# Firm Efficiency and the Destination of Exports: Evidence from Kenyan Plant-level Data

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**Abstract**

Investigating the link between firm efficiency and exports in Kenyan manufacturing, the results show that exporters are more efficient than non-exporters, and relatively efficient firms self-select into exporting. An important new finding is that only for export markets outside Africa, firms must be efficient prior to entry; for those exporting within Africa this requirement seems less binding. Furthermore, the probability to export to other African countries increases if production is intense in physical and human capital, while for export activities outside Africa firm size is more important. Contrary to many other studies, it is also found evidence that export participation yields learning-effects. When testing the hypothesis that the main source of learning-effects is trade with developed countries (South-North), as opposed to trade with other developing countries (South-South), yet another new finding is that learning-effects only obtain in South-South trade. One can therefore conclude that controlling for the destination of exports importantly improves the understanding of the relationship between firm efficiency and exports.

*Keywords*: Destination of exports, firm efficiency, learning-effects, self-selection, Kenya, manufacturing

## 1. Introduction

By now a consensus understanding of the often-observed statistical correlation between a firm's export activities and its technical efficiency seems to have emerged.[1] Earlier work tends to emphasize the conclusion that export participation leads to increased efficiency through so-called learning effects.[2] However, recent studies focus on an alternative explanation, namely, the notion that relatively efficient firms self-select into export activities because the returns from doing so are relatively high (Clerides, Lach and Tybout, 1998). If this is true, then it is not export participation, per se, that makes a firm more efficient, but rather efficiency that causes export participation. This could call for policies different than if the learning-effects hypothesis holds.

The learning-by-exporting hypothesis hinges primarily on the notion that the export recipient is more technologically advanced than the exporter, in other words, the main focus is on South-North trade. But what if a country directs its exports to a country at a similar or lower level of technological development (that is, South-South)? Would there still be productivity gains to be made? An equally relevant question is whether the determinants of exports to the North and South are the same. Previous literature seems to suggest that South-South exporting is more intense in its use of human and physical capital, while South-North exporting is relatively labour-intensive (seen from the perspective of a developing country).[3]

The issue of exports destination appears to have been dormant for many years.[4] This neglect is unfortunate and an attempt is made here to show that taking into account a firm's destination of exports is of significant value for better understanding the relation between firm efficiency and export-decision. For instance, it is possible that exports directed to industrialized countries might contain more learning effects than those directed to other developing countries.[5] Furthermore, while one might accept that firm efficiency is a requirement for entering markets of industrialized countries, it may be expected that penetration into other developing countries' markets is less demanding.

[1] From hereon the term technical efficiency (or just efficiency) is used throughout the paper unless there are particularly strong reasons to maintain the term of productivity.
[2] The World Bank has repeatedly (for example, World Bank, 1993) argued that the East-Asian Miracle to a large extent can be explained by learning effects with consequent improvements in total factor productivity (TFP).
[3] The terms skill and human capital are interchangeably used throughout the paper.
[4] The issue of exports destination was seriously discussed at a World Bank conference in 1987. To the best of our knowledge, this was the most recent event where it held a prominent place on the agenda.
[5] This issue has been debated and is discussed later in the paper.

The relationship between exports and efficiency in developing countries has been investigated before, however, mainly focusing on Latin American and Asian countries. Moreover, compared with the great volume of empirical studies based on macro data, there are relatively few studies that use micro data. To our knowledge, there are only five previous studies linking efficiency and exports that use micro data from sub-Saharan African (SSA) countries (Biggs, 1995; Bigsten et al., 1999; Rankin, 2001; Bigsten et al., 2002; and Granér and Isaksson, 2002). The reason why there are so few studies on SSA is due to the scarcity of plant-level data for this region. This analysis on Kenyan manufacturing contributes to this short list of studies based on plant-level data.

Kenya makes for a particular interesting study because of its relatively (compared to the rest of SSA) strong export-orientation of manufactured exports. Even though only some 10 per cent of manufacturing output is exported, many manufacturing firms participate in export activities. Furthermore, while SSA, generally, has a comparative advantage in unprocessed primary products, Kenya has managed to advance towards exportable manufacturing production. Today, nearly 30 per cent of total exports come from manufacturing production. The main target of this export has so far been other African countries, while exports of manufactured goods to industrialized countries remain low and irregular.

After having followed an import-substitution industrialization strategy for decades with high trade restrictions that led to inefficiency and high costs, Kenya launched a trade reform in 1987, which focused on export promotion and import liberalization. Hence, when firms in the sample were surveyed, they were presumably operating in an environment with more export opportunities than before, and with better access to, for example, foreign capital and raw materials.

Theoretically, as will be discussed to some length later, exporting offers an opportunity to learn from relatively advanced trading partners (notably industrialized ones). From a policy viewpoint this would be an important finding. But, it can also be that a significant export-orientation effect is observed because Kenyan firms, compared to other SSA countries, tend to be relatively efficient, and they export because it is profitable for them to do so, in other words, the self-selection effect.

This study uses detailed data on Kenyan manufacturing firms for the period 1992-1994 to look into these matters. It starts by empirically investigating the link between technical efficiency and exports in the 'standard' way, in other words, without taking export destination into account. As in many similar studies, technical efficiency, on average, is found to be higher among exporters than among non-exporters. Exporters are also larger and more intensely use physical and human capital compared with non-exporters.

Thereafter, it is shown that firms that export within Africa are smaller, but more capital- and skill-intensive than firms that export outside Africa. Controlling for lagged technical efficiency, OLS estimation provides evidence in favour of the self-selection hypothesis; no support is found for the existence of learning effects from exporting. At this stage, the results provide no evidence for the notion that exports destination influences the export effect on technical efficiency. However, changing to the fixed-effects estimator to control for omitted state dependent variables, such as managerial ability, which are likely to be correlated with both exports and technical efficiency, leads to diverging results. In this case, the export parameter is significant, but it is exporting to other African countries and not to the North that yields learning effects. This may point to the importance of issues like appropriate technology in a Basu and Weil (1998) sense, in other words, North technology might be *too* advanced, whereas that of other developing countries could be more in line with the production techniques and capital intensity employed in Kenya's manufacturing sector.

Destination of exports also impacts the effect of efficiency on exports. The paper shows that firms have to be efficient in order to enter export markets outside Africa (for example, the OECD), a requirement that does not appear to apply to export markets within Africa. Interestingly, destination of exports also influences how other determinants affect export decisions. For instance, firm size has a positive effect on the decision to export outside Africa, but no evidence is found that firm size influences the decision to export within Africa. Another interesting result is that high capital intensity increases the probability to export within Africa while factor proportions have no explanatory power on export activities outside Africa.

The paper proceeds as follows: In section two the link between technical efficiency and exports, as well as the role of other explanatory variables is explored, with a special focus on the destination of exports. Section three presents the data and discusses what can be inferred

from descriptive analysis. The estimation results are presented in section four, while section five concludes the paper.

