Thesis submitted in fulfillment of the requirements for the award of a Masters Degree in Economics from the Nova School of Business and Economics

Multinationality and Export Intensity

Ernesto Freitas

Carried out under the supervision of Professor José Mata

Lisbon, 2013

1. INTRODUCTION

Exports are seen as having an important role in fostering economic growth and are a subject of ongoing research interest. Research at the firm level has successfully linked the prior productivity of firms to their decision to participate in export markets (Bernard et al., 1995; Wagner, 2007). However, export market participation is only the first step of a wider internationalization process that might lead to the establishment of manufacturing subsidiaries abroad, in order to avoid trade costs associated with exports from the home country (Johanson & Vahlne, 1977; Dunning, 1980; Brainard, 1993). Thus, productivity might have a detrimental effect on export growth for firms at later stages of their internationalization process, as these firms choose to establish subsidiaries abroad. On the other hand, while high productivity domestic firms might displace manufacturing abroad, countries also host subsidiaries of foreign multinationals that account for a sizeable share of aggregate country exports and follow a similar internationalization process.

We study the relationship between productivity and multinationality for domestic firms, and between productivity and export behavior for purely domestic firms, domestic multinationals and foreign affiliates of multinationals. We then compare the results obtained with predictions from the literature on international trade with heterogeneous firms. First, we examine how the international behavior of domestic firms conforms to the predictions of the literature, concerning export market entry and subsidiary establishment, as their productivity increases. Second, we examine whether a negative relationship between productivity and export orientation of domestic multinationals can be found, as an indication of the substitution of home exports with subsidiary manufacturing. Third, we examine the relationship between productivity and export orientation for foreign affiliates, discuss how they depend on the diverse integration strategies of multinationals, and compare with findings for other countries.

Using recent data on firms operating in Portugal we find that domestic multinationals and foreign affiliates of multinationals account for a very large share of aggregate country exports. We find that, among domestic firms, firms with lower productivity are focused on the domestic market, firms with higher productivity export more, and those with the highest productivity are multinationals. We find little support for a negative relationship between productivity and export orientation for domestic multinationals, and discuss how the absence of this relationship could result from initial subsidiaries being established as non-manufacturing sales outposts. We find no support for a direct relationship between productivity and export orientation of foreign affiliates of multinationals, and discuss how the international integration strategies of foreign affiliates, as determined by host country factors such as transport and labor costs, might contribute to this result.

2. THEORETICAL FRAMEWORK

2.1 High productivity firms become exporters

A persistent finding in the empirical literature on exports is that exporting firms are larger and more productive than non-exporting firms (Wagner, 2007).

The literature has settled that the higher productivity of exporters is better explained by the selection of high productivity of firms into exporting than by the existence of accrued productivity benefits from exporting. In fact, the superior performance characteristics of exporting firms have been found to precede exporting status of firms by several years (Bernard & Jensen, 1999), and there is no significant empirical support for additional performance benefits to exporters due to the export activity itself (Clerides et al., 1998).

The existence of productivity requirements for exporting is expected, as exporting requires that firms bear additional costs relative to domestic activity. Entry in export markets requires that firms bear fixed costs of entry associated with the establishment of distribution or service networks, workforce training or product compliance (Baldwin, 1988). While some of these costs may be sunk, continued operation in export markets requires that firms permanently incur in transport costs and thus remain high productivity firms.

2.2 High productivity firms also become multinationals

Multinationals must be high productivity firms, as they bear high fixed costs of FDI and must possess firm-specific advantages to overcome the costs of operating in a foreign country (Dunning, 1980).

Multinational firms can be expected to have high productivity due to existence of intangible firm-specific assets. The decision to become a multinational firm has been derived as the optimal mode of serving a foreign market, as opposed to resorting to licensing agreements or exporting, when firms attempt to prevent the dissipation of proprietary knowledge-based assets (Ethier & Markusen, 1991). The multinational firm is then viewed as a network of affiliates with access to firm-specific assets, that are related to expertise in engineering, management or marketing (Horstmann & Markusen, 1987), and which are available inside the multinational firm as public goods.

The decision to become a multinational firm has also been derived as the result of high productivity firms choosing to spread their production internationally. International organization of production allows multinationals to exploit scale economies and international factor price differentials (Dunning, 1993). However, only firms with sufficiently low variable costs of production will try to attain those cost related advantages and become multinationals (Grossman et al., 2006).

2.3 Multinational firms have a heterogeneous exporting behavior in home and host countries

Multinational firms establish subsidiaries in host countries partly to prevent the transport costs associated with international trade between home and host countries (Brainard, 1993). In fact, the majority of foreign affiliates have a predominantly domestic market oriented activity (Kneller & Pisu, 2004). Consequently, this strategy precludes an important exporting behavior for the multinational in either the home or host country.

On the other hand, some multinational firms establish exporting affiliates abroad. Noting a growing importance of intra-firm trade, Hanson et al. (2005) show that multinationals organized in vertical production networks place labor-intensive input-processing activities in low-wage countries, thus leading to the establishment of exporting subsidiaries abroad and linking the establishment motive with low labor costs.

The establishment of exporting affiliates is not restricted to vertically integrated multinational firms. Export platform production, where multinational firms establish manufacturing affiliates abroad in order to export to third countries or to the home country, is also an empirically important outcome as found by Hanson et al. (2005). Export platform production in low-cost low-demand countries has been derived as an optimal multinational location strategy to serve demand in a free-trade area such as the EU or the NAFTA. This strategy allows for the large scale economies associated with production in a single plant inside a larger regional bloc to serve its demand, while holding the ability to exploit factor price differentials (Ekholm et al., 2007).

Thus, some foreign affiliates have an exporting activity in the host country, although most foreign affiliates are not expected to. This exporting activity of foreign affiliates in host countries can be justified with concentration of production to achieve scale economies or intermediate production to draw from favorable factor price differentials. Multinational exporting behavior at the home country is left undetermined for the abovementioned strategies. While multinationals are always expected to maintain headquarter services in the home country, whether they displace manufacturing activities from the home country to host countries is dependent on the overall motives for establishing subsidiaries.

2.4 Higher productivity allows exporters to become multinationals

Firms follow a gradual internationalization process that starts with ad hoc exporting and deals with intermediaries in foreign markets, and may progress until the establishment of subsidiaries, first as sales organizations, and later on as local manufacturers (Johanson & Vahlne, 1977). Progress along internationalization stages necessarily alters the exporting role for the multinational firm at home. In particular, if firms establish manufacturing subsidiaries abroad, it may be in substitution of home exports, although the effect of subsidiary establishment on home export behavior is ambiguous as subsidiaries may be established as non-manufacturing sales outposts that may be used as distribution networks in order to increase home exports.

Progress over the various internationalization stages requires, however, that firms overcome several productivity hurdles, as discussed earlier. In fact, international trade models usually model FDI and international trade decisions of firms as linked and dependent on the learned productivity of individual firms. The derived outcome is that, low productivity firms operate in domestic markets, as they cannot profitably incur in the additional transport and trading costs of export markets, and high-productivity firms participate in foreign markets, with the most productive among these opting to serve foreign markets with manufacturing in the host country, as FDI is more costly than exporting (Helpman et al., 2003).

The literature on heterogeneous firms and international trade also relates firms' learned productivity with their international trade decisions in settings were firms face richer integration choices, namely, when firms are able to conduct one or more stages of production internationally. Grossman et al. (2006) show that, in the absence of transport costs, an assumption that invalidates horizontal location motives for multinationals, firms might still locate in a low-demand low-wage country as part of an export platform or vertical FDI strategy. As in the previous case, only sufficiently high productivity firms can incur the fixed costs of any manufacturing FDI activity, as these firms are granted larger savings in variable costs associated with production in the low-wage low-demand country. Firms with insufficiently high productivity must remain in home production and resort to exports to serve foreign markets (Grossman et al., 2006).

Productivity is a key determinant of firms' optimal international integration strategy. An increase in productivity for high productivity exporting firms might lead them to establish manufacturing subsidiaries abroad. Thus, for sufficiently high productivity firms, in contrast to the effect found at earlier stages of export activity, further increases in productivity might have a negative effect on home exports due to a partial or complete displacement of exports through the shift of manufacturing abroad.

