

Exporting Raises Productivity, At Least in sub-Saharan African Manufacturing Firms

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Abstract

Proponents of trade liberalization argue that it will force firms to produce closer to the production possibility frontier and that the frontier will move out faster. This hypothesis is examined by calculating the effect of exporting on productivity for a panel of manufacturing plants in nine African countries. The results indicate that exporters in these countries are indeed more productive, replicating similar findings for developed countries. In contrast, it turns out that exporters have higher productivity growth as well and the growth rate accelerates after entry into the export market. While the first observation can be explained by selection—only the most productive firms engage in exporting—the latter cannot. This result remains after controlling for unobserved productivity differences and self-selection into the export market. I present some evidence what drives the benefits to exporting. The realization of economies of scale, adoption of better technologies, and better enforceability of contracts with foreign clients are found to be important.

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1 Introduction

A positive correlation between the cross-sectional productivity level and export market participation has been established for a number of countries. Based on the experience of the United States, Colombia, Morocco, and Taiwan, researchers have concluded that causation goes from productivity to exporting, see Bernard and Jensen (1999a), Aw, Chung, and Roberts (1998), and Clerides, Lach, and Tybout (1998). I confirm the positive correlation for a sample of manufacturing firms from nine sub-Saharan African countries. In addition, I present evidence for reverse feedback, going from exporting to increases in productivity. Exporters have a higher productivity level, even after controlling for self-selection, and they also enjoy a higher rate of productivity growth. Exporting allows firms to realize returns to scale and to learn about more advanced and different technologies. It also remedies contract enforcement problems that hold back firms producing only for the domestic market. These benefits associated with exporting are likely to be more important for firms in developing countries. It is therefore not surprising that to find evidence for learning-by-exporting for African firms, even though it is absent in more developed countries.

Trade liberalization is often advocated as a way of stimulating the economy, especially in developing countries. It is an integral part of most IMF and World Bank structural reform programs. The example of export-led growth in East Asia illustrates the potential for economic development through trade. An important channel through which trade reforms can benefit a country is by making firms produce more efficiently. Competition with foreign firms will force incumbents to invest in more efficient technologies and exporters are likely to realize scale economies. Clerides, Lach, and Tybout (1998) mention a number of studies that claim the existence of learning-by-exporting effects. It is argued that exporters learn about international best practice production methods, receive knowledge spillovers, export externalities, and feedback from clients, etc. Evidence for these effects rarely goes beyond casual observations or case studies.

Much of the analysis establishing a link between trade liberalization and a resulting increase in industrial production and total factor productivity (TFP), uses aggregate statistics at the industry level. The direct evidence for impact of international trade on firms' performance is meager. It is well known that aggregate trends can be explained by different evolutions at the firm-level. Baily, Hulten, and Campbell (1992) illustrate that this holds particularly true for productivity dynamics. Other studies, by Levinsohn and Petrin (1998) and several papers in Roberts and Tybout (1996), document specifically the important effect trade liberalization has on the distribution of

productivity. One needs to look at micro evidence to establish a firm link. The effect of a change in trade policy on aggregate productivity is also clouded by lagged adjustment. Countries often adjust many economic policies when embarking on trade reforms or reforms are triggered by an unusually large recession. In either case, the resulting productivity change can be attributed to many different factors. An alternative strategy to establish the effect of trade is to compare firms that do not face foreign competition with those that do. Exporters are unambiguously competing with foreign firms and they will be the focus of this analysis. Firms operating in import competing industries also face foreign competition, but they are harder to identify in my sample because the industry they operate in is not known with great detail.

Exporters differ in several ways from non-exporters in the U.S. They are larger, grow faster, and are more capital intensive, as demonstrated in Bernard and Jensen (1995). For developed countries, some researchers have found that exporters are more productive than the average firm, see for example Bernard and Jensen (1999a) and studies cited there. The finding for productivity is particularly important since it led people to explain export market participation as the outcome of a selection mechanism. Only the most productive firms will be able to compete internationally or have a sufficient cost advantage to compensate for transportation costs. Exporters are more productive than non-exporters, not because there are any benefits associated with export activity, but they were simply more productive to start with.

For the sample of African manufacturing firms, on the other hand, there is evidence for reverse feedback. Firms that are active on the export market are able to increase their productivity advantage. Exploiting the time dimension in the panel, I demonstrate that the productivity gap grows if firms remain active on the export market for a longer time. After they exit the export market, their productivity level decreases in consecutive years. An alternative approach uses instrumental variables estimation to control for self-selection. The dummy for export status is an endogenous variable, which is correlated with the unobserved firm-level productivity if learning-by-exporting effects are present. Using instruments to predict export activity, like ethnicity of the owner and location, that are uncorrelated with the firm's productivity, controls for the endogeneity.

Given that exporters benefit from their international activity, even after the decision to start exporting is made, it is natural to ask where the benefits come from. Three different sources are identified. Firms that expand beyond the domestic market realize returns to scale. Estimating separate production functions for exporters and non-exporters confirms that while non-exporters

operate at a point on the production function with significant increasing returns to scale, exporters have exhausted scale economies. Contact with firms operating internationally can improve the domestic production technology, providing a second channel for productivity improvements. This can operate through explicit knowledge transfers, feedback from clients, or externalities. For all but a few developed countries, there is considerable room for technological catch-up. I reject that exporters and non-exporters produce with the same production technology. A final benefit for exporters comes through better contract enforceability. Most plants in the sample extend trade credit and the difficulty finding reliable clients often limits expansion. Contract defaults are less frequent on international sales or on sales to multinational enterprises. Trade liberalization gives firms the opportunity to expand, and realize scale economies, without having to sell to ever more unreliable domestic clients. It is reasonable to expect all three of these effects to be important for African firms, but less so for firms in developed countries. It explains the discrepancy between the finding for developed countries, where feedback goes mainly from productivity to exporting — self-selection—, and the finding in the sample, where feedback goes from exporting to productivity —learning-by-exporting.

The three questions addressed in this study are whether exporters are more productive than the average firm in sub-Saharan Africa, the direction of causation in this relationship, and the sources of productivity benefits for exporters. After introducing the countries and firms in the sample, in Section 2, each of the three questions is addressed in a separate section. Section 6 ends with conclusions.

2 The countries and firms studied

The sample is constructed from firm surveys, carried out between 1992 and 1996 in nine sub-Saharan African countries: Burundi, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Tanzania, Zambia, and Zimbabwe. In each country approximately 200 firms were interviewed in three consecutive years.¹ The data collection was coordinated by the Regional Program on Enterprise Development from the World Bank. Firms are taken from four broadly defined manufacturing sectors: food, textile and clothing, wood and furniture, and metal and equipment; corresponding roughly to the ISIC (version 2) classification industries 31, 32, 33, and 38. A sizable portion of the firms exit the

¹In Cote d'Ivoire only two rounds of interviews were completed and in Burundi and Ethiopia only one.

sample and some were added in later rounds to maintain the sample size. While some of the sample attrition is the result of economic factors, e.g. bankruptcy, the most likely reason for a firm to leave the sample is non-economic. Firms moved or did not want to cooperate anymore. Therefore, I will ignore entry and exit in the sample and not give it an economic interpretation. Van Biesebroeck (2001) shows explicitly that productivity is not correlated with exit in this sample, eliminating a potential endogeneity problem.

