*University of Wisconsin-Madison*
*Department of Agricultural & Applied Economics*

Staff Paper No. 583 May 2016

# Does Freer Trade Really Lead to Productivity Growth? Evidence from Africa

By

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**AGRICULTURAL &**

**APPLIED ECONOMICS**

**STAFF PAPER SERIES**

# DOES FREER TRADE *REALLY* LEAD TO PRODUCTIVITY GROWTH?

# EVIDENCE FROM AFRICA[a]

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## ABSTRACT

Theory predicts that trade liberalization should raise average total factor productivity (TFP) among manufacturing firms. However, this is a generic prediction and depends on maintained assumptions about industries, factor markets, and trade patterns that may not fit well for developing countries. Using firm-level data from Ghana, Kenya, and Tanzania during the 1990s, a period of fairly rapid trade policy liberalization, we estimate productivity effects of trade. Our analysis confirms the well-known association between export intensity and higher productivity of the firm; however, the evidence for "learning by exporting," or an increase in productivity associated with greater exports, is mixed, with several instances of *negative* average TFP growth among exporters. Our analysis indicates that such declines are likely attributable to the effects of lower external tariffs, because the firm-level productivity margin below which exporting is unprofitable moves down as the external tariff rate is reduced. We also find that sales to the rest of the world and sales to other African economies have differential effects on productivity growth rates, and that for country-specific reasons, these effects are not uniform. Controlling for initial productivity and the destination of exports (within or outside Africa) helps us understand why in some cases, export participation is associated with negative rates of TFP growth.

Keywords: Africa, manufacturing, exports, productivity, learning by exporting.
JEL Codes: F14, O14, O33

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[a] *World Development,* forthcoming. The authors acknowledge financial support from the United States Agency for International Development via the CGIAR-U.S. Universities Linkages Program. We thank journal reviewers and editors for helpful comments on earlier drafts. Send correspondence to ian.coxhead@wisc.edu.

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# DOES FREER TRADE *REALLY* LEAD TO PRODUCTIVITY GROWTH? EVIDENCE FROM AFRICA

## 1. INTRODUCTION

Economic theory and empirics confirm the aggregate benefits of international trade to firms that participate in it. But with any competition, there are winners and losers, and trade is no exception. Changes at the extensive margin—that is, the appearance or disappearance of firms or even entire industries—are unexceptional occurrences. At the intensive margin (that is, regarding changes in activity of firms), recent research shows that lowering trade barriers has differential effects on firm profitability and activity, depending on the distribution of firm-specific assets. A large theoretical literature explores the idea that firms with differing levels of total factor productivity within an industry respond to a trade liberalization shock by specializing in exports, producing for domestic markets only, or exiting the industry (Melitz 2003; Chaney 2008; Eaton, Kortum, and Kramarz 2011).

The idea that manufacturing export growth could raise productivity is an important one for emerging economies, where the gains from additional growth translate into poverty reduction and improvements in basic indicators human wellbeing. Sub-Saharan African countries in particular present an important set of cases in which to examine the manufacturing trade-productivity nexus because of the historically low levels of engagement of their manufacturing industries with world markets. From the early 1990s, Sub-Saharan African countries began to join the trend to lower tariff and non-tariff barriers that had been in motion elsewhere in the world for several decades. They had for some time already been the beneficiaries of external trade liberalization, both due to global trends to lower tariffs and due to policies offering developing-country exporters preferential access into wealthy-country markets. These efforts on the global trade front were accompanied by promotion of regional trade agreements (RTAs) and customs unions, and by improvements in transport infrastructure that lower barriers to intra-

continental trade. Each of these changes had a potential impact on trade, and thus, if findings from elsewhere are correct, on firm-level productivity.

In this paper, we consider the relationship between trade and firm-level productivity in three sub-Saharan African economies, Ghana, Kenya and Tanzania, during this period of accelerated trade liberalization in the 1990s and early 2000s. Consistent with some other developing-country studies (see below), we find that a firm's export status is positively and significantly correlated with its productivity—that is, exporters are more productive on average than firms producing only for the domestic market. However, we also find that productivity trends among exporting firms are generally negative over time, a result that contrasts with narratives of "learning by exporting" and other theories of endogenous productivity growth associated with participation in trade. Looking more closely at exports, we find that sales to the rest of the world and sales to other African economies have differential productivity effects—and that these effects are not uniform across countries. We account for these differences in terms of observable differences across the countries in our data set.

The remainder of the paper is structured as follows. In Section 2, we motivate the study and review relevant literature. In Section 3, we move to the data, highlighting special features of African economies that are likely to be relevant to empirical analysis. Here we also propose and apply an econometric model to test for links between trade orientation and firm productivity, and assess and discuss estimation results. The paper concludes in Section 4 with a discussion of implications.

## 2. EXPORTS, TRADE SHOCKS, AND PRODUCTIVITY GROWTH

Economists have long argued that outward-oriented economic strategies have positive growth benefits, and that productivity change is central to the process (Krugman 1987; Rodrik 1988, 1991; Grossman and Helpman 1991). A more open trade regime expands market size for domestic producers, and may cause productivity gains and knowledge spillovers from interaction with foreign firms and markets. Alternatively, causality might run in reverse, from productivity to export growth, as internal growth

processes or constraints produce heterogeneous firms, the most productive of which then self-select into exporting as trade barriers diminish.

In Melitz (2003), an increase in aggregate exposure to trade raises average firm-level total factor productivity (TFP) in manufacturing through the exit of the least productive firms and the reallocation of their labor and other resources to more productive firms. This within-industry restructuring comes about due to competition from imports (which drives out the least productive domestic firms) and opportunities for expansion among those firms that are competitive as exporters. The resulting rise in average TFP is a source of welfare growth over and above the gains from specialization and trade identified in neoclassical trade theory. In its basic form, however, this model, does not allow for endogenous productivity growth at firm level; nor does it accommodate multiple export markets. In Africa, a continent with high overall trade costs and many landlocked countries, there are (at least) three distinct market types: domestic, nondomestic intra-African, and rest of the world (ROW). The data also suggest that there are large fixed costs to "moving up" in terms of markets, whether from domestic to intra-African markets or from these to ROW. In our data, which span more than a decade, almost no firms are recorded as *entering* either of the two types of export market after initially selling only in the domestic market. However, the distribution of their sales among markets does change over time.[1]

Melitz' important trade-theoretic innovation has been refined in a number of ways relevant to our study. Bernard, Redding and Schott (2011) generalize to the case of multiproduct firms with options to sell into multiple markets. Firms select which goods to produce and which markets to sell them into according to their exogenous productivity "draw" and the fixed costs of serving each market. Trade opening induces within-firm resource reallocation across product lines and markets. In an important earlier contribution, Eaton and Kortum (2002), using a Ricardian model, examine multilateral trade choices. Interestingly (for our purposes) their analysis includes scenarios in which groups of countries (e.g., the European Union) liberalize internal trade while maintaining higher tariff rates for nonmembers. Thus Eaton and Kortum provide some guidance as to the expected effects of an expansion in intra-

continental trade. They find that the industry effects of trade liberalization, or of forming an RTA or customs union, differ according to whether labor in each country is fixed within manufacturing, or is mobile between manufacturing and a "backstop" non-manufacturing sector. The former is the assumption made in Melitz (2003), and in that model is the source of welfare gains through the reallocation of a fixed quantity of labor from low to high productivity firms. The latter assumption fits more closely with conditions in African economies, in which manufacturing employment is small in relation to the size of the overall labor market.

Many empirical studies demonstrate positive links from firm productivity to export status via self-selection processes (Hallward-Driemeier, Iarossi, and Sokoloff 2002; Bernard and Jensen 2004, 2009; Álvarez and Lopez 2005). The early literature includes some important developing-country examples (Clerides, Lach, and Tybout 1998; Bernard and Jensen 1999; Granér 2002). There is also empirical evidence for endogenous firm-level productivity growth caused by moving into the export market, or "learning by exporting." Pavcnik (2002), for example, used data on Chilean manufacturing firms during a period of rapid trade liberalization and found evidence of within-plant productivity gains among producers in import-competing sectors.

