‘Learning to export’ and ‘learning to innovate’: Revisiting the relationship between innovation and exports in African firms

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Abstract

This paper examines the relationship between innovation and export performance for African firms. We use Tobit simultaneous equation full information maximum likelihood (FIML) model with selection on a cross-sectional dataset from the World Bank’s Enterprise Surveys for 28 African economies. The paper provides new evidence of a two-way positive relationship between innovation and export performance in African firms: innovation is important for both the ability to export (export propensity) and for export intensity, while exporting also increases the likelihood of innovating. These effects are driven mainly by direct exports and apply to both product and process innovation. We argue that these results point to a two-way relationship in which innovation enables firms to ‘learn to export’, while firms also ‘learn to innovate’ through exporting. A higher share of foreign ownership in firms, as well as firms having an internationally recognised quality certification strengthen the positive effects in both directions.

Keywords: Exports; Export Performance; Innovation; Learning; Firms; Africa
JEL Codes: D22; F14; L25; O12; O32; O55

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1. Introduction

Exports have long been identified as critical for countries' economic growth and development, including for balance of payments, job creation, and for building capabilities and upgrading (Bernard and Jensen 1999; Foster 2006; Melitz 2003; Nguyen 2016). Recognition of the economic importance of exports has led to interest in the determinants of countries' export performance. An established and growing body of empirical literature analyses the key determinants of export performance at the firm level (Freel et al.2019; Haddoud et al. 2018; Wakelin 1998), but a knowledge gap remains, particularly regarding firms in developing countries.

Similarly, innovation has been recognised as crucial to economic development (Dosi et al. 1988; Fagerberg, Mowery, and Nelson 2005; Schumpeter 1934). Innovation and technological upgrading have been recognised as key to structural change and to developing countries 'catching up' with advanced economies (Crespi, Tacsir, and Pereira 2019; Gebreeyesus 2011; Van Dijk and Sandee 2002). At the firm level, innovation matters for building productive capabilities, productivity, competitiveness, adaptability and resilience, and entrance into and performance in international markets (Avenyo et al. 2021; Caldera 2010; Cieślik, Michałek, and Michałek 2014; Guarascio and Pianta 2017; Rossi et al. 2021; Tavassoli 2013).

However, African firms generally perform relatively poorly in both innovation (Kraemer-Mbula and Wamae 2010; Van Dijk 2002; Van Dijk and Sandee 2002) and exports (Adeoti 2012; Rankin, Söderbom, and Teal 2006). In this paper, we analyse the relationship between innovation and export performance for firms in 28 African economies. This is particularly important in the context of the challenges African countries are facing in generating sustainable growth and development, in achieving the Sustainable Development Goals, and on the backdrop of the recent African Continental Free Trade Agreement (AfCTA).

Several empirical studies have established a positive relationship between innovation and firm-level export performance (see, for example, Bazo and Motellón 2018; Becker and Egger 2013; Cieślik and Michałek 2018a; De Fuentes, Niosi, and Peerally 2020; Guarascio and Pianta 2017; Lo Turco and Maggioni 2015; Melitz 2003; Segarra-Blasco, Teruel, and Cattaruzzo 2020; Van Beveren and Vandenbussche 2010). This relationship can operate in both directions and there are two key theoretical explanations for this: self-selection and learning by exporting. Self-selection occurs when the most productive and innovative firms self-select to participate in the export market (Bernard et al. 2003; Melitz 2003; Fassio 2018;

Segarra-Blasco et al. 2020). Conversely, firms can also learn by exporting, making them more productive and competitive (Aw, Chung, and Roberts 2000; Bigsten et al. 2004; Faustino and Matos 2015; Guarascio and Pianta 2017; Melitz 2003; Segarra-Blasco et al. 2020). These interrelated effects potentially can manifest in a virtuous circle of productivity and exporting (Freel et al. 2019). Faustino and Matos (2015), for instance, find that export markets 'select' the most innovative and productive firms (the self-selection hypothesis), while firm-level exports positively influence firm productivity (the learning by exporting hypothesis). While evidence exists on the role of innovation in self-selecting firms into export markets, there is little evidence but growing interest in how exports, in turn, enhance innovation, which we refer to as 'learning to innovate' through exporting.[3] In other words, the direction of the relationship between innovation and export performance remains 'unsettled' (Molina-Domene and Pietrobelli, 2012).

In this paper, we investigate both whether more innovative African firms are better placed to export, and whether African firms that export (and that export more) are more innovative. We also separately interact each of innovation and our two export variables with foreign ownership and certification, to investigate whether and how these affect the relationship between innovation and exports. We use a cross-country dataset from the World Bank Enterprise Survey (WBES) of 28 African countries covering the period 2013 to 2019, and employ a censored Tobit regression with selection. Our results show that technological product and process (TPP) innovating firms are more likely to export and perform better in terms of export sales than non-innovators. Our results also show a positive and highly significant effect of exports on firms' propensity to innovate (i.e., the probability of exporting). These results hold when we separate product and process innovations, as well as direct and indirect exports. We argue that innovation enables firms to 'learn to export', while exporting simultaneously enhances firms' ability to 'learn to innovate'.

A key methodological and empirical contribution of our paper lies in our analysis of a possible two-way relationship between innovation and export performance, testing both the self-selection and learning to export channels, and specifically what we term 'learning to innovate' through exporting. To analyse this simultaneous relationship, the paper estimates a model of firm-level export intensity and export propensity to examine self-selection in export intensity on the one hand, and innovation on the other hand, to analyse how firms learn to

[3] Recent contributions, from contexts outside Africa, include De Fuentes et al. (2020), Segarra-Blasco et al. (2020) and Fassio (2018).

innovate. We employ a robust Tobit simultaneous equation full information maximum likelihood (FIML) structural equation model to address the endogeneity problem and generate efficient estimates. We consider this an improvement on the probit model applied in most studies, that hitherto have examined the effect of innovation on the propensity to export (Amadu and Danquah 2019; Barasa et al. 2016; Cieślik and Michałek 2017, 2018b; Cieślik et al. 2014; Monreal-Pérez, Sánchez, and Sánchez-Marin 2012). Specifically, we analyse the differences in export performance (both propensity to export and export intensity) between innovators and non-innovators after entry into external markets. In the other direction, we simultaneously analyse the technological product and process innovation differences between exporters and non-exporters. These approaches help us to assess learning effects related to exports performance (learning to export), and innovation activities (learning to innovate) by resolving the possible simultaneity problem between export and innovation. In addition, we contribute to the literature by separately analysing these relationships for different types of innovation (TPP, product, and process innovations) and different types of exporting (total, direct, and indirect exports).