## 2. Firm efficiency and destination of exports

In this section, first the relationship between efficiency and exports is discussed. Thereafter, the role of other determinants of efficiency and what prompts the decision to become an exporter are considered. Finally, how the issue of destination of trade enriches the analysis of exports and efficiency is dwelled on.

### *2.1. The relationship between efficiency and export-participation*

There is widespread empirical evidence that exporting plants in developing countries are more efficient than their domestically-oriented counterparts (for example, Handoussa, Nishimizu and Page, 1986; Chen and Tang, 1987; Haddad, 1993; Aw and Hwang, 1995; Tybout and Westbrook, 1995; Clerides et al., 1998; Granér, 2002). Until recently, this evidence was often interpreted as providing support to the theory that learning effects are gained from export activities.

Learning effects may arise when, for instance, foreign customers offer exporters technical assistance, market information or guidance in quality control. Learning could also be acquired more indirectly by, for instance, a firm's monitoring feedback from its own activities or through informal discussions with foreign contacts (Webb and Fackler, 1993). The existence of arduous international competition can also serve as an argument for the notion that productive efficiency is driven by exports. Strong exposure to international competition is seen as increasing the pressure on exporting firms to keep costs low. To keep track of the international frontier, firms are forced to adjust in two ways: to exploit economies of scale, and reduce technical inefficiencies.

An alternative explanation developed in later years for the superior performance of exporters is that it reflects the self-selection of more efficient producers into the export market. Clerides et al. (1998) present a model in which incumbent exporters would choose to export whenever gross operating profit plus expected future payoff from remaining an exporter is higher than the per-period fixed cost of being an exporter (that is, costs dealing with customs and other intermediaries), and non-exporters begin exporting whenever this sum is higher than the per-

period cost plus the sunk entry cost for entering foreign markets (in other words, expenses related to establishing a distribution channel, or production costs for modifying domestic products to foreign tastes). Since gross profit is positively related to productive efficiency the probability that a firm exports should increase with its efficiency level.

Recent empirical literature tends to support the second interpretation of the correlation between exports and efficiency. For instance, Clerides et al. (1998) examine the issue of causality using plant-level data for Colombia, Mexico and Morocco. They find no evidence for efficiency gains from learning and conclude that the self-selection of more efficient producers is the main reason for the productivity differentials between non-exporters and exporters. In a study of the Chilean manufacturing sector, Granér (2002) obtains no significant differences either in technical efficiency or in scale efficiency between plants with respect to export history. However, non-exporting firms that are relatively efficient are more likely than inefficient firms to enter the export market, that is, exporting firms are already relatively efficient before they become exporters. Bernard and Jensen (1999) reach similar results for U.S. manufacturing firms.

In a dynamic industry model based on heterogeneous agents, as opposed to the standard representative-agent model, Melitz (2003) shows the important result that trade may generate productivity gains at the aggregate level, however, without necessarily improving the productivity of individual firms. This can happen because costs associated with export entry alter the distribution of trade gains across firms. The most efficient firms reap trade gains by increasing their market share and profit, while less efficient firms lose in terms of both, and the firms worst off are forced to exit. Thus, although export participation is driven by productivity (the familiar result), increased trade exposure tends to strengthen this self-selection effect by selecting only the most productive firms. This leads to *additional* intra-industry reallocations towards more productive firms. Melitz's (2003) work may be interpreted as another argument against the notion of learning effects, but lends further support to the self-selection hypothesis.[6]

Aw, Chung and Roberts (1998), however, find that both self-selection and learning explain the higher productivity among exporting plants in Taiwanese manufacturing, while none of

the hypotheses explain the disparity in productivity between exporters and non-exporters in the Korean (Republic of) manufacturing sector. Bigsten et al. (2002) acquire similar support for both hypotheses for four SSA countries, including Kenya.

### *2.2. Other determinants of firm efficiency and export-participation*

The correlation between efficiency and exports may also be due to other factors correlated with both variables. Export participation and technical efficiency signal more than a firm just being an exporter or attaining a certain efficiency level. For instance, many empirical studies show that relatively efficient firms in developing countries tend to be large. There is also evidence that manufactured exports source mainly from relatively large firms. Several other firm characteristics, such as physical and human capital intensity, firm age and foreign ownership may influence both the decision to export and technical efficiency.

*Firm size*

Several empirical studies show that relatively efficient firms in developing countries tend to be large (for example, Pitt and Lee, 1981; Haddad and Harrison, 1993; Mengistae, 1995; Brada, King, and Ma, 1997; Lundvall and Battese, 1998). An influential theory linking firm size to technical efficiency is Jovanovic's (1982) version of the passive learning model of firm dynamics. His model predicts that larger firms are more efficient than smaller ones. A selection process leads to an outcome in which efficient firms grow and survive, while inefficient firms stagnate or exit the industry. However, a positive correlation between efficiency and size might also arise if relatively efficient firms have a superior cost structure, or if larger firms have more competent management, both of which would allow them to gain market shares.[7]

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[6] However, note Baldwin and Robert-Nicoud (2004) disputing comment that although freer trade improves industry productivity in a level sense, it could harm it in a growth sense.

[7] A potential problem with attempting to isolate the effect of size on efficiency relates to the fact that the characteristics of measured physical capital and labor may differ across size classes. For instance, smaller-scale enterprises may employ capital equipment that is older than that of larger firms, perhaps because smaller firms, especially if they are also young, might not be able to invest in the latest equipment. Hence, if measured capital fails to reflect productivity differentials due to different vintages of capital, smaller firms may appear to be relatively inefficient, while the opposite might actually be true. However, the opposite argument, in other words, that young firms have better technology while old firms are stuck with old technology, could also be made. Unfortunately, our data do not permit controlling for capital vintage.

Firm size may also influence managers' decision to export. Berry (1992) has surveyed literature linking firm performance and trade policies in developing countries. He finds that, in a typical developing country, there is evidence that manufactured exports source mainly from relatively large firms. This is the case also in the Kenyan manufacturing sector, as is shown in section 3.2. The reason for this may either be that export-participation has a positive impact on firm size due to increased sales, or that large firms self-select into the export market. The latter can be explained by the fact that profits, in absolute terms, typically increase with output. Thus, the probability that expected future payoffs from exporting outweigh the fixed entry cost of exporting increases with firm size.

*Physical capital*

A common argument in favour of the adoption of capital-intensive technologies in developing countries is that such technologies generally are the latest and most efficient (White, 1978). Insofar as Kenyan firms are indeed capital intensive, a positive relation between capital intensity and efficiency may be obtained. However, with a putty-clay production structure that gives rise to different vintages of capital, technical efficiency may be negatively correlated with capital intensity (Hjalmarsson, 1973).

The relation between the use of physical capital and export activities rests on the mapping from factor endowments to trade patterns predicted by the Heckscher-Ohlin model of comparative advantage. To the extent that this model is valid at firm level, manufacturing exports should be concentrated in firms that use the relative abundant factor intensively, that is, if labour is abundant, capital intensity is expected to be negatively related to export activities.