2.5 The impact of productivity on the home country export behavior of multinationals varies with firms' productivity level

The impact of multinationality on home export behavior depends on the type of subsidiaries that are established in host countries. Establishment of manufacturing subsidiaries is expected to have a negative impact in home export behavior, as subsidiary establishment has mostly horizontal motives (Brainard, 1993). However, firms also establish non-manufacturing subsidiaries, as part of firms' distribution networks, which should have a positive effect on home country export behavior.

The establishment of non-manufacturing subsidiaries is sometimes the first stage leading to the establishment of manufacturing subsidiaries. It has been found that some firms establish subsidiaries in the host country as part of their distribution network and then gradually increase the number of manufacturing stages performed at the subsidiary (Johanson & Vahlne, 1977). If the initial subsidiary establishment is done as an effort to enhance the firm's distribution network, we expect initial productivity increases to translate into higher home country export intensity for multinational firms.

Multinational firms that choose to initiate manufacturing activities in substitution of distribution network subsidiaries are likely to have higher productivity than those that choose not to. In fact, when firms choose between establishing more plants with the associated higher fixed costs, or less plants and distribution networks with associated lower fixed costs but higher variable costs, only the most productive firms choose the first option, as more productive firms are more likely to try to minimize variable costs of operation (Lu et al., 2010).

Thus, while initial productivity increases might be expected to lead firms to establish non-manufacturing subsidiaries and lead to an improvement in the home market export performance of multinationals, we expect that further increases eventually result in the establishment of manufacturing subsidiaries that can lead firms to at least partially withdraw from home market exports.

2.6 The relationship between productivity and export intensity of foreign affiliates is undetermined at the outset.

Most of the previous discussion addresses how the establishment of subsidiaries might influence firms' export behavior in the home country, under the assumption that most multinationals establish manufacturing affiliates for horizontal motives. While this motive might be valid for most firms (Brainard, 1993), particularly at the early stages of the internationalization process that were discussed (Johanson & Vahlne, 1977), it does not foresee any exporting role for foreign affiliates on host countries and thus cannot explain the disproportionate share of country exports held by foreign affiliates (Kneller & Pisu, 2004).

The abovementioned vertical integration and export platform strategies explain the exporting behavior for foreign affiliates. Concentration of final or intermediate production in a single country leads to the prediction of a positive relationship between productivity and export intensity, as the higher production levels of the more productive firms cannot be fulfilled with production in alternative plants as is the case of horizontally integrated multinationals.

However, contrary to this hypothesis, Lu et al. (2010) find that, in China, exporting foreign affiliates are less productive than non-exporting foreign affiliates. The authors develop a model similar to the model developed by Grossman et al. (2006) to illustrate how a negative relationship between productivity and the export status of foreign affiliates can be derived, if firms choose between establishing individual plants to serve local markets and establishing a single plant with distribution networks to serve both the local market and markets abroad. As discussed earlier, in this setting non-exporting foreign affiliates are required to have a higher productivity, in order to bear the higher fixed costs associated with establishing individual plants over establishing distribution networks.

Unlike domestic firms, the firms now considered are at a more advanced internationalization stage, since they are productive enough to establish manufacturing subsidiaries abroad, but face a choice between an export platform strategy that concentrates production in a single country and a horizontal integration strategy that disperses production in independent countries. The selection of higher productivity foreign affiliates into local manufacturing is driven by a change in the

optimal integration strategy from export platform production to local production in independent locations when productivity is sufficiently high. This argument would predict, for instance, that some high productivity firms would eventually displace activities from low-cost host countries to their home countries when faced with positive productivity shocks, which might be an empirically relevant result (Sirkin et al., 2012).

However, the result found by Lu et al. (2010) could be dependent on the setting considered. In fact, the result is driven under the assumption of a large domestic demand, both theoretically and in the empirical setting. If domestic demand is low, the productivity threshold to make firms abandon an export platform strategy in favor of local production should be higher. Thus, a low domestic demand could be insufficient to drive a large number of high productivity firms to establish local manufacturing plants to the point of inducing a significantly negative relationship between productivity and export status for foreign affiliates. Additionally, if the low demand country is located inside a large free-trade region with low transport costs with neighboring countries, these costs subsequently reduce the value of exclusively local production and make it less likely to occur. While multinationals might take the larger regional market as the relevant market, and consider installing manufacturing plants at a regional level to substitute distribution networks, this might still not have a visible effect in the export intensity of the local affiliate if the affiliate is accustomed to supply neighboring markets, and thus not contributing to induce a negative relationship between productivity and export intensity.

A low-demand low-wage country located inside a larger regional free trade area is an important setting to test the relationship between productivity and export intensity of foreign affiliates, as countries with this profile have been conjectured to be the most likely recipients of export platform motivated FDI (Ekholm et al., 2007).

3. DATA AND METHODS

3.1 Data

We use data from the SABI dataset which is provided by Bureau van Dijk, and whose primary source in Portugal is "Informação Empresarial Simplificada", a mandatory yearly survey conducted by administrative entities. Almost the whole population of Portuguese firms is required to hand in these surveys, although some legal forms are exempted, mostly non-profit or unlimited liability organizations. The information collected contains balance sheet and income statement data, including information on export activity for recent years.

Firms are also required to provide ownership information, including shareholder and subsidiary stakes along with the country of origin or destination of these stakes. Bureau van Dijk combines this ownership information with exhaustive ownership information collected from firms' public reports on an international basis, in an effort to identify the ultimate shareholder of the firm and its nationality by following all known majority shareholder upstream links for the firm.

Unfortunately we are only provided with the ownership information at the date of data collection, and are not able to identify ownership changes, although we expect firm

ownership data to be stable. We use information on the nationality of the ultimate shareholder of the firm to assign foreign status to firms, and are also able to identify domestic multinationals, defined as domestic firms that report established subsidiaries abroad.

We have access to a panel of firms operating in Portugal from 2008 until 2011, from which we select firms whose primary activity is in manufacturing, and thus classified within ISIC Rev. 4 codes 10 to 33. We restrict our analysis to manufacturing firms, as our earlier discussion does not conform to the determinants of exports and subsidiary establishment decisions of firms operating in the services or in the primary sector. Industry classification data is also only available at the date of data collection, although we also expect that it is not a significant source of error, as we do not expect that many firms change their main industry during the short time span of the data.

Additionally, we drop firms with missing values for any of the following variables: fixed assets, number of employees and added value. In order to comply with the requirements of our estimation procedures, we also drop a small number of firms with negative values for added value and firms operating in three-digit ISIC sectors with less than 10 firms in total. Finally, due to irregular coverage of data, we use a constant sample of firms that are observed in every year of the panel and satisfy all of the cleaning procedures described above.

Our final sample includes 15,580 purely domestic firms (henceforth referred to as "domestic firms"), 100 domestic multinationals and 209 foreign firms. All nominal variables are deflated with the GDP price deflator and reported at 2011 prices.

3.2 Empirical Strategy

We follow a two-step approach. First, we estimate input coefficients of Cobb-Douglas production functions separately for each individual industry, in order to obtain total factor productivity (TFP) estimates for individual firms. Second, for each firm ownership type, we regress firm export orientation on firm productivity, using the estimates of firm productivity obtained in the first step.

3.2.1 Production Function Estimation

To obtain TFP estimates for individual firms we estimate several specifications of the following equation:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it}$$

where y_{it} is the logarithm of value added, used to measure of firm output, and l_{it} and k_{it} are the logarithm of labor and capital, respectively. The error term is assumed separable into ω_{it}, a productivity component and η_{it}, an i.i.d component.

Estimation of the previous equation presents several challenges. The first problem is the simultaneity of input choice. If firms with higher productivity choose higher input levels, then productivity and input usage will be positively correlated and the OLS estimator will be biased upwards for both input coefficients.