The paper also contributes by analysing how foreign ownership and certification affect the relationships in both directions between innovation and exports, and also for different types of innovation and different types of exports. The existing empirical literature examining the relationship between foreign ownership, and firm export performance and innovation provides ambiguous evidence and does not analyse these relationships systematically. Foreign-owned firms are identified to have advantages in access to foreign technologies and the understanding of foreign markets (Wignaraja, 2002), are better able to absorb and adapt foreign technologies and knowledge into the local firm (Molina-Domene and Pietrobelli, 2012), and promote innovation through better learning experiences, marketing connections, know-how, and economies of scale (Wignaraja, 2008; Fassio 2018). Despite, foreign ownership is also found to have no effect (Adu-Danso, & Abbey, 2020) or to have a negative effect (Bishop, & Wiseman, 1999) on innovation. Furthermore, product quality certification enhances a firm's access to and performance in international markets (Calza and Goedhuys, 2020; Masakure, et al., 2008) and also a signal for a firm's innovativeness (Calza and Goedhuys, 2020). In contrast, empirical evidence suggests also that certification tends to have negative effect on product innovation (see for instance, Terziovski and Guerrero, 2014). Given the above, we extend the analysis in this paper and the literature by exploring whether foreign ownership of firms, or having an internationally-

recognised quality certification, moderate or enhance the mutual relationship between innovation and exports performance of African firms.

Broadly, the new evidence offered in this paper also contributes to the sparse literature in this area of research for Africa. The rest of the paper is structured as follows. Section 2 discusses the theoretical and empirical literature on firm exports and innovation. Section 3 describes the data utilised in the paper, provides an explanation of the variables used, presents descriptive statistics, and formulates and presents the estimation strategy employed. Section 4 discusses the empirical results, while Section 5 concludes.

2. Related literature on the relationship between innovation and exports

As noted, there is advanced literature examining the relationship between innovation and firm-level exports, both directly and indirectly (see, for example, Bazo and Motellón 2018; Becker and Egger 2013; Brodzicki, Márquez-Ramos, and Umiński 2018; Cieślik and Michałek 2018a; Guarascio and Pianta 2017; Lejpras 2019; Melitz 2003; Van Beveren and Vandenbussche 2010).

Two main theoretical arguments underpin the positive relationship between innovation and firms' export performance, as identified in the empirical literature. Firstly, the most productive and innovative firms self-select to participate in the export market (the so-called 'self-selection' hypothesis) (Bernard et al. 2003; Guarascio and Pianta 2017; Melitz 2003). That is, innovative firms are more capable of entering export markets as well as of improving their export performance. Empirical studies show that firms invest in innovation inputs to upgrade their technology in order to reduce their marginal cost in order to enter international markets (Bustos 2011; Caldera 2010; Guarascio and Pianta 2017), but also to compete globally after entry into foreign markets (Hwang, Hwang, and Dong 2015). In dynamic models with heterogeneous firms, investment in firm-specific assets can be associated with innovation, which leads to the selection of firms into the export market (Cieślik, Qu, and Qu 2018; Filipescu et al. 2013; Helpman, Melitz, and Yeaple 2004; Melitz 2003). According to Cieślik and Michałek (2018b), productive firms with low marginal costs are also capable of exporting because of their ability to cover entry costs and to cope with international trade costs.

Secondly, firms that export are likely to gain experience, as well as to access external market-related knowledge. The experience and market-related knowledge can positively influence firm innovation (the 'learning by exporting' hypothesis) (Aw et al. 2000; Bigsten et al. 2006; Faustino and Matos 2015; Melitz 2003). Learning by exporting by firms can be

through two main channels. As noted, the first is that exporting firms interact with foreign networks and this interaction promotes the transmission of new technologies and allows access to specific expertise, such as new methods and processes of production, and new product design. Acquiring knowledge through foreign market participation gives firms a competitive advantage over firms that do not participate in foreign trade. Secondly, a rise in external demand leads to higher capacity utilisation, which in turn drives the economies of scale of exporting firms (Faustino and Matos 2015). These experiences and access to market-related knowledge can positively influence firm productivity – the process of learning by exporting (Aw et al. 2000; Faustino and Matos 2015; Melitz 2003).

Schumpeterian growth models consider innovation as key for entry into international markets (Caldera 2010; Cieślik et al. 2014; Filipescu et al. 2013; Tavassoli 2013). The empirical literature focuses mainly on the relationship between product and process innovations and export performance. Product innovations provide a competitive advantage for market penetration through differentiated products (Caldera 2010; Filipescu et al. 2013; Tavassoli 2013). Product differentiation can attract a group of consumers because of their unique nature and modification to meet customer requirements, and product quality and sophistication. Although both innovating and non-innovating firms face similar entry costs, innovative firms generate higher export profit through lower marginal costs, making them more likely to export (Tavassoli 2013). Process innovation reduces firms' costs of production, enhances efficiency, and consequently strengthens firms' market position. Evidence from Monreal-Pérez et al. (2012), for instance, shows a positive and significant effect of process innovation on export propensity. The literature also shows that firms are even more likely to enter the export market and perform better when they simultaneously implement TPP innovation, as process innovation helps to reduce costs through efficient practices, while product innovation improves the quality of products exported (Turco and Maggioni 2015; Van Beveren and Vandenbussche 2010).

Innovation, therefore, can enhance firms' export performance, both in terms of firms' entry into international markets (export propensity) and export intensity. The foregoing suggests that innovative firms are more likely to export than non-innovative firms are because innovative firms find exporting profitable, and the returns from sales can recover the amount invested in innovation inputs, as these firms enjoy a comparative advantage (Caldera 2010).

Available empirical studies largely confirm a positive relationship between firm innovation and firm-level export performance in African countries (Amadu and Danquah

2019; Barasa et al. 2016; Fonchamnyo and Wujung 2016; Marquez-Ramos, Martinez-Zarzoso, and Parra 2018; Vannoorenberghe 2015). However, this evidence remains inconclusive. For instance, Donbesuur et al. (2020) find that technological innovation (product and process innovation) and organisational innovation have a positive synergic influence on export performance in Ghana. Marquez-Ramos et al. (2018) obtain similar results for Egyptian firms. Barasa et al. (2016) investigate the bi-directional relationship in four sub-Saharan African countries. The authors find the association between product innovation and subsequent firm-level export performance to be positive and significant, but the effect of firm exporting on product innovation is positive but not statistically significant. Edeh, Obodoechib, and Ramos-Hidalgo (2020) find that investing in process innovation is essential for export performance through cost efficiency in Nigeria. In contrast, Fonchamnyo and Wujung (2016), in their study of Cameroonian manufacturing firms, find that process innovation has a positive but insignificant effect on export propensity and intensity, with product innovation having a positive and significant effect on export intensity but not on the export propensity.

