Internal innovations, foreign technology and productivity in Sub-Saharan Africa's manufacturing firms: The role of absorptive capacity

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Internal innovations, foreign technology and productivity in Sub-Saharan Africa's manufacturing firms: The role of absorptive capacity

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Abstract

Internal firm innovations and external knowledge/technology transfer are key for spurring the growth of firms and economies. We investigate whether firms that engage in such innovations are more likely to be productive than others as well determine if external knowledge transfers may have an effect on labor productivity mediated by the existence of internal absorptive capacity (generated by human capital and R&D). Using the World Bank Enterprise Survey of 26 African countries and employing both OLS and 2SLS, we find that firms that engage in innovations experience more growth. Most fundamentally, importation of inputs alone in the absence of other innovations does not maximize firm productivity. Finally, firms with a higher absorptive capacity in addition to the other innovations enjoy higher efficiency gains from their imported inputs irrespective firm ownership and size. Government should pursue policies that enhance internal absorptive capacity so as to enable firms tap the global opportunities.

Key words: Africa, Manufacturing firms, R&D, Human capital development, Productivity

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1 Introduction

Models of industry performance e.g., Jovanovic (1982); Ericson and Pakes (1995) assert that firm growth or the failure to, is primarily driven by productivity differences which are determined by firms' internal decisions as well as external factors. This is corroborated by Bartelsman and Doms (2000); José and Martín-Marcos (2010) who show that firm level productivity is key in explaining various aspects of industry dynamics overall. In this paper, we seek to investigate the relationships among the internal and external drivers of productivity differences for firms in Sub-Saharan Africa. Specifically, we systematically seek to show that, first, there exists knowledge generators that are internal to the firm and these are associated with human capital development (HCD) and the performance of R&D, with the human capital component encompassing the degree of skill and training activities. Second, there are external knowledge generators that drive firm productivity through external knowledge transfers through the process of learning by exporting, through import of inputs, and/or through external linkages via foreign ownership. Third and finally, the external knowledge transfers may in turn effect firm productivity via internal innovations (augmented labour productivity generated by human capital and R&D, which is generated by internal absorptive capacity).

The results from R&D are seen through the development of innovative products and processes, while HCD increases skills acquisition through formal worker training, resulting in increased absorptive capacity (see Cohen and Levinthal, 1990; Vandenbussche et al., 2006). The adoption and use of foreign technology which comes with imported inputs, foreign-owned firms, and exporting therefore forms the platform for enhanced productivity and efficiency (Barasa et al., 2019). In developing economies, a majority of firms operate substantially below the production possibilities frontier on account of the low levels of human capital coupled with the use of obsolete equipment (Goedhuys et al., 2008).

Firms' internal innovation efforts are therefore primarily geared towards developing capabilities to absorb, adapt, and eventually improve imported technologies. Enos (1992); Lall (1992) have termed the resulting competences from such internal innovation efforts by firms in developing countries that allow them to utilise equipment and technology efficiently as "technological capabilities". In a dynamic context, firms build capacity by engaging in activities such as research, training, technology, licensing, investment in new machinery which results in the introduction of new products and production processes in the firm and thus reinforce a firm's competitive position (Goedhuys et al., 2008). Internally, they may thus invest in R&D, HCD, and/or adopt foreign technology embodied in imported inputs in order to increase productivity and efficiency (Cohen and Levinthal, 1990). Achieving efficiency is associated with gains that accrue mostly to firms. Efficiency in manufacturing is critical for industrialisation. However, several constraints stand in the way to its realization as the manufacturing environment is characterized by limited access to manufactured inputs, scarcity of human capital with the requisite skills, poor supportive infrastructure, macroeconomic instability, limited prioritization of R&D expenditure among other issues (Barasa et al., 2019; Tybout, 2000; Biggs, 1995).

The relationship between firm productivity and internal and external innovations such as their participation in foreign markets has been extensively investigated (see Bravo-Ortega et al., 2014). In fact, building on the seminal work of Bernard and Jensen (1995), evidence has consistently shown that firms that undertake external innovations through say exports are larger, more productive, and more capital-intensive than non-exporters. In addition, they accumulate more human capital, pay higher wages, and spend more on R&D (see, e.g., Álvarez and López, 2005; Diao et al., 2005; Harris and Li, 2009; Van Biesebroeck, 2005). Recent literature has highlighted the role of such innovations and related activities in engendering firm productivity and export performance (Bravo-Ortega et al., 2014). This paper adds to the evidence on these relationships in a developing country context by analysing the role of internal and external innovations in driving firm productivity.

While differences in firm-level characteristics account for differences in firm productivity, there is limited evidence on studies that investigate how internal innovations impact on productivity in developing countries' firms and more so in Sub-Saharan Africa (SSA) (see Korres, 2012; Barasa et al., 2019; Okafor et al., 2017). Several studies focus on firm size, age and efficiency (Diaz and Sánchez, 2008; Lundvall and Battese, 2000). Thus, while productivity is driven by technical efficiency, the extent to which internal innovations affect productivity needs further investigation (Barasa et al., 2019; Fu et al., 2011). Given the presence of largely unskilled or semi-skilled labour coupled with the fact that the region is a technology follower, absorptive capacity proxied by human capital remains key in maximizing the use of foreign technology that is embodied in imported inputs.

The key motivation for this paper stems from the fact that while existing evidence emphasizes the role of internal innovations in driving productivity for firm growth, this evidence is largely limited on sub-Saharan Africa on the role of both internal and external innovations as well as their interaction to drive firm productivity (see Barasa et al., 2019). In a number of instances, firm innovation, efficiency and productivity have been studied independent of each other (Gashi et al., 2013). In this paper, we seek to contribute to the literature and debate on the role of absorptive capacity arising from internal R&D and HCD in moderating the effect of foreign technology that is embodied in the imported intermediate inputs on firm productivity in a developing country context. There is only a limited number of studies which focus on productivity related effects in the context of absorptive capacity arising from internal innovations at the firm-level in SSA (see Barasa et al., 2019; Okafor et al., 2017).

In this paper, we highlight a key issue on the future of African manufacturing by identifying that absorptive capacity measures matter for promoting productivity in the region. As much of the existing empirical evidence on productivity is at a macro-level (see Benhabib and Spiegel, 1994; Eaton et al., 1998), an investigation into the role of firm level internal innovations and their role in maximizing the contribution of imported technology in a developing country context is worth undertaking. We hypothesize that sub-

Saharan African manufacturing firms can potentially realise productivity gains by spending on R&D, hiring as well as providing workers with skills augmentation opportunities, and by using foreign technology that is embodied in the inputs used for production. We thus contend that internal innovations through the use of R&D and human capital development in combination with the use of foreign intermediate inputs can tremendously enhance firm productivity in African manufacturing. Another argument in this paper pertains to the position that productivity gains are likely to be realised when use of imported intermediate inputs is coupled with HCD.

We hence seek to addresses the following research question:

a) Do internal firm level innovations affect absorptive capacity and hence productivity in manufacturing firms in SSA?

b) Do firms that import technology embodied in intermediate inputs register higher productivity than their counterparts?

c) Do the benefits from external knowledge acquisition differ by ownership of firms or not?

d) Does external knowledge transfer effect labor productivity moderated by the existence of internal absorptive capacity?

We focus on analysing how firms improve productivity by means of internal and external innovations, and the interaction of both. This was achieved with the use of the World Bank Enterprise Survey (WBES) data for 26 African countries. Controlling for potential endogeneity, we address the relationship between firm productivity which is measured in terms of output per worker and the firm's internal and external innovations. We also address the econometric problems that are associated by this type of analysis, such as endogeneity, and the discrete nature of some variables. By controlling for potential endogeneity, we can identify the relationships among a firm's innovations and its productivity. We model the effects of innovations on firm productivity using a two-stage least squares (2SLS) approach using the country-sector-size averages for share of firm output exported, share of firm inputs imported and share of firms workers with high school education as instruments consistent with Fisman and Svensson (2007).

The findings show that both internal and external innovations are critical drivers of firm productivity. However, we observe that the joint effect of the internal and external innovations produce mixed effects on firm productivity in sub-Saharan Africa. In other words, there could be threshold within which the joint effect of internal and external innovations is effective. Given that the sample consists of developing country firms with potentially low levels of either combinations of innovations, this aspect of our findings is not all surprising. The findings are envisaged to contribute to informing the design of public policy instruments that aim to promote firm productivity in developing countries. This is fundamental because the causal direction between the key variables is not neutral. For instance, our findings reveal that firms that invest more in R&D generate remarkable improvements in productivity. Thus, public intervention to subsidise and directly support firms that undertake such innovations would be a step in the right direction. Firms may increase productivity and innovation through exporting in which case, interventions geared towards supporting firms to export, or reduce barriers to the access of foreign markets, would in turn improve aggregate productivity.