For both the exports-cause-productivity and the productivity-causes-exports conjectures, there are two sources of productivity growth at work: those internal to the firm, and industry-level improvements that occur as labor and other resources are transferred from less to more productive firms (this resource movement features, for example, in Pavcnik's findings). Overall, results of empirical trade-productivity analyses are mixed, and the conclusion of Roberts and Tybout (1997) that "the response of aggregate or sectoral exports to changes in policy or the macroeconomic environment will likely be idiosyncratic with respect to country and time period" remains valid.

A smaller empirical literature addresses these issues specifically with African data. Most of this body of work uses various subsets of a panel dataset on manufacturing firms from selected African countries, generated by the Regional Program on Enterprise Development (RPED). These studies report

mixed findings on the export-productivity relationship.[2] An analysis of aggregate effects using data from Cameroon, Ghana, Kenya and Zimbabwe concludes that there is evidence that exporting improves productivity through the learning-by-exporting phenomenon, and that in contrast there is no direct evidence that more efficient firms self-select into exporting activity (Bigsten et al. 2004). Rankin, Söderbom, and Teal (2006) investigate what they describe as the poor export performance of SSA firms. They also find, in the aggregate across five countries, only weak evidence for self-selection into exporting based on efficiency and firm size, and they conclude that firm-specific factors, such as skills and foreign ownership, are predominant. In contrast, van Biesebroeck (2005), in a study of nine countries, finds that both selection as well as learning are in play in generating a positive exporting-productivity relationship.

Baptist and Teal (2014) focus their analysis primarily on the way that use of different production functions in analysis leads to contrasting conclusions about the extent of productivity heterogeneity among African firms. However, their specifications include (as a control) exporting as an explanatory variable. Their results show a positive and statistically significant relationship between exporting and productivity for data combining Ghanaian, Kenyan and Nigerian firms, but no significant relationship in a Tanzania-specific analysis. These findings are fairly robust to the estimation method employed. While the method, measures, and specifications are not directly comparable to ours, the findings are generally consistent with those in our primary econometric analysis (see Section 3).

Another recent strand of the trade-development literature argues that productivity is also affected by the composition of exported goods and by type of trading partner. Hausmann, Hwang and Rodrik (2007) find that "not all goods are alike in their consequences for economic performance" (2007, p.2). In their theoretical model and cross-country empirical analysis, the authors discover that baskets of export goods with "higher quality" (meaning that their production is associated with countries of higher average income than the country in question) lead to better economic performance. To date, only a few studies have explored these ideas with African data. Mengistae and Pattillo (2004), using RPED data from 1992 to 1995 and with country-specific analysis for Ghana and Kenya, focus on the possible productivity

effects of exporting outside Africa versus exporting within the continent. They find that exporters have higher productivity, and that African firms exporting to the rest of the world are significantly more productive than those exporting only within the continent. Granér and Isaksson (2009), using data only on Kenya and for the period 1992-1994, also conclude that the destination of a country's exports has positive productivity effects. Surprisingly, however, they find that it is exports *within* Africa, rather than those to the rest of the world, that contribute the greatest share of "learning by exporting" productivity gains. They speculate that this may be because technologies in other African countries are better suited to production for intraregional trade than are those of other continents, notably industrialized countries. [3]

The Africa findings appear to be contradictory in spite of their reliance on subsets of a common database. One reason for this variety is that some subsets are for specific countries, and those countries' experiences may be idiosyncratic. Another reason is that the 1990s was a period of rapid and sometimes far-reaching changes, both in African trade policies and conditions, and in global trade policies affecting Africa. These changes may have had different, country-specific effects on exporting and thus on productivity. A third reason is that essentially the same process of trade liberalization or lowering of trade costs may have affected countries in different ways, depending on the structure of their exports by destination, and on the presence of neighboring countries with comparative advantage in similar sets of products. We now explore these ideas in more detail.

Trade policy reform is likely to have been a significant contributor to changes in the allocation of sales across markets. During the 1990s, there were three broad types of relevant changes in trade conditions for African economies: (1) reduction in African tariffs on manufactures; (2) liberalization of ROW export markets for African manufactures, and (3) Expansion of regional trade agreements (RTAs) aimed at expanding intra-African trade. Each one is likely to have had distinct *ceteris paribus* effects on average productivity and welfare. In the case of intra-African trade, policies and investments that lowered trade barriers and costs may have had different effects by country, since each country has a unique structure of initial trade restrictions and production costs.

1. *Unilateral reduction of tariffs on manufactures.* Among developing regions, Sub-Saharan Africa has been exceptional for its relatively high manufacturing import barriers and for relatively late moves toward liberalization. Average tariffs were lowered during the 1990s, however (Figure 1) and in the countries we study, average tariff reductions are evident throughout the period covered by our data (Figure 2). These trade policy reforms should affect domestic producers. Specifically, if import competition increases and the least productive domestic firms exit, then average productivity should rise.[4] However, it is not necessary that the most productive firms would also expand production or switch to exporting. On one hand, lower tariffs should reduce the anti-trade bias of protection, which reduces profitability in all traded goods industries. On the other hand, resources (such as labor) given up by manufacturing firms that exit due to lower tariffs or import prices need not be reassigned to other manufacturers (as in the Melitz model); they may also migrate to non-manufacturing industries such as agriculture, natural resource extraction, construction or other service industries.

[Figures 1 and 2]

2. *Liberalization of ROW export markets for manufactures.* Prior to and during the Uruguay Round of multilateral trade negotiations, African exporters of most manufactured products other than textiles received relatively generous trade policy treatment in their most important markets, the OECD economies. These included preferential access under the Generalized System of Preferences (GSP) as well as continent-specific arrangements such as the Lomé Convention (Yeats, Amjadi, Reinke and Ng 1996). Non-tariff barriers (NTBs) applied by OECD importers were also lower for Africa than for developing countries in general, and within Africa, rates for the countries in our study were well below the continental average (Amjadi and Yeats 1995a). Implementation of Uruguay Round reforms in the early 1990s saw small tariff increases for some products and countries, especially in the EU market as NTBs were converted to ad valorem tariffs and before these tariff rates were lowered as agreed. However this "preference erosion" effect was generally small for African exporters of products other than textiles and garments.[5] The one exception in our data set was Tanzania, which in a benchmark study was assessed

to suffer preference erosion equivalent to 4.5% of merchandise exports, the fifth-highest loss on the continent (Subramaian 2003).

The imposition or expansion of preferential access policies can be expected to lower the average productivity of African exporting firms. This is so because the marginal firm that is able to break even by exporting has lower TFP with the preferences than without. The downward shift in average TFP could be offset by endogenous productivity growth ("learning by exporting"), but as noted, the empirical evidence on this effect is mixed. In practice, however, it is likely that the margins created by transport costs from Africa to ROW export destinations have been more important determinants of improved market access than import barriers (Amjadi and Yeats 1995b).[6]

3. *Regional trade agreements in Africa.* Infrastructural investments and RTAs that result in lower intra-Africa trade barriers have differential *ex ante* effects on regional economies, depending on productivity differences and capacity for manufacturing sector supply response. In countries with relatively low average productivity, the lowering or tariffs or trade costs with neighboring economies has Melitz-type effects, since domestic firms now face stronger import competition. For more productive economies, however, the margin between producing for their own domestic market and producing for export to nearby economies moves down, bringing lower-productivity firms into export markets (or, in a model with multiproduct firms, increasing the share of output exported by less productive firms). Bustos (2011) develops a theoretical model of precisely this phenomenon and tests it empirically using firm-level panel data in the context of the Mercosur RTA. His model predicts, and the data analysis finds, that it is predominantly firms in the middle range of the productivity spectrum that enter exporting markets as a consequence of reduced tariffs from the RTA. High-productivity firms were already engaged in exporting and thus experience no change in status, while low-productivity firms continue to produce only for the domestic market. If such an 'entry' effect dominates over Melitz-type effects, then average manufacturing-sector productivity may fall—with a more pronounced TFP decline observed among those firms exporting to less productive regional partners.