We could also have a selection bias. If firms find capital inputs harder to adjust than labor inputs, negative productivity shocks are less likely to lead to firm exit in firms with higher levels of capital. This effect would generate a downwards bias in the OLS estimator of the capital coefficient (Van Beveren, 2012). However, selection bias is found to be much less important empirically than the simultaneity bias (Levinsohn & Petrin, 2003)

There are several alternatives to overcome these problems. The procedures introduced by Olley and Pakes (1996) and Levinsohn and Petrin (2003) are frequently used and make use of assumptions on the timing and dynamics of input usage and TFP, as well as the relationship between inputs and TFP, in order to obtain semi-parametric estimators that are consistent in the presence of a simultaneity bias and even for the less severe selection bias effect in the case of the first procedure.

A less structural approach is to use a fixed effects estimator (Pavcnik, 2002; Levinsohn & Petrin, 2003; Eberhardt & Helmers, 2010). The fixed effects estimator will provide consistent estimates for input coefficients under the assumption that ω_{it} is firm specific but time invariant, that is, assuming $\omega_i \, \forall_t$, which would be unreasonable if firms had time to adjust inputs to their realized productivity. As the fixed effects estimator only uses within firm variation, it is not subject to the simultaneity bias. Assumption of time-invariant fixed effects for firms rules out the selection bias from exit that is due to the realization of low productivity shocks by assumption.

However, fixed effects estimation may be appropriate to our setting. The assumption of time invariant fixed effects may be suited to our short panel. Also, the time period used in out panel provides particularly high within firm variation, thus minimizing the downfall of only using within firm variation instead of cross section variation. Accordingly, we perform fixed effects regressions by each manufacturing sector in our panel, both using two-digit and three-digit ISIC sectors. For comparison purposes, we also perform equivalent OLS regressions for each manufacturing sector in our panel.

3.2.2 Export Intensity Regressions

After obtaining TFP estimates, we estimate several specifications of the following equation with OLS regressions:

$$EI_{it} = DOM\times(\beta_0^{DOM} + \beta_1^{DOM}TFP_{it}) + DMNE\times(\beta_0^{DMNE} + \beta_1^{DMNE}TFP_{it}) + \\ + FOR\times(\beta_0^{FOR} + \beta_1^{FOR}TFP_{it}) + \gamma_{it} + \epsilon_{it}$$

where EI_{it} is firm export intensity, the share of firm output that is exported, DOM, DMNE and FOR are dummies for firm ownership type, indicating whether the firm is a domestic firm, a domestic multinational or a foreign affiliate. γ_{it} stands for a set of common control variables which include, according to specification, 4 year dummies, 21 location dummies and 74 three-digit industry dummies (corresponding to 22 two-digit industries).

4. RESULTS

Table 1 presents aggregate values for performance and input variables in 2011 for our sample. Aggregate value added in our sample is roughly 4% of the GDP of Portugal, which was 185 billion euros in 2011. This low percentage is due to the restriction to manufacturing sectors only, as manufacturing only accounts for about 13% of the GDP in Portugal (World Bank data for 2010; data not available for 2011, but with overall decreasing trend). However, firms in our sample account for a stable share of about 30% of total Portuguese exports in the sample period, as can be seen in Table 2.

We can also observe in Table 1 that domestic multinationals account for around 10% of aggregate sample values in assets, sales, exports and value added, and a substantially smaller share of the number of employees. Foreign affiliates account for around 20% of aggregate assets, value added and sales in our sample, and also account for a substantially smaller share of employees. Nevertheless, foreign affiliates are responsible for a very large share of exports, particularly EU exports as they account for 40% of EU exports in our sample.

Table 3 displays the distribution of firms by each two-digit ISIC Industry. The aggregate number of firms is around 15,000, which compares to a population of around 38,000 manufacturing firms (data from Statistics Portugal). Thus we are able to account for around 30% of manufacturing output and 40% of the number of firms. Although these shares are imprecise, they may indicate an overrepresentation of smaller firms in our sample. Both domestic multinationals and foreign affiliates seem to be moderately well distributed across sectors, although the distribution of domestic multinationals seem to follow more closely that of domestic firms.

Table 4 displays averages of key variables in our sample by firm ownership type. The distribution of some of these variables is depicted in Figure 1. Variables that are directly related with input use such as assets, fixed assets, number of employees, labor costs, skill and labor productivity, are all similar among domestic multinationals and foreign affiliates, although the similarity is smaller for labor related variables, as foreign affiliates seem to hire less but more skilled workers, when compared to domestic multinationals. For any of these variables, foreign affiliates and domestic multinationals have significantly higher average values than domestic firms. Figure 1 illustrates how the distributions of input usage variables and performance variables are similar among domestic multinationals and foreign affiliates, and dissimilar between domestic firms and either domestic multinationals and foreign affiliates. In spite of this similarity, the distributions of input usage and performance variables of foreign affiliates are more left skewed and exhibit higher dispersion than the distributions of domestic multinationals.

Foreign affiliates export considerably more than domestic multinationals, although they are not located in industries with higher levels of export orientation and a higher percentage of domestic multinationals are exporters. Foreign affiliate export intensity is more polarized than that of domestic multinationals, as most foreign affiliates either export most of their production or a small amount of their total production, in contrast with a much more even distribution of domestic multinational firms over export intensity. This helps us understand the relative left skew of the distribution of characteristics for foreign affiliates relative to that of domestic multinationals, as an

important number of foreign affiliates are domestic market oriented and thus can operate at a smaller scale than domestic multinationals. Foreign affiliate exports are more EU market oriented than those of domestic multinationals, and the latter group of firms seems to perform better than foreign affiliates in non EU markets, as illustrated in Figure 1. Domestic firms have a poorer export performance than any other group of firms, with lower exports, a low percentage of exporters and low export intensity among exporters.

Table 5 and 6 present estimates for input coefficients obtained with a set of pooled OLS regressions by both two and three digit industries. As discussed above, the output variable used is deflated value added. The labor input variable used is the number of employees and the capital input variable is deflated fixed assets. Average coefficients for labor and capital are similar in the two-digit or three-digit industry specifications. In the case of a two-digit industry specification, the average capital input coefficient is 0.92 and the average labor input coefficient is 0.15. Average sum of coefficients is 1.08, in favor of returns to scale, with almost no sector reporting negative returns to scale. In the latter case of a three-digit industry specification, the average capital input coefficient is slightly higher at 0.94 and the average labor input coefficient is slightly smaller at 0.14. Average sum of coefficients is still 1.08, again in favor of returns to scale for almost all sectors.

In Table 7 and 8 we report the input coefficients obtained using a fixed effects estimator (within). As expected from the existence of a simultaneity bias leading to an upward bias in OLS estimates, there is a drop in average input coefficient estimates for both input types. In the two-digit case, the average labor input coefficient is now 0.61 and the average capital input coefficient is 0.07, with an average sum of coefficients of 0.68, in favor of decreasing returns to scale, although two sectors still exhibit increasing returns to scale and the overall distribution of the sum of coefficients is larger. In the three-digit case, average labor input coefficient, average capital input coefficient and average coefficient sum are all the same as in the two-digit case.

The capital input coefficient appears to be small, although these input coefficient estimates are similar to those generally found performing fixed effects estimations with value added as the output variable. In particular, Eberhardt and Helmers (2010) find fixed effects estimation to hold a capital input coefficient of around 0.2, sometimes near 0.1, depending on specification. Additionally, fixed assets are generally 25% to 30% of total assets (Table 1). Total assets include intangible assets, which are one the discussed sources of firm productivity, and thus should be excluded. If we were to include total assets as our capital input variable and perform fixed effects regressions we would obtain input coefficients of 0.53 for both labor and capital at the two-digit level and 0.52 and 0.50 for labor and capital, respectively, at the three-digit level (not reported).

In Figure 2 we plot the distribution of TFP estimates according to these 4 specifications and firm ownership type. The distribution of TFP estimates obtained with pooled OLS estimations at the two-digit or three-digit industry level appear to be unreasonably different from the distributions of any performance related variables in Figure 1. On the other hand, either of the two distributions obtained under fixed effect estimations seems to agree with the overall shape of performance variables in Figure

1. As the pooled OLS estimator results in larger estimates for the capital and labor input coefficients, groups of firms with higher productivity and input usage will have more of their performance attributed to the higher input usage, resulting in smaller productivity residuals than in the fixed effect estimation case and smaller differences in estimated productivity across firm ownership groups. As can be seen in Table 9, TFP estimates according to a two or three digit industry level are also highly correlated for any chosen estimator and do not seem to hold considerable differences, although less so in the fixed effects case.

