to which the industry production differs from constant return to scale and the joint significance of the parameters $(\beta, \delta)$ tests for the Translog vs. Cobb-Douglas production function specification. we estimate eq (1) using Aigner, Lovell and Schmidt Maximum Likelihood estimation (Aigner et al., 1977), with time and firm dummies (ALS-DV ML). 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 $v_{it}$. When the residuals are positive skewed (i.e. the longer tail of the distribution lies outside rather than inside the frontier), we fail to estimate the frontier. Three potential reasons can 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. [4]

As 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 $\hat{a}_i$ which reflect deviations with respect to the most efficient firm [the constant term, $\max(a_i)$ ].[5] 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

$$(2) \qquad RTE_{it} = \frac{Y_{it}}{Y_{it}^*} = \exp\left(\frac{a_i - u_{it}}{\max(a_i)}\right)$$

The firm-level variables are derived from the FAME database. 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). Total number of full-time workers measures employment. Output and capital are expressed in real terms using the corresponding output and capital price indices at the four-digit and two-digit SIC

[4] The detection procedure of "outliers" is obtained from Belsley et al. (1980).

[5] Before implementing ALS-DV, I estimate each regression by Least Square Dummy Variables (LSDV) in order to identify the most efficient firm and to perform several specification tests, displayed below in Table 2B.

level, respectively. The introduction of lagged adjustment of output as an explanatory variable captures the dynamic adjustment process, but also serves to alleviate any bias caused by the possible exclusion of explanatory variables other than capital and labour.

The ALS DV ML estimation covers the period 1995-2002 with eight observations per firm. The estimation of the production functions are displayed in Table 2A (estimated coefficients) and Table 2B (statistical tests). [6]The following features summarize the results:

(i) The firm-specific time-invariant effect, $a_i$, captures the relative efficiency of firms, identifying their positions relative to the frontier. This parameter varies across firms in the same industry, incorporating differences in quality of management, in ability to adopt new technologies 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 $b_t$ (grouped by periods of three years) reflect the movement of each sector 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 favorable years for the UK economy after the recession period 1993-1994.

(iii) The time-variant firm-specific efficient term measures the shortfall of the firms relative to their own "best practice" in each period. In eight out of ten of the industries, the specification tests on one of the distributions of the residuals confirm the presence of significant time-variant firm inefficiency (see the ALS-DV columns in Table 2.B)

(iv) The translog specification (i.e. the inclusion of a quadratic term in the log of the capital-labour ratio) was statistically rejected in four industries. The coefficient on the

[6] We have used a two-stage approach to investigate the relationship between technical efficiency and export activity rather than implementing one-stage estimation with a two-equation model, as proposed by Battesse and Coelli (1998), for two reasons. First, we lack of information about the export activities of above 30 per cent of the sample and we do not want to drop firms when estimating the "best possible firm" performance in the industry, which it is used to measure the extent of technical inefficiency of the rest of firms. Implementing a two-stage approach allows us to use all available information in each step of the research. Second, the ALS-LSDV model is able to decompose the technical efficiency term into two, a long-run time invariant term (the average efficiency of each firm relative to the frontier) and a short-run time-variant term (the efficiency of each firm relative to its own "best practice" in each period). Therefore, we can implement a two-time dimension analysis of efficiency-export relationship, in the long-run and in the short-run. The second one is very important as we extent Hay and Liu (1997) research incorporating the impact of foreign competition exposure on efficiency changes.

labour variable can be used to measure of the extent to which the industry deviates from constant returns to scale. The null hypothesis of constant returns of scale is not rejected in six out of ten industries while the rest of industries exhibit decreasing returns to scale. The effect of the capital-labour ratio on output is mixed. In three industries the effect is linear and positive and in two industries the relationship takes a U-shape form. In the remaining industries there is not significant effect.