These three trade-promoting measures have contradictory effects on domestic industry, which in turn implies that their relative magnitudes will also matter. In general, African import tariffs have fallen less than ROW tariffs applied to African exporters, while progress on lowering within-Africa trade barriers and transport costs has been slow and uneven. Among the effects of these three broad types of trade liberalization, if the lower ROW tariff (or equivalently, lower transport cost to ROW markets) effect is dominant, then average TFP among African exporters should be seen to decline. When regional economies are also brought closer together through trade liberalization or infrastructure improvement, the least productive regional trade partners could see a significant loss of manufacturing profitability, with only the most efficient and productive firms surviving. Among more productive regional partners, the combination of lower ROW tariffs and lower regional tariffs and/or trade costs could cause average firm productivity to fall at the same time that manufacturing output expands. In short, there can be no uniform prediction for trade–productivity interactions. Once we take account of the diversity of sources of trade-increasing policy measures, whether freer trade increases average TFP among manufacturing firms or reduces it becomes an empirical question.

In our dataset, Ghana is engaged in trade with both ROW and with its African neighbors in the Economic Community of West African States (ECOWAS), a West African RTA. During the period covered by our data, however, ECOWAS, though large, had failed to produce measurable changes in intra-RTA trade policies (Yeats 1998).[7] For Ghana, then, most trade liberalization took the form of reduced foreign tariffs applied to its exports, with smaller reductions in its own import tariffs (discussed in detail in Lall, Navaretti, Teitel and Wignaraja 1995). From 1997 to 2004, the simple average most favored nation (MFN) tariffs of SSA countries fell by one-fifth, from 21.6 percent to 17.2 percent. Tariffs in ECOWAS countries, fell by less than that—about one-sixth. Over the same period, tariffs imposed by industrial countries fell by more than one-third, from 8.7 percent to 5.7 percent (Yang and Gupta 2005, Table 2). We can predict that when foreign tariff reductions are the dominant form of trade liberalization,

as in the case of Ghana, the margin of productivity at which exports are profitable moves down, with the result that average TFP among exporters to ROW should decline.

In East Africa, the 1990s saw significant steps toward revitalization of a regional economic grouping which by 1999 had evolved into the East African Community (EAC). The original members of this grouping were Kenya, Tanzania, and Uganda. All three share a common history of British colonialism and had constituted a common economic area during the colonial period.[8] Starting from a very low base, intra-EAC trade grew quickly from the 1980s to the 1990s: Kenya's exports to Tanzania increased sixfold between the decades and on average, 14 percent of Kenya's exports went to its other two EAC neighbors in the 1990s, up from 7 percent in the 1980s (IMF 2008). Intra-EAC trade grew sharply through the 1990s, resulting in regional trade intensities much higher than in any other developing-country trading bloc (Kirkpatrick and Watanabe 2005, Table 3 and Figure 1). By the mid-1990s, about 30 percent of Kenyan exports were to other African countries (Yeats 1998), more than half to Tanzania and Uganda. In contrast, as late as 2004 only 7 percent of Tanzania's exports and 14 percent of Uganda's exports went to their EAC partners (Kirkpatrick and Watanabe 2005). While Kenya imported mainly food and raw materials from its regional partners, by the early 2000s Kenya was the source of over 32 percent of the EAC's manufactured imports.

Meanwhile, the EAC as a whole moved toward formation of a customs union. Kenyan and Tanzanian import tariffs were reduced somewhat in the 1990s. Kenya benefited from ROW liberalization in the Uruguay Round, while Tanzania, uniquely in our data set, is estimated to have experienced significant (though temporary) preference erosion (Subramanian 2003). During the 1990s, therefore, lowering of external barriers in ROW and of trade barriers and transport costs within the EAC was probably the most important source of trade shocks for Kenya. Both trends would have reduced the average productivity of its exporting firms. In Tanzania, own tariff reductions and the expansion of EAC trade would have undermined profitability of its tradables sector manufacturers, hastening the exit of the

least profitable firms but not necessarily enhancing growth among the more profitable firms. In world markets, overall trade growth and preference erosion have opposing effects for Tanzanian producers.

Thus in East Africa we can predict that, due to the differences in ROW liberalization, average TFP for exporters to ROW should have decreased in Kenya, while in Tanzanian exporters' TFP might increase or decrease, depending on whether trade growth or preference erosion is the dominant effect. In contrast we can predict that expanded intra-African trade, which in our data occurs primarily within the EAC, should have decreased the margin of productivity at which exports are profitable in Kenya, while having the opposite effect in Tanzania. Thus the effect of increased intra-African trade on TFP should be negative in Kenya and positive in Tanzania.

## 3. DATA AND ANALYSIS

### (a) Data

We use a panel of firm-level data from the Regional Program on Enterprise Development (RPED), supported and conducted by the World Bank and the Centre for the Study of African Economies (CSAE).[9,10] RPED has up to 12 consecutive years of firm-level data from a random selection of privately held manufacturing firms. The industries covered are: food and bakery; furniture; machinery; chemicals and metals; textiles; garments; and wood products. Firms can be either formally registered or informal. The countries covered are Ghana, Kenya, and Tanzania (RPED also contains data from South Africa and Nigeria, but they are insufficient for panel data analysis).

The dataset has information on production, inputs, and sales, including whether sales are to the domestic market or, if exported, to markets within Africa or beyond. Characteristics of the firm—such as age, foreign ownership, output per worker, number of employees, and other features—are also included. There is also more specific information on resource use and outputs, such as profit-to-capital ratios, materials per worker, and average education and age of workers. Table 1 provides definitions, means and standard deviations of the variables used in our estimations. It shows some important differences between

exporting firms and non-exporting firms, with the former in general larger in terms of revenues, labor and capital. Exporting firms are also more likely to be foreign owned. Differences between firms exporting mainly to Africa and those exporting mainly to ROW are negligible, so we have not reported them separately.

[Table 1]

Table 2 describes the main variables of interest divided by country. Foreign ownership shows relatively little variation on average across the countries, averaging 18% of firms, plus or minus 2% depending on the country. The number of firms exporting varies more sharply: 32% of firms in Kenya export while only 14% of Tanzanian and 17% of Ghanaian firms do so. These differences persist even when we disaggregate by export destination: 31% of Kenyan firms export to other African nations, but only 10% of Ghanaian firms and 12% of those in Tanzania. Ghanaian firms, with 13% exporting to the rest of the world, are somewhat more likely to export out of Africa than either Kenya (10% of firms) or Tanzania (7%). Such differences suggest that for existing firms we should see lower barriers to intraregional trade as being relatively important in Kenya, where nearly a third of firms in the sample might be affected, and less important in the other countries. Meanwhile lower barriers on trade to ROW are likely to have the greatest effects on firms in Ghana and the least effect in Tanzania.

[Table 2]

A surprising feature of the data is that despite the number of firms and the length of the series, the data show very few instances of firms that initially sell wholly to domestic markets making the transition to exporting. Nor do they show many transitions from exporting to wholly domestic sales. The kinds of firm-level responses to trade shocks predicted by Melitz (2003) are thus visible only in changes in the *proportion* of sales going to domestic, African and non-African foreign markets. Changes at the firm level in the mix of sales by market are more consistent with the existence of multiproduct firms that change product mixes (or possibly the quality of products and/or production processes) and the destination of

sales. Unfortunately, however, the data are not sufficiently detailed to allow for a test of conjectures related to either products or product quality.