All nine are low-income countries and the level of development varies from a GDP of \$100 per-capita in Ethiopia (measured in \$PPP for 1995) to \$680 per-capita in Cameroon. The manufacturing sector is rather small in most countries, generating less than 10% of GDP, and employing even less of the workforce. The firms included in the sample, represent a significant share of the manufacturing sector in the respective countries. Value added for the sample is almost 40% of manufacturing GDP. The share of exports in GDP varies from 12% in Burundi to 42% in Cote d'Ivoire and exports are very concentrated. One or two agricultural or mining products account for more than 50% of revenues in several countries. The share of manufacturing products in exports rarely exceed its share in GDP. In the sample, the export participation rate is about 23% and the majority of firms export less than 20% of sales. Exporting is more prevalent among large firms and they tend to export more. The share of total output exported (by exporters) is 45%, while the average firm-level export share is only 34%.

Table 1: Number of observations in the sample

	1991	1992	1993	1994	1995	total
Burundi		106				106
Cameroon		202	183 (22)	181 (11)		235
Cote d'Ivoire			148		158 (43)	191
Ethiopia		207				207
Ghana	152	174 (49)	179 (9)			210
Kenya		209	200 (29)	202 (29)		267
Tanzania		193	174 (45)	120 (3)		241
Zambia		203	179 (32)	153 (27)		262
Zimbabwe		184	193 (17)	180 (2)		203

The numbers in brackets for the 2nd or 3rd year count firms that just entered the sample.

To estimate productivity one needs to observe output and inputs. Output is measured by total sales, labor input by the total number of employees, material input includes raw materials and intermediate products, and capital is the replacement value of the plant and equipment at the end

of the year. GDP deflators from World Bank (2000) are used to make output, material, and capital comparable across years. Table 1 indicates the number of firms with non-missing values by country and year. In the second and third years, the number of firms that enter the sample is indicated between brackets. The last column contains the total number of distinct firms in the sample.²

Mainly because of scarcity of data, manufacturing firms in sub-Saharan Africa are rarely studied. Given the amount of protection that still exists and the high dispersion of productivity across firms, the potential benefits of liberalization could be substantial. The evidence linking trade to productivity at the firm-level is very meager for this region. For Cote d'Ivoire, Harrison (1994) finds that foreign plants improve productivity after liberalization, while the effects on domestic plants are negative, but insignificant. For Cameroon, Ghana, Kenya, and Zimbabwe, Bigsten et al. (1999) find positive effects of exporting on productivity and on productivity growth even after accounting for selection and firm heterogeneity. In the next section, I investigate the relationship between productivity and exporting for the firms in the sample.

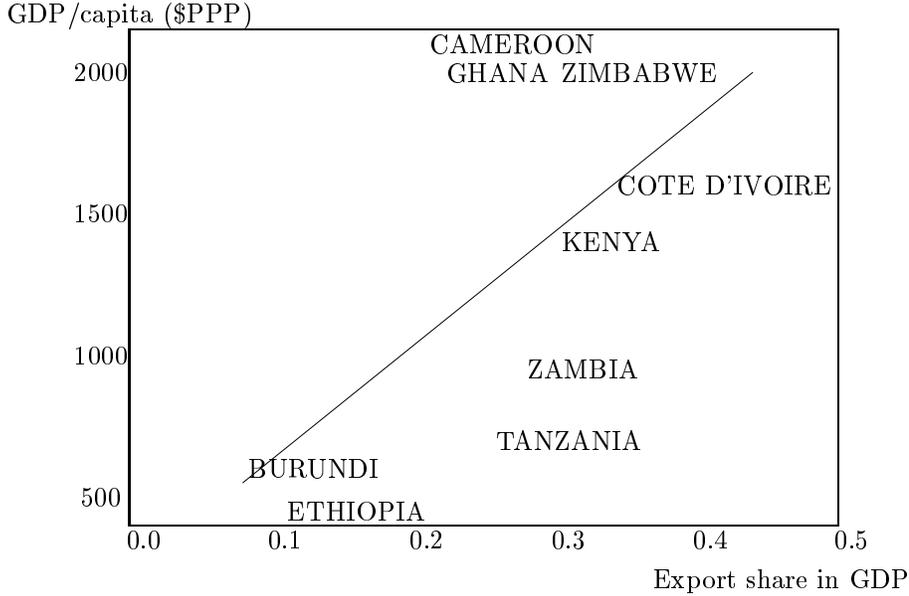
3 Positive correlation between productivity and exporting

A positive correlation between export status and performance measures, like productivity, output growth, wages, and size, has been established for developed countries, see for example Bernard and Jensen (1995) for the U.S. A glance over the macroeconomic performance of the African countries in the sample confirms the positive correlation between exporting and welfare. At the most aggregate level, Figure 3 illustrates that countries where exports make up a higher share of GDP also have higher GDP per-capita (measured in PPP in 1995).

Admittedly, this is a rather crude measure at only one point in time. More generally, the export share in GDP has a positive correlation coefficient with GDP per-capita of 0.44 over the last 20 years for the nine countries in the sample. The correlation climbs to 0.51 for the export share in manufacturing and even to 0.58 if the amount of manufacturing goods in total exports is related to the same welfare measure. I can safely conclude that exporting is more widespread in more prosperous countries, the more so if exports are manufactured products.

To make the same statement for firms, a firm-level measure of productivity is needed. Rather

²Questions in the survey asked about activity in the previous year. E.g. the data for 1992 was collected in the 1993 interviews.



than simply using the firm-level equivalent of GDP per-capita, average labor productivity, it is desirable to use a measure that controls for input substitution and scale economies. Assuming a production function for output in terms of labor, capital, and material inputs,

$$Q_{it} = A_{it} F(L_{it}, K_{it}, M_{it}),$$

Hicks-neutral productivity growth can be calculated as

$$\Delta \log \omega_{it} = \log\left(\frac{A_{it}}{A_{it-1}}\right) = \log\left(\frac{Q_{it}/Q_{it-1}}{F(L_{it}, K_{it}, M_{it})/F(L_{it-1}, K_{it-1}, M_{it-1})}\right), \quad (1)$$

and a Hicks-neutral comparison of the productivity level of firm i with the median firm for the industry, firm m , is

$$\omega_{it} = \frac{A_{it}}{A_{mt}} = \frac{Q_{it}/Q_{mt}}{F(L_{it}, K_{it}, M_{it})/F(L_{mt}, K_{mt}, M_{mt})}. \quad (2)$$

The denominators in (1) and (2) are calculated from an econometrically estimated production function, rather than relying on the theory of index numbers. This allows greater flexibility for variable returns to scale. Index numbers require either the user cost of capital or separate information on scale economies to avoid the constant returns to scale assumption, both of which are hard to come by.