## 4. Efficiency and exports: a non-parametric analysis

In this section we compare the distribution functions of the RTE index calculated in the previous section between exporters and non-exporters, and between regular exporters with different export intensity. To compare the distribution functions of efficiency levels that correspond to firms with different export behavior, we denote a dummy variable, D, that categorize firms into groups (for example, D=0 for non-exporting and D=1 for exporting firms) and then calculate the density function of the RTE index of firm *i* at time *z*, that is obtained from a Gaussian kernel density estimators $\hat{f}(z|t,D)$.[7]

Figure 1 reports the kernel estimate density functions of the RTE index for exporting and non-exporting 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 of exporting firms. Descriptive statistics and hypothesis tests relating to the kernel estimations are provided in Table 3. Looking at the upper part of Table 3, 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 lower part of Table 3 shows the test statistics for equal distribution and stochastic dominance for the two groups of firms[8]. 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.

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

[8] Delgado, Fariñas and Ruano (2002) provides a description of this methodology.

Figure 2 displays the density kernel functions of the RTE index for firms with different export intensity. The left skewness of the density function of heavy exporters (firms with an export/sales ratio above 25%) suggests a higher level of efficiency compared to light exporters. The statistics of stochastic dominance, display in Table 4, cannot be rejected at any significant level. However, the magnitude of the efficiency differentials is smaller than that for exporters compared to domestic-orientated firms. This finding suggests that export status is more important to distinguish between efficient and inefficient firms than export intensity. One possible explication is that the efficiency/export relationship at firm-level is affected by the industry characteristics that confer the country comparative advantage in the foreign markets. For example, the comparative advantage of the industry magnifies the efficiency differences when we compare exporting and non-exporting firms. If fixed entry costs to the export markets are high, the less efficient firms will not find worth paying. As the UK reveals comparative disadvantage in the food and drink industry, the inefficient firms will find even more costly to pay the fixed entry costs, so the efficiency gap between exporting and non-exporting firms will be larger.

## 5. Efficiency and exports: A regression analysis

*Long run analysis*

To complement the non-parametric analysis, we implement a regression analysis where additional firms characteristics are added as determinants of the long run efficiency. The dependent variable is the RTE index described in eq. (2) and referred to the last year in the sample. In line with previous research (Pitt and Lee, 1981; Haddad and Harrison, 1991) the determinants of long-run efficiency are firm size, age, ownership and export status. Since the dependent variable lies between zero and one, the logistic transformation is applied to the dependent variable and estimate the following model.

$$(3) \qquad \log \frac{RTE_{i,2002}}{1-RTE_{i,2002}} = \alpha_0 + \alpha_1 SIZE_i + \alpha_2 AGE_i + \alpha_3 FOREIGN_i + \alpha_4 EXPORT_i$$

The variable SIZE is measured by the average sales value between 1995 and 2001, AGE is equal to the number of years since registration in Company House until 1995, and the variable FOREIGN is a dummy that takes value of one if the firm is a foreign subsidiary, zero otherwise. The expected relation between the explanatory variables and technical efficiency is as follows. Larger firms are usually to be more efficient than smaller firms because they are thought to have superior organization or technical knowledge. Older firms exhibit a positive relation with efficiency because they have gained experience from past operations and because their survival may reflect their efficiency. The variable FOREIGN seeks to reflect differences in efficiency between foreign and domestic-owned firms, which can be due to differences in the organization of production, input usage or technology access. Finally, we derive three measures of export behavior. (EXPORT). First, a dummy variable if the firm has exported at least one year. Second, a dummy variable that takes value of one if the firm has exported every year and on average its export/sales ratio is above 2.5% over the period 1995-2002. Third, a dummy variable that takes value of one if the firm has exported every year and on average its export/sales ratio is above 25% over the period 1995-2002.

Table 4 shows the results of estimating eq. (5) using OLS. In all the estimations, the positive and significant coefficient on size confirms that larger firms are more likely to achieve higher levels of efficiency. The positive and significant coefficient on foreign ownership suggests a greater deviation from maximum efficiency levels in domestic-owned firms, confirming the results in Griffith and Simpson (2001), who observed a higher labor productivity of foreign-owned compared to domestic-owned establishments in the UK over the period 1980-1996. Finally the coefficient on age is not statistically significant.