The data form an unbalanced panel and countries are observed for different time periods. Some firms exit or enter during the observation period, and other firms cannot be traced in some years. Sometimes, previously interviewed firms decline to be interviewed again. A common pattern is for firms to report for several years, fail to report for one or more additional years, resume reporting, and then fail to report again, depending on the duration of the data series.[11] We cannot be entirely sure whether they have actually ceased operations or are simply failing to report; nor does the dataset documentation provide information on this. With regard to entry, the number of firms entering the dataset after the initial year is a negligible fraction of the total observations.

(b) Empirical analysis

In this section, we examine relationships among firm characteristics, such as ownership, trade orientation, and total factor productivity (TFP) growth. Our starting point is a basic production function from which we recover estimates of TFP levels and changes over time for the dataset as a whole and for a variety of relevant subsets. For any firm, denote output per worker $Y$ as a function of inputs of capital, labor, material inputs, and other inputs, all measured in constant U.S. dollars and denoted by $K$, $L$, $M$, and $O$, respectively. Suppressing subscripts, we have

$$Y = A\, f(K, L, M, O), \tag{1}$$

where $A$ is a measure of TFP.

A large theoretical literature exists on the potential determinants of TFP across firms, but here our focus is on the effects of firm characteristics and exporting. We are interested in differential productivity and productivity growth across firms, industries, and countries, as well as among firms with different characteristics, including foreign ownership, which is represented by a binomial variable $F$, and destination of exports $X$. We hypothesize that each of these, along with time $T$, could affect overall

productivity levels, implying that in equation (1), $A = A(X, F, T)$. We assume Cobb-Douglas technology, which gives the function

$$Y = A^{\alpha} K^{\beta_1} L^{\beta_2} M^{\beta_3} O^{\beta_4}. \quad (2)$$

In this expression, unconditional initial TFP is equal to $A^{\alpha}$. Effects on output of increases in capital $K$, labor $L$, material $M$, and other inputs $O$ are given by the respective $\beta$ terms. Under constant returns, the sum of $\beta_1$ through $\beta_4$ should be insignificantly different from unity.

Taking the logarithm of equation (2) and choosing units such that ln $A$ = 1, indexing firms by $i$ and time by $t$, and writing this in the form of an estimable model, the resulting basic equation is

$$\ln Y_{it} = \alpha + \sum_k \beta_k \ln Z_{it}^k + \mu_i + \varepsilon_{it} \quad (3)$$

in which $Z = (K, L, M, O)$; $\mu_i$ is a fixed effect at the firm level; and $\varepsilon_{it}$ is an independently and identically distributed error term. Instead of estimating (3) we adopt a two-step procedure where we first estimate the production function, compute the value of our TFP measure $A$, and then estimate its determinants.

Although equation (3) represents a standard Solow-type TFP estimation, improvements in TFP are likely to be known and anticipated by firm managers, which would potentially make observations of inputs (for example, capital investments) endogenous to changes in TFP that are observed by firm managers but not by econometricians. Olley and Pakes (1996) proposed using capital investment as a proxy for increases in TFP; however, their method relies on observing firm exit and nonzero investments, which our dataset does not provide. Levinsohn and Petrin (2003) proposed a more tractable method using intermediate inputs as a proxy for capital investments. In their approach, demand for intermediate inputs by firm $i$ in period $t$ is a function of both capital $K_{it}$ and of TFP, $\omega_{it}$, such that $M_{it} = M_{it}(K_{it}, \omega_{it})$. As long as this function exhibits monotonicity, we can invert it to obtain $\omega_{it} = g^{-1}(K_{it}, M_{it})$. We estimate this from our data using Levinsohn and Petrin's revenue-based generalized method of moments estimator, as described by Petrin, Poi, and Levinsohn (2004):

$$Y_{it} = \alpha + \beta_o O_{it} + \beta_l L_{it} + \beta_k K_{it} + \beta_m M_{it} + \omega_{it} + e_{it}$$

$$= \beta_o O_{it} + \beta_l L_{it} + \varphi_{it}(K_{it}, M_{it}) + e_{it}, \quad (4)$$

where $\varphi_{it}(K_{it}, M_{it}) = \beta_0 + \beta_k K_{it} + \beta_m M_{it} + g^{-1}(K_{it}, M_{it})$. This equation is estimated using ordinary least squares, with a third-order polynomial approximation in $K_{it}$ and $M_{it}$ taking the place of $\varphi_{it}(K_{it}, M_{it})$. The estimation procedure then makes use of moment conditions on the relationship between the previous period's error terms, as described by Petrin, Poi, and Levinsohn (2004), and uses bootstrapped standard errors. The estimates of TFP, $\omega_{it}$, are calculated from equation (4) as follows:

$$\omega_{it} = \exp(y_{it} - \beta_o O_{it} - \beta_l L_{it} - \beta_k K_{it} - \beta_m M_{it}). \quad (5)$$

A second method of estimating a production function with potentially endogenous and predetermined variables is to use the dynamic panel systems estimator, as suggested by Blundell and Bond (1998) and Arellano and Bover (1995). This model is an extension of the dynamic panel models of Arellano and Bond (1991). The dynamic panel data approach uses lagged values of the dependent variable as instruments for potential endogeneity in equation (3) caused by anticipated TFP shocks in both the levels and the first differences. In the systems approach we add in the idea that some of the independent variables might be endogenous (correlated with current changes in productivity) or predetermined (correlated with past changes in productivity). Thus, as in the Levinsohn-Petrin (L-P) estimation we are able to control for how input use might vary with changes in productivity. In particular—and analogously to the L-P model—we assume that capital is predetermined, which implies that changes in productivity at time $t$ produce changes in the capital stock at time $t$+1. We also let material inputs be endogenously determined with the error term during the same period. As is standard in the dynamic systems models, both of these are then instrumented with lagged values. We employ a single lag, since tests of higher orders of lags did not yield improved results.

The dynamic panel systems estimator is built from the following equation, where $\boldsymbol{x}$ is a vector of exogenous variables (labor and other inputs) and $\boldsymbol{w}$ is a vector of endogenous and predetermined variables (materials and capital respectively).

$$lnY_{it} = \alpha + \sum_{j=1}^{p} \gamma_j lnY_{i,t-j} + \boldsymbol{x}_{it}\beta_1 + \boldsymbol{w}_{it}\beta_2 + u_i + \varepsilon_{it} \quad (6)$$

In (6) the number of lags, $p$, of the dependent variable used as instruments is determined by the model, while we use a single lag on the endogenous and predetermined variables. We estimate (6) with a robust variance-covariance matrix. The TFP measure of interest $\ln(\omega_{it})$ is then produced from the predicted values of equation (6).

Using our estimates of TFP from the L-P and dynamic systems models, we then conduct a second-stage estimation of how TFP, measured as $\ln(\omega_{it})$, changes with the variables of interest related to firm export status and ownership. This represents a similar panel data model to equation (3), but we now have TFP as our dependent variable and have already controlled for inputs, so they no longer appear. The estimating equation is as follows:

$$\ln\omega_{it} = \alpha + \rho T_t + (1 + \rho T_t) * (\eta^{r\prime}\boldsymbol{X}_{itr}) + \gamma F_{it} + \delta'\boldsymbol{D} + \mu_i + \varepsilon_{it}, \quad (7)$$

where we have allowed for separate productivity effects from exports to more than one destination $r$, each denoted by an element of the vector $\boldsymbol{X}_{itr}$ with marginal productivity effect $\eta^r$, as well as a vector of control variables in $\boldsymbol{D}$. We use two measures of exporting, the percentage of total output exported to Africa or ROW, and then dummies of whether a firm exports to Africa and/or ROW which are interacted with the time trend. Equation (7) is estimated using a Hausman-Taylor (H-T) estimator, which allows us to have time invariant variables, such as foreign ownership, as well as endogenous variables (percentage of output exported) within a fixed-effects panel data framework. The H-T estimator uses the within estimator as a first stage and exogenous variables as instruments to then obtain consistent estimates of time invariant and endogenous variables.