*Human capital*

Human capital is expected to positively correlate with efficiency. For example, the skill-intensity of operations may capture the potential for technological activities such as R&D.

Assuming that the average wage cost per employee reflects employees' skills, a good reason to proxy human capital by wage costs as a variable explaining technical efficiency is that, in the estimation of efficiency, labour input is measured as the average number of employees during the year. This measure of labour, however, does not take into account the heterogeneity of the labour force or hours worked. Hours worked may differ between small

and large firms. Furthermore, it may be the case that family labour, which is employed with greater intensity in small firms, works longer and with greater intensity than hired labour. If this is the case, a best-practice frontier, based on labour force data that fail to reflect hours worked or intensity of effort, may falsely indicate that relatively small firms are closer to the frontier.

A high educational level within firms facilitates international contacts and export-participation. In addition, using the same reasoning as above for physical capital, it can be argued that intensity with which a firm avails of human capital influences the decision whether to export at all. As mentioned in section 2.3, this reasoning applies aptly to the decision whether to export to developed or developing countries.

*Firm age*

Firm age may capture the extent of a firm's learning experience. Older firms are usually considered to be more efficient than younger ones, because owners, managers and employees have gained experience from past operations. Furthermore, firms' survival, per se, may reflect their superior efficiency. On the other hand, if young firms are more likely than old firms to use modern, and hence more efficient, capital equipment in the production process, it may dampen the positive effect from learning, or even result in a negative effect from firm age on technical efficiency.

Older firms may have a superior cost structure and may therefore be able to better handle sunk costs associated with export entry. If this holds true, firm age would be expected to enter positively in the export-decision regression. Furthermore, over time a firm may have established enough international contacts to decide on engaging in export activities.

*Foreign ownership*

Foreign-owned multinational corporations operating in developing countries are assumed to be more efficient than domestic-owned firms because of greater experience in management and superior organizational structure. However, it is quite possible that foreign firms seeking to acquire domestic ones target relatively efficient firms, that is, domestic firms are efficient before the ownership structure changes. If so, it may be the case that efficiency explains foreign ownership and not the other way around.

Sunk costs associated with entry into the export market may vary with – besides the already discussed firm size, firm age and technical efficiency — the firm ownership structure. The structure of ownership may be important for the cost to access foreign markets. The importance of foreign ownership in manufactured exports in many developing countries reflects the advantage of proprietary information, as well as special access to marketing networks abroad (Berry, 1992). A positive effect from foreign ownership on the export decision is thus expected.

### *2.3. The importance of trade destination*

The literature on learning effects, as well as on the decision to export from developing countries, to some degree, hinges on whether exports are directed to more developed countries. Therefore, it would be interesting to examine whether the determinants of exporting within Africa differ from those of exporting outside Africa. In addition, it is investigated whether learning effects from exports and self-selection behaviour are sensitive to export destination.

It has been recognized that South-South exports (that is, exports between developing countries) are more intensive in physical and human capital than are exports from South to North (Amsden, 1980; Havrylyshyn and Wolf, 1987). In theory, this may be explained within the framework of an extended Heckscher-Ohlin model, such as the one presented by Havrylyshyn and Wolf (1987). Amsden (1986) argues that since greater South-South trade increases the skill and capital content of production, South-South exports embody high learning effects, while learning effects from labour-intensive South-North exports are more or less absent. Although her argument is based on the notion of learning-by-doing rather than learning-by-exporting, statistically, exports to other African countries may turn out to have a stronger effect on technical efficiency than exports outside Africa.

Havrylyshyn and Wolf (1987) admit that, in theory, South-South exports may have a greater potential for learning, but argue that since the relatively poor export and growth performance of most developing countries is strongly biased towards trade to other developing countries, this may suggest that learning is not really that important in practice. One reason may be that the learning potential arising from knowledge and technology transfer from the export recipient is higher for South-North exports. This means that for exports as a whole, with the

majority of exports being directed to other African countries, learning effects may not be that high.

Are the determinants of South-South exports different from those of South-North exports? The fixed per-period cost and the fixed entry cost of exporting are probably lower for developing countries because the larger markets of the North may require larger export quantities. If this argument holds, the hypothesis that technical efficiency and firm size are important determinants of the decision to export should be weaker in the case of South-South exports. Furthermore, it is likely that product standards and competition are higher in markets of the North, which may be another argument why efficiency and firm size could be more important for exports to North than to South. It may be expect that factor proportions are more important in explaining South-South trade than in explaining South-North trade. In particular, capital and skill intensities can be expected to have a positive impact on the decision of Kenyan firms to export to other African countries.

## 3. Data and descriptive analysis

In this section, the data are briefly discussed and followed up with a descriptive analysis of key variables.

### *3.1. Data description*

The data used in this paper are based on a comprehensive panel data set on a sample of firms within the Kenyan manufacturing sector for 1992-1994, collected over the period 1993 to 1995.[8] The data, compiled from three annual surveys, were organized by the World Bank in a research project entitled "Regional Program on Enterprise Development".

The original dataset consists of 276 firms that were interviewed at least once and provides 656 observations. Of these, 169 firms appeared in all interview rounds (61.2 per cent), 44 (16per cent) firms were interviewed twice, while 63 (22.8 per cent) firms were interviewed only once. Thus, 213 firms were observed at least twice. Some of the firms interviewed once or twice were replacements for those firms that disappeared from survey I. Between surveys I

[8] Although the term firm is used throughout the paper, the panel actually contains plants and not firms (a firm could consist of several plants). This means, for instance, that exports come from domestic output only.

and III, 54 (24.1 per cent) were lost, either because they ceased to operate, or because they could not be retraced again, or because they simply declined to be interviewed again.

All firms fall under four different sectors (about 25 per cent in each sector): food, wood, textiles, and metals. These sectors were selected because they were perceived to have the greatest likelihood of exporting. The firms are located in four different cities: Nairobi (about 64 per cent), Mombasa (18 per cent), Nakuru (9 per cent), and Eldoret (9 per cent). In terms of size, they range from micro (1-5 employees, about 27 per cent), small (6-20, 19 per cent), medium (21-75, 30 per cent) to large (76-, 23 per cent). The dataset covers both formal, that is, registered (some 75 per cent) and informal firms (25 per cent).[9]

Not all firms in the original survey are included in the study. Bakeries were excluded on the grounds that they mainly produce goods that do not fare well for exports. Firms with less than six employees (which includes all informal firms) were also excluded, because of unreliable data.[10] The dataset used thus consists of 339 observations of 161 firms. However, in the subsequent regression analysis another 148 observations were excluded because of the need to use lagged variables.

### *3.2. Comparative behaviour of exporting and non-exporting firms*

The proportion of exporting firms by sector and firm size is shown in table 1. Firm size is defined by the value of output.[11] Exporting firms are defined as those that direct some fraction of sales to foreign markets.