While the role of innovation in enhancing export performance is of particular interest to policymakers and academia, especially given the poor performance of African countries in international trade (Wakelin 1998), the empirical literature remains limited and inconclusive (Vannoorenberghe 2015). Few studies also consider the simultaneous effect of export on innovation in the African context. This paper contributes to addressing these evidence gaps.

3. Data and methodology

3.1 Survey data and country sample

The paper uses the WBES data, which is firm-level enterprise surveys produced by the World Bank, first conducted in 1998. WBES data is now available for 144 countries across the world and covers large, medium and small enterprises. The WBES has some important advantages, including that it is a representative survey that randomly stratifies firms by size, industry, and location; and secondly, the WBES allows for cross-country comparisons. Based on these, the use of the WBES survey data for country and cross-country firm-level analyses is increasingly popular in the empirical literature.

This paper uses the most recent cross-sectional datasets for 28 African countries collected between 2013 and 2019. We append the surveys for all available African countries that have

similar and comparable variables of interest[4], controlling for the different survey years with time dummies. Unfortunately, the nature of the dataset does not allow for the construction of a firm-level panel, as most of the same firms do not appear in previous surveys. Our final country sample includes three countries from North Africa (Egypt, Morocco, Tunisia), eleven from West Africa (Benin, Cote d'Ivoire, Gambia, Ghana, Guinea, Liberia, Mali, Niger, Nigeria, Sierra Leone, Togo), three from Central Africa (Cameroon, Chad, Democratic Republic of Congo), seven from East Africa (Djibouti, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda), and four from Southern Africa (Eswatini, Lesotho, Zambia, Zimbabwe).[5]

3.2 Empirical strategy

We analyse the two-way relationship between innovation and export performance at the firm level. Given the evidence that firms may self-select to participate in the export market (Cieślik and Michałek 2018b; Melitz 2003; Véganzonès-Varoudakis and Plane 2019), we formulate a Tobit econometric selection model, as follows:

Selection Equation

$$Export\ propensity_{ij}^{*} = Innovation_{ij}\,\delta_1 + X_{ij}\delta_2 + \rho_i \quad (1.1)$$

$$Export\ propensity_{ij} = \{^{1\ if\ Export\ propensity_{ij}^{*}=1}_{Otherwise} \quad (1.2)$$

Regression Equation

$$Export\ Intensity_{ij} = Innovation_{ij}\delta_3 + M_{ij}\,\delta_4 + \mathcal{E}_i,\ if\ Export\ propensity_{ij}^{*} = 1, \quad (1.3)$$

where $Export\ propensity_{ij}^{*}$ is a latent variable indicating whether or not enterprise i in country j engaged in export activities over the period under consideration. $Export\ propensity_{ij}$ is a dummy variable taking the value 1 if enterprise i in country j is engaged in export activities, and zero otherwise. $Export\ Intensity_{ij}$ is a censored (left and right) continuous variable capturing the percentage of sales from direct and indirect exports. $\rho_i\ and\ \mathcal{E}_i$ are multivariate normally distributed error terms. X_{ij} and M_{ij} are vectors of enterprise, location, year, industry- and country-specific covariates that may affect enterprise

[4] Based on this, countries such as Burundi, Botswana, Burkina Faso, Cape Verde, Eritrea, Gabon, Madagascar, Namibia, Rwanda, and Senegal are excluded from the sample.
[5] See Table 5 in the Appendix for the list of countries and the year of the survey in each case.

i in country $j's$ probability to export, and export performance, respectively (see Table 6 in the Appendix and section 3.3 below for further details).

The main issue in estimating equations 1.1 to 1.3 is that the innovation variable may be endogenous, rendering our parameter estimates biased and inconsistent. This may occur in two ways. Firstly, through simultaneity, where exporting firms acquire knowledge in the global market about foreign demand and technology, leading to an upsurge in their innovation activity (learning by exporting) (Monreal-Pérez et al. 2012). Secondly, through persistence, where firms that anticipate that they will be successful in the international market direct their resources and investment towards innovation (self-selection) (Van Beveren and Vandenbussche 2010).

Based on the foregoing and the evidence that not all enterprises innovate (see Mairesse and Mohnen 2002; descriptive statistics in Table 1), we formulate a probit model for innovation in which we examine the determinants of innovation, as:

$$Innovation_{ij}^{*} = Export\ propensity_{ij}\delta_5 + Z_{ij}\,\delta_6 + \sigma_i \tag{2.1}$$

$$Innovation_{ij} = \{^{1\ if Innovation_{ij}^{*}=1}_{Otherwise}, \tag{2.2}$$

where $Innovation_{ij}^{*}$ is a latent variable indicating whether enterprise i in country j introduced either product innovation or technological product and process (TPP) innovation over the period under consideration. $Innovation_{ij}$ is a dummy variable taking the value 1 if the enterprise innovated, and zero otherwise. We also introduce export propensity in the innovation equation to examine the possible reverse causality between innovation and exports, based on the earlier discussion. In line with Classen et al. (2014), Gebreeyesus and Mohnen (2013), and Robson, Haugh, and Obeng (2009), Z_{ij} is a vector of enterprise, location, year, industry- and country-specific covariates that may affect an enterprise i in country $j's$ probability to innovate. σ_i is a normally distributed error term.

Following Gebreyeesus and Mohnen (2013), we formulate the above equations as a structural equation model, where we simultaneously estimate the innovation and export equations by maximum likelihood. This approach is found to address the endogeneity problem and generate efficient estimates (Gebreeyesus and Mohnen, 2013). The resource-based view (RBV) model advocates that a firm that takes advantage of its internal resources and capabilities survives in the international market and is more likely to enjoy sustainable competitive advantage (see, for instance, Filipescu et al. 2013). We use R&D and training as exclusion variables in the innovation equation and in line with the RBV model (Filipescu et al. 2013; Porto and González 2014). R&D, for instance, is an innovation input and only

positively related to firm-level exports through innovation outcomes (Caldera 2010; Ganotakis and Love 2011; Tavassoli 2013; Van Beveren and Vandenbussche 2010).

3.3 Variables and descriptive statistics

We consider two dimensions of export performance: export propensity (engaging in exports at all) and export intensity (share of exports in a firm's total sales). We define exporters broadly as enterprises that are engaged in either direct or indirect export activities, and apply this to both export propensity and intensity. Indirect exporters are firms that export products through foreign affiliates or work with trade intermediaries, while direct exporters export directly to the foreign markets. We analyse both export propensity (whether or not a firm engages in exports) and export intensity (measured as the average percentage of sales from exports), in both cases including both direct and indirect firm-level exports.