The control variable vector includes industry dummy variables, as well as a measure of the real effective exchange rate (REER) for each country and year. For each country, REER measures the value of its currency relative to those of its trading partners (using trade-share weights), adjusted by price differences as captured by the CPI, the most widely accessible domestic price index. The REER thus reflects both the nominal exchange rate and macroeconomic forces that are expected to have an effect on tradable sector profitability through changes in domestic prices relative to those in trading partners. A

high value of REER indicates an overvalued nominal exchange rate, which is typically (though not always) the result of inflation at a rate persistently higher than that of a country's trading partners. It also indicates diminished international competitiveness of domestic production.[12]

Null hypotheses based on the model of equation (7) are as follows:

(a) $\rho = 0$: secular TFP growth is zero;

(b) $\gamma = 0$: foreign ownership has no effect on TFP levels;

(c) $\eta^r = 0$: firms that export more to destination *r* have no difference in TFP levels; and

(d) $\rho\eta^r = 0$: firms that export to destination *r* have no difference in TFP trends.

Note that acceptance of hypothesis (c) provides evidence against the idea that more productive firms select into exporting, whereas acceptance of (d) provides evidence that there are no "learning by exporting" productivity effects. These are the main foci of our estimation work.

(c) Results

Table 3 shows production function estimates. These broadly display expected signs, magnitudes and significance (cf. Yasar and Morrison-Paul 2007). The estimated parameter on capital in both the Cobb-Douglas and the Dynamic Systems models is quite low by the standards of usual manufacturing production processes. This is likely due to low levels of variation across years in the capital variable, an issue that is better addressed in the Levinsohn-Petrin models. Tests of the null hypothesis of constant returns to scale cannot be rejected at a 5% level for the Levinsohn-Petrin and Cobb-Douglas fixed effects results, while the dynamic systems shows a significant decreasing returns to scale parameter of 0.93.[13]

[Table 3]

TFP estimates calculated from the production function estimates are the dependent variables in the subsequent regressions. Table 4 presents these initially for the pooled country data. These estimates confirm that TFP levels are higher among exporting firms, whether they export mainly within Africa or to ROW. The latter result is robust across both estimation methods; the former is confirmed only in the L-P

estimates. The secular trend of TFP is negative, however, and significantly so in the L-P estimates. Interacting the time trend with indicators for the destination of exports, we see no effect in the pooled data for exports to Africa, but a significant negative effect in both models for exporters to the rest of the world. In combination with the secular time trend result, these estimates point to an overall decline in TFP, and a significantly higher rate of decline among exporters to ROW than among all firms. Were it not for the negative secular TFP trend we might conclude that this evidence of mean reversion could be caused by productivity spillovers from exporting firms, which have initially higher TFP, to other firms. We cannot rule this out in the dynamic systems model (since the secular TFP estimate is statistically zero), but the L-P result rejects it.

[Table 4]

Finally, we see in both models using pooled data that foreign ownership has no differential influence on TFP levels, while the REER does. An increase (i.e. appreciation) in the real effective exchange rate has a significant negative impact on productivity. African manufacturing is highly dependent on imported intermediate inputs. A real appreciation therefore has two opposing effects: it lowers the competitiveness of outputs in external markets, and it lowers the domestic market cost of imported intermediate and final goods. A negative effect of REER on TFP is consistent with the idea that cheaper inputs encourage output increases by firms at the lower TFP margin of profitable production, though other interpretations are also possible.

The results in Table 4 are estimates for all three countries combined, but the narrative of our paper highlights some country-specific predictions. In Table 5, therefore, we report the same TFP estimates separately by country. The table contains several contrasting results. First, in the L-P models the secular trend of TFP is significantly negative in Kenya and Ghana, consistent with evidence in the literature of flat or stagnating overall productivity growth in African countries over this period, but it is positive (and large) in Tanzania. In the DS models, the secular trend is zero in all cases.

[Table 5]

Second, firms that export to ROW show generally higher TFP levels than those that do not. The difference is significant across both models only in Ghana, and in the DS model for Kenya and Tanzania. In these cases and that of Kenyan exporters to Africa we can assert, through rejection of hypothesis (d), that there is support for the claim of self-selection into exporting by more productive firms. However, Tanzanian exporters to Africa have significantly *lower* TFP, a seemingly anomalous result.

Third, despite somewhat higher TFP levels, firms that export show no evidence of "learning by exporting" other than among Tanzanian firms that export to Africa. The other estimates of time trend interacted with export destination are either negative or statistically zero. Finally, the REER has a consistent and mostly significant negative association with TFP across all countries and models.

(d) Robustness Checks

The L-P and dynamic systems results are robust to a number of specification tests, including exclusion of the REER and its interaction with indicators of export destination. We also include a variable that measures the weighted average education level of workers in the firms in a robustness check regression. We find it insignificant and its inclusion has no effect on any other parameters of interest. Further, dividing the sample between small and large firms (the dividing point being 10 employees) also produces the same results, though the results for small firms are much weaker due to smaller sample sizes and (plausibly) higher degrees of measurement error. This last check is nevertheless useful in that it suggests the results with respect to total factor productivity are not driven by differences in scale economies between firms. Tables of robustness checks are attached in an appendix to this paper.

(e) Discussion

A large empirical literature demonstrates that firm-level trade–TFP relationships vary by country, for many reasons including multiple-product firms, multiple export destinations, the possibility of factor movement into or out of non-manufacturing sectors, and multiple possible sources of a trade or price

shock. The data to which we have access preclude rigorous tests for selection into exporting or for changes in product mix by export destination (as in Bernard, Redding and Schott, 2011), or precise and direct tests of the influences of trade and trade policy shocks on firm-level productivity. Instead, we use qualitative information on the relative magnitudes of trade liberalization from non-African and African (RTA) sources. Thus, the inferences we draw are necessarily only suggestive. Nevertheless, our results are sufficiently different from many previous findings and are sufficiently robust with respect to model specification that some discussion is warranted.

We predict that when lower foreign tariffs or trade costs are the dominant form of trade liberalization, the margin of productivity at which exports from African economies are profitable moves down, with the result that average TFP among exporters to ROW should decline. Our econometric estimates support this for pooled data, and robustly in country-specific tests for the case of Ghana, with somewhat less robust results for Kenya and Tanzania. Among Ghanaian firms, initial TFP is significantly and positively linked to the percentage of exports sent outside Africa. The rate of TFP growth among firms selling into domestic or African markets is zero, whereas that for exporters to ROW is significantly negative, at –1.5 to –0.5 percent per year. These estimates are strongly consistent with the prediction that when foreign tariff reductions dominate trade liberalization, average productivity among exporters will fall as the lower productivity margin compatible with profitability in exporting to ROW declines. The data (as previously noted) do not show evidence of entry into exporting by new firms, however. Rather, the result presumably comes from the diversion of sales from domestic or African markets to ROW by existing exporters. Within these firms, it is possible that lower-technology products (simpler types of textiles, garments or metal products, perhaps) can now be profitably exported to ROW, whereas in the past, these products had been sold only within the domestic and African markets. To check on this trend, however, requires a finer level of product disaggregation than is available in the RPED dataset.