Table 11 reports the distribution of firm TFP estimates for our preferred specification of fixed effects regression at the three-digit level, by firm ownership type. It illustrates the similarity in the distribution of TFP estimates for foreign affiliates and domestic multinationals, a higher overall productivity of firms in any of these two groups relative to domestic firms, and also a slightly higher dispersion of productivity of foreign affiliates relative to domestic multinationals. At the last two classes of TFP estimates, we find only 0.4% of domestic firms, but 15% of domestic multinationals and 16.3% of foreign affiliates.

Figure 3 depicts how the TFP of firms of any ownership type increases as firms age. Accordingly, the slope of the lines fitted for any firm ownership type is always positive. This result is consistent with gradual productivity increases over time and can justify firms' gradual progress over internationalization stages (Johanson & Vahlne, 1977).

Figure 4 depicts a non-parametric local polynomial regression of export intensity on TFP estimates by firm ownership type. Domestic multinationals and foreign affiliates share overall similar levels of productivity, that are much higher than those for domestic firms. Domestic firms exhibit a positive relationship between productivity and export intensity. For foreign affiliates the relationship between productivity and export intensity appears to be negative, while for domestic multinationals the relationship between productivity and export intensity appears to be mostly flat, but negative for very high productivity levels.

We now turn to the second stage estimation results. Table 12 displays the results of this estimation procedure in 4 different specifications. Export intensity is measured in percentage points. The first two specifications are performed with no additional control variables, while the last two specifications include three sets of dummy variables, including year dummies, location dummies and the district level, and industry sector dummies at the three-digit level. Specifications (1) and (3) include different intercepts and linear terms for each firm ownership type, while specifications (2) and (4) also include one quadratic term on productivity in order to allow for a non-linear effect of productivity on firm export intensity. Reported t-statistics are computed with robust standard errors, clustered at the firm level.

The specification in column (1) shows that foreign affiliates and domestic multinationals alike are much more export oriented than domestic firms. Both firm ownership dummies are above 50 percentage points, and thus we expect multinational firms of any type to export more than half of their output. We are not able to reject the null hypothesis that the dummies for foreign affiliate and domestic multinational are equal (*p-value* = 0.733). However, their response to an increase in productivity is

different. While foreign affiliates exhibit a negative effect of productivity on export intensity, the effect of productivity on export intensity for domestic multinationals is not significant (*p-value* 0=0.943). Domestic firms, on the other hand, have an intercept of 12.6 percentage points, much lower than the intercepts of other ownership types, but a higher effect from productivity increases. Although the effect is strong enough to generate the predicted negative export intensity values for the range of productivity estimates for domestic firms in our sample, the threshold value is very low at -1.05, and thus it only occurs for a small group of firms (Table 10).

The specification in column (2) includes a quadratic term in productivity for every firm ownership type. All dummy coefficients seem similar to the estimates in specification (1). Again, we are unable reject the null hypothesis of equality of dummy coefficients for foreign affiliates and domestic multinationals. Domestic firms exhibit a significant linear coefficient estimate, which is similar in magnitude to the one found in specification (1), but also exhibits a positive and significant estimated coefficient for the quadratic term. The linear and quadratic coefficients for foreign affiliates are both negative, but no longer significant individually, although the *p-value* for the test of joint significance of both coefficients is only 0.0503. Both the linear and quadratic coefficients for domestic multinationals are significant, but it is the only firm ownership type with estimated coefficients of different signs. Thus, the linear term is positive and the quadratic term is negative, thus implying initial positive effects of productivity on export intensity, but subsequent increases with diminishing positive effects. The coefficient estimates imply negative marginal effects of TFP from level 1.93 of TFP onwards, a region where 15% of domestic multinationals are located.

As discussed earlier, specifications (3) and (4) contain estimation results from OLS regressions that include sets of year, location and industry dummies as control variables. The results obtained are similar to those in specifications (1) and (2). Due to the inclusion of control variables, only differences in ownership dummies remain interpretable, not individual ownership dummy levels. We continue to fail to reject the null hypothesis of equality between the foreign affiliate dummy and the domestic multinational dummy, and these remain higher than the domestic dummy. In specification (3) all linear coefficients have the same sign and the magnitude only decreases considerably for domestic multinationals, while remaining not significant, relative to specification (1). The only change in significance levels is that the linear coefficient for foreign affiliates is no longer significant (*p-value* of 0.148). Specification (4) also holds similar results to specification (2). In particular, we are unable to reject the null hypothesis that ownership dummies for domestic multinationals and foreign affiliates are equal. Linear and quadratic coefficients for domestic firms are similar to specification (2). The sign and lack of significance for the linear and quadratic terms for foreign affiliates are also similar to specification (2), although it is even harder to reject the null hypothesis that the coefficients are jointly significant (*p-value* = 0.3645). For the linear and quadratic terms of domestic multinationals we have the same magnitude, sign and significance as in specification (2). The coefficient estimates for the linear an quadratic terms of domestic multinationals now imply negative marginal effects of TFP from level 2.44 of TFP onwards, a region where only 6% of domestic multinationals are located.

Table 12. OLS Regressions of Export Intensity

Dependent Variable: Export Intensity (in percentage points)

	(1)	(2)	(3)	(4)
Domestic	12.608***	11.686***	-2.031	-3.358**
	(65.893)	(52.806)	(-1.306)	(-2.118)
Domestic X TFP	11.969***	11.912***	12.357***	12.236***
	(34.119)	(34.059)	(37.914)	(37.990)
Domestic X TFP^2		2.291***		2.802***
		(6.509)		(8.518)
Foreign	53.453***	52.757***	33.251***	33.149***
	(12.641)	(11.073)	(7.690)	(6.811)
Foreign X TFP	-5.534**	-3.662	-3.600	-2.943
	(-2.080)	(-0.686)	(-1.447)	(-0.569)
Foreign X TFP^2		-0.666		-0.053
		(-0.496)		(-0.042)
DMNE	51.409***	47.445***	31.197***	26.797***
	(12.090)	(11.140)	(6.821)	(5.235)
DMNE X TFP	0.185	6.918*	1.065	7.832*
	(0.072)	(1.750)	(0.423)	(1.760)
DMNE X TFP^2		-1.788***		-1.606**
		(-2.919)		(-2.307)
Industry Dummies	*NO*	*NO*	*YES*	*YES*
Location Dummies	*NO*	*NO*	*YES*	*YES*
Year Dummies	*NO*	*NO*	*YES*	*YES*
Number of observations	63,556	63,556	63,556	63,556

Note: *** p<0.01, ** p<0.05, * p<0.1. *t-statistics* in parenthesis

A robustness check is performed to ensure that the choice of a linear probability model does not influence results in the presence of a fractional dependent variable that is bounded to the unit interval. We follow Papke and Wooldridge (1993) in using a method that combines the usual logistic transformation of the dependent variable with a binomial distribution, in order to allow the dependent variable to take extreme values of zero or one (nor reported). For the subsets of firms that we are mostly interested, namely domestic multinationals and foreign affiliates, the only change in significance for the interaction terms with productivity is that the linear term for domestic multinationals in the equivalent specification to specification (3) is now significant, although still positive, which is still in agreement with our results. All significant productivity interaction terms have the same sign as before. Robustness of results for these groups of firms is expected as they have non extreme export intensity values, as seen in Figure 4. However, as Figure 4 illustrates, domestic firms have some extreme values near to zero, and thus we expect that the convexity could be partially induced by the imposition of a linear probability model. Accordingly, the quadratic terms for domestic firms are negative in this regression. Thus we should interpret the quadratic term for domestic firms with caution when using the simpler and more easily interpretable linear probability model, although and we expect no bias in our results for the groups of multinational firms.

Our results suggest that, unconditional on productivity levels, domestic multinationals and foreign affiliates do not have significantly different export intensity levels, which stresses the importance of multinationality status for export performance, irrespective of the type of established subsidiaries. Hence, domestic multinationals and foreign affiliates alike seem to export at least a share of 30% of their output more than domestic firms, even if we control for industry, year and location.