With respect to the relationship between efficiency and exports, Row 1 shows a positive and statistically significant coefficient on exporting firm confirming the earlier results that export activity exhibit less deviation from the best-practice efficiency levels relative to domestic-orientated firms. The higher value of the coefficient on regular exporter with an average export intensity of 2.5% in Row 2 indicates that the continuous presence in foreign market has a stronger impact on long run efficiency than an irregular presence. Finally, in Row 3 the coefficient on heavy exporter, although positive, is smaller than that of regular exporter, suggesting that it is export participation rather than export intensity what stimulates firms to be the most efficient ones in the long run.

*Short run analysis.*

We now turn to the determinants of shifts in the efficiency of firms over the short run analyzing a sub-sample of 134 "regular" exporters with complete information over the period 1997-2002. The selection of only regular exporting firms allows us to separate the impact on efficiency performance of competition in the domestic product market and competition in the international product market. We use an extended version of the Hay and Liu (1997) specification for comparison purposes:

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

In the RTE index 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 $\Delta RTE_{it} = -(u_{it} - u_{it-1})$ 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 efficiency improvements each period? We examine are of three kinds of explanatory variables reflecting differing sort of competition. 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. Comparative efficiency is assessed by examining the change in efficiency of all other firms in the sector ($\Delta RTE_{-it}$). 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. A second type of competition comes from the ability of managers to capture rents under the form of slack (Vickers, 1995). A fall in cash flow, which we measure by the change in gross profits lagged one period ($\Delta\pi_{it-1}$) might spur the firm to improve efficiency. A third type of competition comes from the own firm performance in the product market competition. If a firm interprets falling sales as a signal of loss of competitiveness, it will react to improve its performance (Nickell, 1996). The change in the domestic market share lagged one period ($\Delta MS_{it-1}$) measures changes in the domestic product market while the change in the export/sales ratio ($\Delta XS_{it-1}$) measures changes in competition in international markets. In the way $\Delta RTE_{it}$ is defined, we expected that the sign of the coefficients on $\Delta MS_{it-1}$ and $\Delta XS_{it-1}$ to be negative. Finally, the empirical equation is completed by introducing year dummies to pick up any cyclical effects.

Two further points merit comment. First, $\Delta u_{it}$ is a first difference in logs so the explanatory variables are also expressed as such. Second, the dependent variable $\Delta u_{it}$ 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 I instrument the variables $\Delta u_{it}$ and $\Delta u_{-it}$ using its lagged terms. The specification tests at the bottom of Table 5 validate the regression specification as well as the use of the selected instruments. Moreover, the test of joint significance of the coefficients on the time dummies is not statistical significant. This may be explained by the fact that when estimating $u_{it}$ from the stochastic frontier production functions we have already controlled for these effects with year dummies, so we have successfully distinguished the $\Delta u_{it}$ from cyclical effects.

The regression results are given in Table 5 for the sample of 134 regular exporters over the period 1997-2002. Lagged declines in profits lead to improvements in current efficiency. The rest of variables are not statistically significant. One possible explanation of the lack of significance is that firms may respond different to different competition mechanisms depending on their ownership structure (Short, 1994). In regression (2) and (3) of Table 5 we investigate the possibility that efficiency behavior has different determinants for private independent owned firms and subsidiary firms. The results reveal that the type of ownership matters to analyze the impact of competition on efficiency changes. On the one hand, cash shortages continue stimulating firms to improve efficiency. On the other hand, competition in the domestic product market (measured by domestic market share) only improves efficiency among private independent firms, while competition by comparison (measured by rival firms efficiency) only improves efficiency among subsidiary firms. Finally, the coefficient on the change of export/sales ratio is not statistically significant in any of the specifications, so competition in the foreign markets has no discernable impact on short run efficiency changes.