The functional form for the production function is Cobb-Douglas, as is the case in most of the literature. Estimates using a translog production function yielded very similar results, not surprisingly given that the elasticities of substitution between inputs were estimated close to one. With the translog specification there were a number of violations of the second order conditions, caused by the large volatility in input use. A similar volatility in factor shares also made the index numbers approach less attractive. I do allow for variable returns to scale, which are expected to be increasing for the African firms in the sample.

One econometric problem to address is the endogeneity of firm-level productivity. A firm will choose its inputs knowing its own productivity. As a result, inputs will be correlated with the error term in the production function, making least squares an inconsistent estimator. One solution is to use instruments for the unobserved productivity. An alternative is to substitute productivity using an expression derived from the firm's first-order conditions, an approach pioneered by Olley and Pakes (1996). Both estimators yielded very similar parameter estimates.³ Van Biesebroeck (2001) shows that exit from the sample is uncorrelated with productivity, a potential problem that only the Olley and Pakes estimator would fix. Because the Olley and Pakes estimator is only possible for observations with positive investment, I use instrumental variables in the final calculations. The endogeneity problem will be more pronounced for inputs that the firm can adjust more easily, as discussed in Marschak and Andrews (1944), which is confirmed by the results in Blundell and Bond (2000). Lagged inputs and location and sectoral dummies are used as instruments for capital and labor.⁴

I estimate

$$q_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \beta_t t + \epsilon_{it}$$

separately by country. Table A.1 in the appendix contains the coefficient estimates. Lower case variables indicate logarithms. The input coefficients look plausible and imply increasing returns to scale for most countries. Using these results, the level and growth rate of productivity can be calculated from equations (1) and (2).⁵ For Burundi and Ethiopia only one year of data is available

³The correlation between the productivity measures obtained using both estimators was 0.985.

⁴Much of the literature estimates a value added production function, deducting materials from sales. This can be rationalized if material input is independent of output or varies perfectly in proportion with output fluctuations. In both cases, a firm does not choose material input in response to productivity. The results treating material as exogenous were also the closest to the results obtained with the Olley and Pakes estimator.

⁵There is a lot of volatility and dispersion in the sample and it is difficult to determine whether this reflects actual productivity differences or if it is the result of measurement errors. As a cautionary measure, firms that are more than 10 times as productive as the median firm or have only one tenth of the productivity are omitted. Similarly,

and the average of the input coefficient estimates from the other countries is used to calculate productivity levels.

The comparison between exporters and non-exporters is reported in Table 2. The table contains the median productivity level and growth rate separately for exporters and non-exporters. Five of

Table 2: Productivity comparison in level and growth rate (medians).

	Productivity level		Productivity growth	
	non-exporter	exporter	non-exporter	exporter
Burundi	0.94	1.36		
Cameroon	1.00	0.98	-0.083	0.115
Cote d'Ivoire	0.83	1.04	0.253	-0.093
Ethiopia	0.99	1.85		
Ghana	1.01	0.96	0.076	0.198
Kenya	1.02	0.97	-0.089	-0.012
Tanzania	1.00	1.12	0.011	-0.080
Zambia	1.01	0.88	-0.104	-0.206
Zimbabwe	0.97	1.00	-0.129	-0.137

The median productivity level is 1 for each country, and productivity growth is measured in percentages.

the nine countries show a higher productivity level for exporters, which is on average 35% higher. In four countries the difference is above 12%. Only one country shows non-exporters having an advantage of 13%. The other three countries where non-exporters have the highest productivity level only record differences of less than 5%, which was not statistically significant. Given the general consensus in the literature that exporters are more productive, I expected the results to be more conclusive. One potential explanation, discussed later, is omitted variable bias in the estimation of productivity. For example, returns to scale can be overestimated, which could result in lower productivity for exporters. The results in Table 4 control for that and show a more consistent productivity advantage for exporters. In Section 4.2, I explicitly control for self-selection into the export market, which strengthens the productivity advantage for exporters as well. The growth performance shows a tie, with each category showing the highest growth rates in three countries, and less than 1% difference in growth rate for Zimbabwe. Using averages instead of medians or classifying firms by export status in the previous period, does not change the picture substantially.

firms that show productivity improvements or deteriorations of more than 200% are dropped as well. These firms combined represent about 1% of the sample.

The results are not a complete surprise, because exporters are on average significantly larger than non-exporters. Table 3 illustrates that 43% of the firms that do not export have ten employees or less. An additional 37% has less than fifty employees, while only 4% is large, counting more than 250 employees. The situation is almost exactly the reverse for exporters. Only 4% has ten employees or less, while 78% has more than fifty employees. The higher output that exporters achieve for the same amount of inputs is explained as the realization of scale economies, rather than a productivity advantage. Comparing both categories of firms conditional on their size, a different picture emerges. The results in Table 3 reveal that micro, small and medium sized exporters are more productive than the corresponding non-exporters.⁶ Micro, small and large sized exporters have higher productivity growth as well.

Table 3: Productivity comparison conditional on size.

Categories (employees)	Size distribution		Productivity level		Productivity growth	
	non-exp.	exporter	non-exp.	exporter	non-exp.	exporter
Micro (1-10)	0.43	0.04	1.06	1.18	-0.038	0.113
Small (11-50)	0.37	0.18	0.94	1.14	-0.022	0.049
Medium (51-250)	0.16	0.44	0.97	1.01	0.074	-0.092
Large (251+)	0.04	0.34	1.20	0.94	-0.085	-0.076

An additional reason for the less than stellar performance of the exporters is their relative capital intensity combined with the capital coefficients being estimated higher than usual. Failure to account for the endogeneity problem posed by unobserved productivity led to an upwardly biased labor coefficient estimate in many other studies, which is likely to bias the estimate of the capital coefficient downwards. Olley and Pakes (1996) clearly illustrate the potential problem (compare any of the first five columns in their Table VI with the last four). Table 4 demonstrates that exporters are significantly more capital intensive than non-exporters. It lowers total factor productivity if capital receives more weight in the input aggregator. Using labor productivity instead, which does not rely on estimation of scale economies and neglects capital, exporters have significantly higher productivity, as illustrated in the last two columns of Table 4.

Finally, I investigate what the impact of exporters is on the aggregate productivity growth for each country. A country as a whole can become more productive if individual firms increase productivity or if more productive firms increase their share in economic activity. Firm-level productivity

⁶The productivity level for large non-exporters, just as the result for micro exporters, is based on very few firms.

Table 4: Capital intensity and labor-productivity level (medians)

	Capital-labor ratio		Labor productivity level	
	non-exporter	exporter	non-exporter	exporter
Burundi	0.94	1.13	0.98	1.76
Cameroon	0.70	2.05	0.80	2.15
Cote d'Ivoire	0.72	1.42	0.65	1.54
Ethiopia	1.09	0.58	0.99	1.50
Ghana	0.95	2.71	1.02	0.99
Kenya	0.82	2.45	0.72	2.00
Tanzania	0.88	1.55	0.99	2.11
Zambia	0.98	1.45	0.94	1.54
Zimbabwe	0.65	1.57	0.74	1.22

Both statistics are calculated relative to the median, similarly as equation (2).

growth is only one channel to increase aggregate productivity, it is neither a necessary nor a sufficient condition. Even if individual exporters have zero or negative productivity growth, they might still contribute positively to the aggregate growth if they are more productive than average. For example, a firm with negative productivity growth ($\Delta \log \omega_{it} < 0$) can have a positive contribution if $\frac{\Delta \theta_{it}}{\theta_{it}} > -\frac{\Delta \log \omega_{it}}{\log \omega_{it}}$. Relocation of resources from non-exporters to more productive exporters can reverse the firm-level productivity effect.