However, the effect on an increase in productivity is different for domestic multinationals and foreign affiliates. The effect of productivity on the export intensity of domestic multinationals is initially positive and later on negative, as expected. Nevertheless, the threshold productivity level required to induce a negative marginal effect of productivity on export intensity of domestic multinationals is very high and thus unlikely to affect a significant number of domestic multinationals. These results are coherent with initially established subsidiaries performing a non-manufacturing distribution role, while subsequent subsidiaries may perform manufacturing roles. Although this effect does not seem to be very large, it is large enough to break down the overall positive association between productivity and export intensity. However, we cannot account for how much our particular setting influences the result, as a low domestic demand might encourage the establishment of distribution networks and low labor prices can deter transfer of manufacturing to subsidiaries abroad.

The international involvement of domestic firms according to their productivity level seems to be as follows: low productivity domestic firms are focused on the domestic market; the most productive domestic firms are exporters; the highest productivity domestic firms are multinationals. This results holds before and after controlling for industry, year and location and is consistent the predictions of the literature.

The productivity of foreign affiliates does not seem to have a significant effect on their export intensity, after industry, year and location are accounted for. Although the coefficient for the productivity variable is negative and significant before addition of control variables, and remains negative in specifications (3) and (4), we fail to reject the hypothesis that there is no effect of productivity on the export intensity of foreign affiliates in both specifications (3) and (4). Thus, we cannot reject the negative effect of productivity on export intensity of foreign affiliates, as found in Lu et al. (2010). While the persistently negative sign of the coefficients on productivity may suggest that the failure to find a negative relationship is due to a lower sample size than the one used in Lu et al. (2010), in particular since a clear relationship exists for domestic multinationals which constitute a smaller group of firms, it is consistent with the findings of other studies. It has been found that the export intensity of foreign affiliates in the United Kingdom is similarly unresponsive to individual firm characteristics when compared to domestic firms (Kneller & Pisu, 2004). This finding has been taken as evidence of the existence of complex integration strategies of multinationals whose strategic decisions are not explained in a linear fashion by firm characteristics, which is in agreement with our hypothesis that a low-demand low-wage setting moderates the effect of productivity on export intensity of foreign affiliates.

5. CONCLUSIONS

We studied the relationship between productivity and international participation of purely domestic firms, domestic multinationals and foreign affiliates of multinationals. We have found a direct relationship between domestic firms' productivity and both export intensity and multinationality, with the hierarchy predicted by the international trade literature, that is, low productivity domestic firms are domestic market oriented, higher productivity domestic firms export more, and the highest productivity domestic firms are multinationals.

We have found that multinationals as a whole make up for a very important share of exports and that the impact of productivity on the export intensity of multinational firms is different from that of purely domestic firms and thus firms' multinationality status is important in assessing export behavior. Among multinational firms, domestic multinationals and foreign affiliates also respond differently to productivity, although they share similar characteristics and an overall similar level of export orientation.

We have found that domestic multinationals do not exhibit a negative relationship between export orientation and productivity, unlike what could be expected from the FDI literature. A possible explanation for this finding is the importance of the establishment of subsidiaries as sales outposts at an intermediate internationalization stage, as documented in the business literature.

We were not able to find a direct relationship between productivity and export intensity for foreign affiliates. Although we cannot reject the negative relationship that is found in other studies, this is evidence of a larger heterogeneity within foreign affiliates, as domestic multinationals have a clear relationship between productivity and export intensity, while constituting a smaller group of firms. The heterogeneity of foreign affiliates may be related to host country characteristics, as export platform and vertical integration strategies are more likely to be pursued by multinationals in low-demand low-wage countries. Thus, identification of the pursued integration strategies by foreign affiliates may be required in order to obtain better predictions of their export behavior.

REFERENCES

Baldwin R. 1988. Some empirical evidence on hysteresis in aggregate US import prices. *NBER Working Paper No. 2483.*

Bernard AB, Jensen JB. 1999. Exceptional exporter performance: cause, effect, or both? *Journal of International Economics* 47: 1-25.

Bernard AB, Jensen JB, Lawrence RZ. 1995. Exporters, jobs, and wages in US manufacturing: 1976-1987. *Brookings Papers on Economic Activity. Microeconomics* 1995: 67-119.

Brainard SL. 1993. An empirical assessment of the proximity-concentration tradeoff between multinational sales and trade. *NBER Working Paper No. 4580.*

Clerides SK, Lach S, Tybout JR. 1998. Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. *The Quarterly Journal of Economics* 113: 903-947.

Dunning JH. 1980. Toward an eclectic theory of international production: some empirical tests. *Journal of International Business Studies* 11: 9-31.

Dunning JH. 1993. The globalization of business: The challenge of the 1990s. *Routledge.*

Eberhardt M, Helmers C. 2010. Untested assumptions and data slicing: A critical review of firm-level production function estimators. *Discussion paper 513, University of Oxford.*

Ekholm K, Forslid R, Markusen JR. 2007. Export-Platform Foreign Direct Investment. *Journal of the European Economic Association* 5: 776-795.

Ethier WJ, Markusen JR. 1991. Multinational Firms, Technology Diffusion and Trade. *Journal of International Economics* 41: 1-28.

Grossman GM, Helpman E, Szeidl A. 2006. Optimal integration strategies for the multinational firm. *Journal of International Economics* 70: 216-238.

Hanson GH, Mataloni Jr RJ, Slaughter MJ. 2005. Vertical production networks in multinational firms. *Review of Economics and statistics* 87: 664-678.

Helpman E, Melitz MJ, Yeaple SR. 2003. Export versus FDI. *NBER Working Paper No. 9439.*

Horstmann I, Markusen JR. 1987. Licensing versus direct investment: A model of internalization by the multinational enterprise. *Canadian Journal of Economics*: 464-481.

Johanson J, Vahlne J. 1977. The internationalization process of the firm-a model of knowledge development and increasing foreign market commitments. *Journal of International Business Studies* 8: 23-32.

Kneller R, Pisu M. 2004. Export-oriented FDI in the UK. *Oxford Review of Economic Policy* 20: 424-439.

Levinsohn J, Petrin A. 2003. Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies* 70: 317-341.

Lu J, Lu Y, Tao Z. 2010. Exporting behavior of foreign affiliates: Theory and evidence. *Journal of International Economics* 81: 197-205.

Olley GS, Pakes A. 1996. The dynamics of productivity in the telecommunications equipment industry. *Econometrica* 64: 1263-1297.

Papke LE, Wooldridge J. 1993. Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. *Journal of Applied Econometrics* 11: 619-632.

Pavcnik N. 2002. Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *The Review of Economic Studies* 69: 245-276.

Sirkin HL, Rose J, Zinser M. 2012. The US Manufacturing Renaissance: How Shifting Global Economics Are Creating an American Comeback. *Knowledge@Wharton.*

Van Beveren I. 2012. Total factor productivity estimation: a practical review. *Journal of Economic Surveys* 26: 98-128.

Wagner J. 2007. Exports and productivity: a survey of the evidence from firm-level data. *The World Economy* 30: 60-82.