The remainder of this paper is as follows. Section 2 presents the literature review which gives the basis for the hypotheses to be tested. Section 3 develops the methodology of the study and discusses the sources and types of data including the how the analysis of the data is conducted. Section 4 presents the results from the analysis, discussion and subsequent robustness checks, while Section 5 offers the conclusion.

2 Literature review

The role of productivity growth in driving the underlying differences in income across nations is widely established in the literature (see Hall and Jones, 1999). Endogenous growth theory suggests that innovation is the primary source of productivity growth (Grossman and Helpman, 1991). However, the development of new products and technologies is primarily a preserve of developed economies (Eaton and Kortum, 2001). Developing countries thus rely on technology and knowledge transfer from the developed economies than on direct investment in research and development. This is the case as firm-level innovation by means of investing in internal R&D is both a risky and costly undertaking as compared to the adoption of foreign technology (Fu et al., 2011; Barasa et al., 2019). On the other hand, the adoption of imported technology is reliant upon a firm's capacity to absorb new knowledge which in turn, is subject to some degree of internal R&D and HCD (Cohen and Levinthal, 1989; Lewandowska, 2015). Griffith et al. (2004) provide evidence of efficiency gains from interacting foreign technology adoption with internal R&D.

2.1 R&D expenditure and firm productivity

Internal R&D is a key innovation input that is critical in explaining firm productivity resulting from the development of new technologies (Baumann and Kritikos, 2016). Firms that invest in R&D have been found to be more productive and efficient (Baumann and Kritikos, 2016). In fact, Torii (1992) suggests that R&D expenditure has a positive and significant effect on efficiency due to the fact that is generates capacity that results in the introduction of new products and production processes. Therefore, R&D expenditure is expected to foster productivity as it gives rise to home grown technology that is best suited to the socio-economic and technological conditions of firms (Li, 2011). However, a number of empirical studies find a negative relationship between R&D expenditure and productivity. For instance, Gumbau-Albert and Maudos (2002) in their examination of the determinants of efficiency in the Spanish manufacturing industry find a negative relationship between R&D expenditure and efficiency. This finding was attributed to the fact that first, R&D expenditure may have dynamic effects. As such, the effect of current R&D expenditure on innovation may only be observed in a later period. Second, it is possible that some firms engage in excessive R&D expenditure which may result in innovation, but at the same time give rise to inefficiency.

Torii (1992) further contends that rapid innovation driven by R&D expenditure results in relative inefficiency in the non-innovating firms. Consequently, R&D expenditure is therefore likely to yield mixed results with respect to efficiency and productivity. In this study, we test the hypothesis that internal R&D has a significant effect on firm productivity.

2.2 HCD and firm productivity

Sub-Saharan Africa, remains one of the most populous regions of the world, and by extension has a large labour force. However, the region's large labour force lacks the requisite skills for industrial development (Tybout, 2000). The inadequacy of skills coupled with a low quality labour force have been identified as contributory factors to the inefficiency and low productivity among its manufacturing firms (Barasa et al., 2019). HCD efforts that entail knowledge acquisition through training are therefore critical for improving the region's skills set and overall quality of the labour force (Lall et al., 2016). Formal training is a central element of HCD that creates a productive, efficient and agile workforce (Lall et al., 2016). Empirical evidence shows a positive and statistically significant effect of HCD on technical efficiency in a number of African economies (Gokcekus et al., 2001; Oyelaran-Oyeyinka and Lal, 2006). Biggs (1995) similarly finds evidence that formal training engenders technical efficiency among manufacturing firms in several sub-Saharan African economies. We therefore hypothesise that HCD has a positive effect on firm productivity.

2.3 Imported inputs, ownership and firm productivity

Typically, technology is embodied in imported inputs, equipment, and machinery (Lall et al., 2016; Wagner, 2012). Indeed, Kasahara and Rodrigue (2008); Okafor et al. (2017) argue that firms in the less developed world are partly dependent on international transfer of technology from advanced economies in compensation for the low investment in research and development in their home countries (Nichter and Goldmark, 2009). This therefore suggests that imports of inputs and capital goods are important in bridging the technological gap between the North and the South. Note however that besides attempting to close the technological gap between the North and South, optimising technological acquisition partly depends on the absorptive capacity of firms in the South (Okafor et al., 2017; Foster-McGregor et al., 2016; Augier et al., 2009).

There is growing consensus in the literature which argues that importation of firm inputs enhances productivity (Kasahara and Rodrigue, 2008; Grieco et al., 2017). Importation of intermediate inputs and offshoring certain aspects of production, helps firms to strategically specialize in activities where they have particular strengths. This has a further consequence of enhancing firm productivity (Foster-McGregor et al., 2016). In addition, there are potential indirect effects from knowledge spill overs such as learning effects that are likely to be stronger for imported inputs than for exports. This is based on the fact that imported intermediate products and capital equipment embody foreign knowledge and thus allow the importing user to acquire key information that would otherwise be costly to obtain (see Coe and Helpman 1995). There is already evidence of the role of capital goods importation in improving productivity. Using a panel of Chilean manufacturing firms, Kasahara and Rodrigue (2008) show that importation of inputs enhances productivity. The aforementioned result is consistent with that of Grieco et al. (2017) for studies on China. However, productivity gains from importation of inputs are hinged on a firm's absorptive capacity. Indeed, in a study of Ghanaian and Sub-Saharan African firms, Okafor et al. (2017) and Foster-McGregor et al. (2015) respectively argue that productivity gains from imported inputs are higher when a firm has a robust absorptive capacity. Similarly, Augier et al. (2009) argues that absorptive capacity is pertinent for productivity gains from imported inputs to be enjoyed by a firm.

In addition to the use of imported inputs, foreign ownership is more likely to have positive efficiency effects in the context of sub-Saharan African manufacturing firms (see Ulku and Pamukcu, 2015). Two reasons are advanced for this argument. First, foreign ownership is often a source of critical human capital especially in instances where new management and production practices are adopted (Barasa et al., 2019). With foreign ownership, firms are likely to easily adopt imported technology. Second, foreign ownership offers labour training opportunities for host economies (Vu, 2016). De Marchi et al. (2017) show that learning from firms that are linked to the global value chains reinforces learning at the local level and such linkages has been reported as very effective for reinforcing innovation opportunities for developing countries firms.We therefore posit that foreign ownership results in productivity gains for manufacturing firms in developing countries (Mazaheri and Mazumdar, 2005). In the context of this study, foreign ownership is expected to have positive effect on firm productivity. We hence hypothesise that foreign ownership and importation of inputs have a positive effect on firm productivity.

2.4 *Absorptive capacity and firm productivity*

A fundamental determinant of any economy's success in adopting foreign technology is measured by the degree of "adaptive" research activities (Barasa et al., 2019). Successful adoption of foreign technology is conditional on a firm's absorptive capacity. Absorptive capacity is related to the ability of a firm's internal capacity to identify, assimilate and exploit knowledge from the external environment (Cohen and Levinthal, 1989). The degree of absorptive capacity thus depends on human capital and internal R&D, as these are crucial for generating new knowledge and promoting learning (Griffith et al., 2004). Successful adoption of foreign technology that is embodied in the imported inputs is therefore dependent upon internal firm level innovation efforts that entail concerted investments both in R&D (Fu et al., 2011) and HCD (Lewandowska, 2015). A firm's ability to optimally utilise foreign technology to the degree that it enhances productivity occurs when there is absorptive capacity and internal R&D (Li, 2011). Since SSA firms import technology that is embodied in their intermediate inputs from relatively advanced countries, efficiency gains can only be expected to be realised when the importation of such inputs is coupled with existence of the requisite human capital to utilize it. Essentially, HCD entails concerted efforts by a firm's human resource unit to facilitate training of employees there by building a firm's absorptive capacity. In this paper, we contend that productivity gains originating from successful use of foreign technology are dependent upon internal R&D, and HCD, respectively. The study therefore posits that imported inputs in combination with R&D expenditure reinforce each other's effects on technical efficiency. Put simply, HCD augments a firm's absorptive capacity and in the presence of imported inputs reinforces a firm's productivity.

3 Data sources and empirical strategy

3.1 Data

The World Bank Enterprise Survey (WBES) data was used to investigate the role of a firm's internal innovations in generating efficiency gains from importing inputs and other channels of knowledge external to the firm such as foreign ownership and exporting. The survey uses a harmonised questionnaire to collect firm-level data globally. For the case of most African countries, two waves of data exist with some countries like Niger having data as recent as 2017 (see Table A1 in the appendix). The WBES provides a unique opportunity to undertake this study since it contains all the key variables needed for the successful implementation of the study. WBES contains information on firm-level employment and sales and hence makes it possible to compute firm-level output per worker which is our measure of productivity. It also contains information on share of imported inputs in total imports which we use to construct the main explanatory variable of interest. Variables used to proxy absorptive capacity include; skills composition of the labour force, whether workers received formal training/reskilling and whether firms undertake Research and Development (R&D) activities. Other important business environment and specific firm characteristics also exist in the WBES such as, age of the firm, size, export status, ownership, access to finance, corruption/bribery, licensing, infrastructure, crime, competition, capacity utilization, land and permits, taxation, informality, business-government relations, innovation and technology. The surveys are administered to a representative sample of firms in the non-agricultural formal private economy and as such manufacturing and services sectors. In this study, we focus our investigation on only manufacturing enterprises because they are more dependent on inputs and intermediates during the production process than service firms.