As discussed, innovation gives firms a competitive advantage in the international market (Rossi, et al. 2021; Cieślik and Michałek 2018a), and so can be expected to have a positive effect on firm-level exports (Rossi, et al. 2021; De Fuentes et al. 2020; Hwang et al. 2015). A firm is argued to gain a competitive advantage compared with others when it introduces a new product and/or an efficient process or method of production. We consider innovation as a technological product and process (TPP) innovation (De Fuentes et al. 2020; Lo Turco and Maggioni 2015), defined broadly as the introduction of either product and/or process innovations by the enterprise. In the first of our extensions, we also separately consider product innovation and process innovation. In a second extension, we decompose both exports and intensity of exports into direct and indirect exports. These extensions also serve to check the robustness of our results.

Vertical knowledge flows from foreign suppliers and clients are an essential determinant of the extent to which a firm is innovative (Wadho and Chaudhry 2018). According to Cieślik and Michałek (2018b), firms that can adapt and implement international technologies can accelerate firm export intensity. Firms with a higher share of foreign ownership may more easily adopt global technologies and quickly capture vertical knowledge that flows to domestic firms. As noted, product quality certification is identified to enhance a firm's export activities (Calza and Goedhuys, 2020; Masakure, et al., 2008) and innovation activities (Calza and Goedhuys, 2020). To capture these possible effects, we control for the share of foreign ownership and certification as additional variables of interest.

Based on the empirical literature, we control for relevant covariates. According to Serrasqueiro and Nunes (2008), larger manufacturing firms typically have a relatively long

history, can benefit from economies of scale, are more profitable, and demonstrate prospects of exporting. Furthermore, the size of the enterprise could indicate market power and greater internal resources (Gebreyeesus and Mohnen 2013; Mairesse and Mohnen 2010). Large firms tend to increase exports through their scope of internationalisation and economies of scale (D'Angelo and Buck 2019). Conversely, small firms have been found to be more innovative (Gebreyeesus and Mohnen 2013). To control for possible endogeneity in relation to firm size, we define this as the number of employees working for the establishment three fiscal years ago (Gebreyeesus and Mohnen 2013). We also control for labour productivity, measured as the establishment's total sales three fiscal years ago divided by the number of employees in the same period. Owing to the high levels of competition in foreign markets as a result of expensive entry costs, enterprises that are expected to export should have a high labour productivity ratio (Fassio 2018; Monreal-Pérez et al. 2012; Pla-Barber and Alegre 2007). Lower unit labour costs may enhance firms' international competitiveness. We measure labour cost as the total costs incurred by establishments for compensating their labour per worker, three fiscal years ago.

There is empirical evidence indicating that skilled employees have a positive impact on both innovation and exports (Nguyen et al. 2008; Söderbaum and Teal 2000; Tavassoli 2013; Van Beveren and Vandenbussche 2010). We therefore also control for whether the enterprise considers the lack of skilled labour force as a major constraint to their activities. Innovation is a costly process and access to finance is important for firm innovation (see, for example, Ayyagari, Demirgüç-Kunt, and Maksimovic 2011). We therefore expect enterprises that have financial constraints to be less innovative and perform worse in terms of innovation and export performance. We also control for the firm's industry (sector), as well as for country-specific effects (Cieślik and Michałek 2018a).

Table 1 presents the summary statistics for all variables included in our model; see Table 6 in the Appendix for definitions of all variables.

4. Results

Section 4.1 reports our main results on the two-way relationship between innovation and exports, including the mediating roles of foreign ownership and certification. We then extend these results by exploring these relationships for different types of innovation (product vs. process innovation) in section 4.2 and of exports (direct vs. indirect exports) in section 4.3; these also assist as robustness checks on our main results.

4.1 Main results

The estimation results showing the relationships in both directions between innovation and exports (both the propensity to export and export intensity) are shown in Table 2, using Tobit simultaneous equation FIML. The first two panels of Table 2 explore the effects of innovation on exports, with panel 1 (columns (1a-1c) focusing on export propensity and panel 2 (columns (2a-2c) focusing on export intensity. In the third panel of Table 2 (columns 3a-3c), we analyse the relationship in the other direction: the effects of exports on innovation. All these regressions include foreign ownership and certification as explanatory variables of interest; we also include interaction terms between foreign ownership and innovation (columns 1b and 2b) and foreign ownership and exports (3b), and between certification and innovation (columns 1c and 2c) and certification and exports (3c).

These regressions control for the endogeneity of innovation; we estimate both our exports and innovation equations simultaneously with a recursive structure to control for possible endogeneity of innovation and exports. The significance of rho_12 in both models confirms that firms self-select to export and innovate, confirming our choice of a selection model as appropriate.

As noted, our innovation variable, measured as the introduction of technological product and process innovations (TPP), is positive and statistically significant at the 1% level in both the export propensity (1a) and export intensity (2a) equations. This result suggests that innovative firms are more likely to export and perform better in terms of export than are non-innovators. These findings add to findings from the existing literature examining the effect of innovations on exports (Rossi, et al. 2021; Amadu and Danquah 2019; Barasa et al. 2016; Cieślik et al. 2014; De Fuentes et al. 2020; Filipescu et al. 2013; Lo Turco and Maggioni 2015; Monreal-Pérez et al. 2012). This result suggests that innovation enhances firms' ability to venture into foreign markets (export propensity), but also enables them to export more (export intensity). Innovation generates a synergic influence that enables firms to gain a competitive advantage in foreign markets. This may be because of product

differentiation through quality and efficiency gains in the production process, leading innovative firms to be better able to open up and enter into new markets and to respond quickly and adapt to market changes compared with non-innovators.[6]

In terms of other variables in the export equations, we find that our measures of foreign ownership, certification, and size of the firm are positive and highly significant predictors of both the probability of firms to export and perform better in terms of export sales, in line with expectations and with the extant literature. Firms with a larger percentage share of foreign ownership may have better access to foreign markets and, given the knowledge of foreign markets and quality standards, they may become more successful exporters. Large firms may have the financial and human resources to export, but also the market power and influence to advertise and sell more exports. Also, the results show that enterprises with an internationally recognised quality certification tend to be more likely to export and sell more exports, suggesting that these firms are better able to satisfy the product quality standards of the foreign market. In contrast, the cost of labour per worker is a significantly negative explanator of exports. These results suggest that the rising cost of labour increases the cost of production, and hence the price of exports, thereby reducing both export propensity and intensity. This finding highlights the critical role of labour costs in the internationalisation of a firm's exports. In the export model, we also find that exporting is capital intensive, and firms that lack access to finance tend to have a lower probability to export. Skills constraints, especially severe ones, are positively associated with the propensity to export. This may be because firms that export typically require more skilled employees, so even where their workforce is relatively high-skilled, they still experience severe skills constraints more sharply than do non-exporting firms.