To sum up, there is not support for the hypothesis that the short run efficiency of firms as measured by the $u_{it}$ is affected by competition in the foreign product market place: a fall in export intensity does not stimulate a firm to improve its efficiency. This result suggest that learning-by-exporting in the food and drink industry, in which the UK reveals comparative disadvantage, is simply the outcome of the presence in the export market. The finding is opposite to Castellani (2002) evidence for a sample of Italian manufacturing firms.

The other kinds of competition act as disciplinary mechanisms to improve efficiency, in line with Hay and Liu (1997) findings in the 1970s and 1980s in the UK manufacturing. However, I found that ownership structure matters to identify which kind of competition has larger disciplinary effect on firm performance.

## *6.-Conclusions*

This paper has examined the relationship between technical efficiency and export activity in the UK food and drink industry using a large sample of 331 firms over the period 1995-2002 drawn from FAME databank.

The results can be summarized as follows. First, the data provide robust evidence that exporters obtain 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 than firms with high propensity to export. Hence 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. This finding suggests firm-specific attributes such as managerial quality or internal organization play an important role in the performance of exporting firms. 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 exposure to competition in export markets on short run efficiency improvements.

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Figure 1: Kernel density functions of RTE index according to export status.

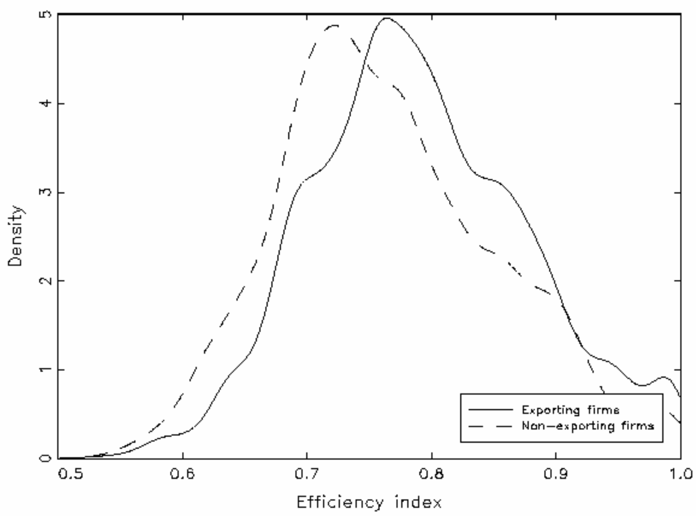


Figure 2: Kernel density functions of RTE index according to export intensity.

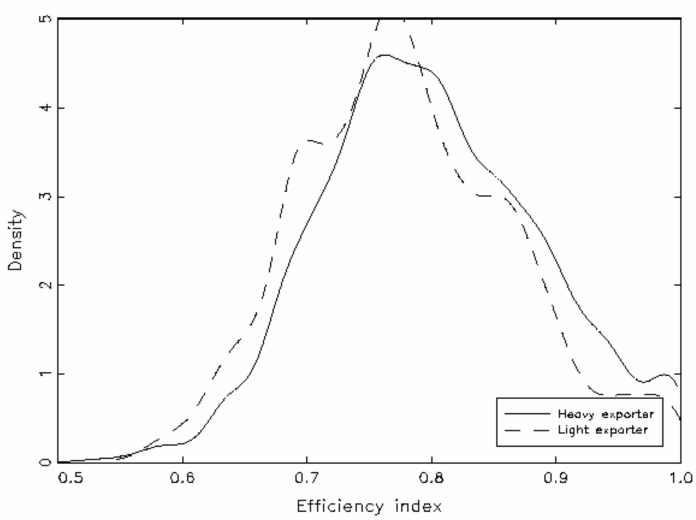

Table 1: Dataset description. Distribution of firms in FAME by food & drink industries. UK, 1994-2002.