3.2 Empirical strategy

Following Okafor et al. (2016) and Foster-McGregor et al. (2015), we estimate the effect of both internal and external to the firm knowledge on firm productivity. The internal to the firm knowledge is associated to human capital and the performance of Research and Development (R&D), and that human capital is itself a vector that contains simultaneously the skills composition and training activities. The external to the firm knowledge arrives to the firm through external knowledge transfers, and that these transfers of knowledge may operate through exports, imports of inputs, and/or through linkages because of foreign ownership. It is important to note that these external knowledge transfers may have an effect on labor productivity mediated or moderated by the existence of internal absorptive capacity (generated by human capital and R&D). As is conventionally expected, typical control variables such as firm's age, size and country, year, and industry fixed effects are included. Our empirical strategy uses several specifications as follows:

(1) Firms' labour productivity is regressed on imported inputs, R&D, Foreign ownership, Export status, Training of workers, and skills composition of workers (in addition to controls such as size and age as well as sector, country, and year fixed effects).

$$(1) y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 r_{itjc} + \alpha_5 s_{itjc} + \alpha_6 w_{itjc} + \alpha_7 X_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$$

In all our models y_{itjc} is log output per worker of firm i in industry j at time t and country c. In model (1) output per worker is a function of imports of inputs (m_{itjc}), foreign ownership (f_{itjc}), export status (e_{itjc}), R&D (r_{itjc}), reskilling/training activities (s_{itjc}), labour force skills composition (w_{itjc}), vector of observable firm characteristics (X_{itjc}) including firm age and size and year (γ_t), sector (γ_j) and country (γ_c) fixed effects. ε_{itjc} is the zero-mean error which is identically and independently distributed across firms. This model helps us appreciate the importance of knowledge variables internal and external to the firm in influencing firm level productivity. According to the predictions of Antràs and Helpman (2004), the productivity distribution of foreign sourcing firms should be higher than for firms, which do not source abroad.

(2) Includes all variables in specification one (1). Additionally, specification (2) includes the interaction terms between potential external knowledge variables and the internal knowledge ones (capturing a mediating factor due to their role as absorptive capacity variables). Under this type of thinking, there are several possible models: (i) one of the specifications includes the interaction terms between the external knowledge variables (imported inputs, exporting, and foreign ownership) by R&D.

$$(2) y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 r_{itjc} + \alpha_5 s_{itjc} + \alpha_6 w_{itjc} + \alpha_7 X_{itjc} + \beta(m \times r)_{itjc} + \delta(f \times r)_{itjc} + \varphi(e \times r)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$$

The rest of the variables are as defined in (1) above. Here the additions to equation (1) are the interaction terms between the external knowledge variables (imported inputs, foreign ownership, and export status) and one of the internal knowledge variables (R&D) given by $(m \times r)_{itjc}$, $(f \times r)_{itjc}$ and $(e \times r)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from R&D activities. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (2).

(ii) another specification extends equation (1) by adding the interaction terms between the external knowledge variables and one of the internal knowledge variables (reskilling/training activities of firms).

(3) $y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 r_{itjc} + \alpha_5 s_{itjc} + \alpha_6 w_{itjc} + \alpha_7 X_{itjc} + \vartheta(m \times s)_{itjc} + \mu(f \times s)_{itjc} + \pi(e \times s)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$

The variables in equation (3) that do not appear in equation (1) include the interaction terms between the external knowledge variables (imported inputs, foreign ownership and export status) and one of the internal knowledge variables (reskilling/training activities of firms) given by $(m \times s)_{itjc}$, $(f \times s)_{itjc}$ and $(e \times s)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from reskilling/training activities of firms. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (3).

(iii) Another specification extends equation (1) by adding the interaction terms between external knowledge variables by the dummy of skills composition of the labour force.

(4) $y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 r_{itjc} + \alpha_5 s_{itjc} + \alpha_6 w_{itjc} + \alpha_7 X_{itjc} + \sigma(m \times w)_{itjc} + \tau(f \times w)_{itjc} + \theta(e \times w)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$

The variables in equation (4) that do not appear in equation (1) include the interaction terms between the external knowledge variables (imported inputs, foreign ownership and export status) and one of the internal knowledge variables (high skills composition of the labour force) given by $(m \times w)_{itjc}$, $(f \times w)_{itjc}$ and $(e \times w)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from high skills composition of the labour force. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (4).

(iv) Another specification extends equation (1) by including all the interaction terms simultaneously together with all the variables included in specification (1) above.

$$(5)\quad y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 r_{itjc} + \alpha_5 s_{itjc} + \alpha_6 w_{itjc} + \alpha_7 X_{itjc} + \beta(m \times r)_{itjc} + \delta(f \times r)_{itjc} + \varphi(e \times r)_{itjc} + \vartheta(m \times s)_{itjc} + \mu(f \times s)_{itjc} + \pi(e \times s)_{itjc} + \sigma(m \times w)_{itjc} + \tau(f \times w)_{itjc} + \theta(e \times w)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$$

The variables are as defined in specifications 1, 2, 3 and 4 above.

(v) Finally, we construct the absorptive capacity index from the three knowledge variables internal to the firm (reskilling/training, high skills composition and R&D). The motivation behind the absorptive capacity index is to understand the importance of complementarity of the different proxies of absorptive capacity. What is the productivity differences amongst firms that adopted only one of the internal innovations from those that adopted two of three or three of three and those who did not innovate at all? We answer this question by constructing four indices for internal knowledge variables: (a) The index equals one if a firm performed R&D activities, was involved in reskilling/training only, and zero otherwise. (b) The index equals one if a firm performed R&D activities, had high skills composition only, and zero otherwise. (c) The index equals one if a firm was involved in reskilling/training, had high skills composition of the labour force only, and zero otherwise. (d) Finally, the index equals one if the firm was involved in reskilling/training activities, had high skills composition of her workers, and performed R&D and equals to zero otherwise. Firms' labour productivity is regressed on imported inputs, foreign ownership, and export status, absorptive capacity index and the interaction terms between absorptive capacity indices and the external knowledge variables (imported inputs, foreign ownership, and export status). In addition, we include other controls (age and size as well as sector, country, and year dummies). We undertake the analysis using several specifications:

$$(6)\quad y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 X_{itjc} + w_1 rs_{itjc} + \omega_2 (m \times rs)_{itjc} + \omega_3 (f \times rs)_{itjc} + \omega_4 (e \times rs)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$$

Equation (6) includes all variables in equation (1). However, in addition, it includes the absorptive capacity index (rs) that indicates firms that undertook R&D and reskilling activities. It also includes interaction terms with the external knowledge variables (imported inputs, foreign ownership and export status) given by $(m \times rs)_{itjc}$, $(f \times rs)_{itjc}$ and $(e \times rs)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from R&D and reskilling activities. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (6).

$$(7)\quad y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 X_{itjc} + w_5 rw_{itjc} + \omega_6 (m \times rw)_{itjc} + \omega_7 (f \times rw)_{itjc} + \omega_8 (e \times rw)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$$

Equation (7) includes all variables in equation (1). However, in addition, it includes the absorptive capacity index (rw) that indicates firms with high skills composition and undertook R&D activities. It also includes interaction terms with the external knowledge variables (imported inputs, foreign ownership and export status) given by $(m \times rw)_{itjc}$, $(f \times rw)_{itjc}$ and

$(e \times rw)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from high skills composition and R&D activities. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (7).

(8) $y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 X_{itjc} + w_9 sw_{itjc} + \omega_{10}(m \times sw)_{itjc} + \omega_{11}(f \times sw)_{itjc} + \omega_{12}(e \times sw)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$

Equation (8) includes all variables in equation (1). However, in addition, it includes the absorptive capacity index (sw) that indicates firms with high skills composition and undertook reskilling activities. It also includes interaction terms with the external knowledge variables (imported inputs, foreign ownership and export status) given by $(m \times sw)_{itjc}$, $(f \times sw)_{itjc}$ and $(e \times sw)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from high skills composition and reskilling activities. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (8).

(9) $y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 X_{itjc} + w_{13} rsw_{itjc} + \omega_{14}(m \times rsw)_{itjc} + \omega_{15}(f \times rsw)_{itjc} + \omega_{16}(e \times rsw)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$

Equation (9) includes all variables in equation (1). However, in addition, it includes the absorptive capacity index (rsw) that indicates firms that undertook R&D activities, reskilling, and had high skills composition. It also includes interaction terms with the external knowledge variables (imported inputs, foreign ownership and export status) given by $(m \times rsw)_{itjc}$, $(f \times rsw)_{itjc}$ and $(e \times rsw)_{itjc}$. The estimated coefficients on these variables can be interpreted as the extra effect on productivity coming from imported inputs, foreign ownership and export status for firms with absorptive capacity emerging from R&D activities, reskilling, and high skills composition. The total effect for these firms will be the respective coefficient on imported inputs, foreign ownership and export status in equation (1) plus the respective coefficients on interaction terms obtained in equation (9).