Aggregate productivity can be decomposed in a firm-level and compositional effect as follows

$$\Delta \omega_t = \sum_{j=1}^J \bar{\theta}_{jt} \Delta \log \omega_{jt} + \sum_{j=1}^J \Delta \theta_{jt} \overline{\log \omega_j},$$

where a line over a variable indicates it is the average over the value at the beginning and at the end of the period.⁷ The input aggregates, calculated from the production function estimates, are used as weights. I additionally distinguish between the contributions of firms by export status. Firms are classified as exporters or non-exporters if they remain in or out of the export market for the entire sample period. There are two more categories, one for firms that start exporting at some point during the sample period and one for those that leave the export market.

Table 5 contains the results for the decomposition for both terms and all four export categories by country. Using only continuing firms, the results from the last two columns in Table 2 that also

⁷Because $\sum_j \Delta \theta_{jt} = 0$, it does not matter whether the productivity level in the second term is normalized by the level of the median firm or not.

contains the effects of firm turnover. The qualitative results are similar. In the bottom panel the results are normalized to measure the percentage contribution to the total for the country. The signs have been reversed if the aggregate growth is negative. The aggregate firm-level productivity growth is negative in most countries. If it is positive, it is driven by the exporters or firms that just entered the export markets. Firms that exit the export market invariably make a negative contribution to productivity growth.

The results in the right half of Table 5 are more revealing. The sum of compositional effects are positive in all countries, indicating that resources move to above average productive firms. In particular, the contribution of exporters and firms starting to export is large and almost invariably positive. It turns out that the beneficial effect of exporters on aggregate productivity growth comes mostly through resource reallocation.

4 Feedback from exporting to productivity: learning-by-exporting

I showed that exporters have an average a higher level of productivity, but there are two ways to explain it. More productive firms can self-select into the export market, without deriving any benefit from their exporting activity. Alternatively, exporters can learn from their international activities and increase productivity. Technology transfers and scale economies are most often mentioned as potential sources of benefits to exporting. To address the direction of feedback it is important to work at a sufficiently disaggregate level. Giles and Williams (2000) show that previous studies using more aggregate (time-series) data to establish Granger-causality from exporting or trade reform to output growth are very sensitive to model specification.

Recently, some research uses panels of firms in different countries. The extra cross-sectional variation makes identification of the export effect more robust. Using U.S. data, Bernard and Jensen (1995) illustrate clearly that exporters are different from average plants, having higher productivity being one of the differences. In a follow-up paper, Bernard and Jensen (1999a), they find strong evidence for selection and weak or no evidence for learning-by-exporting. This confirms previous results by Clerides, Lach, and Tybout (1998) and Aw, Chung, and Roberts (1998) for Colombia, Mexico, Morocco, Taiwan, and South Korea. One dissenting opinion is provided by Bigsten et al. (1999), who find a positive effect of export status on productivity growth in four sub-

Table 5: Contribution of firm-level growth and compositional changes by export status

	Firm-level productivity growth					Contribution of the compositional effect					total
	export	non-export	start	exit	sum	export	non-export	start	exit	sum	
Cameroon	0.130	-0.031	0.002	-0.002	0.099	0.313	-0.003	0.002	0.004	0.316	0.415
Cote d'Ivoire	-0.033	0.021	-0.088	0.000	-0.100	0.092	0.004	-0.026	0.002	0.072	-0.028
Ghana	0.032	-0.005	0.067	-0.082	0.013	0.016	0.019	0.009	-0.007	0.037	0.050
Kenya	0.175	0.047	-0.008	-0.005	0.209	0.046	0.001	0.006	-0.003	0.051	0.260
Tanzania	-0.126	-0.051	-0.005	-0.052	-0.235	0.053	0.011	0.042	0.026	0.132	-0.103
Zambia	-0.184	-0.056	-0.019	-0.064	-0.323	-0.009	-0.018	0.001	0.005	-0.022	-0.345
Zimbabwe	-0.260	-0.025	-0.022	-0.003	-0.310	-0.019	0.000	0.001	-0.002	-0.020	-0.330
Average	-0.038	-0.014	-0.010	-0.030	-0.092	0.070	0.002	0.005	0.004	0.081	-0.012
Cameroon	31	-7	0	0	24	75	-1	0	1	76	100
Cote d'Ivoire	-118	75	-314	0	-357	329	14	-93	7	257	-100
Ghana	64	-10	134	-164	26	32	38	18	-14	74	100
Kenya	67	18	-3	-2	80	18	0	2	-1	20	100
Tanzania	-122	-50	-5	-50	-228	51	11	41	25	128	-100
Zambia	-53	-16	-6	-19	-94	-3	-5	0	1	-6	-100
Zimbabwe	-79	-8	-7	-1	-94	-6	0	0	-1	-6	-100
Average	-328	-123	-90	-257	-799	607	17	43	31	699	-100

Growth rates are cumulative from period 1 to period 3. Firms that enter or exit the export market at some point during the sample are put in the start and exit category for the entire period. The bottom panel denotes percentages of the total (negative where applicable).

Saharan African countries.⁸ Pavcnik (2000) finds positive effects of trade liberalization dummies on firm-level productivity for Chile, which she interprets as firms responding to competitive pressure from importers.

The effect of exporters does not only come from increased productivity at the firm-level. Bernard and Jensen (1999b) illustrate the positive contribution of expansion by exporters to aggregate productivity growth in the United States. Exporters are more productive and they expand faster. Even without improving firm-level productivity this raises aggregate productivity. Tybout and Westbrook (1995) show that in more open sectors productivity increases faster and that with trade liberalization scale economies got realized in Mexico, reinforcing the importance of exporters. Krishna and Mitra (1998) estimate that trade liberalization in India resulted in lower mark-ups, realization of scale economies, and (insignificantly) higher productivity growth.

Two strategies are adopted to investigate the direction of feedback between exporting and productivity. The first strategy exploits the time dimension in the panel. If learning-by-exporting effects are important, exporters should be able to increase the productivity gap with time spent in the export market. It is also likely that the productivity gap is larger for firms that sell a larger share of output abroad. The second strategy addresses the endogeneity of the export decision using instrumental variables. Variables that predict export status, but do not affect productivity (except through the learning-by-exporting effect), are used to identify the effect of exporting on output, controlling for self-selection into the export market based on productivity.