APPENDIX

Table 1. Aggregate Values for 2011

	Ownership Type						
	DOM		DMNE		FOR		Total
Assets (€ '000 000)	30,177	*71%*	4,493	*11%*	7,900	*19%*	42,570
Fixed Assets (€ '000 000)	8,986	*73%*	1,054	*9%*	2,243	*18%*	12,283
No. Employees	320,875	*83%*	23,835	*6%*	40,680	*11%*	385,390
Sales (€ '000 000)	28,672	*66%*	4,140	*9%*	10,831	*25%*	43,642
Exports (€ '000 000)	10,158	*54%*	1,844	*10%*	6,871	*36%*	18,873
EU Exports (€ '000 000)	8,222	*52%*	1,301	*8%*	6,237	*40%*	15,761
Value Added (€ '000 000)	7,867	*73%*	874	*8%*	2,104	*19%*	10,844

Table 2. Aggregate Exports by year (Millions of Euros)

	Ownership Type					
Exports	DOM	DMNE	FOR	Sample Total	Portugal	Sample
2008	8,892	1,646	5,769	16,307	59,144	27.6%
2009	7,828	1,577	4,793	14,198	49,311	28.8%
2010	8,800	1,694	6,102	16,595	55,577	29.9%
2011	10,158	1,844	6,871	18,873	62,232	30.3%

Note: Portuguese Exports include non-manufacturing exports

Table 3: Distribution of Firms by Industry and Firm Ownership Type

ISIC Rev.4 - two digits	Ownership Type			
	DOM	DMNE	FOR	Total
	No.	No.	No.	No.
10 - Manufacture of food products	2,030	13	23	2,066
11 - Manufacture of beverages	194	3	5	202
13 - Manufacture of textiles	824	7	10	841
14 - Manufacture of wearing apparel	1,498	10	4	1,512
15 - Manufacture of leather	850	3	6	859
16 - Manufacture of products of wood and cork	1,094	5	6	1,105
17 - Manufacture of paper products	179	3	8	190
18 - Printing and reproduction of recorded media	810	2	0	812
20 - Manufacture of chemical products	235	2	22	259
21 - Manufacture of pharmaceutical products	31	2	6	39
22 - Manufacture of rubber and plastics products	472	5	12	489
23 - Manufacture non-metallic mineral products	1,076	5	18	1,099
24 - Manufacture of basic metals	117	1	7	125
25 - Manufacture of fabricated metal products	2,985	19	18	3,022
26 - Manufacture of electronic products	70	1	5	76
27 - Manufacture of electrical equipment	212	5	11	228
28 - Manufacture of machinery and equipment	566	9	8	583
29 - Manufacture of motor vehicles, trailers	179	1	29	209
30 - Manufacture of other transport equipment	49	0	0	49
31 - Manufacture of furniture	920	3	1	924
32 - Other manufacturing	508	0	5	513
33 - Repair and installation of machinery	681	1	5	687
Total	15,580	100	209	15,889

Table 4: Summary Statistics (2008-2011)

	Ownership Type			
averages	DOM	DMNE	FOR	Total
Sales (€ '000 000)	1.8	39.9	47.0	2.6
Valued Added (€ '000 000)	0.5	9.0	10.0	0.7
Assets (€ '000 000)	1.9	42.6	38.3	2.6
Fixed Assets (€ '000 000)	0.6	10.3	11.3	0.8
No. Employees	20.5	234.7	199.0	24.2
Labor Costs (€ '000 000)	0.3	4.8	5.2	0.4
Skill (Cost per Worker, € '000)	13.5	20.8	27.4	13.8
Labor Productivity (VA per Worker, € '000)	21.2	40.2	55.0	21.7
Exports (€ '000 000)	0.6	16.9	28.2	1.0
Exporter Dummy	0.429	0.985	0.891	0.438
Exports as Share of Output	0.123	0.516	0.470	0.130
EU Exports as Share of Exports	0.779	0.709	0.834	0.780
Sector Exports as Share of 2D Sector Output	0.368	0.381	0.403	0.369
Sector Exports as Share of 3D Sector Output	0.352	0.419	0.409	0.353
Export Intensity Classes				
0%	0.571	0.015	0.109	0.562
>0 - 20%	0.248	0.195	0.289	0.248
20 - 40%	0.053	0.180	0.089	0.055
40 - 60%	0.037	0.210	0.080	0.039
60 - 80%	0.032	0.163	0.100	0.034
80 - <100%	0.053	0.238	0.315	0.058
100%	0.005	0.000	0.018	0.005

Figure 1: Distribution of Key Variables by Firm Ownership Type of Exporter

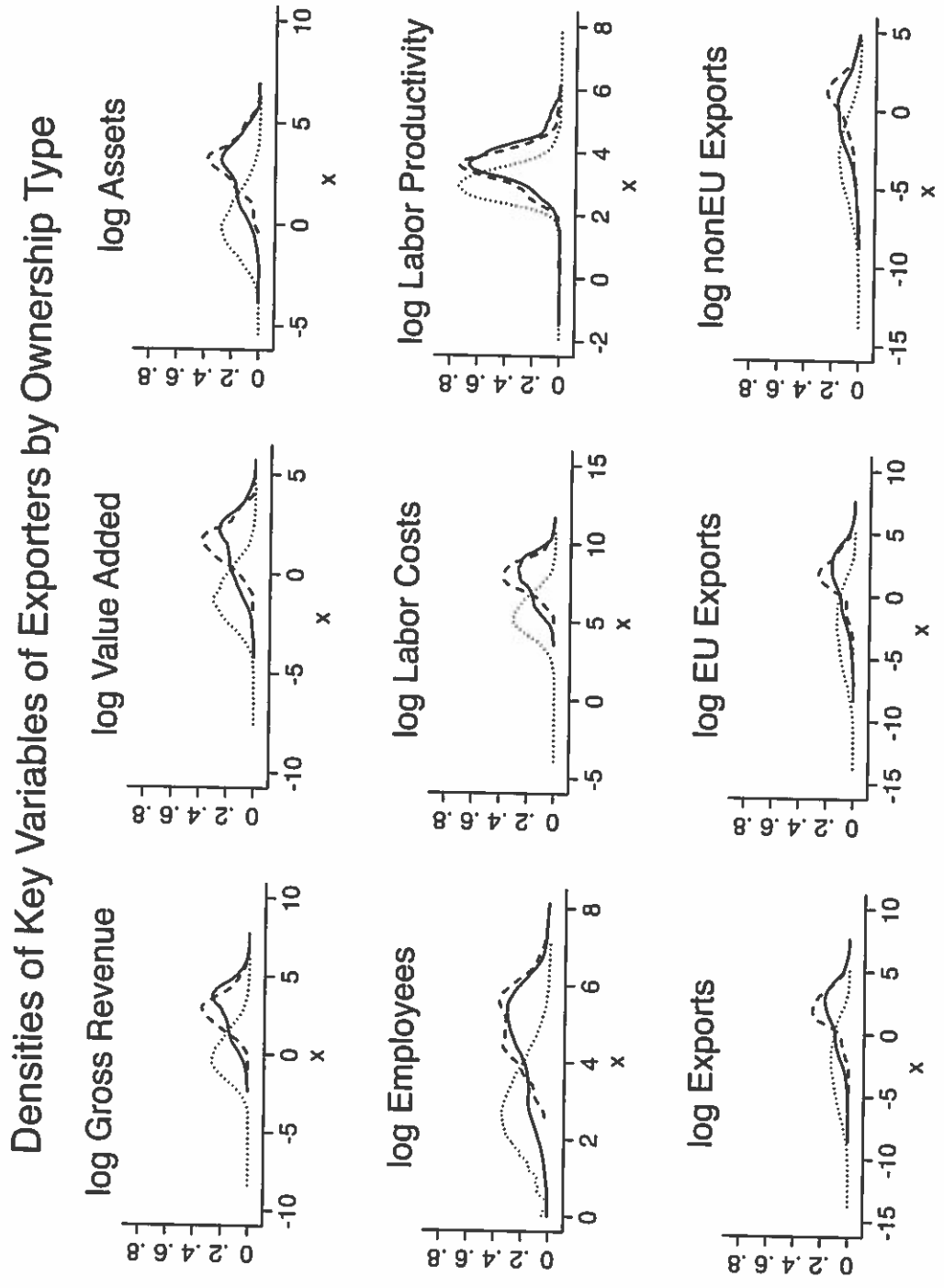

Table 5: Input Coefficient Estimates from Pooled OLS at the two-digit level

ISIC Rev4 2D Description	Firms No.	Labor Coef.	Capital Coef.	Coef. Sum
Man food products	2,066	0.91	0.18	1.09
Man beverages	202	0.79	0.28	1.07
Man textiles	841	0.87	0.14	1.01
Man wearing apparel	1,512	0.85	0.14	1.00
Man leather	859	0.79	0.20	0.99
Man products of wood and cork	1,105	0.94	0.14	1.08
Man paper products	190	0.93	0.19	1.12
Reproduction of recorded media	812	0.93	0.15	1.08
Man chemical products	259	0.98	0.20	1.18
Man pharmaceutical products	39	1.44	-0.13	1.30
Man rubber and plastics products	489	0.89	0.18	1.07
Man other mineral products	1,099	0.97	0.17	1.14
Man basic metals	125	0.96	0.13	1.09
Man fabricated metal products	3,022	0.94	0.15	1.09
Man electronic products	76	0.97	0.11	1.09
Man electrical equipment	228	1.01	0.10	1.11
Man machinery and equipment	583	0.94	0.13	1.07
Man motor vehicles, trailers	209	0.98	0.11	1.10
Man other transport equipment	49	0.89	0.07	0.96
Man furniture	924	0.98	0.11	1.09
Other manufacturing	513	0.93	0.11	1.04
Repair & installation machinery	687	1.02	0.12	1.14
Averages weighted by number of firms		0.92	0.15	1.08