Finally, equation (10) extends equation (1) by including simultaneously all absorptive capacity indices and interaction terms considered in specifications 6, 7, 8 and 9 above.

(10) $$y_{itjc} = \alpha_0 + \alpha_1 m_{itjc} + \alpha_2 f_{itjc} + \alpha_3 e_{itjc} + \alpha_4 X_{itjc} + w_1 rs_{itjc} + \omega_2 (m \times rs)_{itjc} + \omega_3 (f \times rs)_{itjc} + \omega_4 (e \times rs)_{itjc} + w_5 rw_{itjc} + \omega_6 (m \times rw)_{itjc} + \omega_7 (f \times rw)_{itjc} + \omega_8 (e \times rw)_{itjc} + w_9 sw_{itjc} + \omega_{10} (m \times sw)_{itjc} + \omega_{11} (f \times sw)_{itjc} + \omega_{12} (e \times sw)_{itjc} + w_{13} rsw_{itjc} + \omega_{14} (m \times rsw)_{itjc} + \omega_{15} (f \times rsw)_{itjc} + \omega_{16} (e \times rsw)_{itjc} + \gamma_t + \gamma_j + \gamma_c + \varepsilon_{itjc}$$

Import status (m_{itjc}) as our main variable was constructed to equal 1 if a firm imports intermediate goods and 0 otherwise. In terms of ownership (f_{itjc}), we generate a dummy variable equal to 1 if a firm is foreign owned and 0 if it is domestically owned. Firm ownership refers to who owns the majority shares. If 50 percent of the firm's shares are owned by a foreigner (resident) then the firm is foreign (domestic) owned. We generate a dummy variable equal to 1 if 50 percent of the firm's shares are owned by foreigners and 0 otherwise. Export status (e_{itjc}) is a dummy variable that is equal to 1 if a firm participates in the global trading arena as an exporter either directly or indirectly and 0 otherwise. There is consensus in the literature that exporters are more productive compared to their counterparts and hence a positive sign is expected on this dummy variable (Bbaale, 2011; Wagner, 2007).

Research and Development (R&D) (r_{itjc}) is equal to 1 if a firm performed R&D activities and zero otherwise. In the data, firms were asked whether during the last fiscal year, the establishment spent on R&D excluding market research. Reskilling/training activities (s_{itjc}) of firms is equal to 1 if firms reskilled their employees and zero otherwise. Skills composition (w_{itjc}) is equal to 1 if the share of a firm's employees with university degrees is above the mean (on average 12% employees have university degrees) and 0 otherwise. This variable measures the extent to which employees can be able to understand and operationalize the new knowledge or technology embodied in the external knowledge variables.

X_{itjc} is a vector of observable control variables specific to the firm and these account for differences between firms. These variables include firm size and age. The WBES defines firm size according to the number of employees; small (<20), medium (20-99) and large (100 and over). Dummy variables for small, medium and large firms were generated accordingly. We computed the age of the firm by taking the difference between the year in which the survey was conducted and the year the firm started operations. In order to capture the non-linearity of age, a variable age squared was included in the regressions. Being a continuous variable, age and age square were transformed into natural logs. Old firms are assumed to have exhausted their scope for learning and/or introduction of "new blue prints" for their production processes and hence we expect a positive sign on the coefficient for age and a negative sign on the coefficient for age square.

It is important to note that we follow the same modeling approach even when we create different groups of firms following either their import or export status. For example, we categorize imports of inputs into two; imports by domestically owned firms and imports by foreign owned firms. Under this categorization, we intend to understand differences in efficiency gains between these two groups of importers. Another categorization seeks to estimate productivity differences between importers only, exporters only, and two-way traders that do export and import at the same time.

In order to estimate our models, we employed OLS as a baseline model and later, we use 2 Stage Least Squares to address the endogeneity that is implied by the relationship under consideration. We attempt minimise endogeneity concerns by constructing instruments that are correlated with our share of firm output exported, share of firm inputs imported and share of firms workers with high school education but not with firm productivity. As such following Aterido et al. (2011), Gauthier and Goyette (2014), Mawejje and Okumu (2016) and Okumu and Mawejje (2019) we generate the instruments using country-sector-size averages for the aforementioned endogenous variables. For example for firm i its value for proportion of high school graduates will be given by the average of the proportion of high school graduates in country j, size s and isic c excluding the proportion of high school graduates employed by firm i.

Consistent with Fisman and Svensson (2007) this way of instrumentation assumes that the endogenous variable are composed of three parts. The firm, country, sector and size components that is $endo_i$, $endo_j$, $endo_s$ and $endo_c$ respectively. Implying that $endo_{ijsc} = endo_i + endo_j + endo_s + endo_c$ where we assume that $endo_j$, $endo_s$ and $endo_c$ are determined by the business environment and corresponding sector-size technologies to suggest that they are exogenous to the firm. Implying that while $endo_j$, $endo_s$ and $endo_c$ are not associated with $endo_i$, they are however correlated with $endo_{ijsc}$. Consequently we thus instrument for $endo_{ijsc}$ using $endo_{jsc}$. This technique of instrumentation abates endogeneity concerns arising from unobservable characteristics that could be associated with productivity albeit at the country-sector-size level. This method of instrumentation is also argued to abate endogeneity concerns arising from measurement errors (Gauthier and Goyette, 2014).

The first stage regression in which our measure of share of firm: output exported, inputs imported and workers with high school education is regressed on against their respective instruments while controlling for independent variables as shown in equation….

$$(11) \qquad endo_{ijscl} = \beta_0 + \beta_1 Avendo_{jsc} + other\ variables + +\mu_{ijsc}$$

Where $Avendo_{jsc}$ is the instrument employed in the first stage regression and represents average share of firm: output exported, inputs imported and workers with high school education computed at the country-sector-size grouping as the average for each firm in the sample excluding the share of firm: output exported, inputs imported and workers with high school education computed for the specific firm for which the average is calculated.

4 Findings

This section presents the findings of the study in line with the research questions and hypotheses raised in section 1 and 2 of the paper. First, we present the descriptive statistics and results from a cross-tabulation to provide a preliminary indication of the empirical relationships.

4.1 Descriptive evidence

Table 1 shows the descriptive statistics of the variables included in the empirical estimations. On average, 56% of the firms in our sample are importers of inputs and intermediates and of these 10% are foreign owned firms while 46% are domestically owned. Importers only are 37% compared to 5% and 18% that are exporters only and two-way traders respectively.

Importers with a high concentration of highly skilled workers are 36% compared to 20% of importing firms with a low concentration of highly skilled workforce. Firms whose workers were formally trained or reskilled are 25% while 18% of the firms spent on R&D activities in the financial year preceding the survey.

Considering firm size, 19%, 32% and 49% are large, medium and small firms respectively. Only 13% of firms in our sample are foreign owned while 23% are exporters. The average age of firms in our sample is 18 years implying that the majority of firms in our sample are in their youthful stage.

Table 2 shows results of some cross-tabulations of the different categories of the import status and selected firm characteristics. It can be observed that importers of inputs are more productive than non-importers while foreign owned importers are more productive than domestically owned importers. In terms of the skills composition, importers with a high concentration of highly skilled workers are more productive compared to those firms with low concentration of highly skilled workers. A higher share of importers of inputs (31%) have formally trained workers (reskilled) compared to 17% of non-importers. Similarly, 42% of foreign owned importers have formally trained workers compared to 29% of domestically owned importers. As might be expected, 35% of importers with a high concentration of highly skilled workers have workers that were formally trained compared to 29% of their counterparts. A higher percentage of importers of inputs (23%) spent on R&D compared 12% of counterparts that are non-importers. More foreign owned importers (28%) spent on R&D compared to 22% of domestically owned importers. In the same vein, 32% of importers with a high concentration of skills spent on R&D compared to 20% of importers with a low concentration of highly skilled labour.

By size, there is a high share of medium and large firms that are importers of inputs compared to the non-importers. Similarly, there is a high share of medium and large firms that are foreign owned importers compared to domestically owned importers. This implies that foreign owned firms are usually larger compared to domestically owned firms. Additionally, there is a high share of firms with a high concentration of skilled workers that are medium and large compared to those with a low concentration of skilled workers. Importers of inputs are more likely to be foreign owned (17%) compared to only 7% of non-importers that are foreign owned. Importers with a high concentration of highly skilled workers are more likely to be foreign (19%) compared to 16% of firms with a low concentration of skilled workers that are foreign owned.