4.1 Evolution of the productivity gap

The first approach to uncover learning-by-exporting effects is to look whether firms that are exporting for a longer time or export a larger share of output have a larger productivity advantage. I regress the productivity level on a number of dummies characterizing the export experience of a firm, controlling for country, sector, time, and firm-size effects. I also use the growth rate of productivity as dependent variable and dummies for the length and intensity of the export experience as regressors.⁹ The finding that productivity growth is positively correlated with exporting is harder to explain by self-selection, which is likely to be based on the productivity level. The results

⁸Bigsten et al. (1999) uses some of the same data as this paper, but limits the sample to only four countries and uses a different approach to calculate productivity.

⁹For the export history regressions, dummies to control for left and right censoring caused by the limited duration of the panel are included as well.

for all four regressions are in Table 6.

Table 6: Productivity level and growth conditional on the export history and intensity.

Dependent variable:	Productivity level		Productivity growth	
	coefficient	(s.e.)	coefficient	(s.e.)
<u>History:</u>				
Exporter at t	0.040	(.039)	-0.032	(.058)
Exporter at $t - 1$	0.001	(.050)	0.052	(.057)
Exporter at $t - 2$	0.090	(.074)	0.162	(.069)
Stop exporting at $t + 1$	-0.111	(.090)	-0.264	(.151)
<u>Intensity:</u>				
Any exports	0.132	(.047)	0.027	(.061)
Exports > 10% of sales	-0.184	(.059)	0.038	(.076)
Exports > 50% of sales	0.032	(.076)	0.031	(.097)
Exports > 90% of sales	0.153	(.105)	-0.148	(.149)

OLS regressions with dummies controlling for country, sector, time, and firm-size.

The top-left panel confirms the finding from the previous section that exporters have a higher productivity level than non-exporters. The average productivity advantage stands at 4%. Firms that have been exporting in the current and previous period do not show an additional productivity advantage, but long-time exporters, those active on the export market for all three years of the sample, show an additional 9% productivity advantage. Relative to non-exporters the cumulative advantage attains 13.1%. The next coefficient indicates that firms that will exit the export market in the next period, have a lower productivity level even before they exit, which supports self-selection. Whether firms that stop exporting in the future have a higher or lower productivity level than non-exporters, depends on the number of years they were active on the export market, which supports the learning-by-exporting hypothesis.

The top-right panel contains largely similar results using productivity growth as dependent variable. Although exporters have lower productivity growth than non-exporters, the effect is estimated very imprecisely. Firms that were active on the export market for two periods display a productivity growth advantage of 5% relative to firms just starting to export and 2% relative to non-exporters. The advantage over non-exporters climbs to 18.2% if firms exported every year in the sample period. Firms about to leave the export market also display significantly lower growth before exiting. Both level and growth regressions suggest that the performance of firms improves

with time spend in the export markets. It is unlikely to be solely the result of self-selection. Even if there is some productivity advantage for firms that choose to export, they are able to increase the gap in successive years if they continue to export.

The bottom two panels in Table 6 reveal that firms that export a larger share of output also have a larger productivity advantage, although there is a drop for intermediate export intensities. Surprisingly, firms that export between 10% and 50% of output show a lower productivity level than non-exporters, although the difference is insignificant. The productivity advantage over non-exporters stands at 13.3% for firms that export only a small portion of their output (less than 10% of sales) or almost their entire output (more than 90% of sales). Using a quadratic specification for the export share, gives a convex function with a minimum for an export share around 20%. The productivity growth results reveal gradually increasing productivity growth if the export share rises. Only firms that concentrate almost completely on exporting show a lower productivity growth.

The results in Table 6 show a higher productivity level and growth rate for firms that have been active on the export market for a longer time period or export more of their production (with some exceptions). This is more supportive of learning-by-exporting than self-selection, but many of the coefficients are estimated insignificantly. To be more conclusive, a larger sample or, even more desirably, a longer panel is needed. In the next section, I address the endogenous nature of the export decision explicitly.

4.2 Effect of exporting, controlling for self-selection

The question to answer is whether a firm that exports has a higher productivity than it would have without exporting. A more direct way of asking the question is whether the experience gained in exporting allows a firm to produce more output with the same amount of inputs. Assume that the data generating model is

$$q = x \beta + \alpha EX + \epsilon, \tag{3}$$

q is output, x is a vector of inputs, and EX is a dummy variable, taking the value of one for exporters and zero otherwise. I am interested to know whether α , the coefficient on the export dummy, is zero or not.

Most of the literature, including the regressions in the previous section, takes a roundabout way to answer this questions. The usual two-step approach consists in first regressing output on

inputs to obtain $\hat{\beta}$, from which a productivity measure, $q - x\hat{\beta}$, is calculated. In the second step, productivity is regressed on the export dummy, controlling for other variables. It is clear that if EX is correlated with x the first-stage estimation will suffer from omitted variable bias and yield biased estimates of β . Given that firms self-select in the export market, it is plausible that inputs will be correlated with export status and one cannot hope to get an unbiased estimator for α in the second stage.

The straightforward solution to test whether activity on the export market increases output, given inputs, is to include the export dummy directly in the production function. It immediately reintroduces the self-selection problem. The endogeneity of the exporting decision is likely to cause correlation between EX and ϵ , because of unobserved productivity differences. If more productive firms are more likely to enter the export market, the correlation between the export dummy and output is not necessarily the result of learning-by-exporting effects. The problem is that the export status for firms is not randomly assigned. The output difference between exporters and non-exporters can be calculated as,¹⁰

$$\text{OD} = E[q_1|EX = 1] - E[q_0|EX = 0],$$

but if firms self-select in the export market this is not a very interesting comparison. Potential output for exporters might have been larger even if these plants were not active on the export market. In that case $E[q_0|EX = 1] > E[q_0|EX = 0]$ and the sign of OD is not very informative.

A more interesting quantity to compute is

$$\begin{aligned} \text{TOT} &= E[q_1|EX = 1] - E[q_0|EX = 1] \\ &= \text{OD} + E[q_0|EX = 1] - E[q_0|EX = 0] \end{aligned}$$

which is called the “effect of treatment on the treated” in the labor literature. It measures the output differential an exporter ($EX = 1$) can expect by virtue of being active on the export market (q_1), relative to what it would have achieved without exporting (q_0). This is a counterfactual comparison because $E[q_0|EX = 1]$ is unobservable. It will differ from the output difference unless the last term is zero. If potential output does not vary between actual exporters and non-exporters, the effect

¹⁰ q_1 denotes the potential output level if the firm exported, governed by equation (3), even though the firm can be an exporter ($EX = 1$) or non-exporter ($EX = 0$) in the sample.

of treatment on the treated can be measured by simply comparing sample differences in output between exporters and non-exporters. If firms choose to export depending on their productivity level, it is unlikely to hold.