In the TPP model (column 3a), the measures of export, training, certification, firm size, research and development (R&D), whether the firm is located in the capital city, and whether the firm conducts training for its workers, are positive and highly significant. The

[6] We also report an alternative set of regressions, testing the effect of innovation on export and export intensity using a simple Tobit model. Table 7 in the Appendix reports the estimation results of the effect of innovation on export and export intensity using the Tobit model. The results are qualitatively similar to the main export models reported in Table 2, showing a positive and significant effect of innovation on the probability to export and on export intensity. However, the estimation coefficients in the Tobit model (Table 7 in the Appendix) are consistently smaller as compared with the coefficients of the Tobit simultaneous equation FIML model (columns 1a and 2a in Table 2). This suggests that the Tobit model underestimates the effect of innovation and other covariates on export and export intensity. We, therefore, rely on the Tobit simultaneous equation FIML model where we consider innovation to be endogenous, and simultaneously estimate the innovation and export equations jointly, as our preferred model (see Table 2). The alternative results shown in the Appendix also assist in verifying the robustness of our main results.

results also show that the cost of labour, manager's experience, and skills constraint variables, are all positive but weak determinants of technological product and process innovations. Our exclusion restrictions, R&D and training, are both positive and strongly significant, suggesting the robustness of the model. R&D enables firms to create, adapt, and apply new knowledge, leading to a higher propensity to introduce innovations; this is in line with Amadu and Danquah (2019). Firms that conduct formal training programmes for permanent, full-time employees tend to have higher levels of human resources to innovate; this corroborates the extant literature, which highlights a positive correlation between education/apprenticeship and innovativeness of firms (Nguyen et al. 2008; Tavassoli 2013).

Of key interest in the third panel of Table 2 (columns 3a-3c) is the export variable, which is positive and highly significant. The strong significance of the export variable suggests that firms that export tend to have a higher propensity to innovate. This finding is consistent with the learning to export hypothesis, and with extant empirical literature such as De Fuentes et al. (2020), Di Cintio, Ghosh, and Grassi (2019), Lo Turco and Maggioni (2015) and Xie and Li (2018). The result, however, is contrary to Barasa et al. (2016), who find a positive but statistically insignificant effect of firm exporting on product innovation. Our finding suggests that exporting firms may be better able to undertake product innovation through firm learning in foreign markets. This further highlight the role of international experience gained through exporting in the innovation process, in line with evidence from Oura, Zilber, and Lopes (2016). That is, firms 'learn to innovate' through exports. We consider this an important finding and contribution, with relevant policy implications, as discussed further below.

To further understand the two-way relationship between innovation and export performance, we also interact each of foreign ownership and certification with each of exports (see columns 1b-c and 2b-c) and TPP innovation (see columns 2c). In columns 2 (a-c) and 3 (a-c) of Table 2, we report estimation results where we interact our TPP innovation and exports variables with foreign ownership, and certification respectively.

Both sets of results suggest that the mutual relationship between innovation and export performance, are to some extent, conditional on both certification and the share of foreign ownership. This is in the sense that both foreign ownership and certification enhance the effects of the 'learning to export' and the 'learning to innovate' strategies of firms. A finding worth noting is that the enhancing effects of TPP innovation by foreign ownership and certification on exports only holds for the probability of exporting but not the intensity of exports upon entry into foreign markets. That is, innovative firms that have a higher share of

foreign ownership or an internationally recognised quality certification are more likely to enter export markets, but do not necessarily lead to higher levels of export intensity upon entry into external markets. These results are in line with the sparse empirical literature including Wignaraja (2002) and Molina-Domene, and Pietrobelli (2012), and suggest that firms with a higher share of foreign ownership, and internationally recognised quality certification are privileged in terms of access to and absorption of foreign technologies, and knowledge of foreign markets. Hence, these firms are more likely to innovate and export to stay closer to the competitive frontier, as they have exporting, and innovation built into their core business strategy.

4.2 Extension by type of innovation (product and process innovation)

To extend the main results reported in Table 2, and to provide additional insights into the relationship between innovation and export performance, we conduct separate estimations in which we decompose TPP innovations into product innovation and process innovation. This also serves as a robustness check on our main results.

Table 3, columns 1 and 4, present the results for our main variables in all three equations. The results are generally qualitatively similar to our earlier TPP results, corroborating the robustness of our main results. These results further suggest that both product and process innovations increase firms' likelihood to export, in line with the extant literature (Monreal-Pérez et al., 2012; Barasa et al., 2016). The results also show that process innovation strongly drives the export intensity of firms through efficiency gains. In contrast, the significance of product innovation vanishes in the export intensity equation, suggesting that new product innovations do not have any effects on export intensity. This may be explained by the type of new products exported, as these products may only be new to firms' local context and not novel in the international market. This would suggest that the degree of novelty of the exported product matters for its overall performance on the international market. Also, the results imply that the overall positive effect of TPP innovation on export propensity and intensity (identified in our earlier results) is driven mainly through efficiency and cost-competitive gains made by firms as a result of the introduction of process innovation. Our results also show that export propensity positively but weakly affects both product innovation and process innovation.

Columns 2 and 3, and 5 and 6 of Table 3 report estimation results where we separately interact each of our product and process innovations with each of foreign ownership and certification respectively; columns 2 and 3 report results for product

innovation while 5 and 6 report results for process innovation. The direct positive effect of certification on process innovation is consistent with the literature (Terziovski and Guerrero, 2014). The direct positive effect of certification on product innovation is in contrast with other empirical studies (Terziovski and Guerrero, 2014). For export intensity, the results show largely that there are statistically not significant indirect relationships between both foreign ownership and certification and product and process innovations. In the export propensity panel, our results show that the interaction terms are positive and significant, suggesting that both foreign ownership and certification enhance the likelihood to export through product innovation. This result also holds for process innovation. That is, firms that introduce product or process innovations and have a higher share of foreign ownership or certification tend to have a higher probability to export. We also find similar results in the innovation equations (product and process) in panel 3. The results suggest that firms that export and have a higher share of foreign ownership or certification tend to have a higher likelihood to introduce both product and process innovations.

4.3 Extension by type of exports (direct and indirect exports)

In a second extension, we decompose the export propensity and export intensity variables into direct and indirect exports. This also serves as an additional robustness check on our main results. These results are reported in Table 4.