Exporters are more likely to be importers of inputs (33%) compared to 10% that are non-importers. Exporters are more likely to be foreign owned importers (52%) compared to 29% that are domestically owned exporters. Exporters are more likely to have a high concentration of highly skilled workers (33%) compared 32% with a low concentration of skilled workers. Importers are on average older (20 years) compared to non-importers (16 years).

4.2 Empirical results

The empirical evidence emerges from the estimation of the ten (10) models specified in section two and ultimately the four research questions raised earlier in section one. During our estimations, we take note of internal and external knowledge generators at firm level. Internal knowledge generators include reskilling of workers, Research and Development, and a measure of the degree of skills composition amongst workers (share of workers with a university degree). External knowledge generators include importation of inputs, exporting, and foreign ownership of firms. We generate scenarios during model estimations where we interact internal and external knowledge generators in order to understand the extent of the absorptive capacity. We provide evidence on whether the importation of intermediates leads to efficiency gains at firm level (Table 3). In Table 4 we sought to observe productivity differences between foreign owned importers compared to domestically owned importers. We compare productivity differences between importers only, exporters only and two-way traders and the results are presented in Table 5. In Table 6, we disaggregate importers according to skills composition and we seek to understand productivity differences amongst importers with low and high skills composition. We sought to understand the importance of the degree of absorptive capacity on firm productivity where we constructed indices of absorptive capacity; R&D and reskilling only, R&D and high skills composition only, reskilling and high skills composition only and R&D, reskilling and high skills composition. The results are presented in Table 7. Finally, in Table 8 we attempt to tackle the endogeneity problem by employing the instrumental variable two-stage least squares in our estimation. We constructed continuous variables for the potentially endogenous variables namely; share of firm inputs imported, share of firm output exported, and share of firm workers with high school education. We used the country-size-sector averages of those variables as instruments. The Sargan's (1958) statistic tests whether the instruments are uncorrelated with the error term and whether the model is misspecified such that one or more of the excluded exogenous variables should have been part of the structural model. Basing on the results on the test for each model, we could not reject the null hypothesis that our instruments are valid and that the model is well specified.

The results in Table 3 show that internal knowledge generators namely, worker reskilling, a high skill composition ad well as expenditure on R&D contribute to firm productivity with the reskilling of workers, playing the leading role. Specifically, reskilling of workers improves firm productivity by 21-45% (Table 3). Our findings imply that internal knowledge generation is very important for manufacturing firms and this is in line with previous literature (Baumann and Kritikos, 2016; Torii 1992; Lall et al., 2016; Gokcekus et al., 2001; Oyelaran-Oyeyinka and Lal, 2006). Our finding also show that external knowledge generators namely, importation of inputs, foreign ownership and exporting contribute to firm level productivity with foreign ownership playing a leading role. Being an importer of inputs increases firm productivity by 32-39% compared 36-45% for exporters and 43-48% for foreign owned firms. These observed differences are in line with the predictions of the Antràs and Helpmans (2004) model and the empirical findings in literature that find that importers of inputs are more productive compared to their counterparts (Okafor et al., 2016; Foster-McGregor et al., 2015; Gopinath and Neiman, 2014; Grieco et al., 2017; Halpern at al., 2015; Amiti and Wei, 2009; Kasahara and Rodrigue, 2008 for Chile; Augier et al., 2009; José and Martín-Marcos, 2010).

In table (3) we see a negative and statistically significant coefficient on the interaction term between imports of inputs and reskilling. Performing reskilling activities as well as importation of inputs decreases firm productivity by close to 22%. Since the coefficient on the level variable of importation of inputs is positive and statistically significant (32-39%), the total effect is therefore positive (10-17%). Similarly, the interaction term on export status and reskilling is negative and statistically significant (22%). However, since the coefficient on the level variable of an exporter is positive and statistically significant (37-45%), the total effect is therefore positive (15-23%).

Considering the productivity differences between foreign owned importers and domestically owned importers, we observe that both foreign owned and domestically owned importers are more productive compared to non-importers (Table 4). Being a foreign owned importer leads to an efficiency gain of 45-60% compared to an efficiency gain of 30-38% of domestically owned importers in the same model. Our findings imply that foreign owned importers stand to benefit more from the imports of inputs probably because of the already existing linkages they have with the foreign market players compared to domestically owned importers. This might imply that foreign owned firms that import inputs might not have to pay some of the sunk costs of importing like establishing market networks and dealing with a different legal and regulatory framework compared to the domestically owned importers. Our findings are in contrast with Foster-McGregor et al. (2015) who find that domestically owned importers enjoy a higher import premium compared to foreign owned importers. Just like in Table (3), the positive and statistically significant effect of both internal and external knowledge generators continue to be visible in Table 4. In table (4) we see a positive and statistically significant effect on the interaction term between foreign ownership and R&D. Performing R&D activities by a foreign owned firm increases firm productivity by close to 60%. Since the coefficient on the level variable of foreign ownership is positive and statistically significant (26-35%), the total effect is therefore positive (86-95%). On the other hand, the interaction term on domestic importer of inputs and reskilling is negative and statistically significant (28%). However, since the coefficient on the level variable of a domestic importer is positive and statistically significant (30-35%), the total effect is therefore positive. Further to that, the interaction term on export status and reskilling is negative and statistically significant (22%). However, since the coefficient on the level variable of an exporter is positive and statistically significant (35-43%), the total effect is therefore positive.

Our findings show important productivity differences between importers only, exporters only and two-way traders (Table 5). Being a two-way trader increases firm level productivity by close to 70-78% compared to 35-40%, and 50-66% for importers only, and exporters only respectively. Our finding partially support evidence from Foster-McGregor et al. (2015) who find that two-way traders are more productive compared to exporters only and importers only. However, they are partially in contrast with Foster-McGregor et al. (2015) who found that importers only are more productive compared to exporters only, we observe the reverse. Just like in Table (4), coefficients on the internal and external knowledge generators are positive and highly statistically significant. On the other hand, the interaction term on exporters only and R&D is negative and statistically significant (62%). However, since the coefficient on the level variable of a exporters only is positive and statistically significant (62%) and of the same magnitude as the interaction term, the total effect is therefore neutral. The interaction term on exporters only and reskilling is negative and statistically significant (62%). However, since the coefficient on the level variable of exporters only is positive and statistically significant (63%), the total effect is therefore positive. The interaction term on two way traders and reskilling is negative and statistically significant (43%). However, since the coefficient on the level variable of two way traders is positive and statistically significant (78%), the total effect is therefore positive (35%). This implies that being a two way trader coupled with reskilling reinforce each other to lead to efficiency gains at firm level.

Our findings underscore the role of internal knowledge generation that contributes to augmenting a firm's absorptive capacity which in turn contributes to the observed productivity gains which are generated by human capital and R&D when subjected to the knowledge and technology embodied in the imported inputs (Table 6). This analysis is premised on the view that it is not importing per se that leads to efficiency gains but rather importation in an environment of high absorptive capacity that can be represented by the quality of the workforce (Li, 2011; Cozza and Zanfei, 2016). Importers with a high concentration of highly skilled labour are observed to outperform their counterparts. Being an importer with skilled labour increases firm productivity with the highest gains being recorded by importers with lower skills. Being an importer with a high concentration of highly skilled labour increases firm level productivity by 32-36% compared to 40-46% for importers of inputs with a low concentration of highly skilled labour. This result might mean that importers of inputs with a low concentration of highly skilled labour still have a wider latitude to learn from importing activities compared to their counterparts. Reskilling workers through specialized training and refreshers courses has a significant contribution to enhancing firm productivity and so is R&D expenditure. Our findings suggest that in order to reap the efficiency benefits of importing intermediates and capital goods, firms must boost their absorptive capacity in order to be in a better position to utilize the new knowledge and technology. These findings are in line with previous literature (Okafor et al., 2016; Foster-McGregor et al., 2015; Augier et al., 2009) that found the enhancing role of absorptive capacity in reaping the import premium associated with inputs and capital goods. The interaction term on importers with low skills composition and reskilling is negative and statistically significant (43-45%). However, since the coefficient on the level variable of importers with low skills composition is positive and statistically significant (50-51%), the total effect is therefore positive (6-7%). The interaction term on export status and reskilling is negative and statistically significant (32-36%). However, since the coefficient on the level variable of export status is positive and statistically significant (45-47%), the total effect is therefore positive (11-13%).

In Table (7), we constructed difference indices to measure the degree of complementarity of absorptive capacity variables in influencing productivity. We considered firms that enagaged in R&D and reskilling only, R&D and high skills composition only, reskilling and high skills composition only, and firms that combined all the three measures of absorptive capacity; R&D, reskilling and high skills composition. During our model estimation, we include one at a time plus its interaction terms with the external knowledge generators and then finally we included all in one model simultaneously with their interaction terms. We find that firms that engaged in R&D and reskilling are more productive by 55% compared to their counterparts that did nothing. The interaction term foreign ownership and R&D combined with reskilling is negative and statistically significant (44%). However, since the coefficient on the level variable of foreign ownership is positive and statistically significant (55%), the total effect is therefore positive (11%). Firms that engaged in R&D and had high skills composition are more productive by 44% compared to their counterparts that did nothing. Firms that engaged in reskilling and had high skills composition are more productive by 35% compared to their counterparts that did nothing. The interaction term foreign ownership and reskilling combined with high skills composition is negative and statistically significant (44%). However, since the coefficient on the level variable of foreign ownership is positive and statistically significant (42%), the total effect is therefore negative (2%).