It is possible that the difference in potential output disappears after conditioning on observable variables. This is known as selection on observables. The necessary assumption is

$$q_0, q_1 \perp\!\!\!\perp EX|x, \quad \text{which implies that } E[q_0|x, EX] = E[q_0|x], \quad (4)$$

see Angrist (1998). If the variables in x are discrete, one can simply compare the output differences between firms in the same cells, defined by the x -categories. For continuous variables, it is easier to carry out the comparison using regression analysis, as in equation (3). If one includes control variables in x that satisfy (4), $\hat{\alpha}$ will measure the effect of treatment on the treated. A caveat for the regression approach is the embedded assumption that the conditional density function of q on x is linear. Aw, Chung, and Roberts (1998), Bernard and Jensen (1999a), and Bigsten et al. (1999) run such regression of calculated productivity on EX_{t-1} .¹¹

The assumption that exporting, conditional on observable characteristics, is independent of potential output is implausible and unnecessary strong. Unobserved productivity differences are likely to generate correlation between export status and the error term, invalidating assumption (4). Another solution is to model the selection explicitly and jointly estimate (3) with an equation governing export market participation. Clerides, Lach, and Tybout (1998) take this approach to evaluate the impact of exporting on firms in Colombia and Morocco. They jointly estimate an average variable cost equation and the selection rule for entry into the export market. The two equations they estimate are (simplified significantly)

$$\log AVC_{it} = x_1\beta_1 + \beta_c \log AVC_{it-1} + \alpha EX_{it-1} + \omega_{1i} + \epsilon_{1it} \quad (5)$$

$$EX_{it} = \begin{cases} 1 & \text{if } \pi(AVC_{it}, \dots) + x_2\beta_2 + \omega_{2i} + \epsilon_{2it} \geq \gamma \tilde{EX}_{it-j} \\ 0 & \text{otherwise.} \end{cases} \quad (6)$$

α captures the effect on costs of being active on the export market.

Estimation of equations (5) and (6) is complicated by the unobservability and potential correlation between the productivity terms ω_1 and ω_2 . Both terms are integrated out, allowing for

¹¹It should be noted that the two-stage omitted variable problem still applies to their results.

correlation. The profit function in equation (6) is approximated by a linear function of exogenous variables. If learning-by-exporting effects are important, it is imperative to include contemporary costs in the profit function approximation or to include lagged export status together with lagged costs, as in their equation (11). Failure to do so makes the coefficient on export history in the selection equation (γ) absorb learning effects in addition to the sunk costs of exporting. They estimate γ positive and α not significantly different from zero. Given the previous caveat, this is not conclusive against, but still unsupportive evidence for the learning-by-exporting hypothesis.

Given the estimation difficulties in Clerides, Lach, and Tybout (1998), a more straightforward solution to the endogeneity problem is to use instrumental variables.¹² If one is willing to make the assumption

$$q_0, q_1 \text{ (or } \epsilon) \perp Z|x, \quad \text{with } E[Z EX] \neq 0, \quad (7)$$

one can use the variables in Z as instruments for EX . This is less restrictive than the assumption in (4). Only the instruments need to be independent of the (stochastic part of) potential output, while before the export status itself had to be independent. Clerides, Lach, and Tybout (1998) also estimate equation (5) separately using a generalized method of moments estimator (GMM), allowing for more flexibility in specification. This is a preferred strategy (at least in terms of restrictiveness) if one is mainly interested in estimating α . The validity of this approach hinges crucially on the power of the instruments, but the authors did not mention them in the paper. The results they obtain using this approach are slightly more supportive of the learning-by-exporting hypothesis in Colombia and significantly so for a number of Moroccan industries.

My strategy is to adopt assumption (7), as implicit in the GMM estimation in Clerides, Lach, and Tybout (1998), and use instruments. From the previous discussions I take away three lessons. First, a consistent estimator for the production function requires instruments to control for the endogeneity of unobserved productivity differences and input choices (from Section 3. Second, I also need instruments for the exporting dummy if firms self-select in the export market. Third, to avoid omitted variable bias, if input choices are correlated with the export decision, the effect of exporting has to be estimated directly in the production function. The results for the production function estimations with a dummy for lagged exports and all countries lumped together are in Table 7. In the first column, equation (3) is estimated simply by least squares. In the second column,

¹²For a very general discussion about the minimum assumptions needed to identify α , see Heckman and Robb (1985)

capital and labor input are instrumented as before. The third column uses additional instruments, dummies for the location of the firm, ethnicity of the owner, and foreign ownership, for the export dummy. The intuition is that firms located in the capital will be more prone to exporting simply because transport infrastructure is better developed. The ethnicity of the owner influences the extent of domestic and foreign contacts. If the owner belongs to a domestic minority or speaks a foreign language, the firm is more likely to export. Firms with some foreign ownership are, *ceteris paribus*, also more likely to export. The final column replicates the results with contemporaneous export status instead of the lagged dummy.

Table 7: The effect of exporting on output.

Estimation method Instrumented	OLS	IV (L, K)	IV (L, K, EX)	IV (L, K, EX)
Lagged export (EX_{t-1})	0.052 (.055)	0.006 (.057)	0.351 (.254)	
Export (EX_t)				0.226 (.286)
Labor	0.445 (.024)	0.378 (.035)	0.301 (.042)	0.316 (.044)
Capital	0.131 (.011)	0.236 (.021)	0.235 (.021)	0.239 (.021)
Material	0.539 (.013)	0.489 (.015)	0.510 (.016)	0.506 (.017)
Time	0.012 (.039)	0.015 (.040)	0.005 (.040)	0.003 (.040)

Equations contain dummies for country and time, standard error in brackets.

The results in Table 7 are supportive of the learning-by-exporting hypothesis, with the preferred results in the third column. Instrumenting for inputs raises the capital coefficient at the expense of labor, as expected. All input coefficients look plausible. Average Hicks-neutral productivity growth is negligible and returns to scale total 1.05, increasing but within the realm of possibility. Controlling for the endogeneity of the export decision raises the productivity advantage for exporters to 35.1% and even for the contemporaneous export dummy it is 22.6%. Estimating the production functions separately by country gives similarly supportive results for learning-by-exporting. Table 8 contains the effects of contemporaneous, lagged, and two periods lagged export dummies on output, separately by country. The coefficients are positive for almost all countries and lags, and often the productivity advantage for exporters is very large.

Table 8: Effect of exporting on output, by country.

	EX_{t-1}	(RTS)	EX_{t-1} (CRS)	EX_t	EX_{t-2}
Cameroon	0.63	(1.02)	1.17	0.49	3.30
Cote d'Ivoire	0.75	(1.02)	0.99	1.36	
Ghana	-0.89	(1.04)	0.75	0.26	-0.25
Kenya	0.49	(1.01)	1.27	0.34	1.55
Tanzania	0.40	(0.99)	0.43	1.71	2.17
Zambia	-0.09	(1.11)	1.36	-1.63	0.33
Zimbabwe	0.02	(0.99)	0.11	0.14	0.69

IV estimation results for the coefficient on export status, using instrumental variables for inputs and export status.

A natural next step is to question what is causing the higher productivity that exporters enjoy. I investigate three potential benefits: returns to scale, technology adoption, and better contract enforceability.