Table 6: Input Coefficient Estimates from Pooled OLS at the three-digit level

Sector	Firms	Labor	Capital	Sum
101	205	0.92	0.15	1.07
102	60	0.80	0.18	0.98
103	76	0.88	0.20	1.08
104	61	0.97	0.15	1.12
105	105	1.04	0.16	1.20
106	41	0.99	0.19	1.18
107	1,343	0.99	0.09	1.08
108	116	0.85	0.21	1.06
109	59	0.83	0.18	1.01
110	202	0.79	0.28	1.07
131	46	0.90	0.01	0.91
132	79	0.89	0.12	1.01
133	132	0.74	0.22	0.96
139	584	0.89	0.14	1.03
141	1,347	0.84	0.15	0.99
143	165	0.93	0.09	1.02
151	90	0.75	0.24	0.99
152	769	0.80	0.19	0.99
161	248	0.98	0.14	1.12
162	857	0.94	0.15	1.08
171	12	0.75	0.33	1.08
172	178	0.91	0.18	1.09
181	812	0.93	0.15	1.08
201	54	0.82	0.33	1.15
203	62	1.07	0.11	1.18
204	75	1.08	0.09	1.17
205	68	0.95	0.22	1.17
212	39	1.44	-0.13	1.30
221	56	1.05	0.05	1.10
222	433	0.87	0.20	1.07
231	155	1.20	0.09	1.29
233	61	0.95	0.21	1.16
234	121	0.94	0.14	1.08
235	14	1.25	0.25	1.50
236	197	0.95	0.18	1.12
237	523	0.96	0.14	1.11
239	28	0.70	0.34	1.05
242	12	1.29	-0.01	1.28
243	18	1.01	0.15	1.16
244	32	0.96	0.12	1.08
245	63	0.96	0.10	1.06
251	1,337	1.01	0.12	1.14
252	50	0.95	0.13	1.08
253	10	0.69	0.08	0.77
255	119	0.98	0.12	1.10
256	506	0.95	0.13	1.08
257	505	0.85	0.18	1.03
259	495	0.91	0.15	1.05
261	28	1.01	0.03	1.04
262	12	1.12	0.03	1.14
263	11	0.97	0.18	1.14
265	25	0.82	0.20	1.01
271	78	1.00	0.09	1.09
273	17	1.26	-0.02	1.25
274	55	1.06	0.10	1.16
275	32	0.90	0.15	1.05
279	46	1.21	0.10	1.31
281	53	0.96	0.12	1.08
282	226	0.94	0.12	1.06
283	45	0.98	0.15	1.14
284	42	0.86	0.19	1.05
289	217	0.95	0.12	1.07
291	11	1.01	0.13	1.14
292	76	1.02	0.05	1.07
293	122	0.92	0.15	1.07
301	23	0.89	0.05	0.94
309	26	0.92	0.11	1.03
310	924	0.98	0.11	1.09
321	148	0.98	0.09	1.07
323	16	0.91	0.27	1.18
325	174	0.99	0.12	1.11
329	175	0.90	0.10	1.00
331	554	1.00	0.11	1.11
332	133	1.01	0.14	1.15
Weighted Avg.		0.94	0.14	1.08

(continues)

Table 7: Input Coefficient Estimates from Fixed Effects at the two-digit level

ISIC Rev4 2D Description	Firms No.	Labor Coef.	Capital Coef.	Coef. Sum
Man food products	2,066	0.42	0.05	0.48
Man beverages	202	0.23	0.29	0.53
Man textiles	841	0.56	0.06	0.62
Man wearing apparel	1,512	0.62	0.05	0.67
Man leather	859	0.72	0.10	0.82
Man products of wood and cork	1,105	0.66	0.09	0.74
Man paper products	190	0.53	0.11	0.64
Reproduction of recorded media	812	0.50	0.09	0.59
Man chemical products	259	0.64	0.03	0.66
Man pharmaceutical products	39	0.32	0.12	0.44
Man rubber and plastics products	489	0.71	0.11	0.82
Man other mineral products	1,099	0.71	0.05	0.76
Man basic metals	125	1.09	0.06	1.15
Man fabricated metal products	3,022	0.61	0.07	0.69
Man electronic products	76	1.07	0.13	1.20
Man electrical equipment	228	0.72	0.08	0.79
Man machinery and equipment	583	0.58	0.10	0.69
Man motor vehicles, trailers	209	0.49	0.09	0.58
Man other transport equipment	49	1.01	-0.01	1.00
Man furniture	924	0.70	0.07	0.76
Other manufacturing	513	0.59	0.05	0.64
Repair & installation machinery	687	0.66	0.06	0.72
Averages (weighted by firm number)		0.61	0.07	0.68

Table 8: Input Coefficient Estimates from Fixed Effects at the three-digit level

Sector	Firms	Labor	Capital	Sum
101	205	0.48	0.05	0.53
102	60	0.56	0.05	0.61
103	76	0.29	0.00	0.29
104	61	-0.16	0.02	-0.14
105	105	0.43	0.19	0.62
106	41	0.15	0.04	0.19
107	1,343	0.51	0.04	0.55
108	116	0.37	0.07	0.44
109	59	0.19	0.15	0.34
110	202	0.23	0.29	0.53
131	46	1.26	-0.01	1.25
132	79	0.33	0.08	0.40
133	132	0.51	0.00	0.51
139	584	0.57	0.09	0.66
141	1,347	0.63	0.05	0.67
143	165	0.58	0.04	0.62
151	90	0.73	0.16	0.89
152	769	0.71	0.09	0.81
161	248	0.61	0.15	0.75
162	857	0.66	0.08	0.74
171	12	1.62	0.12	1.74
172	178	0.53	0.11	0.63
181	812	0.50	0.09	0.59
201	54	0.59	0.20	0.79
203	62	0.38	-0.02	0.36
204	75	0.75	-0.01	0.74
205	68	0.58	0.03	0.62
212	39	0.32	0.12	0.44
221	56	1.00	0.07	1.07
222	433	0.68	0.12	0.80
231	155	0.93	0.09	1.02
233	61	0.79	-0.00	0.79
234	121	0.53	0.01	0.55
235	14	0.78	-0.42	0.36
236	197	0.69	0.06	0.75
237	523	0.70	0.04	0.75
239	28	0.29	0.09	0.38
242	12	2.34	-0.49	1.85
243	18	0.85	0.09	0.94
244	32	0.52	0.08	0.60
245	63	0.59	0.03	0.63
251	1,337	0.68	0.08	0.77
252	50	0.83	-0.03	0.81
253	10	0.84	-0.06	0.78
255	119	0.47	0.06	0.52
256	506	0.56	0.06	0.62
257	505	0.50	0.06	0.56
259	495	0.60	0.09	0.69
261	28	1.74	-0.04	1.70
262	12	0.79	0.18	0.97
263	11	0.76	0.26	1.01
265	25	0.79	0.09	0.88
271	78	0.78	0.02	0.80
273	17	0.42	0.05	0.47
274	55	0.41	0.07	0.48
275	32	0.90	0.18	1.07
279	46	0.57	0.18	0.75
281	53	0.19	0.06	0.26
282	226	0.52	0.17	0.70
283	45	0.39	0.05	0.44
284	42	0.48	-0.01	0.48
289	217	0.77	0.04	0.81
291	11	0.41	0.14	0.56
292	76	0.44	0.11	0.55
293	122	0.52	0.08	0.60
301	23	1.03	0.04	1.07
309	26	0.98	-0.12	0.85
310	924	0.70	0.07	0.76
321	148	0.61	0.04	0.65
323	16	1.00	-0.19	0.81
325	174	0.52	0.04	0.56
329	175	0.61	0.09	0.70
331	554	0.67	0.06	0.73
332	133	0.60	0.08	0.68
Weighted Avg.		0.61	0.07	0.68