The results are again consistent with our previous findings, corroborating our main results. Specifically, we find similar results in the direct export equation, suggesting that the positive mutual relationship identified above are driven mainly by direct exports. These results confirm the mutual relationship between innovations and exports, and the critical role of foreign ownership and certification in reinforcing the identified mutual relationship between innovation and export activities of African firms.

5. Conclusion

The roles of exports and innovation in driving competition and economic development are well established in both the policy and research spheres. The existing literature provides evidence of a positive relationship between firm-level innovation and export performance. However, there is a lack of robust cross-country analysis of the export-innovation relationship and the evidence remains inconclusive in Africa, notably at the firm level. This paper adds methodologically and empirically to the export-innovation literature by examining the two-way relationship between innovation (technological product and process, product

only, and process only) and export performance (both propensity and intensity), testing both the channels of learning to export through innovation and learning to innovate through exporting. Our analyses of the indirect effects of foreign ownership and certification, and the effect of innovation on direct and indirect exports also add to this literature.

Estimating an adapted Tobit model with selection on a cross-sectional dataset from the World Bank's Enterprise Surveys in 28 African economies, we find two baseline results that corroborate the extant literature in which these are typically analysed separately. Firstly, innovation is an important contribution to the ability to export and to export performance among African firms, consistent with the learning to export hypothesis. Secondly, our findings also suggest that firms that export tend to have a higher propensity to innovate. That is, exports enable learning to innovate by African firms. Taking both results together, we argue that innovations afford firms to have lower transaction costs and a competitive edge to venture into foreign markets and to sell more products. Also, exporting firms acquire essential knowledge and technology that reinforce their tendency to introduce technological product and process innovations through efficient production techniques, product modification, and differentiation. In sum, innovation aids firms' entry into foreign markets and enhances the market performance of exported products, while the experience and technological knowledge acquired from entry into foreign markets generate a positive, simultaneous effect on firms' ability to introduce technological product and process innovations. These effects are found to be reinforced by higher share of foreign ownership and by having an internationally-recognised quality certification.

These findings contribute to the firm-level export-innovation literature in Africa and also have pertinent implications for both innovation policy and trade policy. These are especially important, as African firms generally tend to be both less innovative and less export-oriented than firms in other regions, and innovation and export performance are important at the macro level in African countries. Our findings show strongly that innovation is essential for the export performance of African firms. To raise firms' ability to export and their success in exporting, policymakers in Africa could develop strategies to encourage innovation including the introduction of new or significantly improved products or processes of production. Innovations are more likely to be successful in international markets if firms have well-developed networking capabilities and meet international quality standards. Networking through channels for social capital benefits could enhance the export performance of products. An effective policy directed towards creating such networks in African innovation systems could be the first step. The newly ratified African Continental

Free Trade Agreement (AfCFTA) could provide an impetus in this direction. A sufficient blend of local and foreign knowledge in product modification, for instance, could also help improve product quality and the novelty of innovations. The bidirectional relationship between exports and innovation found here underscores the importance of innovation for African firms to take up the export opportunities opened up through the AfCFTA, as well as more broadly in international markets.

This paper is based on cross-sectional data due to the lack of suitable cross-country firm-level panel data on exports and innovation in Africa. In future research, the availability of panel data to explore the relationship between innovation and export performance, particularly self-selection before entry into international markets, could provide additional insights into the export-innovation literature. Given that the ease of learning to export and technological learning to innovate may differ across countries, examining the relationship between exports and innovation across specific export markets and destinations, and consequently products, may be an additional avenue for future research. Finally, while the fourth edition of the Oslo Manual (OECD/Eurostat 2018) identifies four main types of innovation, namely product, process, marketing, and organisational innovations, this paper separately analyses the introduction of product and/or process (TPP), product, and process innovations. This is because the analyses of organisational and marketing innovations are beyond the scope of this paper. However, future studies could extend our paper by examining these different types of innovation.

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Table 1: Descriptive statistics

Variable name	Mean	Std. dev.	Min	Max	N
Export propensity	0.236	0.425	0	1	9 604
Direct export propensity	0.169	0.37	0	1	9 604
Indirect export propensity	0.126	0.332	0	1	9 604
Export intensity	39.887	16.553	1	100	2 187
Direct export intensity	23.168	32.373	0.5	100	2 187
Indirect export intensity	16.719	27.183	1	100	2 187
TPP innovation	0.42	0.49	0	1	9 604
Product innovation	0.359	0.48	0	1	9 604
Process innovation	0.277	0.447	0	1	9 604
Cost of labour per worker (lag 2) (log)	10.8	2.8	0	1	9 604
Sales per worker (log)	12.8	3.30	0	30.18	9 604
R&D	0.154	0.36	0	1	9 604
Ownership	10.0	27.15	0	100	9 604
Certification	0.16	0.36	0	1	9 604
Log of size (lag 2)	3.05	1.3	0.693	10.24	9 604
Finance constraint	1.75	1.3	0	4	9 604
Capital city	0.36	0.48	0	1	9 604
Manager’s experience	17.906	11.069	1	52	9 604
Training	0.286	0.452	0	1	9 604
Skills constraint	1.178	1.165	0	4	9 604

Table 2: Relationship between innovation and exports using Tobit simultaneous equation FIML

	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
	Export propensity[a]			Export intensity			TPP[a]		
TPP innovation	0.197***	1.628***	1.655***	5.183***	4.907***	5.014***			
	(5.64)	(53.09)	(52.92)	(4.51)	(5.78)	(5.73)			
Ownership	0.006***	0.005***	0.004***	0.226***	0.0510***	0.0375***	0.001	0.001**	0.003***
	(11.54)	(8.13)	(7.34)	(13.67)	(3.47)	(3.61)	(1.08)	(2.55)	(4.96)
Certification	0.586***	0.292***	0.426***	19.44***	2.944***	3.045***	0.161***	0.126***	0.052***
	(14.18)	(7.39)	(8.96)	(14.37)	(3.52)	(2.65)	(3.39)	(3.13)	(3.33)
TPP*Ownership		0.002***			0.0281				
		(2.92)			(1.44)				
TPP*Certification			0.255***			0.031			
			(4.63)			(0.02)			
Export propensity							0.122***	1.682***	1.686***
							(3.08)	(56.61)	(56.14)
Export propensity*Ownership								0.003***	
								(3.64)	
Export propensity *Certification									0.170***
									(2.92)
Sales per worker (lag 2) (log)	-0.0104	-0.011*	-0.012*	-0.439*	-0.191	-0.197	0.005	0.013**	0.0129**
	(-1.48)	(-1.76)	(-1.85)	(-1.81)	(-1.49)	(-1.53)	(0.87)	(2.10)	(2.10)
Cost of labour per worker (lag 2) (log)	-0.031***	-0.036***	-0.0350***	-1.645***	-1.013***	-1.026***	0.0169*	0.030***	0.030***
	(-3.40)	(-4.24)	(-4.17)	(-5.34)	(-5.93)	(-6.00)	(1.85)	(3.60)	(3.55)
Log of size (lag 2)	0.220***	0.121***	0.119***	6.835***	6.846***	6.836***	0.053***	0.040***	0.040***
	(15.74)	(9.55)	(9.35)	(15.04)	(16.82)	(16.79)	(3.53)	(3.17)	(3.16)
Finance constraint - minor	0.043*	0.0164	0.0167				0.025	-0.013	-0.010
	(1.74)	(0.40)	(0.42)				(0.56)	(-0.32)	(-0.25)
Finance constraint - moderate	-0.055**	-0.0433	-0.0460				0.0187	0.0320	0.0335
	(-2.11)	(-1.06)	(-1.14)				(0.40)	(0.80)	(0.84)
Finance constraint - major	-0.084***	-0.096**	-0.0940**				0.0512	0.0764*	0.077*
	(-3.11)	(-2.33)	(-2.28)				(1.09)	(1.91)	(1.93)