5 Scale, technology, and contracts

5.1 Scale

The most intuitive and straightforward benefit for exporters is the ability to sell in a larger market. The domestic market in all of the sample countries is relatively small and returns to scale are estimated to be increasing. Producing at a higher scale would therefore be desirable for these firms. In a survey of manufacturing in developing countries, Tybout (2000) mentions that the potential scale economies in developing countries are smaller than commonly expected. He cites, based on studies for Asia, Latin America and Northern Africa, returns to scale between 1.05 and 1.1, which correspond well to the results in the previous section. He is right to argue that such mild economies of scale are unlikely to be the cause of the stalled development process, but profit maximizing firms can be expected to try to exploit them, for example by starting to export.

The first two columns in Table 3 illustrate that exporters are on average much larger than non-exporters. 78% of the internationally active firms count more than 50 employees, while 80% of the domestically focused firms do not reach this threshold. Only 26% of the firms in the sample are active on the export market, but they are not randomly distributed. 79% of the large firms and half of the median firms are exporters compared with only 2% of the micro firms and 14% of the

small ones. As before, the question arises whether large firms choose to be exporters, for example because they can better afford the sunk or fixed costs associated with exporting, or that exporting has allowed them to grow large. The answer is probably a bit of both. Counting only the domestic portion of sales, exporters are still significantly larger than non-exporters, but not nearly as much as for total sales.

Many of the firms in the sample report to be operating at a lower scale than they would like. Using the same firm-surveys, results in Van Biesebroeck (2001) show that 16% of the firm-owners state insufficient demand as the principal limit to expansion, second only to credit availability. A third of the owners list it as one of the three most important problems. It is a particularly acute problem for micro and small enterprises that do not export, while small exporters hardly mention it. Small non-exporters complain about insufficient demand, while the few exporters that remained small did so by choice. It seems that domestically oriented firms are more constrained and that having access to a larger export market alleviates some of the growth constraints.

It is interesting to note that the size of the productivity advantage attributed to exporters depends crucially on the assumption regarding returns to scale. The results in Table 8 show that the productivity advantage for exporters is estimated larger if constant returns to scale are imposed. This is more pronounced the larger the scale economies are. Under constant returns to scale, the export dummy absorbs some of the size effect. Similar as for productivity, there is a positive correlation between size and export status, but many underlying effects can explain this. For example, if the technology was constant returns to scale to start with, it was the increase in market size for exporters that allowed firms to exploit the scale economies, increase output, and move along the production function. It is also possible that there are multiple technologies. The superior technology has a higher minimum efficient scale and is only available to exporters or only optimal for them.

5.2 Technology

Some authors have argued that technology transfers provide a second channel for exporters in developing countries to improve productivity. Barro and Sala-i-Martin (1997) build a model where countries copy new technologies from more advanced trading partners, leading to convergence in income between countries. It is hard to detect technology transfers directly, but the impact on technology can be visible. Exporters differ in many respects from non-exporters. They have a

higher capital-labor ratio, invest more frequent, have higher value added as a percentage of sales, introduce new technology more frequent, and are more likely to have a formal training program for employees. For most of these criteria a small or medium firm that is active on the export market resembles a large firm that does not export. Export activity is a good substitute for size. It gives small firms access to “technology” that is otherwise reserved for large firms.

The scale and technology difference between exporters and non-exporters can be analyzed in a more formal way. I estimate the production function in (8) for the entire sample and separately by export status, using instruments for inputs and export status (if applicable), and including controls for country and sector.

$$\log \frac{Q}{L} = \beta_{j0} + \beta_{jk} \log \frac{K}{L} + \beta_{jm} \log \frac{M}{L} + \beta_{jRTS} \log L + \beta_{jt} t + \text{controls} + \epsilon_j \quad (8)$$

$j = \text{entire sample, exporters, non-exporters}$

Results are in Table 9, where I also test for a structural break in the sample between the two categories of firms. Exporters differ not only from non-exporters in productivity level, but also in input substitution possibilities or returns to scale. The Chow test for structural break, which assumes equal variation of the error term for both types, rejects that exporters and non-exporters share the same technology. The Wald test, which allows for different variations, confirms this result.¹³ For both tests, the hypothesis that all coefficients (including controls) are equal can be rejected, as well as the hypothesis that only the input coefficients and time trends differ. The numbers in brackets behind the test statistics in Table 9 are the critical values at the 1% significance level.

The two categories of firms differ mostly with respect to the returns to scale and time trend estimates. Returns to scale (the coefficient on labor input) are only barely distinguishable from one for exporters, indicating that these firms have exhausted almost all scale economies. Non-exporters, on the other hand, are still producing at a point on the production function with significant increasing returns to scale, which stand at 1.13 and are significantly positive. Exporters also enjoy positive Hicks-neutral productivity growth, mirroring the results in Section 4.1. Allowing for a different shape of the production function highlights the difference.

¹³Both the Chow and Wald test statistic are taken from Greene (1993).

Table 9: Testing for differences in technology and scale economies.

sample	all firms	exporters	non-exporters
material	0.525 (.015)	0.571 (.029)	0.515 (.017)
capital	0.205 (.021)	0.174 (.046)	0.203 (.024)
labor (RTS)	0.078 (.034)	0.046 (.023)	0.134 (.022)
Lagged export	0.251 (.247)		
time trend	0.006 (.040)	0.166 (.063)	-0.044 (.047)
Chow test (all variables)		6.65 (2.32)	
Chow test (only inputs and time)		262.0 (3.32)	
Wald test (all variables)		56.23 (23.2)	
Wald test (only inputs and time)		20.31 (13.3)	

Each equation contains dummies for country and sector, standard error in brackets.

The critical value for the 1% significance level for the tests is in brackets.

When only testing for different inputs and time trends, controls are allowed to vary.

5.3 Contracts

Finally, I compare the incidence of a number of problems between exporters and non-exporters. The firm-surveys used to collect the data contained questions on problems the firm-owners face, credit availability, and contractual problem. I mentioned earlier that lack of demand was the second biggest obstacle to expansion, the first one being access to credit. Access to formal sources of credit is very much dependent on firm size. 78% of all loans in the sample go to large firms. At the same time, micro exporters have as much access to credit as the average non-exporter. This is important because more than half of the owners rank access to credit as one of their three main problems. Apparently, banks use export status (along with size) as one of the main determinants to decide on loans. Exporters are also less likely to cite access to and cost of imported raw materials, difficulty obtaining foreign exchange and competition from imports as a major problems, while these are major obstacles for non-exporters. Conditional on export status, the incidence of these problems is inversely related to firm size. At the same time, micro or small exporters cite them as problems only as frequently as medium-sized or large non-exporters do.

Another problem that is more prevalent for the firms in sub-Saharan Africa than for their counterparts in developed countries is late or non-payment by clients. It is a slightly more frequent

problem for firms active on the export market, although they also extend more trade credit to their clients. At the same time, firms report that only 2% of the client related payment problems are with foreign firms, while in 84% of the cases it is a domestic firm or individual (the remainder is sales to government). Foreign clients are as reliable as relatives or family that also have only 2.5% incidence of default. In almost half of the cases, the payment problem with a foreign client was the first business contact with that firm. Sales to foreign firms are more likely to be paid or paid on-time, especially once a business relationship has been established. This stands in marked contrast with the way business is conducted domestically. In five out of six cases where a domestic client defaults, the two firms already had an established business relationship. Half of the time, the firm continues doing business with the faulty client, regardless whether it is a domestic or foreign firm. This makes it unlikely that foreigners behave better, because the punishment for default is larger. The resolution methods to deal with problems also do not differ by origin of the trading partner. I conclude that defaults are a common occurrence with domestic business partners, while they are a rarity for foreign clients, especially once a relationship has been established.