In the total sample, 38 per cent of the firms export. The proportion of firms that export are highest in the metals sector and lowest in the wood sector. The propensity to export increases dramatically with firm size; only 13 per cent of the small firms are exporters, while as many as 67 per cent of the large firms direct some portion of their sales to foreign markets. The positive relation between export propensity and firm size is common for all sectors.

[9] All details about the data collection and sampling procedure can be found in Aguilar and Bigsten (2002).
[10] Liedholm and Mead (1987) argue that measurement errors in survey data are more pronounced and frequent for small firms.
[11] All variables are in constant 1992 prices.

The relationship between technical efficiency and firm size is shown in table 2, where the means and medians of technical efficiency are presented for three different size categories. Technical efficiency estimates are obtained from Data Envelopment Analysis (see description in the Appendix). The table confirms the findings of many previous studies that large firms are more efficient in production. The mean technical efficiencies for large firms are higher than for small firms in all sectors. However, in the food and textiles sectors, the mean technical efficiencies are higher for small firms than for medium-sized firms. Median technical efficiency (in parenthesis) always increases with firm size.

In table 3, the following six relative characteristics of exporting and domestically-oriented firms are compared: technical efficiency, firm size, capital- ratio, human capital, firm age and the proportion of foreign ownership between the two groups. Technical efficiency and firm size are defined as before. Capital-labour ratio is the ratio of the replacement cost of machines and equipment in million Kenyan shilling (Ksh) and the average number of employees. Human capital is computed as the total remuneration to workers in thousand Ksh divided by the number of employees.

The comparison of firm characteristics between exporting firms relative to those producing solely for the domestic market confirms what earlier empirical work has documented. Exporters are more efficient, larger and more intensive in physical as well as human capital. Technical efficiency is higher for exporters in all sectors, ranging from 10 per cent higher in mean technical efficiency for textiles to 67 per cent higher in wood. The pattern is similar when medians are compared.

The difference in mean firm size between exporters and non-exporters is striking. Sector-wise comparisons reveal that exporting firms are anywhere between twice as large (food) and little more than seven times (textiles) larger than non-exporters. This result confirms the general observation for developing countries that exports tend to originate from relatively large establishments.

The mean capital-labour ratio among exporters is 67 per cent larger than for their domestically-oriented counterparts in the total sample. In the food sector, however, exporters, on average, are less capital-intensive than non-exporters. This is also the sector with the smallest mean difference in size between exporters and non-exporters.

It is usually assumed that developing countries, like Kenya, are labour-abundant compared to their relatively developed trading partners and, therefore, they are expected to export relatively labour-abundant commodities. The contradicting result in table 3 (except in the food sector) may be explained by a positive relation between exports and firm size together with the observation that large firms tend to be more capital intensive than smaller ones. This issue is further investigated in section 4.

Exporting firms seem to possess a higher level of human capital. No clear pattern emerges from comparisons of firm age between the groups. Exporting firms tend to be older in the food sector and younger in the textiles sector. Finally, table 3 shows that the proportion of foreign ownership is more than three times higher among exporters.

Actually, all variables thought to influence technical efficiency and the export decision are significantly positively correlated with each other. For instance, large firms are more intense in physical and human capital, they have a higher degree of foreign ownership and are older compared to smaller firms.

Table 4 focuses on how the characteristics of firms that export to other African countries solely relate to firms that direct some or all of their exports outside Africa.[12] Columns 1 and 2 compare export destination with the alternative of not exporting at all. Previous results that exporting firms are more efficient, larger, more intensely use physical and human capital and tend to have some foreign ownership are largely confirmed.

But there are important differences to report depending on the destination of exports. Firms exporting solely within African tend to be smaller, but relatively abundant in both physical and human capital. This is in line with Lall's (1987) observations on India, and the view that Kenyan manufacturing firms have a comparative advantage in these two types of capital when compared with firms in other SSA countries, especially its main trading partners, the neighbours Tanzania and Uganda. To the extent the theory of comparative advantage is

[12] Approximately 23 per cent of the firms export. Of these, almost half of them direct their exports exclusively to other African countries (mainly United Republic of Tanzania), the rest direct their exports to both within and outside Africa, or exclusively outside Africa.

applicable here, it also dictates trade with countries outside Africa because relatively low-skilled and labour-intensive products dominate that kind of exports.

Even though the descriptive analysis shows that technical efficiency is higher among exporters, it is difficult at this stage to say whether this is because export activities spur technical efficiency, because efficient firms start exporting, or because of characteristics that influence both technical efficiency and the probability of being an exporter. The results in table 4 show that both firm size and human capital are correlated with export participation and technical efficiency. Both these variables are, however, correlated with other firm characteristics that may influence export participation and technical efficiency. Based on multivariate analysis, it is possible to better isolate the effect of firm characteristics on the exporting decision and technical efficiency.

## 4. Regression analysis

Having provided a descriptive analysis with special emphasis on exports, this section discusses a few modelling concerns. Thereafter, the results obtained from regression analysis are analysed.

### *4.1. Modelling issues*

The two objectives here are first, to understand what drives firm efficiency and export-participation, respectively. To this end, two standard models are estimated, the first of which explains technical efficiency and has, among the explanatory variables, a dummy variable indicating whether a firm exports or not, as well as technical efficiency lagged one period. The second model has the export dummy variable as the dependent variable and efficiency as one of its arguments.

The second objective is to investigate the effects of taking into account the destination of exports for which similar models as for the first objective are estimated. The difference is that, in the efficiency regression, the export dummy variable is replaced by two destination-of-exports dummy variables, while in the export decision regression, the dependent variable is now a trichotomous one: firms that do not export at all, those that only export to other African countries, and those that direct at least some of their exports outside of Africa. These

decisions are estimated simultaneously in a multinomial logit. However, it should be noted that it is only possible to distinguish between firms that export to Africa solely and those that *mix* destination of exports. The reason for choosing to cluster specialist exporters with mixed exporters is simply because very few firms specialize in exports to North. As will be seen, this does not seem to affect the results significantly.

In all models mentioned earlier, the explanatory variables, besides exports and efficiency, are firm size, capital-labour ratio, firm age, human capital, and foreign ownership (all continuous variables are in logs). For all models, using the first lag of these variables hopefully helps to rectify the suspected simultaneity bias caused by potentially endogenous explanatory variables. Such bias would most likely overestimate the parameters, since the estimate would include the effect of, for example, firm size on technical efficiency as well as technical efficiency on firm size. The use of lagged explanatory variables, however, it is not enough to permit any causal interpretation of the results, since the first lag indicates predetermination only and does not imply that a variable necessarily causes the dependent variable.

In addition to the OLS estimator, the fixed-effects estimator is used. The reason is that this estimator can capture the effect of time-invariant omitted variables specific to firms (for example, managerial ability) that may be correlated with both exporting and technical efficiency. Moreover, it also accounts for differences in initial technical efficiency among firms and different initial endowments of other right-hand side variables. One way to deal with endogenous right-hand side variables might be to use an Arellano-Bond estimator, but available data do not permit this, since several firms are observed once or twice at the most.