| SIC 92 4 digits | Sector Name | FAME | SFPF (94-02) | All years information on export activity (1995-2002) | Exporting firms | Regular exporters X/S>2.5% | Heavy regular exporters X/S>25% |
|---|---|---|---|---|---|---|---|
| **1512** | Production and preserving of poultry | 178 | 43 | 33 | 18 | 14 | 5 |
| **1513** | Production and preserving of pork | 212 | 71 | 52 | 24 | 16 | 7 |
| **1533** | Fruit and vegetables not elsewhere classified | 346 | 89 | 58 | 31 | 23 | 8 |
| **1551** | Milk, butter, cheese and other milk products | 131 | 32 | 23 | 13 | 7 | 2 |
| **1561** | Grain milling and cereals | 171 | 38 | 24 | 15 | 8 | 4 |
| **1571** | Manufacture of prepared feeds for farm animals | 124 | 44 | 26 | 12 | 10 | 4 |
| **1584** | Cocoa, chocolate and confectionary | 134 | 57 | 35 | 22 | 14 | 8 |
| **1589** | Soups & other products nec | 109 | 36 | 21 | 18 | 14 | 7 |
| **1592** | Destilled potable alcoholic beverages | 166 | 51 | 32 | 22 | 12 | 4 |
| **1596** | Beer | 93 | 40 | 27 | 19 | 16 | 5 |
| **Total** | **Selected industries** | 1664 | 501 | 331 | 194 | 134 | 54 |

Notes: (X/S) stands for the share of export sales on total turnover (export intensity). Manufacture of prepared feeds for farm animals (1571) include pet food (1572); Destilled potable alcoholic beverages (1592) includes ethylic alcohol from fermented materials (1591).

Table 2.A. Estimates of the SFPF (Equation 3). Period 1995-2002. UK food and drink industries.

| **INDUSTRIES** | | **PARAMETERS** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SIC 92** | **Name** | **Constant** | **Y(-1)** | **L** | **K/L** | **K/L^2** | **97-99** | **00-02** |
| **[1512]** | **Poultry meat** | 3.210* | 0.649 (2.6) | -0.104 (0.7) | 0.340 (1.6) | -0.020 (0.5) | 0.194* | 0.151* |
| **[1513]** | **Pork industry** | 6.741* | 0.722 (2.8) | -0.048 (1.3) | -0.105 (0.7) | 0.048 (2.1) | 0.143* | 0.092* |
| **[1533]** | **Preserved Fruit & vegetables** | 7.785* | 0.709 (2.5) | -0.223 (5.8) | 0.194 (6.1) | -- | -0.001 | 0.106* |
| **[1551]** | **Milk& derivates** | 8.476* | 0.621 (9.2) | 0.002 (0.0) | -1.517 (3.1) | 0.249 (3.3) | 0.074 | 0.058 |
| **[1561]** | **Grain milling & cereals** | 8.096* | 0.825 (5.3) | 0.017 (0.1) | 0.267 (4.3) | -- | 0.076 | 0.087* |
| **[1571]** | **Food for animals** | 5.977* | 0.777 (7.0) | -0.162 (2.5) | -0.160 (0.9) | 0.048 (1.4) | 0.198* | 0.151 |
| **[1584]** | **Confectionary** | 6.671* | 0.851 (2.5) | -0.050 (1.1) | -0.241 (1.3) | 0.072 (2.4) | -0.015 | 0.022 |
| **[1589]** | **Soups** | 7.007* | 0.776 (4.0) | -0.512 (2.4) | 0.388 (0.7) | -0.052 (0.4) | 0.099* | 0.175* |
| **[1592]** | **Destilled alcoholic drinks** | 6.709* | 0.491 (4.5) | -0.190 (3.6) | 0.818 (2.0) | -- | -0.021* | -0.188* |
| **[1596]** | **Beer** | 10.079* | 0.578 (6.4) | -0.596 (1.6) | -0.321 (0.7) | -- | 0.359* | 0.385* |

Reported Aigner, Lovell and Schmidt maximum likelihood coefficients with time period and firm specific dummies. No dummies are included for the years 1995 and 1996, which are subsumed in the constant. * indicates that estimates are significant at least 5% level. Values in parenthesis are t-statistic.