Exporting seems to be a way for smaller firms to get access to credit, sell to clients that pay more timely and reliably, have access to raw materials, and have sufficient demand for their products. These problems are less severe for large firms, whether they export or not. Small firms get around them by entering the export market.

6 Conclusions

I have shown that in this sample of manufacturing firms in sub-Saharan Africa exporters have a higher level of productivity than non-exporters. This replicates similar findings for a number of other countries. In contrast with the other studies, the productivity gap is not solely attributed to self-selection of more productive firms into the export market. I find evidence for learning-by-exporting as well. Exporters not only have a higher productivity level, they also have a higher rate of productivity growth. The productivity advantage is larger for firms that have been exporting for a longer period or for firms that export a larger share of output. Finally, the productivity advantage for exporters remains after controlling for the endogeneity of the export decision using instrumental variables.

To explain the productivity gap, returns to scale are particularly important. Exporters have exhausted scale economies, while non-exporters are producing at a point on the production function

where there are significant increasing returns to scale. I can reject the hypothesis that both types of firms produce with the same technology, possibly the result of exporters acquiring more advanced technologies from interacting with more developed clients and competitors. In particular, exporting is a way for smaller firms to replicate the access to credit, frequent investments, rate of introduction of new technologies and employee training programs that are otherwise reserved for larger firms. Exporting gives firms access to demand, raw materials and foreign exchange that non-exporters lack. It also helps firms to avoid accounts-collectible problems that are common with domestic clients. This last effect has not been documented before and warrants further investigation.

References

- Angrist, J. D. (1998, March). Estimating the Labor Market Impact of Voluntary Military Service Using Social Security Data on Military Applicants. *Econometrica* 66(2), 249–288.
- Aw, B. Y., S. Chung, and M. J. Roberts (1998, May). *Productivity and the Decision to Export: Micro Evidence from Taiwan and South Korea*. NBER Working paper No. 6558.
- Baily, M. N., C. Hulten, and D. Campbell (1992). Productivity Dynamics in Manufacturing Plants. *Brookings Papers: Microeconomics* 4(1), 187–267.
- Barro, R. J. and X. Sala-i-Martin (1997, March). Technological Diffusion, Convergence, and Growth. *Journal of Economic Growth* 2(1), 1–26.
- Bernard, A. B. and J. B. Jensen (1995). Exporters, JObs, and Wages in U.S. Manufacturing, 1976-1987. *Brookings Papers on Economic Activity, Microeconomics*. Washington DC.
- Bernard, A. B. and J. B. Jensen (1999a). Exceptional Exporter Performance: Cause, Effect, or Both? *Journal of International Economics* 47(1), 1–26.
- Bernard, A. B. and J. B. Jensen (1999b). *Exporting and Productivity*. NBER Working Paper No. 7135.
- Bigsten, A., P. Collier, S. Dercon, M. Fafchamps, B. Gauthier, J. W. Gunning, J. Habarurema, A. Oduro, R. Oostendorp, C. Pattillo, M. Söderbom, F. Teal, and A. Zeufack (1999). Exports and Firm-level Efficiency in the African Manufacturing Sector. mimeo.
- Blundell, R. and S. Bond (2000). GMM Estimation with Persistent Panel Data: An Application to Production Functions. *Econometric Reviews* 19(3), 321–340.

- Clerides, S. K., S. Lach, and J. R. Tybout (1998). Is Learning By Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco. *Quarterly Journal of Economics* 113(3), 903–947.
- Giles, J. A. and C. L. Williams (2000). Export-led Growth: A Survey of the Empirical Literature and some Non-causality Results. Part 1. *Journal of International Trade & Economic Development* 9(3), 261–337.
- Greene, W. H. (1993). *Econometric Analysis* (2nd ed.). New York: MacMillan.
- Harrison, A. E. (1994, February). Productivity, Imperfect Competition, and Trade Reform. Theory and Evidence. *Journal of International Economics* 36(1-2), 53–73.
- Heckman, J. J. and R. Robb (1985). Alternative Methods for Evaluating the Impact of Interventions. In J. J. Heckman and B. Singer (Eds.), *Longitudinal Analysis for Labor Market Data*, pp. 156–245. New York: Cambridge University Press.
- Krishna, P. and D. Mitra (1998). Trade Liberalization, Market Discipline and Productivity Growth: New Evidence from India. *Journal of Development Economics* 56, 447–62.
- Levinsohn, J. and A. Petrin (1998). *When Industries Become more Productive, Do Firms?: Investigating Productivity Dynamics*. NBER Working Paper No. 6893.
- Marschak, J. and W. H. Andrews (1944). Random Simultaneous Equations and the Theory of Production. *Econometrica* 12, 143–205.
- Olley, G. S. and A. Pakes (1996). “The Dynamics of Productivity in the Telecommunications Equipment Industry”. *Econometrica* 64(6), 1263–97.
- Pavcnik, N. (2000). *Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants*. NBER Working Paper No. 7852.
- Roberts, M. and J. Tybout (1996). *Industrial Evolution in Developing Countries*. New York: Oxford University Press for the World Bank.
- Tybout, J. R. (2000, March). Manufacturing Firms in Developing Countries: How Well Do They Do, and Why? *Journal of Economic Literature* 28, 11–44.
- Tybout, J. R. and M. D. Westbrook (1995). Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries. *Journal of International Economics* 39, 53–78.
- Van Biesebroeck, J. (2001, July). Firm Development and the Lack Thereof in Sub-Saharan Africa. mimeo. Stanford University.

World Bank (2000). African Development Indicators. computer file.

Appendix

A Additional estimation results

Table A. 1: Parameter estimates for the production function.

	β_l	β_m	β_k	t	RTS	wL/S	M/S
Burundi						0.303	0.501
Cameroon	0.515	0.366	0.364	-0.084	1.245	0.253	0.472
Cote d'Ivoire	0.360	0.223	0.532		1.115	0.239	0.449
Ethiopia						0.250	0.601
Ghana	0.173	0.662	0.156	-0.122	0.991	0.254	0.568
Kenya	0.420	0.488	0.265	0.010	1.173	0.263	0.516
Tanzania	0.231	0.477	0.301	-0.021	1.009	0.274	0.498
Zambia	0.501	0.530	0.130	0.055	1.161	0.238	0.501
Zimbabwe	0.234	0.587	0.190	0.111	1.011	0.244	0.507
average	0.348	0.404	0.277		1.028		

The estimated coefficients are obtained using instrumental variables for labor and capital. The last two columns contain the share of wages and material in sales.