With the exception of firm size, the variables discussed in the descriptive analysis, and used here as well, are defined as before. For the regression analysis, the choice was based on what is considered a more appropriate measure of firm size. An ideal measure of firm size would take into account the level of all production factors. In the literature, a common measure of firm size is the number of employees, which is a partial measure only.[13] Since there are systematic differences in capital-labour ratios between exporters and non-exporters on one hand, and firms with different output levels on the other, the size difference between firms

[13] Obviously, the mirror image of this 'problem' arises if the capital stock is used as a proxy for firm size. If exporters produce with a more capital-intensive technology than do non-exporters, the size difference between firms will be overestimated.

and, in particular, between exporters and non-exporters is underestimated (for example, see table 4). Therefore, firms' potential output is used as a measure of size, defined as observed output divided by technical efficiency. Potential output is a weighted sum of capital and labour. Apart from reducing the above-mentioned flaw, it is important to note that this definition is also independent of variations in technical efficiency.[14]

The reason for including a lagged dependent variable is to ensure that a correlation between efficiency and exports is not mistakenly interpreted as causality running from exports to efficiency when in fact causality may run in the other direction (for example, because efficient firms export because it is profitable for them to do so). It is well known that in panels such as this one, allowing for a lagged dependent variable may lead to complications because of correlation between the lagged dependent variable and the (firm-specific) error term. Such a correlation renders the OLS estimates biased. In addition, the lagged dependent variable may, in the productivity equation, lead to so called Nickel-bias. This can occur when the panel has a large number of units observed over a short time period. The direction of this bias is upward/downward if the correlation between the lagged dependent variable and a regressor is positive/negative (Nickel, 1981). However, the estimation techniques needed to handle, or at least mitigate, these biases demand much longer time series than are available here (for example, chapter 8 in Baltagi (1995) discusses this topic).

Nevertheless, two points seem rather clear. First, the inclusion of lagged efficiency has a crucial impact on the results, since they pertain to export changes; the results with respect to the other explanatory variables are affected only to a small extent. In addition, this also leads one to conclude that autocorrelation may not be a very serious issue in this case, at least not so problematic as to prevent us from comparing the results of the two OLS specifications. Second, controlling for firm-specific effects has profound consequences for the results. Changing the estimator (from OLS to fixed-effects) significantly alters conclusions not only on the export-efficiency relation but also for other variables.

Finally, for both technical efficiency and export decision regressions, a number of control variables have been included. These are: industry dummy variables to capture unobserved

[14] This is because technical efficiency is measured in the output-direction. We also used observed output as a proxy for firm size to check that the results were not driven by our size measure. The results were similar and did not alter any of the conclusions.

industry-specific variables, such as product characteristics or the extent of domestic and foreign competition, and time dummy variables to capture the influence of time-varying macro-variables, such as credit-market conditions, exchange rates, and trade policy.

### *4.2. Estimation results*

Table 5 presents the results of the efficiency equations based on OLS (columns 1-3) and the fixed-effects estimator (columns 4-6). In columns 1 and 4, the results of a technical-efficiency specification that excludes lagged technical efficiency are presented. Columns 2-3 and 5-6, on the other hand, show the parameters for two different specifications of the technical efficiency equation, both of which include lagged efficiency. While columns 1-2 and 4-5 contain a dummy variable for exports activities (taking the value of 1 if the firm exports, and 0 otherwise), in the third and sixth specifications, the export dummy variable for export is replaced by two dummy variables, which indicate whether firms export to Africa solely, or whether they direct some or all of their exports to countries outside Africa. In all cases, efficiency is measured under the assumption of variable returns to scale (VRS) technology.

Starting with the results for technical efficiency and based on OLS, it is shown that the existence of learning effects depends on whether a lagged dependent variable is included or not. Excluding lagged efficiency some support for learning effects (at the 10 per cent level of statistical significance) are indeed found, whereas the inclusion of it implies that the hypothesis of learning effects no longer is supported by the data. This result holds irrespective of how exporting enters the specification.

These conclusions are considerably altered when controlling for firm-specific effects. Although inclusion of lagged technical efficiency reduces the exporting parameter, as opposed to the OLS case, it is clearly statistically significant. Hence, there is indeed support for learning effects from exporting. Even more interesting, these learning effects derive from trade with other African countries only, while exports outside Africa are not statistically significant. Hence, this seems to support Amsden's arguments on the importance of South-South trade discussed in section 2.3. A complementary hypothesis may relate to the issue of appropriate technology, in other words, that the technology of the North is less suitable for a country in the South.

Having obtained this result, attention is turned to a discussion of the other explanatory variables. Using OLS, the parameter of firm size is positive and statistically significant, but this result disappears completely when employing the fixed-effects estimator. A plausible explanation is that firm size may have served as an instrument for omitted or poorly measured factors of production. For instance, Mengistae (1995) found that firm size (and firm age) "mainly proxy for the influence of owner human capital" in Ethiopian manufacturing. Since it is common across studies to find a "size effect", it is interesting to note that the results of this paper indicate that such an effect may represent an omitted variables problem rather than that large firms, per se, are relatively efficient.

Human capital enters with an expected positive sign and indicates that firms with a greater amount of human capital are more efficient, although the parameter is significant at the 10 per cent level only. On the other hand, if variations in average wage (proxy for human capital) represent variations in average hours worked, the positive parameter might only reflect failure to properly measure labour input in the DEA estimations. Firm age is insignificant in all specifications, while foreign ownership is so using OLS.[15] Hence, the common presupposition that firms with some foreign ownership are more efficient than domestic ones finds no support in the regressions.

Using the fixed-effects estimator, capital-intensity has a positive effect on technical efficiency. Finally, the sign of lagged technical efficiency changes from positive to negative when a change from OLS to fixed-effects is made. This may suggest a correlation between lagged technical efficiency and some omitted variable, which overstated the effect of the former variable on technical efficiency; this result again shows the importance of using an appropriate estimator for analysing the export-efficiency relationship.

Next, turning to the results for the export-decision regressions (table 6), column 1 presents the marginal effects (evaluated at the means) for the export-decision equations with the choices — export or not to export. A positive marginal effect indicates a positive impact on the probability that a firm is an exporter. Columns 2 and 3 present the marginal effects (evaluated at the means) for the export-decision equations obtained from a robust multinomial logit estimator with choices — export to Africa solely or export outside Africa, respectively. An

exporter belongs to the latter category, if some fraction of exports is directed outside Africa. While in the binary logit it is possible to include sector dummy variables, this was not the case in the multinomial logit because one of the export choices had no variation in one of the sectors.[16] However, the inclusion of sectors does not qualitatively alter the estimation results obtained in the binary logit model. Also note that because panel estimation of the multinomial logit is non-trivial, only the pooled version of it is presented.