As expected, firms engaged in all the three internal knowledge generators are more productive than those who did nothing and even those engaged in only two knowledge activities. Firm engaged in the three internal knowledge generators are 66-73% more productive than counterparts engaged R&D and reskilling only (55%), R&D and high skills composition (44%) and reskilling and high skills composition (35%). This results emphasizes strongly the importance of complementarity of internal knowledge generators in influencing productivity. It is more rewarding for a firm to engage in more than in less. The interaction term on imported inputs and the three internal knowledge generators is negative and statistically significant (29-35%). However, since the coefficient on the level imported inputs is positive and statistically significant (39-40%), the total effect is therefore positive (5-10%). The interaction term on export status and the three internal knowledge generators is negative and statistically significant (23%). However, since the coefficient on the level export status is positive and statistically significant (42%), the total effect is therefore positive (19%).

In terms of other variables, our measures of human capital development significantly influence firm level productivity across all our specifications (Table 3-7). Firms that spend on R&D in the financial year preceding the survey increase firm productivity compared to their counterparts (see Baumann and Kritikos, 2016). Firms whose workers were formally trained or reskilled increased firm productivity compared to counterparts. Biggs (1995) shows evidence of the role of formal training in improving technical efficiency in sub-Saharan African manufacturing firms. The importance of human capital development in enhancing productivity is also documented by Okafor et al. (2016) and Foster-McGregor et al. (2015). As expected, other firm characteristics such as size, age and ownership have the expected behaviour in all our models.

In Table 8, we tackle these issue of reverse causality in our estimation with respect to the effects of the internal and external innovations on productivity. We attempt minimise endogeneity concerns by constructing instruments that are correlated with our share of firm output exported, share of firm inputs imported and share of firms workers with high school education but not with firm productivity. In line with the previous literature (Aterido et al., 2011; Gauthier and Goyette, 2014; Mawejje and Okumu, 2016; and Okumu and Mawejje, 2019) we generate the instruments using country-sector-size averages. Our findings still reinforce the role of both internal and external knowledge generators innovations in contributing to firm productivity. Moreover, we find evidence of productivity improvements regardless of firm ownership or size.

5 Conclusion

The study set out to investigate the role of firm's innovations that are internal to the firm in terms of human capital development and R&D, with the human capital component encompassing the degree of skill and training activities. Second, innovations that are external to the firm that drive firm productivity through external knowledge transfers in the process of learning by exporting, through import of inputs, and/or through external linkages via foreign ownership. Third and finally, the external knowledge transfers that in turn effect firm productivity via internal innovations (augmented labour productivity generated by human capital and R&D which in generates internal absorptive capacity). Several models were estimated where the first sought to ascertain whether there is a premium associated with the importation of inputs? In the second estimation we sought to establish the productivity differences between foreign owned and domestically owned input importing firms. In the third model, we analysed the productivity differences between input importing firms that do not produce for export, exporting firms that do not import inputs, and two-way traders that both import inputs and export their products, while the fourth model estimated the importance of importers with high skills composition in influencing productivity. In the firth model, we constructed absorptive capacity indices with different combinations to try to understand the role of internal knowledge complementarity in influencing firm productivity.

We used WBES data set and employed both OLS and 2SLS to analyse the relationship between internal and external knowledge generators and firm productivity. We find that, in majority of our estimations, results show positive productivity effects from a firm's internal and external innovations. Our results therefore imply that both sources of knowledge generation affect productivity by theree channels: (1) directly through human capital development and R&D, with the human capital component encompassing the degree of skill and training activities, external knowledge transfers in the process of learning by exporting, through import of inputs, and/or through external linkages via foreign ownership and, (2) indirectly through external knowledge transfers that in turn effect firm productivity via internal innovations (augmented labour productivity generated by human capital and R&D which in generates internal absorptive capacity). The second loop is the innovation-productivity virtuous circle. While more innovation increase productivity, this greater productivity induces larger scale innovations (Bravo-Ortega et al., 2014).

Finally, our findings indicate that firms with a higher absorptive capacity through HCD and R&D enjoy a higher efficiency gains from importing inputs compared to counterparts with a low absorptive capacity. Our findings suggest that in order to reap the efficiency benefits of importing intermediates and capital goods, firms must invest in building their absorptive capacity in terms of improving the quality of the workforce such as reskilling or recruitment of highly skilled workers and R&D. Additionally, governments should make it easier, by loosening import barriers, for firms to import inputs since importation leads to efficiency gains once compared to non-importation. This should particularly be helpful to domestically owned firms whose benefit from importation seems minimal. Domestic firms need to establish networks with foreign firms as this can open up opportunities for learning.

6 Declarations

Availability of data and materials
Data is available for verification of the findings if requested.
Competing interests
On behalf of all authors, the corresponding author states that there is no conflict of interest.
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Tables

Table 1: Descriptive statistics of the variables used in the empirical analysis

Variable	Obs	Mean	Min	Max
Log Labour productivity	3,361	9.431665	2.906603	15.42409
Share of inputs imported	4,429	0.3196252	0	100
Share of workers with high school education	4,283	0.619491	0	100
Share of workers a University Degree	2,640	0.1148902	0	1984
Share of sales exported	4,616	0.1133947	0	100
Share of firms importing inputs	4,717	0.577274	0	1
Foreign importers	4,717	0.098368	0	1
Domestic importers	4,717	0.478906	0	1
Importers only	4,717	0.353403	0	1
Exporters only	4,717	0.053424	0	1
Two way traders	4,717	0.223871	0	1
Importers with high skills	4,717	0.389654	0	1
Importers with low skills	4,717	0.187619	0	1
Share of firms reskilling workers	4,671	0.285378	0	1
Research and Development	4,686	0.227059	0	1
Medium Size firms	4,717	0.323299	0	1
Large Size firms	4,717	0.237439	0	1
Foreign ownership	4,717	0.12932	0	1
Share of firms exporting	4,717	0.277295	0	1
Age	4,607	21.63838	0	126

Source: **Authors' own computations from WBES**

Table 2: Import status and selected firm characteristics

Variable	Importers	Non-importers	Foreign importers	Domestic Importers	Low skills importer	High kills importer
Labour productivity	9.453316	8.943273	9.96931	9.351887	9.358742	9.618655
Workers formally trained	0.3115296	0.1716139	0.4242175	0.2877046	0.2917125	0.3489821
Research & Development	0.2329871	0.1205463	0.2836676	0.2241851	0.1970847	0.3160112
Medium Size firms	0.3369722	0.288762	0.3742331	0.3292586	0.3037794	0.3969719
Large Size firms	0.2667368	0.0900386	0.4133436	0.2363867	0.2582227	0.282127
Foreign ownership	0.1715112	0.0732404	1	0	0.1607763	0.1909158
Export status	0.3256609	0.105325	0.5153374	0.2863947	0.3235955	0.3293944
Age	19.55118	16.28489	19.37412	19.58749	19.29969	20.00336

Source: **Authors' own computations from WBES**

Table 3: Imported inputs and firm productivity

VARIABLES	(1)	(2)	(3)	(4)	(5)
Imports of inputs	0.347***	0.341***	0.385***	0.321***	0.351***
	(0.0423)	(0.0444)	(0.0451)	(0.0480)	(0.0508)
Reskilling of workers (TR)	0.206***	0.210***	0.433***	0.207***	0.454***
	(0.0547)	(0.0548)	(0.0986)	(0.0547)	(0.102)
High Skills Composition (SC)	0.130***	0.131***	0.127***	0.0785	0.0737
	(0.0486)	(0.0487)	(0.0486)	(0.0695)	(0.0703)
Research and Development (R&D)	0.215***	0.234**	0.224***	0.215***	0.164
	(0.0617)	(0.115)	(0.0621)	(0.0619)	(0.119)
Imported inputs * R&D		0.0359			0.110
		(0.134)			(0.142)
Foreign ownership * R&D		0.154			0.137
		(0.176)			(0.185)
Exporting * R&D		-0.156			-0.0917
		(0.124)			(0.132)
Medium size firms	0.376***	0.374***	0.368***	0.376***	0.368***
	(0.0464)	(0.0466)	(0.0465)	(0.0465)	(0.0466)
Large firms	0.387***	0.387***	0.384***	0.386***	0.384***
	(0.0611)	(0.0611)	(0.0613)	(0.0611)	(0.0613)
Foreign ownership	0.481***	0.447***	0.473***	0.456***	0.433***
	(0.0699)	(0.0770)	(0.0836)	(0.0821)	(0.0957)
Exporting	0.356***	0.390***	0.426***	0.367***	0.445***
	(0.0546)	(0.0584)	(0.0626)	(0.0619)	(0.0697)