Also in Section 2, we argued that the ceteris paribus effects of lower intra-African trade barriers or trade costs would depend on where each country stood in relation to TFP among its key trading

partners. We argued that Ghana would gain relatively little from intra-West African trade, while the East African countries of Kenya and Tanzania would each experience differential effects. Countries such as Tanzania with low average productivity should see intensified competition from neighbors, leading to exit of their least productive firms and a rise in average TFP. In contrast, in the more productive regional economies such as Kenya, lower regional trade barriers mean that firms that were formerly unable to make a profit exporting will now be able to do so (at least to their neighbors). At the margin between selling to domestic markets and selling to neighboring African markets, less productive firms will shift into exports (or, in multiproduct firms, less productive lines produced within diversified firms will now be exported). These are the results we obtained (as shown in Table 5) for the two East African countries. In Tanzania, average productivity is initially somewhat lower than in Kenya. During the period covered by the data, average manufacturing-sector TFP in Tanzania rises by as much as 9 percent per year. There is no clear difference in TFP growth rates between exporters and nonexporters,[15] which is consistent with the prediction of a general decline in Tanzanian manufacturing activity, led by exits among the least productive firms, with resources so released presumably migrating into agriculture or services.

In Kenya, unlike in Tanzania, firms that export to Africa are significantly more productive than other firms. However, whereas average TFP growth among *all* Kenyan firms is nonpositive, that among Kenya's exporters to Africa declined by 2.6 percent per year relative to all firms. Again, this finding is consistent with the predictions from a model in which lower barriers to intra-RTA trade dominate the effects of other forms of trade liberalization, permitting less productive firms to become or remain competitive in export markets from which they would otherwise be excluded. As noted, the share of Kenya's manufacturing output exported within Africa increased substantially during the 1990s. Among Kenyan exporting firms, total output on average did not grow in real terms through the 1990s. However, that of Kenya's exporters to other African countries did grow by a statistically significant margin over other firms.

# 4. CONCLUSIONS

It is well known that manufacturing-sector growth is a key to sustained economic growth in the aggregate and, moreover, that productivity growth is the key to long-run growth in manufacturing industries. The economies of sub-Saharan Africa have historically grown quite slowly, despite constant attention from international financial institutions and the donor community. In the African context, structural constraints to manufacturing-sector productivity growth are acknowledged to be important elements in the overall growth experience.

Using firm-level data on three African countries, we tested for relationships between manufacturing productivity growth and trade. As expected, firms that export are (in most cases) significantly more productive, by a TFP measure, than firms selling only into domestic markets. However, secular TFP growth rates are found to be positive only in one country (Tanzania); they are negative or statistically zero in two others (Ghana and Kenya). The observed pattern of TFP levels and trends is consistent with predictions about these countries' changing external trade conditions. The key to the observed patterns appears to lie in a model allowing for multiple export destinations and differential types and rates of trade policy liberalization, multiproduct firms, and the existence of a sizable non-manufacturing component to employment of domestic factors of production. All of these phenomena are well-documented characteristics of African firms and economies.

In spite of the constraints imposed by the data, our results convey some new insights into the growth of African manufacturing. In the past, foreign ownership may have been a significant source of productivity growth, though the direction of causation between foreign ownership and higher TFP at the firm or industry level remains unproven. More can be said from our data about the influence of trade. In Africa, post-independence import substitution policies have been slow to break down. At the same time, domestic markets have remained small, limiting the scope for the kinds of endogenous productivity gains (whether within or between firms) that the empirical literature has associated elsewhere with manufacturing sector growth. Although Africa's export markets have become more open, this by itself

has not helped to increase TFP. In fact, as we see, it has contributed to a lowering of TFP growth as the margin of profitable exporting moves down. Similarly, the expansion of intra-African regional trade seems to have had mixed effects. Firms in less productive economies experienced intensified import competition from neighbors, and average TFP in manufacturing rose due to the exit of less-productive firms. However, more productive firms have not necessarily appeared because of competition in factor markets from agriculture, mineral extraction and services. Meanwhile, the more productive regional economies have also experienced declining average productivity as the effective size of their intra-regional market has grown.

The results of our analysis are robust to a variety of alternative specifications. However, more and better data are needed to test the generalizability of the findings we have reported. With the current dataset, we can only examine the changes in productivity among exporting and nonexporting firms. A longer, richer dataset with more detailed information on firm entry and exit would allow us to provide more definitive results on the effects of trade on overall industry productivity.

Finally, our findings in the paper may shed some light on the well-documented TFP decline in many African economies during the 1980s and 1990s. This decline is frequently attributed to domestic factors including conflict, institutional failures, corruption, and more. One interpretation of our results is that those factors are not entirely to blame for lower TFP during this era of African economic history. Some component of the decline may instead be due to external trade policy reforms that expanded export opportunities for African firms, a change that gave an assist to exporters whose low productivity had previously inhibited their growth. Improved data quality and quantity in the future may permit a rigorous exploration of this conjecture.

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ENDNOTES

[1] Unfortunately, the aggregation level of the data makes it impossible to know whether these are identical products going to different markets or differentiated products produced by multiproduct firms for different markets. This remains a subject for research with new data.

[2] See Söderbom and Teal (2003) for a broad-brush exploration of exporting and performance at both the firm and country level across nine countries, and Bigsten and Söderbom (2006) for a more detailed review of the RPED data based studies up until that date.

[3] There are other studies based on the RPED data,that however do not explore the productivity-trade relationship. For example, Bigsten et al. (1999) consider determinants of exporting status among African manufacturing firms using early rounds of the RPED dataset, but do not include in their analysis any measure of firm productivity. On the other hand, Waldkirch and Ofosu (2010) are concerned with the drivers of productivity, among which they however do not consider exporting behaviour.

[4] On the other hand, if tariff reductions apply to imports of intermediate goods then their reduction raises effective rates of protection. This could diminish or even reverse the pressure on less productive firms to exit.

[5] Preferential access for African exporters was reinstated by the U.S. African Growth and Opportunity Act and the European Union's Everything but Arms initiative, both of which came into effect at the very end of our data series.

[6] For manufacturers, high transport costs reduce effective protection in two ways, by raising the landed price of imported intermediate goods and lowering the effective price of exported outputs.

[7] This has since changed. In 2013 ECOWAS adopted a common external tariff and agreed to substantially reduce barriers to trade within the RTA, with implementation from 2015.

[8] The three countries were previously linked through several agreements, including the East African Community (1967–77). East African Cooperation was agreed on in 1993 and launched in 1996.

Continuing negotiations led to the formation of the East African Community in 1999 (http://www.eac.int/about-eac/eac-history.html, accessed January 4, 2012). Kenya, Tanzania, and Uganda are also members of the Common Market for Eastern and Southern Africa, established in 1993.

[9] The dataset and its documentation is archived on the CSAE webpage, http://www.csae.ox.ac.uk/datasets/cfld/cfld-main.html

[10] As mentioned in Section 2, several other studies have used the RPED dataset. However, this paper uses a longer panel than several of the RPED based studies, offers intra-country analysis for multiple countries, and makes an empirical differentiation of the export-productivity nexus by type of trading partner, as explained later in this Section.

[11] With this dataset it is unfortunately impossible to conduct checks of robustness by, for example, conducting the analysis after eliminating all observations (firms) that are missing (whether or not they have been replaced by similar other firms) for more than, say, 4 out of the 12 years, because this would drastically reduce the sample size of the panel, making the country-level regressions practically infeasible. This remains a caveat for any of the previous as well as this study using the RPED dataset.

[12] REER data were obtained from http://www.bruegel.org/publications/publication-detail/publication/716-real-effective-exchange-rates-for-178-countries-a-new-database/, accessed May 24, 2012.

[13] In robustness checks we divide the sample into small (less than 10 employees) and large firms as a way of controlling for a potential bias due to scale economies in our results. We find that the results are broadly similar, although the small firm parameters are not as accurately estimated due to smaller sample sizes. See section 3(d).

[14] Complete tables of these robustness checks are available in the online appendix.

[15] In the L-P results (Table 5) there is no significant TFP difference associated with exporting from Tanzania to any destination. The dynamic systems results show slightly lower TFP for exporters to ROW,

and slightly higher for exporters to Africa, with the two estimates of approximately equal and opposite sign.