Finance constraint - very severe	-0.161***	-0.127**	-0.122**			0.049	0.010**	0.010*
	(-4.49)	(-2.46)	(-2.32)			(0.84)	(1.98)	(1.95)
Capital city	0.002	-0.108***	-0.107***			0.133***	0.120***	0.120***
	(0.01)	(-3.48)	(-3.48)			(3.89)	(4.02)	(4.01)
Manager's experience (log)	0.0248	-0.001	-0.004			0.0506*	0.0224	0.0227
	(1.59)	(-0.05)	(-0.15)			(1.79)	(0.91)	(0.93)
Skills constraint - minor	0.129***	0.053	0.054			0.067*	0.0124	0.0101
	(5.71)	(1.53)	(1.57)			(1.74)	(0.37)	(0.30)
Skills constraint - moderate	0.089***	0.00721	0.005			0.058	0.0376	0.0377
	(3.46)	(0.18)	(0.14)			(1.28)	(0.97)	(0.98)
Skills constraint - major	0.187***	0.0789*	0.079*			0.053	-0.0165	-0.0214
	(6.28)	(1.76)	(1.71)			(1.01)	(-0.37)	(-0.47)
Skills constraint - very severe	0.505***	0.221***	0.218***			0.155*	-0.0481	-0.0555
	(10.26)	(2.82)	(2.75)			(1.75)	(-0.62)	(-0.70)
R&D						0.817***	0.292***	0.290***
						(17.84)	(11.10)	(12.49)
Training						0.429***	0.179***	0.176***
						(12.17)	(9.56)	(10.36)
Country FE	Yes	Yes	Yes					
Year FE	Yes	Yes	Yes					
Industry FE	Yes	Yes	Yes					
rho_12	1.188***	2.715***	2.713***					
	(64.58)	(236.45)	(236.66)					
Wald Chi^2	2 410.10	2393.55	2016.87					
Prob>Chi^2	0.000	0.000	0.000					
N	9,604	9,604	9,604					

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a] Reported values are odds ratios.

Table 3: Relationship between innovation (product vs. process) and export performance using Tobit simultaneous equation FIML

	(1)	(2)	(3)	(4)	(5)	(6)
			Export intensity			
Product innovation	1.602	1.081***	1.775***			
	(1.39)	(7.78)	(8.46)			
Process innovation				5.192***	0.320	1.069
				(4.18)	(0.39)	(1.28)
Ownership	0.227***	0.0418***	0.0367***	0.227***	0.0660***	0.0419***
	(13.76)	(2.91)	(3.58)	(13.69)	(4.73)	(4.03)
Certification	19.87***	2.839***	2.099*	19.47***	2.729***	4.192***
	(14.69)	(3.44)	(1.85)	(14.43)	(3.27)	(3.79)
Product innovation*Ownership		0.010				
		(0.51)				
Process innovation *Ownership					0.0454**	
					(2.54)	
Product innovation*Certification			1.407			
			(1.04)			
Process innovation*Certification						1.855
						(1.43)
			Export propensity[a]			
Product innovation	0.135***	1.581***	1.605***			
	(3.87)	(57.32)	(60.22)			
Process innovation				0.147***	1.608***	1.648***
				(3.93)	(55.63)	(43.18)
Ownership	0.006***	0.002***	0.002***	0.006***	0.005***	0.004***
	(11.60)	(3.22)	(3.67)	(11.53)	(8.86)	(7.14)
Certification	0.595***	0.340***	0.461***	0.591***	0.327***	0.481***
	(14.40)	(8.44)	(10.74)	(14.28)	(7.82)	(9.30)
		0.340***				
		(8.44)				

Process innovation*Ownership					0.002***	
					(2.93)	
Product innovation *Certification			0.219***			
			(6.95)			
Process innovation *Certification						0.270***
						(4.03)
	Product innovation[a]			Process innovation[a]		
Export propensity	0.067*	1.637***	1.654***	0.0780*	1.686***	1.730***
	(1.68)	(56.45)	(57.74)	(1.87)	(56.88)	(36.85)
Ownership	0.002	0.002***	0.003***	0.001*	0.001***	0.0021***
	(0.35)	(3.48)	(5.58)	(1.67)	(4.12)	(3.67)
Certification	0.101**	0.173***	0.090**	0.205***	0.120***	0.017
	(2.14)	(4.17)	(2.03)	(4.13)	(2.73)	(0.32)
Exports*Ownership		0.002***			0.003***	
		(3.47)			(4.56)	
Exports*Certification			0.164***			0.259***
			(3.58)			(3.35)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
rho_12	1.184***	2.709***	2.710***	1.183***	2.713***	2.708***
	(64.77)	(24.68)	(25.23)	(64.58)	(27.19)	(26.59)
N	9 604	9 604	9 604	9 604	9 604	9 604

t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include all variables in Table 2. [a] Reported values are odds ratios.