First the results from the standard logit model are discussed. With this specification, the marginal effect of technical efficiency on the decision to export is positive and statistically significant. This result strongly underscores that the cost of entering the export market is lower for relatively efficient firms and provides support for the self-selection hypothesis. Hence, the results confirm what today seems to be the standard result in these types of regressions, that is, relatively efficient firms self-select themselves into the export market.

Also related to the costs of exporting is firm size. The variable enters the specification with a marginal effect that is positive, as well as economically and statistically significant. The significance of the parameter of firm size can be interpreted as suggesting that larger firms can bear the costs associated with starting and maintaining export operations.

The marginal effect for firm age is statistically significant at the 10 per cent level and enters with a negative sign. The unexpected negative effect of firm age may be explained by the possibility that relatively young firms utilize more recent technology, while older firms are stuck with relatively obsolete physical capital. Thus, in contrast to our expectations, controlling for firm size and efficiency, older firms may be less competitive in the international market. Another explanation, related to the aforementioned one, is that old firms may yet have to adjust from the X-inefficiency caused by protection during the import-substitution policy period. However, it could also be that young firms start with the goal of exporting outside Africa and, therefore, make the necessary adjustments to be able to do so right from the start-up stage (see, for example, Fafchamps, El Hamine and Zeufack, 2001). Soon it will be seen whether this is indeed the case.

[15] Because the foreign ownership dummy variable is constant over time for the majority of firms, it does not appear in the case of the fixed-effects estimator.
[16] None of the firms in the metal sector export outside Africa.

Introducing some degree of foreign ownership increases firms' probability of participation in exports by 0.32. Foreign ownership must, therefore, be considered as an important determinant of exporting. For the overall decision of whether to export or not, capital-intensity and human capital appear to be of little consequence.

Next the results obtained by multinomial logit for destination of exports are dealt with. The model provides some interesting results, but before going ahead, a Wald-test is undertaken to determine whether the analysis of destination of exports, compared to the analysis of a standard binary logit model, is statistically meaningful. The Wald-test reveals that this, indeed, is the case.[17]

A very interesting result is that the effect of technical efficiency on the export decision, in terms of statistical significance (but not parameter size), is different for firms that direct their exports to Africa solely, and for those that direct some of their exports outside Africa. That is, for exports to markets outside Africa, it is necessary that firms are efficient prior to their entry. This may suggest that competition in exports markets of the North is harder than in those in the South. Another explanation could relate to higher sunk costs for entering export markets outside Africa. This result stands in contrast to the results of, for instance, Rankin (2001) for South Africa. In that study it was found that firms exporting outside the South African Development Community (SADC) area were more efficient than firms trading within it.

Firm size has a positive and statistically significant effect on the decision to export outside Africa, while the marginal effect of firm size on decision to export within Africa only is statistically insignificant. This differing effect is statistically significant at the 1 per cent level. Thus, the positive size effect found in the binary logit model seems to be due to the effect of exports directed outside Africa. The reason for this may be that the cost for entering export markets is lower in the African market than it is to markets outside Africa. Another explanation could be that in the short run small Kenyan firms may be unable to supply the large quantities demanded by large markets.

Another interesting result is that high physical capital intensity, as well as human capital

[17] The $\chi^2$ value is 14.37 and is significant at 5 per cent.

increases the probability to export within Africa, while factor proportions have no explanatory power on export activities outside Africa. This means that Kenyan firms might have a comparative advantage in physical and human capital within Africa. Furthermore, it must be noted that the difference between the effects on exports within Africa and outside Africa is statistically significant for the capital-labour ratio only (at the 5 per cent level).

There is no statistically significant difference arising from foreign ownership on the probability to export between the two export destinations. Thus, influence from foreign ownership seems to be important for any venture into export activities. A plausible explanation that foreign ownership increases the probability to export within Africa is that firms from developed countries tend to enter the perhaps relatively unknown African market by forming joint ventures with Kenyan firms. Finally, although the negative marginal effect for firm age in the binary logit model was of concern, it is no longer statistically significant in any of the export destinations.

## 5. Conclusions

The general finding that efficiency and export activities in developing countries are positively correlated has often been interpreted as support for the existence of learning effects. However, a competing strand of literature maintains that relatively efficient firms self-select into export activities. The implied causalities of these theories thus run in opposite directions.

This study's first conclusion is that support can be found for self-selection behaviour among Kenyan manufacturing firms. In addition, evidence of learning effects from exporting is detected. In that, the results obtained here differ from those of many other studies on the subject but agree with, for instance, Bigsten et al. (2002).

Thereafter the issue whether the destination of export mattered for the conclusions drawn was investigated, as it is possible that learning effects emanate from trade with industrialized countries, where the scope for learning is expected to be greater. However, such support was not found. Instead, it is exports to other African countries that lead to learning effects, which supports Amsden's arguments with respect to South-South trade. Furthermore, it may be an indication that North technology is inappropriate (for example, too advanced) for Kenyan manufacturing firms. Two important modelling aspects played big roles in achieving this

result, namely, that of controlling for lagged efficiency and firm-specific effects. Failing to do so may thus lead to a misinterpretation of the often-observed correlation between efficiency and exports.

This study also addresses the question whether requirements for entering a South market are the same as those for entering a North market. A finding worth highlighting is that efficiency is important for entry into North markets, but not into South ones. There are also important differences with respect to the inference of exports within and outside Africa. First, the importance of firm size pertains to exports outside Africa only. This result may be explained by higher costs of penetrating North markets than South markets. For that reason, firms have to be relatively large to bear the costs associated with starting and maintaining export operations outside Africa. Hence, the issue of different costs of penetrating different markets seems to be another important consideration, which is not highlighted sufficiently in traditional analysis of exports and efficiency.

Second, it was observed that firms exporting to other African countries use physical and human capital more intensively and, controlling for other factors, that the probability for a firm to export within Africa increases with the firms' physical and human capital intensity. These findings might lead one to speculate that Kenyan firms have a comparative advantage in production intensive in its use of those factors of production for exports destined to other African countries.

Although this study does not permit any far-reaching policy conclusions, one policy implication may be to question *general* export promotion policies for increasing efficiency; more specifically targeted export promotion policies, namely, at countries at similar technological level, may have the highest pay off. While the common result that firms self-select into exporting activities has been obtained also here, an important contribution of the paper has been to highlight differences between North-South and South-South trade, in particular the differing requirements for entering North and South exports markets.

Finally, looking ahead it would be interesting to see whether the significant role of export destination found in Kenya also holds in other countries. For countries where data over a longer time period exist, an attempt at modelling the dynamics might reveal interesting

insights. It is felt that these are two promising research avenues to embark on when the required data become available.