Log firm Age	0.224*	0.226*	0.219*	0.223*	0.218*
	(0.119)	(0.119)	(0.120)	(0.119)	(0.120)
Log Age square	-0.0383	-0.0387*	-0.0369	-0.0381	-0.0366
	(0.0233)	(0.0233)	(0.0234)	(0.0233)	(0.0234)
Imports of inputs *TR			-0.218*		-0.254**
			(0.112)		(0.118)
Foreign ownership *TR			0.0341		-0.00489
			(0.147)		(0.155)
Exporting *TR			-0.216**		-0.185
			(0.107)		(0.113)
Imports of inputs *SC				0.0879	0.0926
				(0.0901)	(0.0906)
Foreign ownership *SC				0.0808	0.0694
				(0.151)	(0.151)
Exporting *SC				-0.0303	-0.0244
				(0.106)	(0.106)
Constant	8.570***	8.566***	8.540***	8.592***	8.564***
	(0.289)	(0.288)	(0.287)	(0.289)	(0.287)
Observations	3,275	3,275	3,275	3,275	3,275
R-squared	0.397	0.397	0.398	0.397	0.399
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4: Foreign and domestic importers and firm productivity

VARIABLES	(1)	(2)	(3)	(4)	(5)
Foreign importer of inputs	0.512***	0.586***	0.445***	0.554***	0.598***
	(0.132)	(0.145)	(0.154)	(0.165)	(0.174)
Domestic importer of inputs	0.332***	0.320***	0.380***	0.302***	0.346***
	(0.0436)	(0.0464)	(0.0477)	(0.0507)	(0.0539)
Reskilling of workers (TR)	0.207***	0.208***	0.480***	0.208***	0.422***
	(0.0499)	(0.0500)	(0.0899)	(0.0500)	(0.0866)
High Skills Composition (SC)	0.131***	0.131***	0.127***	0.0707	0.0647
	(0.0456)	(0.0456)	(0.0456)	(0.0694)	(0.0697)
Research and Development (R&D)	0.215***	0.194*	0.227***	0.215***	0.153
	(0.0563)	(0.108)	(0.0563)	(0.0563)	(0.103)
Foreign importer of inputs * R&D		-0.496			0.0466
		(0.351)			(0.189)
Domestic importer of inputs *R&D		0.0937			0.100
		(0.124)			(0.124)
Foreign ownership *R&D		0.598*			
		(0.328)			
Exporting *R&D		-0.149			
		(0.110)			
Medium size firms	0.377***	0.374***	0.369***	0.377***	0.375***
	(0.0458)	(0.0458)	(0.0458)	(0.0458)	(0.0458)
Large firms	0.388***	0.386***	0.386***	0.387***	0.393***
	(0.0590)	(0.0591)	(0.0591)	(0.0591)	(0.0592)
foreign	0.353***	0.264**	0.431***	0.271*	0.255*
	(0.116)	(0.125)	(0.132)	(0.147)	(0.147)
Exporting	0.354***	0.387***	0.425***	0.365***	0.371***

	(0.0497)	(0.0550)	(0.0582)	(0.0590)	(0.0590)
Log firm Age	0.224**	0.226**	0.220**	0.221**	0.217**
	(0.110)	(0.110)	(0.110)	(0.110)	(0.110)
Log Age square	-0.0383*	-0.0387*	-0.0373*	-0.0378*	-0.0368*
	(0.0214)	(0.0214)	(0.0214)	(0.0214)	(0.0214)
Foreign importer of inputs * TR			0.251		-0.229
			(0.301)		(0.168)
Domestic importer of inputs *TR			-0.283***		-0.327***
			(0.107)		(0.106)
Foreign ownership *TR			-0.398		
			(0.278)		
Exporting *TR			-0.216**		
			(0.0990)		
Foreign importer of inputs * SC				-0.0961	-0.0856
				(0.273)	(0.273)
Domestic importer of inputs *SC				0.102	0.113
				(0.0895)	(0.0902)
Foreign ownership *SC				0.229	0.233
				(0.238)	(0.237)
Exporting *SC				-0.0295	-0.0406
				(0.0959)	(0.0960)
Constant	8.576***	8.577***	8.538***	8.601***	8.574***
	(0.290)	(0.290)	(0.290)	(0.290)	(0.291)
Observations	3,275	3,275	3,275	3,275	3,275
R-squared	0.397	0.398	0.399	0.397	0.398
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES

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

Table 5: Importers only, exporters only, two-way traders, and firm productivity

VARIABLES	(1)	(2)	(3)	(4)	(5)
Importers only	0.380***	0.391***	0.428***	0.350***	0.398***
	(0.0453)	(0.0471)	(0.0477)	(0.0510)	(0.0540)
Exporters only	0.494***	0.615***	0.629***	0.504***	0.660***
	(0.102)	(0.111)	(0.119)	(0.124)	(0.134)
Two way traders	0.688***	0.699***	0.777***	0.673***	0.754***
	(0.0652)	(0.0696)	(0.0731)	(0.0726)	(0.0803)
Reskilling of workers (TR)	0.208***	0.213***	0.506***	0.208***	0.505***
	(0.0546)	(0.0547)	(0.109)	(0.0547)	(0.111)
High Skills Composition (SC)	0.130***	0.131***	0.130***	0.0671	0.0563
	(0.0486)	(0.0487)	(0.0485)	(0.0723)	(0.0731)
Research and Development (R&D)	0.217***	0.325***	0.227***	0.218***	0.251*
	(0.0618)	(0.126)	(0.0621)	(0.0620)	(0.129)
Importers only *R&D		-0.116			-0.0313
		(0.160)			(0.165)
Exporters only *R&D		-0.622**			-0.472
		(0.271)			(0.295)
Two way traders *R&D		-0.124			-0.000543
		(0.156)			(0.165)
Foreign ownership *R&D		0.141			0.128
		(0.175)			(0.184)

Medium size firms	0.374***	0.371***	0.367***	0.373***	0.366***
	(0.0464)	(0.0465)	(0.0465)	(0.0465)	(0.0466)
Large firms	0.390***	0.386***	0.385***	0.389***	0.384***
	(0.0612)	(0.0612)	(0.0612)	(0.0612)	(0.0613)
Foreign ownership	0.485***	0.453***	0.482***	0.458***	0.441***
	(0.0699)	(0.0769)	(0.0835)	(0.0821)	(0.0956)
Log firm Age	0.226*	0.224*	0.221*	0.225*	0.217*
	(0.119)	(0.119)	(0.120)	(0.119)	(0.120)
Log Age square	-0.0388*	-0.0383	-0.0373	-0.0386*	-0.0364
	(0.0234)	(0.0233)	(0.0234)	(0.0233)	(0.0234)
Importers only *TR			-0.343**		-0.342**
			(0.133)		(0.137)
Exporters only *TR			-0.622***		-0.474*
			(0.233)		(0.250)
Two way traders *TR			-0.426***		-0.428***
			(0.139)		(0.146)
Foreign ownership *TR			0.0254		-0.0123
			(0.147)		(0.154)
Importers only *SC				0.112	0.128
				(0.0991)	(0.0993)
Exporters only *SC				-0.00599	0.0861
				(0.211)	(0.213)
Two way traders *SC				0.0604	0.0684
				(0.119)	(0.120)
Foreign ownership *SC				0.0855	0.0746
				(0.151)	(0.151)
Absorptive capacity index (AI)					
Constant	8.547***	8.537***	8.510***	8.571***	8.536***
	(0.290)	(0.289)	(0.288)	(0.290)	(0.288)
Observations	3,275	3,275	3,275	3,275	3,275
R-squared	0.397	0.398	0.399	0.398	0.400
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Importers with High Skills Composition and firm productivity