Table 1—Descriptive Statistics of Variables Used in the Regressions

| Variable | Definition | Overall Mean | Std. Dev. | Mean for exporters | Mean for non-exporters |
|---|---|---|---|---|---|
| Output | Log of firm revenue, real US dollars | 11.47 | 2.34 | 13.72 | 10.88 |
| Capital | Log of firm capital, real US dollars | 10.69 | 3.12 | 13.65 | 9.97 |
| Material inputs | Log of material inputs, real US dollars | 10.70 | 2.41 | 12.88 | 10.13 |
| Other inputs | Log of other inputs, real US dollars | 8.99 | 2.64 | 11.52 | 8.36 |
| Workers | Log of number of employees | 3.18 | 1.49 | 4.64 | 2.80 |
| Any foreign ownership | Dummy=1 if firm has foreign ownership | 0.18 | 0.38 | 0.38 | 0.13 |
| Exports | Dummy=1 if firm exports | 0.20 | 0.40 | 1 | 0 |
| Pct export in Africa | Pct output exported within Africa | 2.91 | 10.65 | 13.63 | 0 |
| Pct export ROW | Pct output exported outside Africa | 6.29 | 21.64 | 27.29 | 0 |
| Real eff. exchange rate | Nominal exchange rate adjusted for CPI differentials using trade weights | 108.22 | 32.17 | | |

Source: Authors' calculation. Data: 3,775 observations from 959 Firms, (1991-2002)

Table 2—Span and Size of Firm Level Data

| | Ghana | Kenya | Tanzania |
|---|---|---|---|
| Total observations | 1,809 | 960 | 1,006 |
| Number of firms | 240 | 373 | 346 |
| Years covered | 1991–2002 | 1992–1999 | 1992–2000 |
| Any foreign ownership (0 - 1) | 0.19 | 0.18 | 0.16 |
| Exporters (0 - 1) | 0.17 | 0.32 | 0.14 |
| Exporters within Africa (0 - 1) | 0.10 | 0.31 | 0.12 |
| Exporters ROW (0 - 1) | 0.13 | 0.10 | 0.07 |

Source: Authors' calculation. Note: Last two rows may add up to a figure larger than the 'exporters' figures as a firm may export both within and outside Africa.

Table 3—Production Function Estimates

| Variable | Description | Levinsohn-Petrin | Fixed effects | Dynamic Systems |
|---|---|---|---|---|
| L.Output | Lag of log (firm revenue) | | | 0.322*** |
| | | | | (0.0717) |
| Capital | Log(firm capital) | 0.297* | 0.0241 | 0.0435 |
| | | (0.157) | (0.0171) | (0.0316) |
| L.Capital | Lag of log(firm capital) | | | -0.00790 |
| | | | | (0.0238) |
| Material Inputs | Log(firm material inputs) | 0.263 | 0.619*** | 0.754*** |
| | | (0.178) | (0.00849) | (0.0366) |
| L.Material | Lag of log(firm material inputs) | | | -0.228*** |
| | | | | (0.0608) |
| Workers | Log(firm number of employees) | 0.179*** | 0.189*** | 0.0812** |
| | | (0.0124) | (0.0185) | (0.0399) |
| Other Inputs | Log(firm other inputs) | 0.157*** | 0.130*** | 0.0512** |
| | | (0.00919) | (0.00892) | (0.0233) |
| Constant | | | 2.824*** | 1.066*** |
| | | | (0.197) | (0.193) |
| Test of CRTS | | $\chi^2(1)=0.15$ | F(1, 2812)=2.68 | $\chi^2(1)=3.89$ |
| | | Prob = 0.69 | Prob = 0.102 | Prob = 0.049 |
| Observations | | 3,775 | 3,775 | 2,513 |
| Number of firms | | 959 | 959 | 736 |

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4—Productivity Estimates: All Countries

| Variable | Description | Levinsohn-Petrin | Dynamic Systems |
|---|---|---|---|
| Pct export in Africa | Percentage of output exported within Africa | 0.00415*** | 0.000748 |
| | | (0.00148) | (0.00120) |
| Pct export ROW | Percentage of output exported out of Africa | 0.00399*** | 0.00380*** |
| | | (0.00132) | (0.000965) |
| REER | Real effective exchange rate | -0.00139*** | -0.000681* |
| | | (0.000520) | (0.000353) |
| time | Time trend | -0.0350*** | 0.00110 |
| | | (0.00377) | (0.00293) |
| timexA | Time trend * Exporter to Africa | -0.00277 | -0.00552 |
| | | (0.00578) | (0.00435) |
| timexNA | Time trend * Exporter outside Africa | -0.0185** | -0.0100* |
| | | (0.00741) | (0.00599) |
| anyfor | Dummy=1 if the firm has any foreign ownership | 0.0861 | 0.0352 |
| | | (0.0785) | (0.0360) |
| Constant | | 3.898*** | 1.101*** |
| | | (0.0939) | (0.0602) |
| Industry dummies? | | Yes | Yes |
| Observations | | 2,584 | 2,054 |
| Number of firms | | 738 | 626 |

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5—Productivity Estimates: By Country

| | Ghana | | Kenya | | Tanzania | |
|---|---|---|---|---|---|---|
| Variable description | L-P | DS | L-P | DS | L-P | DS |
| Percentage of output exported within Africa | 0.000450 | -4.61e-05 | 0.0167*** | 0.00764 | 0.00126 | -0.0105** |
| | (0.00190) | (0.00126) | (0.00285) | (0.00598) | (0.00572) | (0.00442) |
| Percentage of output exported out of Africa | 0.00356** | 0.00302*** | 0.00552 | 0.0111** | 0.00257 | 0.0104** |
| | (0.00160) | (0.000973) | (0.00413) | (0.00554) | (0.00361) | (0.00481) |
| Real effective exchange rate | -0.00208*** | -0.00102** | -0.00910** | -0.0113 | -0.00587* | -0.0105** |
| | (0.000701) | (0.000476) | (0.00393) | (0.0132) | (0.00310) | (0.00491) |
| Time trend | -0.0370*** | 0.00364 | -0.0534*** | -0.00136 | 0.0915*** | 0.00508 |
| | (0.00454) | (0.00305) | (0.0127) | (0.0238) | (0.0148) | (0.0127) |
| Time trend * Exporter to Africa | 0.00732 | 0.00120 | -0.0259** | -0.0170 | 0.0202 | 0.0211** |
| | (0.00791) | (0.00520) | (0.0123) | (0.0163) | (0.0123) | (0.00935) |
| Time trend * Exporter outside Africa | -0.0143 | -0.00484 | -0.0209 | -0.0368 | -0.0277* | -0.0330** |
| | (0.00935) | (0.00652) | (0.0199) | (0.0302) | (0.0162) | (0.0162) |
| Constant | 4.239*** | 1.152*** | 4.355*** | 1.792** | 3.457*** | 2.658*** |
| | (0.139) | (0.0716) | (0.263) | (0.809) | (0.448) | (0.840) |
| Industry Dummies? | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,475 | 1,387 | 565 | 340 | 544 | 327 |
| Number of firms | 214 | 211 | 310 | 248 | 214 | 167 |