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**Table 1. Proportion of firms exporting, by sector and firm size, average of 1992-1994**

| Sector | Small | Medium | Large | ALL |
|---|---|---|---|---|
| Food | 0.21 | 0.47 | 0.74 | 0.47 |
| Textiles | 0.05 | 0.22 | 0.64 | 0.30 |
| Wood | 0.04 | 0.14 | 0.46 | 0.21 |
| Metals | 0.24 | 0.64 | 0.88 | 0.58 |
| **ALL** | **0.13** | **0.36** | **0.67** | **0.38** |

*Note*: The size categories were obtained by dividing the firms into three equal-sized groups based on output of the firms in each sector. Small corresponds to the lowest third, medium to the middle third, and large to the highest third.

**Table 2. Mean (Median) technical efficiency, by sector and firm size, average of 1992-1994**

| Sector | Small | Medium | Large | ALL |
|---|---|---|---|---|
| Food | 0.57 (0.42) | 0.47 (0.45) | 0.71 (0.67) | 0.58 (0.49) |
| Textiles | 0.65 (0.53) | 0.64 (0.59) | 0.79 (0.84) | 0.70 (0.66) |
| Wood | 0.37 (0.29) | 0.38 (0.31) | 0.51 (0.48) | 0.42 (0.35) |
| Metals | 0.31 (0.15) | 0.48 (0.38) | 0.76 (0.74) | 0.51 (0.46) |
| **ALL** | **0.46 (0.37)** | **0.49 (0.43)** | **0.68 (0.66)** | **0.55 (0.49)** |

*Note*: Technical efficiency is an index ranging from 0 to 1, where 1 indicates full efficiency. The size categories were obtained by dividing the firms into three equal-sized groups based on output of the firms in each sector. Small corresponds to the lowest third, medium to the middle third, and large to the highest third.

**Table 3. Comparison of firm characteristics: the ratio between the mean (median) for exporting firms and non-exporting firms, by sector, average 1992-1994**

| | Food | Textiles | Wood | Metals | All |
|---|---|---|---|---|---|
| Technical efficiency (VRS) | 1.43 *** | 1.10 | 1.56 *** | 1.67 *** | **1.41 *** ** |
| | (1.33) | (1.00) | (1.80) | (2.28) | **(1.60)** |
| Firm size | 2.10 *** | 7.33 *** | 6.67 *** | 4.07 *** | **4.39 *** ** |
| | (11.42) | (6.42) | (5.96) | (6.00) | **(7.63)** |
| Capital-labour ratio | 0.73 | 2.91 *** | 1.22 | 1.32 *** | **1.67 *** ** |
| | (1.14) | (4.10) | (1.23) | (1.29) | **(2.18)** |
| Human capital | 1.67 ** | 1.12 | 1.25 ** | 1.47 *** | **1.51 *** ** |
| | (1.11) | (0.99) | (1.53) | (1.30) | **(1.33)** |
| Firm age | 1.44 *** | 0.53 *** | 1.16 * | 1.07 | **0.98** |
| | (1.93) | (0.67) | (0.94) | (1.00) | **(1.03)** |
| Foreign ownership [a] | 4.72 *** | 4.29 ** | 1.97 *** | 4.15 *** | **3.52 *** ** |

*Note*: Figures greater than one indicate a higher mean for exporting firms. ***, ** and * indicate statistical significance at 1 per cent, 5 per cent and 10 per cent, respectively.

[a] The ratio between the proportion of foreign ownership for exporting firms and non-exporting firms.

**Table 4. Comparison of firm characteristics**[#]

| | **Africa vs. No exports** | **Outside vs. No exports** | **Africa vs. Outside** |
|---|---|---|---|
| Technical efficiency (VRS) | 1.20 ** | 1.41 *** | 0.85 |
| Firm size | 3.36 *** | 4.95 *** | 0.65 *** |
| Capital-labour ratio | 2.63 *** | 1.51 | 1.43 *** |
| Human capital | 2.12 *** | 1.46 ** | 1.31 ** |
| Firm age | 1.16 * | 1.19 | 0.97 |
| Foreign ownership [a] | 4.64 *** | 3.29 *** | 1.11 |

*Note*: [#] The ratio between the mean for firms exporting to Africa solely and non-exporting firms, firms exporting to Africa and elsewhere ("Outside") and non-exporting firms, and firms exporting to Africa solely and firms exporting to Africa and elsewhere.
***, **, and * indicate statistical significance at 1per cent, 5 per cent, and 10 per cent, respectively. Figures greater than one indicate a higher mean for exporting firms in the first two cases and higher firms specializing on exporting to Africa in the third case. Significance levels in the first two cases were obtained by regressing the dependent variable on a constant and a dummy variable indicating destination of exports. In the third case, significance levels were obtained from a regression of the dependent variable on dummy variables indicating exports to 'Africa solely' and 'Outside Africa', respectively. Thereafter, the hypothesis $\beta_{AFRICA} = \beta_{OUTSIDE}$ was tested. Note that 'Outside Africa' is composed of firms that direct some of their exports outside Africa.
[a] The ratio between the proportion of foreign ownership for exporting firms and non-exporting firms.

**Table 5. Technical efficiency and destination of exports**

| | Technical Efficiency - OLS | | | Technical Efficiency – Fixed effects | | |
|---|---|---|---|---|---|---|
| | Export dummy | Export dummy | Destination dummies | Export dummy | Export dummy | Destination dummies |
| Constant | -1.372*** (5.669) | -0.757*** (3.206) | -0.769*** (3.092) | | | |
| Technical efficiency$_{t-1}$ | | 0.382*** (5.093) | 0.384*** (5.023) | | -0.726*** (10.988) | -0.736*** (10.983) |
| Exports$_{t-1}$ (Anywhere) | 0.213* (1.841) | 0.107 (1.095) | | 0.421*** (3.260) | 0.322*** (2.668) | |
| Exports$_{t-1}$ (Africa only) | | | 0.103 (0.822) | | | 0.170*** (3.002) |
| Exports$_{t-1}$ (Outside Africa) | | | 0.085 (0.644) | | | 0.074 (0.427) |
| Firm size$_{t-1}$ | 0.065*** (3.804) | 0.050*** (3.202) | 0.050*** (3.205) | 0.046 (0.786) | -0.003 (1.264) | -0.028 (1.330) |
| Capital-labour ratio$_{t-1}$ | -0.077* (1.842) | -0.044 (1.205) | -0.046 (1.214) | 0.084 (1.108) | 0.117* (1.972) | 0.116* (1.846) |
| Human capital $_{t-1}$ | 0.118*** (3.013) | 0.096** (2.415) | 0.096** (2.367) | 0.091 (1.477) | 0.067* (1.723) | 0.066* (1.678) |
| Firm age $_{t-1}$ | -0.028 (0.367) | -0.037 (0.554) | -0.034 (0.505) | -1.901** (2.218) | -0.712 (1.083) | -0.699 (1.060) |
| Foreign ownership | 0.056 (0.479) | 0.031 (0.325) | 0.034 (0.356) | | | |
| No. of observations | 191 | 191 | 191 | 191 | 191 | 191 |
| Adjusted $R^2$ | 0.22 | 0.33 | 0.33 | 0.51 | 0.75 | 0.73 |
| *Hypothesis tests:* | | | | | | |
| Joint $\beta=0$ [a] | 5.07*** [10,180] | 8.16*** [11,179] | 7.35*** [12,177] | 2.55*** [129,62] | 5.30*** [130,61] | 5.00*** [130,60] |
| Heteroscedasticity[b] | 17.11*** [10] | 16.64*** [11] | 17.87*** [12] | -------- | -------- | -------- |
| $\beta_{Exp(Afr)}= \beta_{Exp(Out)}$ [c] | -------- | -------- | 0.13 [1] | -------- | -------- | -------- |