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS
High skill composition (SC)	0.313***	0.295***	0.344***	0.327***
	(0.0653)	(0.0676)	(0.0703)	(0.0704)
Importers with High skills Composition	0.351***	0.405***	0.496***	0.509***
	(0.114)	(0.127)	(0.130)	(0.136)
Importers with Low skills Composition	0.275***	0.270**	0.250**	0.253**
	(0.107)	(0.108)	(0.107)	(0.109)
Reskilling of workers (TR)	0.252***	0.251***	0.585***	0.585***
	(0.0671)	(0.0672)	(0.121)	(0.123)
Research and Development (R&D)	0.190**	0.298*	0.203***	0.205
	(0.0788)	(0.153)	(0.0788)	(0.155)
Importers with High skills Composition *R&D		0.0523		0.131
		(0.185)		(0.194)
Importers with Low skills Composition *R&D		-0.134		-0.0181
		(0.212)		(0.222)
Foreign ownership *R&D		0.117		0.117
		(0.218)		(0.236)
Exporting *R&D		-0.253		-0.169
		(0.156)		(0.165)
Foreign ownership	0.508***	0.472***	0.533***	0.509***
	(0.0925)	(0.104)	(0.115)	(0.115)
Exporting	0.315***	0.380***	0.445***	0.475***
	(0.0739)	(0.0798)	(0.0887)	(0.0895)
Log firm Age	0.0597	0.0634	0.0451	0.0456
	(0.169)	(0.169)	(0.168)	(0.168)
Log Age square	0.0129	0.0121	0.0170	0.0167
	(0.0320)	(0.0319)	(0.0318)	(0.0318)
Medium Size firms	0.415***	0.407***	0.399***	0.396***
	(0.0655)	(0.0657)	(0.0654)	(0.0656)
Large firms	0.487***	0.488***	0.472***	0.476***
	(0.0845)	(0.0847)	(0.0849)	(0.0852)
Importers with High skills Composition *TR			-0.212	-0.239
			(0.146)	(0.154)
Importers with Low skills Composition *TR			-0.445**	-0.431**
			(0.180)	(0.189)
Foreign ownership *TR			-0.0504	-0.0847
			(0.189)	(0.206)
Exporting *TR			-0.355***	-0.319**
			(0.133)	(0.140)
Constant	7.687***	7.684***	7.621***	7.629***
	(0.252)	(0.250)	(0.250)	(0.250)
Observations	3,275	3,275	3,275	3,275
R-squared	0.445	0.446	0.448	0.449
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Absorptive capacity combinations and firm productivity

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Imports of inputs	0.323***	0.358***	0.363***	0.363***	0.394***	0.396***
	(0.0599)	(0.0616)	(0.0614)	(0.0618)	(0.0665)	(0.0666)
Absorptive capacity (R&D+Reskilling=rs)		0.546**				0.0941
		(0.224)				(0.285)
Imported inputs*rs		-0.199				0.0606
		(0.226)				(0.283)
Foreign ownership*rs		0.377				0.611**
		(0.247)				(0.301)
Export status*rs		-0.439**				-0.405*
		(0.186)				(0.216)
Medium size firms	0.415***	0.461***	0.460***	0.459***	0.426***	0.423***
	(0.0654)	(0.0652)	(0.0649)	(0.0649)	(0.0647)	(0.0647)
Large firms	0.487***	0.559***	0.561***	0.576***	0.496***	0.478***
	(0.0845)	(0.0838)	(0.0842)	(0.0839)	(0.0851)	(0.0846)
Foreign ownership	0.508***	0.433***	0.477***	0.419***	0.549***	0.553***
	(0.0925)	(0.100)	(0.0948)	(0.0994)	(0.115)	(0.116)
Export status	0.314***	0.410***	0.349***	0.366***	0.419***	0.424***
	(0.0739)	(0.0773)	(0.0739)	(0.0755)	(0.0900)	(0.0901)
Log Age	0.0588	0.0771	0.0572	0.0552	0.0586	0.0659
	(0.169)	(0.163)	(0.167)	(0.167)	(0.164)	(0.163)
Log Age square	0.0131	0.0108	0.0150	0.0146	0.0148	0.0140
	(0.0320)	(0.0312)	(0.0316)	(0.0316)	(0.0311)	(0.0309)
Reskilling	0.251***					
	(0.0670)					
High Skills Composition	0.297***					
	(0.0746)					
R&D	0.191**					
	(0.0789)					
Absorptive capacity (R&D+ high skills Composition=rw)			0.441**			-0.0762
			(0.190)			(0.249)
Imported inputs*rw			-0.209			0.0680
			(0.232)			(0.290)
Foreign ownership*rw			0.137			-0.00128
			(0.342)			(0.384)
Export status*rw			0.0254			0.348
			(0.221)			(0.254)
Absorptive capacity (Reskilling+ high skills Composition=sw)				0.352*		-0.248
				(0.189)		(0.241)
Imported inputs*sw				-0.182		0.104
				(0.210)		(0.264)
Foreign ownership*sw				0.438*		0.682**
				(0.263)		(0.320)
Export status*sw				-0.101		0.0899
				(0.194)		(0.230)
Absorptive capacity (R&D+Reskilling+ high skills Composition=rsw)					0.662***	0.734***
					(0.113)	(0.139)
Imported inputs*rsw					-0.289**	-0.353**
					(0.132)	(0.165)
Foreign ownership*rsw					-0.139	-0.574**

					(0.187)	(0.251)
Export status*rsw					-0.232*	-0.214
					(0.131)	(0.162)
Constant	7.684***	8.678***	8.692***	8.700***	8.627***	8.613***
	(0.252)	(0.353)	(0.357)	(0.355)	(0.345)	(0.345)
Observations	3,275	3,308	3,308	3,308	3,308	3,308
R-squared	0.445	0.439	0.438	0.438	0.444	0.448
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES

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

Table 8: Absorptive capacity and firm productivity: IV Approach

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Share of inputs imported	0.0900***	0.150***	0.156***	0.182***	0.731*	0.737*
	(0.0156)	(0.0410)	(0.0475)	(0.0528)	(0.382)	(0.385)
Share of workers with high school education (SC)	0.181***	0.280***	0.277***	0.270***	0.547***	0.547***
	(0.0272)	(0.0655)	(0.0658)	(0.0660)	(0.191)	(0.190)
Share of sales exported	0.0804***	0.0655	0.0921	0.113	0.0914	0.291
	(0.0213)	(0.0480)	(0.0623)	(0.0760)	(0.694)	(0.745)
Share of inputs imported*R&D			-0.0416			0.0292
			(0.0574)			(0.0512)
Share of sales exported*R&D			-0.0849			-0.0747
			(0.0688)			(0.0655)
Foreign ownership*R&D			0.229			0.238
			(0.227)			(0.247)
Reskilling of workers (TR)	0.234***	0.215***	0.213***	0.669***	0.211***	0.585***
	(0.0692)	(0.0703)	(0.0705)	(0.156)	(0.0715)	(0.135)
Research and Development (R&D)	0.210***	0.186**	0.393**	0.191**	0.210**	0.209
	(0.0809)	(0.0831)	(0.175)	(0.0823)	(0.0832)	(0.158)
Medium Size firms	0.341***	0.269***	0.260***	0.252***	0.278***	0.255***
	(0.0687)	(0.0790)	(0.0811)	(0.0806)	(0.0814)	(0.0843)
Large Size firms	0.427***	0.311**	0.306**	0.288**	0.403***	0.387***
	(0.0875)	(0.123)	(0.125)	(0.128)	(0.0922)	(0.0942)
Foreign ownership	0.545***	0.521***	0.453***	0.543***	0.483	0.450
	(0.0975)	(0.0992)	(0.114)	(0.124)	(0.607)	(0.619)
Log firm Age	0.0215	0.00120	0.0145	-0.00975	-0.0943	-0.107
	(0.180)	(0.182)	(0.181)	(0.181)	(0.200)	(0.200)
Log Age square	0.0153	0.0183	0.0159	0.0213	0.0361	0.0399
	(0.0337)	(0.0339)	(0.0338)	(0.0337)	(0.0370)	(0.0369)
Share of inputs imported*TR				-0.127**		-0.0987**
				(0.0550)		(0.0427)
Share of sales exported*TR				-0.0925		-0.0710
				(0.0762)		(0.0563)
Foreign ownership*TR				-0.114		-0.256
				(0.205)		(0.216)
Share of inputs imported*SC					-0.157*	-0.153*
					(0.0930)	(0.0918)

Share of sales exported*SC					-0.00467	-0.0408
					(0.168)	(0.174)
Foreign ownership*SC					0.00664	0.0175
					(0.150)	(0.151)
Constant	7.556***	7.658***	7.622***	7.591***	6.756***	6.648***
	(0.270)	(0.326)	(0.329)	(0.325)	(0.740)	(0.748)
Observations	2,908	2,908	2,908	2,908	2,908	2,908
R-squared	0.455	0.449	0.450	0.452	0.411	0.414
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Sargan (score) (p-value)		0.1755	0.1835	0.1865	0.1786	0.1790

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

Appendix

Table A1: List of countries in our sample

Country	Wave 1	Wave 2	Frequency
Angola	2006	2010	291
Benin	2009	2016	142
Botswana	2006	2010	199
Burundi	2006	2014	162
Cameroon	2009	2016	208
Cote d'Ivoire	2009	2016	310
DRC	2010	2013	365
Ethiopia	2011	2015	706
Egypt	2013	2016	3188
Ghana	2007	2013	669
Guinea	2006	2016	162
Kenya	2007	2013	810
Madagascar	2009	2013	467
Malawi	2009	2014	268
Mali	2007	2010	461
Mauritania	2006	2014	132
Namibia	2006	2014	287
Niger	2009	2017	103
Rwanda	2006	2011	140
Senegal	2007	2014	508
Swaziland	2006	2016	145
Tanzania	2006	2013	713
Togo	2009	2016	80
Uganda	2006	2013	685
Zambia	2007	2013	668
Zimbabwe	2011	2016	665

Source: WBES