Table 4: Relationship between innovation and export performance (direct vs. indirect) using Tobit simultaneous equation FIML

	(1)	(2)	(3)	(4)	(5)	(6)
	Direct export intensity			Indirect export intensity		
TPP	12.65***	10.50***	5.434***	8.606***	23.72***	22.55***
	(7.41)	(4.88)	(2.60)	(3.48)	(17.64)	(4.41)
Ownership	0.098***	0.152***	0.099***	0.206***	0.018	-0.003
	(4.22)	(4.43)	(4.30)	(5.51)	(0.89)	(-0.12)
TPP*Ownership		0.0957			0.0356	
		(1.25)			(1.47)	
Certification	1.882	1.669	3.535	28.39***	4.485***	3.385**
	(1.01)	(0.43)	(1.35)	(9.33)	(3.44)	(2.09)
TPP*Certification			4.078			1.947
			(1.28)			(0.70)
	Direct export propensity[a]			Indirect export propensity[a]		
TPP	1.630***	1.656***	1.698***	0.155***	1.669***	1.656***
	(46.40)	(43.75)	(44.75)	(3.79)	(49.17)	(47.63)
Ownership	0.004***	0.006***	0.004***	0.004***	0.003***	0.001***
	(7.98)	(6.71)	(8.01)	(5.71)	(4.50)	(3.47)
TPP*Ownership		0.001*			0.002***	
		(1.94)			(2.90)	
Certification	0.236***	0.231***	0.412***	0.381***	0.0771*	0.102
	(5.07)	(5.38)	(8.01)	(7.48)	(1.82)	(1.57)
			0.327***			0.052
			(5.63)			(0.60)
	TPP[a]					
Export propensity	0.117***	1.713***	1.689***	0.112**	0.719***	0.708***
	(2.76)	(38.98)	(41.74)	(2.54)	(3.14)	(3.49)
Ownership	0.001	0.002***	0.002***	0.001	0.001	0.001*
	(0.74)	(2.59)	(4.40)	(1.09)	(0.98)	(1.72)
Export propensity *Ownership		0.002**			0.001	
		(2.41)			(1.08)	
Certification	0.162***	0.041	0.028***	0.144**	0.056	0.037
	(3.39)	(0.94)	(3.58)	(2.39)	(1.35)	(1.25)
Exports propensity *Certification			0.129**			0.036
			(2.25)			(0.15)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
rho_12	0.161***	0.145***	0.089***	0.978***	0.908***	0.906***
	(27.10)	(9.58)	(9.85)	(39.43)	(44939.89)	(3578.4)
N	9 604	9 604	9 604	9 604	9 604	9 604

t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include all variables in Table 2. [a] Reported values are odds ratios.

Appendix

Table 5: List of countries and survey year

Country	Year of survey
Benin	2016
Cameroon	2016
Chad	2018
Cote d'Ivoire	2016
Djibouti	2013
Democratic Republic of Congo	2013
Egypt	2016
Eswatini	2016
Ethiopia	2015
The Gambia	2018
Ghana	2013
Guinea	2016
Kenya	2018
Lesotho	2016
Liberia	2017
Malawi	2014
Mali	2016
Morocco	2019
Mozambique	2018
Niger	2017
Nigeria	2014
Sierra Leone	2017
Tanzania	2013
Togo	2016
Tunisia	2014
Uganda	2013
Zambia	2013
Zimbabwe	2016

Table 6: Definition of variables

Variable name	Definition
Export propensity	A dummy variable equal to one if the firm is involved in either direct or indirect exports, and zero otherwise
Direct export propensity	A dummy variable equal to one if the firm is involved in direct exports, and zero otherwise
Indirect export propensity	A dummy variable equal to one if the firm is involved in indirect exports, and zero otherwise
Export intensity	A continuous variable showing the percentage of sales from direct and/or indirect exports in the last fiscal year, constructed as the sum average of direct and indirect export intensities
Direct export intensity	A continuous variable showing the percentage of sales from direct exports in the last fiscal year.
Indirect export intensity	A continuous variable showing the percentage of sales from indirect exports in the last fiscal year
TPP innovation	A dummy variable equal to one if the firm introduced either product and/or process innovations in the last three years
Product innovation	A dummy variable equal to one if the firm introduced a product innovation in the last three years
Process innovation	A dummy variable equal to one if the firm introduced a process innovation in the last three years
Cost of labour per worker (lag 2) (log)	Log of cost of labour divided by total employment three fiscal years ago
Sales per worker (log)	Log of cost of sales divided by total employment three fiscal years ago
R&D	A dummy variable equal to one if the firm spent on research and development (excluding market research) during the last fiscal year
Ownership	A continuous variable measuring the percentage share of foreign ownership of the enterprise
Certification	A dummy variable equal to one if the firm has an internationally-recognised quality certification, and zero otherwise
Log of size (lag 2)	Log of the total number of employees in the enterprise three fiscal years ago
Finance constraint	A categorical variable indicating the extent to which lack of access is an obstacle to the firm: no obstacle (0), minor obstacle (1), moderate obstacle (2), major obstacle (3), and very severe (4)
Capital city	A dummy variable equal to one if the firm is located in the capital city, and zero otherwise
Manager's experience (log)	Log of manager's experience in years
Training	A dummy variable equal to one if the enterprise indicates that it had conducted formal training programmes for permanent, full-time employees in the last fiscal year
Industry	List of 33 industries classified according to ISIC Revision 3.1: manufacturing (group D), construction (group F), services (groups G and H), transport, storage and communications (group I) and IT (group K sub-sector 72)
Skills constraint	A categorical variable indicating how much inadequately educated workforce is an obstacle to the firm: no obstacle (0), minor obstacle (1), moderate obstacle (2), major obstacle (3), and very severe (4).

Table 7: Relationship between innovation and exports using Tobit

	Export propensity[a]	Export intensity
TPP innovation	0.132***	4.216***
	(4.05)	(4.15)
Ownership	0.005***	0.182***
	(12.16)	(12.45)
Certification	0.518***	15.99***
	(13.60)	(13.50)
Sales per worker (lag 2) (log)	-0.014**	-0.415**
	(-2.04)	(-2.00)
Cost of labour per worker (lag 2) (log)	-0.034***	-1.354***
	(-3.93)	(-5.06)
Log of size (lag 2)	0.178***	5.432***
	(13.60)	(13.86)
Finance constraint - minor	-0.017***	
	(-4.43)	
Finance constraint - moderate	-0.016***	
	(-4.32)	
Finance constraint - major	-0.019***	
	(-4.13)	
Finance constraint - very severe	-0.026***	
	(-4.53)	
Capital city	0.001	
	(0.61)	
Manager's experience (log)	0.022***	
	(3.96)	
Skills constraint - minor	0.008***	
	(3.33)	
Skills constraint - moderate	0.015***	
	(3.73)	
Skills constraint - major	0.003	
	(1.21)	
Skills constraint - very severe	0.023***	
	(3.20)	
Country FE	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
rho_12	5.771***	5.771***
	(106.85)	(106.85)
Wald Chi^2	2 111.47	2 111.47
Prob>Chi^2	0.000	0.000
N	9,604	9,604

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a] Reported values are odds ratios.