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

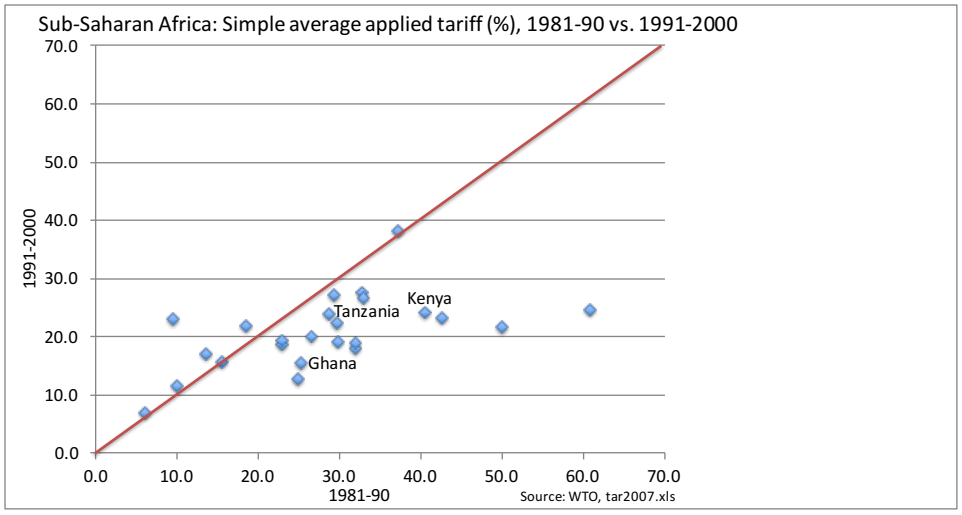


Figure 1: Changes in average applied tariff rates, Sub-Saharan Africa, 1980s to 1990s (Source: WTO)

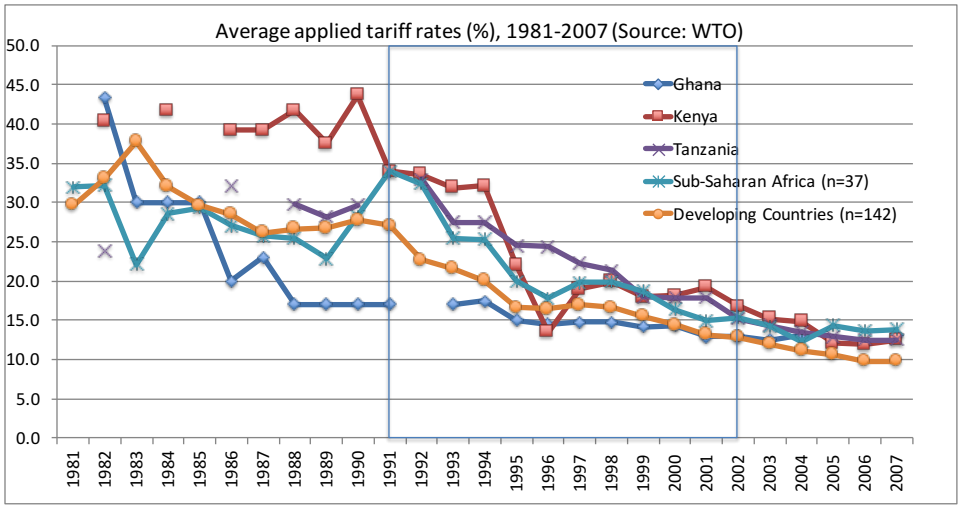


Figure 2: Average applied tariff rates in study countries (source: WTO)

**Appendix: Robustness Checks**

Table A1: Different formulations of Real Effective Exchange Rates & Education weights for labor

| | LABELS | (1) L-P | (2) Dynamic System | (3) L-P | (4) Dynamic System | (5) L-P | (6) Dynamic System |
|---|---|---|---|---|---|---|---|
| pexpa | Pct output exported within Africa | 0.00433*** | 0.000835 | 0.00412*** | 0.000722 | 0.00385** | 0.000741 |
| | | (0.00148) | (0.00120) | (0.00148) | (0.00120) | (0.00151) | (0.00124) |
| pexpna | pct output exported out of Africa | 0.00418*** | 0.00387*** | 0.00348** | 0.0035*** | 0.00390*** | 0.00385*** |
| | | (0.00132) | (0.000966) | (0.00144) | (0.00105) | (0.00132) | (0.000982) |
| reer | Real exchange rate | | | -0.00146*** | -0.00070* | -0.0013*** | -0.000726** |
| | | | | (0.000529) | (0.00036) | (0.00051) | (0.000339) |
| reerxna | REER X Exports out of Africa | | | 0.000588 | 0.000184 | | |
| | | | | (0.000772) | (0.00058) | | |
| time | Time Trend | -0.0336*** | 0.00190 | -0.0344*** | 0.00125 | -0.0345*** | 0.00119 |
| | | (0.00375) | (0.00291) | (0.00386) | (0.00299) | (0.00380) | (0.00298) |
| timexNA | Trend*exporter outside Africa | -0.0198*** | -0.0106* | -0.0241** | -0.0110 | -0.0175** | -0.00970 |
| | | (0.00741) | (0.00601) | (0.0107) | (0.00810) | (0.00747) | (0.00614) |
| timexA | Trend*exporter to Africa | -0.00235 | -0.00488 | -0.00279 | -0.00562 | -0.00224 | -0.00532 |
| | | (0.00579) | (0.00435) | (0.00578) | (0.00436) | (0.00592) | (0.00451) |
| anyfor | dummy=1 if foreign ownership | 0.0876 | 0.0371 | 0.0878 | 0.0369 | 0.102 | 0.0372 |
| | | (0.0780) | (0.0357) | (0.0785) | (0.0360) | (0.0817) | (0.0370) |
| eduwgt | weighted average education of workers | | | | | -0.000257 | 0.00285 |
| | | | | | | (0.00532) | (0.00393) |
| Constant | Constant | 3.722*** | 1.011*** | 3.901*** | 1.100*** | 3.876*** | 1.085*** |
| | | (0.0661) | (0.0373) | (0.0939) | (0.0603) | (0.109) | (0.0734) |
| Obs | | 2,584 | 2,054 | 2,584 | 2,054 | 2,431 | 1,970 |
| Firms | | 738 | 626 | 738 | 626 | 704 | 603 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A2: Regressions dividing sample by small and large firms
Small firms are less than 10 employees
All regressions use TFP from Levinsohn-Petrin first stage estimated separately for large and small firms

| | LABELS | (1) L-P Small Firms | (2) L-P Large Firms | (3) L-P Large Firms Ghana | (4) L-P Large Firms Kenya | (5) L-P Large Firms Tanzania |
|---|---|---|---|---|---|---|
| pexpa | Pct output exported within Africa | 0.000414 | 0.00398*** | 0.000731 | 0.0131*** | 0.000625 |
| | | (0.00372) | (0.00116) | (0.00145) | (0.00253) | (0.00324) |
| pexpna | Pct output exported out of Africa | 0.0122 | 0.00428*** | 0.00389*** | 0.00618* | 0.00124 |
| | | (0.00815) | (0.00106) | (0.00126) | (0.00355) | (0.00230) |
| reer | REER | -0.000475 | -0.00231*** | -0.00131** | -0.00786** | -0.000145 |
| | | (0.000575) | (0.000482) | (0.000589) | (0.00381) | (0.00225) |
| time | Time Trend | 0.00572 | -0.0233*** | -0.0182*** | -0.0585*** | 0.0421*** |
| | | (0.00510) | (0.00343) | (0.00395) | (0.0136) | (0.0114) |
| timexNA | Trend*exporter outside Africa | -0.0309 | -0.00687 | -0.00643 | -0.0136 | -0.0112 |
| | | (0.0312) | (0.00577) | (0.00687) | (0.0170) | (0.0109) |
| timexA | Trend*exporter to Africa | -0.00150 | -0.00412 | 0.00119 | -0.00949 | 0.0111 |
| | | (0.0209) | (0.00449) | (0.00582) | (0.0115) | (0.00739) |
| anyfor | dummy=1 if the firm has any foreign ownership | 0.0798 | 0.327*** | 0.475*** | 0.119 | 0.164 |
| | | (0.155) | (0.0730) | (0.119) | (0.112) | (0.116) |
| Constant | Constant | 2.032*** | 5.252*** | 5.050*** | 5.984*** | 4.270*** |
| | | (0.0951) | (0.0942) | (0.127) | (0.265) | (0.328) |
| Obs | | 759 | 1,825 | 1,090 | 404 | 331 |
| Firms | | 306 | 545 | 189 | 208 | 148 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1