Table 2.B. Estimates of the SFPF (Equation 1). UK food and drink industries. 1995-2002. Specification tests.

| INDUSTRIES | | SPECIFICATION TESTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Least Square Dummy Variable Estimation (LSDV) | | | | | ALS-LSDV Estimation | | | | | |
| SIC 92 | Name | Firm effects | Hausman (fixed vs random) | Breush Pagan (heterosc.) | Durbin Watson (AR1) | $R^2$ adjusted | λ | σ | $\mu/\sigma_v^2$ (T) $\sigma_v^2$ (E) | θ | Distrib. of u | # observ [firms] |
| [1512] | Poultry products | 12.79 | 5.92 (9) | 8.45 | 1.93 | 0.89 | -- | -- | 0.074 | 7.899 | E | 336 |
| | | [0.00] | [0.74] | [0.48] | | | | | [4.90] | [7.73] | | [42] |
| [1513] | Pork products | 71.04 | 15.3 (9) | 15.59 | 2.08 | 0.95 | 1.843 | 0.19 | 0.563 | -- | T | 568 |
| | | [0.00] | [0.08] | [0.01] | | | [4.14] | [3.89] | [0.29] | | | [71] |
| [1533] | Preserved fruit & vegetables | 79.49 | 85.3 (8) | 26.21 | 2.05 | 0.94 | 0.433 | 0.113 | -- | -- | H | 712 |
| | | [0.00] | [0.00] | [0.00] | | | [1.76] | [2.55] | | | | [89] |
| [1551] | Milk& derivates | 44.85 | 13.1 (9) | 102.1 | 2.02 | 0.93 | -- | -- | 0.064 | 8.487 | E | 256 |
| | | [0.00] | [0.15] | [0.00] | | | | | [3.86] | [5.70] | | [32] |
| [1561] | Grain milling & cereals | 75.94 | 503.4 (8) | 134.25 | 2.05 | 0.96 | 2.33 | 0.248 | 0.442 | -- | T | 304 |
| | | [0.00] | [0.00] | [0.00] | | | [2.74] | [2.70] | [0.21] | | | [38] |
| [1571] | Food for animals | 21.03 | 19.4 (9) | 31.96 | 2.20 | 0.89 | 0.911 | 0.137 | 0.225 | -- | T | 352 |
| | | [0.00] | [0.02] | [0.00] | | | [1.50] | [1.83] | [0.03] | | | [44] |
| [1584] | Confectionary | 64.17 | 24.4 (9) | 62.9 | 2.17 | 0.97 | -- | -- | 0.091 | 36.72 | E | 456 |
| | | [0.00] | [0.00] | [0.00] | | | | | [6.36] | [1.49] | | [57] |
| [1589] | Soups | 24.74 | 13.14 (8) | 1.15 | 2.04 | 0.90 | -- | -- | 0.086 | 7.123 | E | 288 |
| | | [0.00] | [0.10] | [0.89] | | | | | [3.95] | [3.34] | | [36] |
| [1592] | Destilled alcoholic drinks | 74.45 | 43.8 (8) | 10.42 | 2.14 | 0.96 | 1.351 | 0.120 | 0.163 | -- | T | 408 |
| | | [0.00] | [0.00] | [0.31] | | | [1.53] | [1.75] | [0.03] | | | [51] |
| [1596] | Beer | 16.40 | 64.4 (8) | 21.12 | 2.19 | 0.94 | 1.412 | 0.168 | -- | -- | H | 320 |
| | | [0.00] | [0.00] | [0.00] | | | [1.86] | [6.82] | | | | [40] |