*Note*: ***, **, and * indicate statistical significance at 1 per cent, 5 per cent, and 10 per cent, respectively. T-values are in parenthesis. All continuous variables are in logs. Industry (Food, Wood and Textiles) and Time (Year 2) dummy variables are included in OLS, whereas only the time dummy variable enters in the case of the fixed-effects estimator.

[a] For OLS: F-test of slope parameters jointly = 0, F[k, N-k-2].

[b] For OLS: Breusch-Pagan test of $H_0$: homoscedasticity, $\chi^2$[df].

[c] Wald test of parameters Exports(Africa only) = Exports(Outside Africa), $\chi^2$[df].

**Table 6. Export-participation and technical efficiency**

| | Export participation | | |
|---|---|---|---|
| | **Anywhere** | **Africa only** | **Outside Africa** |
| | **(binary logit)** | **(multinomial logit)** | |
| Constant | 0.097 | 0.115 | -0.035 |
| | (0.431) | (0.847) | (1240) |
| Technical efficiency$_{t-1}$ | 0.377*** | 0.077 | 0.070* |
| | (4.976) | (1.493) | (1.858) |
| Firm size$_{t-1}$ | 0.283*** | -0.002 | 0.033* |
| | (6.952) | (0.082) | (1.816) |
| Capital-labour ratio$_{t-1}$ | 0.028 | 0.103*** | -0.007 |
| | (0.732) | (3.435) | (0.306) |
| Human capital $_{t-1}$ | 0.045 | 0.066* | 0.006 |
| | (1.040) | (1.701) | (0.206) |
| Firm age $_{t-1}$ | -0.110* | -0.037 | -0.067 |
| | (1.853) | (0.870) | (1.615) |
| Foreign ownership | 0.315*** | 0.237*** | 0.162*** |
| | (3.001) | (3.444) | (2.827) |
| No. of observations | 191 | 191 | 191 |
| Pseudo-$R^2$ [a] | 0.60 | -------- | -------- |
| Log-likelihood | -71.86 | -121.14 | -121.14 |
| *Hypothesis tests:* | | | |
| Joint $\beta=0$ [b] | 103.8*** | 92.65*** | 92.65*** |
| | [10] | [14] | [14] |
| Mlogit vs. Logit [c] | -------- | 14.37** | 14.37** |
| | | [8] | [8] |
| Heteroscedasticityd [d] | 24.73*** | -------- | -------- |
| | [1] | | |
| $\beta_{AFR-eff.}= \beta_{OUT-eff}$ [e] | | | 0.21[1] |
| $\beta_{AFR-size}= \beta_{OUT-size}$ [e] | | | 14.19[1] *** |
| $\beta_{AFR-caplab}= \beta_{OUT-caplab}$ [e] | | | 5.87[1] ** |
| $\beta_{AFR-human}= \beta_{OUT-human}$ [e] | | | 1.13[1] |
| $\beta_{AFR-age}= \beta_{OUT-age}$ [e] | | | 0.67[1] |
| $\beta_{AFR-foreign}= \beta_{OUT-foreign}$ [e] | | | 0.05[1] |

*Note*: ***, **, and * indicate statistical significance at 1 per cent, 5 per cent, and 10 per cent, respectively. Z-values for marginal effects are in parenthesis. All continuous variables are in logs. Industry (Food, Wood and Textiles) and Time (Year 2) dummy variables are included.

[a] For Logit: Pseudo $R^2$ (Zavoina and McElvey, 1975).

[b] For Logit and Mlogit: $H_0$: Wald tests of slope parameters jointly = 0, $\chi^2$[df].

[c] Wald test of mlogit(Africa only) slope parameters jointly = mlogit (Outside Africa) slope parameters, $\chi^2$[df].

[d] For Logit: Likelihood ratio test of $H_0$: homoscedasticity, $\chi^2$[df].

[e] Wald test of $\beta_i$(Africa only) = $\beta_i$(Outside Africa), $\chi^2$[df].

## Appendix

### *The model of efficiency measurement*

Technical efficiency is analysed based on deterministic nonparametric frontiers or data envelopment analysis (DEA). The approach is based on Farrell (1957) and extensions of his work by Charnes et al. (1978), and related work by Färe et al. (1983, 1985) and Banker et al. (1984). In this approach efficiency of a production unit is measured relative to the efficiency of all other production units, subject to the restriction that all units are on or below the best practice frontier.

Let the technology for each manufacturing sub sector be represented by a technology set, S, defined as:

$$S = \{(x,y) : y \text{ can be produced by } x\} \tag{A1}$$

where $y$ is a vector of outputs and $x$ a vector of inputs. It is assumed that $S$ is closed and convex, it has free disposability of outputs and inputs and variable returns to scale is allowed. Since the sub sectors are heterogeneous, each sector has its own specific technology and the technology is defined as a common technology over time. Thus, for each sub sector, efficiency is measured relative the most productive units during the entire period. The Farrell output efficiency measure is the ratio of the observed output quantities and the output quantities produced at the frontier given the input and output mix, and for a feasible point ($x$, $y$) it is defined as:

$$E^o(y,x) = \min_\delta \left\{ \delta : (x, \frac{y}{\delta}) \in S \right\}, \delta > 0. \tag{A2}$$

Based on the non-parametric technology given the assumption of variable returns to scale the Farrell output efficiency measure equals the inverse of the optimum value of the linear programming problem (A3) to (A6), that is, $E^o(y,x)=\mu^{-1}$

$$Min\ \mu = \sum v_i\, x_{i0} + v_0 \tag{A3}$$

$$\sum_{k=1}^{s} \mu_k\, y_{k0} = 1 \tag{A4}$$

$$-\sum_{k=1}^{s}\mu_k y_{kj}+\sum_{i=1}^{m}v_i x_{ij}+v_0\geq 0 \quad j=1,\ldots,N \tag{A5}$$

$\mu_k,\ v_i \geq 0,\quad v_0$ unrestricted (A6)

where $\mu_k$ and $v_i$ are the weights of the Linear Programming problem, $m$ is the number of inputs and $s$ is the number of outputs. There is a single output and three inputs, where the latter are capital, labour and materials. N stands for the number of production units in the sub-sector times the number of years.