(continues)

Figure 2: Distribution of Firm TFP Estimates by Estimator

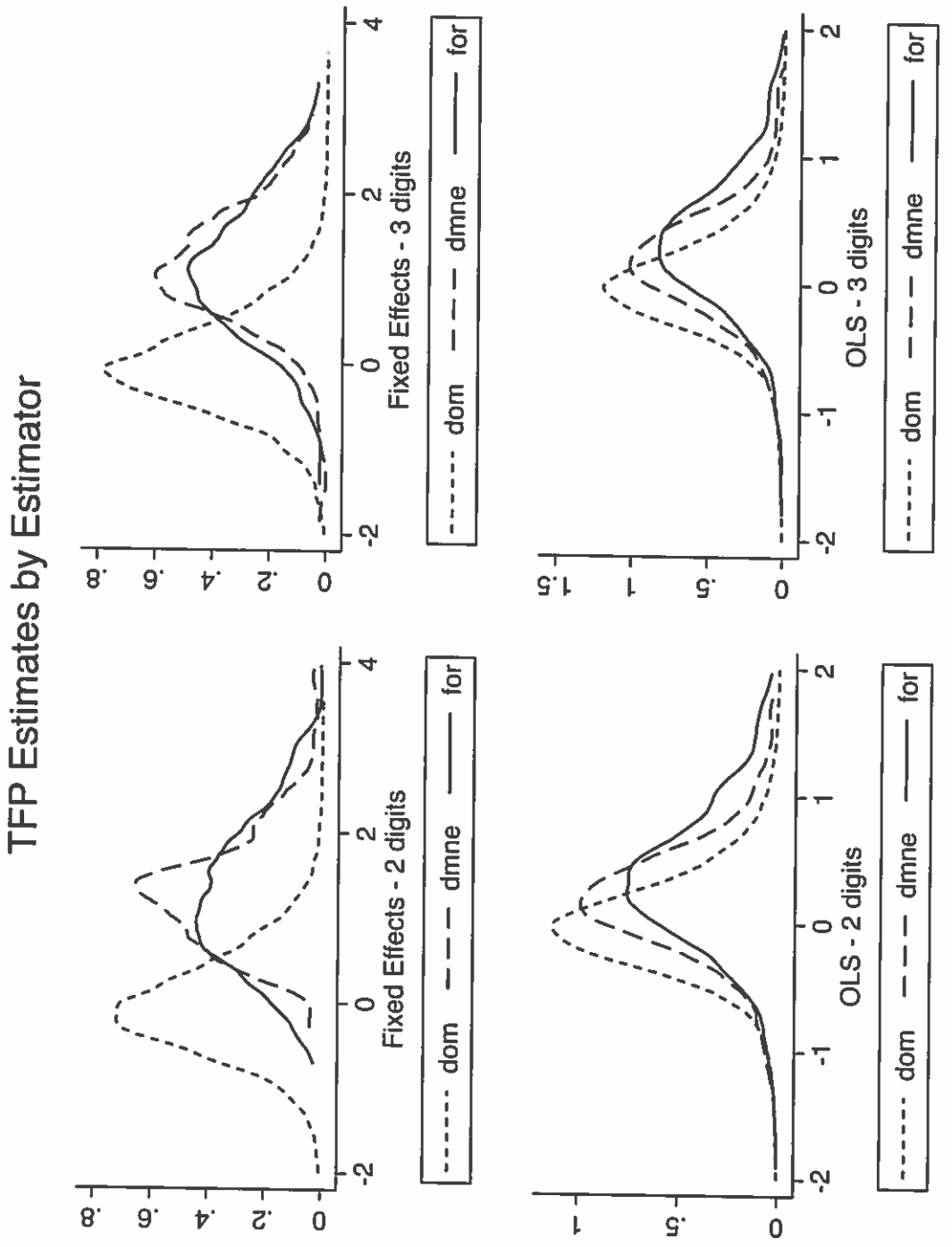

Table 9. Correlation of TFP Estimates across Estimators

	FE2D	FE3D	OLS2D	OLS3D
FE2D	1.000			
FE3D	0.929	1.000		
OL2D	0.528	0.494	1.000	
OL3D	0.503	0.509	0.972	1.000

Table 10. Summary Statistics of TFP Estimates (FE3D) by Firm Ownership Type

TFP	DOM	DMNE	FOR	Total
N	15,580	100	209	15,889
mean	-0.024	1.246	1.166	-0.000
sd	0.633	0.965	0.936	0.662
min	-3.687	-1.850	-1.401	-3.687
p10	-0.739	0.338	0.156	-0.733
p25	-0.398	0.775	0.547	-0.392
p50	-0.055	1.179	1.080	-0.043
p75	0.339	1.670	1.730	0.363
p90	0.761	2.267	2.351	0.814
max	4.431	6.076	5.367	6.076

Table 11. Distribution of TFP Estimates (FE3D) by Firm Ownership Type

TFP Classes				
	DOM	DMNE	FOR	Total
]-∞,-4]	0.000	0.000	0.000	0.000
] -4,-2]	0.005	0.000	0.000	0.004
] -2, 0]	0.538	0.050	0.081	0.529
] 0, 2]	0.454	0.800	0.756	0.460
] 2, 4]	0.004	0.130	0.153	0.007
] 4, ∞[	0.000	0.020	0.010	0.000

Figure 3: Firm Age and TFP by Firm Ownership Type

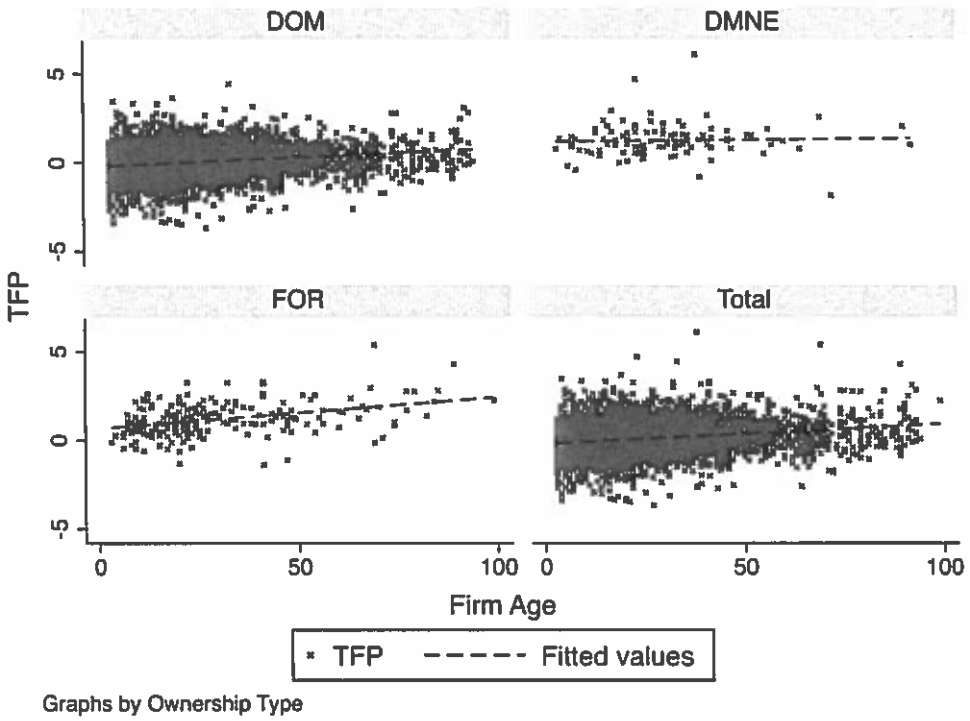

Figure 4: Non-Parametric Local Polynomial Regressions of Export Intensity on TFP by Firm Ownership Type