Notes. LSDV statistics. For the Wald tests ,CHI(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; the Durbin-Watson statistic is for first order autocorrelation. ALSDV statistics. The null hypothesis of time-variant inefficiency is based on the significance of $\lambda$, $(\sigma_v^2+\sigma_u^2)$, $\theta$, $\sigma_v$ under different distribution assumptions. For the truncated normal (T) distribution of the $u_{it}$ the relevant statistics are $\lambda$, $(\sigma_v^2+\sigma_u^2)$ and $\mu/\sigma_v$ ; for the half normal (H) , $\lambda$ and $(\sigma_v^2+\sigma_u^2)$; and for the exponential distribution (E) $\lambda$ and $\sigma_v$. If the appropriate 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 3: Tests based on efficiency distribution

| **Descriptive statistics** | Exporting firms | Non-exporting firms | Heavy exporters | Light exporters |
|---|---|---|---|---|
| Lower quartile | 0.74 | 0.69 | 0.74 | 0.72 |
| Median | 0.78 | 0.73 | 0.78 | 0.78 |
| 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 |
| 1995 | 4.35 | 0.00 | 3.37 | 0.01 |
| 1996 | 3.97 | 0.00 | 3.21 | 0.00 |
| 1997 | 3.08 | 0.00 | 2.55 | 0.00 |
| 1998 | 5.23 | 0.00 | 4.77 | 0.00 |
| 1999 | 6.88 | 0.00 | 5.19 | 0.00 |
| 2000 | 3.26 | 0.00 | 3.23 | 0.00 |
| 2001 | 4.02 | 0.00 | 3.29 | 0.00 |
| 2002 | 4.62 | 0.00 | 4.47 | 0.01 |

The test for **equality** of cumulative distribution and the test of **differences** in cumulative distribution are, respectively,

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

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

where $n$ and $m$ are the number of firms in each sample and $\hat{F}(.)$ and $\hat{G}(.)$ are their estimated cumulative distribution functions (Smirnov, 1939)

Table 4: The determinants of technical efficiency levels in UK food manufacturing. 1995-2002.

| | (1) | (2) | (3) |
|---|---|---|---|
| Constant | -1.343 | -1.739 | -1.720 |
| | (18.40) | (14.20) | (12.39) |
| Size | 0.0008 | 0.0008 | 0.0007 |
| | (5.93) | (5.55) | (5.59) |
| Age | 0.0003 | 0.0005 | 0.0004 |
| | (0.04) | (0.08) | (0.26) |
| Foreign ownership | 0.231 | 0.111 | 0.126 |
| | (6.06) | (5.21) | (4.72) |
| Exporting firm | 0.086 | | |
| | (2.42) | | |
| Regular exporter>2.5% | | 0.178 | |
| | | (3.86) | |
| Heavy exporter>25% | | | 0.053 |
| | | | (2.13) |
| N | 321 | 321 | 321 |
| R-sq | 0.577 | 0.583 | 0.546 |

*Notes:* Observations with value of zero and one are not included in the logistic model (i.e. the 10 "best practice" firms in each industry) In brackets heteroskedasticity-robust t-statistics. See text for definition of the variables.

Table 5: The determinants of changes in short-run technical efficiency in UK food & drink manufacturing. 1997-2002.

| | All firms | Private independent firms | Subsidiary firms |
|---|---|---|---|
| lagged short-run efficiency | 0.072 | 0.089 | 0.075 |
| | (2.86) | (2.50) | (1.98) |
| rival firm efficiency | 1.009 | 0.268 | 1.392 |
| | (1.72) | (1.26) | (2.55) |
| lagged market share | -0.008 | -0.095 | -0.007 |
| | (0.93) | (3.56) | (0.80) |
| lagged profits | -0.137 | -0.265 | -0.081 |
| | (2.25) | (2.37) | (2.28) |
| lagged export/sales | 0.006 | -0.021 | 0.003 |
| | (0.74) | (0.11) | (1.17) |
| Time dummies | 18.82 (5) | 11.31 (5) | 13.38 (5) |
| 2on order correlation | 1.031 | 1.192 | 0.636 |
| Sargan test | 20.44 (15) | 15.12 (15) | 17.92 (15) |
| Number of observations | 804 | 366 | 438 |

*Notes:* Dependent variable is -(u-u[t-1]); Lagged dependent variable and contemporaneous rival firm efficiency are instrumented by lagged short run efficiency change and rivals' efficiency changes; Regression includes (omitted) year dummies.