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## **Revisiting the causal effects of exporting on productivity: Does price heterogeneity matter?**

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# Revisiting the causal effects of exporting on productivity: Does price heterogeneity matter? <sup>☆</sup>

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## Abstract

In most empirical studies that establish the export-productivity relationships, output is measured in values rather than in quantities. This makes it difficult to distinguish between productivity and within-firm changes in price that could occur following exposure to international markets. Using detailed data on quantity and prices from Ethiopian manufacturing firms in the period 1996-2005, this paper distinguishes efficiency from revenue based productivity and examines what this means for the estimated relationship between exporting and productivity. The main results show that exporters are more productive than non-exporters in terms of revenue based productivity and this is explained by both self-selection and learning effects. However, when correcting for price heterogeneity, exporters appear to be similar to non-exporters both before and after export entry. Overall, the results suggest that the increase in firm-level productivity following entry into foreign markets is associated with changes in prices as opposed to productive efficiency.

*Keywords:* Export; revenue productivity; physical productivity; price heterogeneity; Africa; Ethiopia

*JEL codes:* F14, D22, O14, O55

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## 1 Introduction

This paper examines the effect of exporting on firms' productivity while accounting for price differences across firms. The relationship between exporting and productivity has attracted much research interest aimed at understanding the extent to which exposure to international markets impacts on firm and industry productivity. One of the most robust stylised facts established from empirical research on firm heterogeneity in international trade is the superior productivity of exporters compared with firms serving only the domestic market. The self-selection of more productive firms into export and/or the increase in post-export-entry productivity due to learning effects are the most commonly suggested explanations for the observed export premium.<sup>1</sup> However, there is a dearth of evidence when it comes to identifying the precise mechanisms through which exporting affects the measured productivity, which largely remains a black box. One reason is that the standard approach in this literature uses a crude measure of productivity, leaving aside the details, in particular price variations across firms. Specifically, when estimating productivity, researchers proxy quantity output by firm-level revenues deflated by industry-level price indices, resulting in revenue total factor productivity. However, as first explained by Foster et al. (2008), this measure confounds the impact of differences in prices across firms with differences in productive efficiency. Thus, the impact of price heterogeneity on the estimated relationships between export and productivity remains largely unexplored. Such an exploration could provide a better understanding of the mechanism at work.

The present paper therefore fills this gap, exploiting information on price and physical output from Ethiopian manufacturing firms to construct measures of physical total factor productivity in order to isolate the effect of exporting on productive efficiency. The main conclusions drawn from the analysis are threefold. First, exporting is associated with high revenue productivity and this is explained by both self-selection into export and learning effects. Second, when removing the price effect in estimating productivity, both the pre-export and post-export productivity advantage of exporting firms disappears. The learning effect results are robust to correcting for selection of more productive firms into export and addressing the potential endogeneity of export status in

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<sup>1</sup>The presence of trade costs is the explanation why only most productive firms self-select into export (Bernard et al., 2003; Melitz, 2003). Most notably, Melitz (2003) formalises that only firms with above a certain productivity cut-off can generate enough profit to cover the fixed costs of exporting and thus firms below the threshold on the productivity distribution serve domestic markets only. On the other hand, the learning by exporting hypothesis argues that entering into foreign market improves the productivity of exporting firms due to knowledge flows from foreign buyers and due to the pro-competitive effect of participating in international markets (Clerides et al., 1998; Aw et al., 2000). For example, to obtain better quality products, foreign buyers might engage in R&D collaborations with domestic producers that subsequently increase productivity. Fierce competition in international markets also forces exporting firms to invest in new technology, innovation, product quality and marketing.

productivity estimation. Third, there is a substantial price difference across firms within an industry (defined by four-digit ISIC) and exporters on average charge higher prices than non-exporters. Furthermore, price appears to be decreasing in productive efficiency but increasing in revenue productivity, suggesting that more efficient (and thus low-cost) firms charge lower prices than less efficient (high-cost) firms. The overall results suggest that the now-standard approach of examining the relationship between exporting and productivity using revenue-based productivity as a measure masks an important source of heterogeneity, and the increase in firm-level productivity following entry into foreign markets is associated with changes in prices as opposed to productive efficiency.

This paper contributes to different strands of the literature. Its first key contribution is to the heterogeneous firms trade literature that seeks to identify the actual effects of exporting on firm efficiency and understand the selection of firms into exporting. A large number of studies examine the relative importance of selection based on productivity and learning effects of exporting to explain the superior (revenue) productivity of exporters over non-exporters. While empirical evidence on selection dominates in studies from developed countries, the learning effect is largely documented in developing countries (ISGEP, 2008; Wagner, 2007, 2012). On the other hand, studies for Sub-Saharan Africa (SSA) firms typically show the complementarity of the two effects (Bigsten et al., 2004; Van Biesebroeck, 2005). Similarly, an earlier study for Ethiopia using similar data finds the presence of both selection and learning effects of exporting (Bigsten and Gebreeyesus, 2009). A more recent study by Siba and Gebreeyesus (2017) however shows that the pre-export productivity advantage of Ethiopian exporters is mainly driven by firm fixed effects. Based on a meta-analysis of empirical papers including firm-level studies from SSA, Martins and Yang (2009) conclude that the effect of exporting on productivity is larger for firms in developing countries than developed countries.<sup>2</sup> Despite the consistent results across this line of studies, one crucial common drawback is that their analysis is based on revenue total factor productivity. Thus, they do not distinguish between the effect of exporting that generates through efficiency and the effect due to within-firm changes in prices. The current paper differs from the previous studies as it does not focus on the impact of exporting on productivity per se, but the impact of price heterogeneity on the estimated link between exporting and productivity. By doing so, it clearly splits the price and efficiency channels through which exporting affects overall firm performance, which have important implications on the welfare gains and resource reallocations associated with trade (Melitz and Trefler, 2012).

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<sup>2</sup>Lopez (2004) introduces the concept of conscious self-selection, in which selection into export is a result of conscious investment decisions by forward-looking firms that aim to improve their productivity with explicit purpose of becoming exporters. Empirical studies for developing countries, for example Espanol (2007) find supporting evidence on the conscious self-selection hypothesis.

The second contribution is to recent studies that recognise the importance of addressing price bias in estimating the causal effect of international trade on productivity. For example, De Loecker (2011) cautions inferring productivity effects using deflated revenue as an output measure, showing that correcting the price heterogeneity lead to a substantially reduced productivity gains for Belgian textile producers following trade liberalisation. This result shares the argument of De Loecker and Goldberg (2014) that trade increases within-firm revenue productivity through its effect on the reallocation of resources from less profitable to more profitable products, but the efficiency gains due to trade is insignificant. In a related study, De Loecker and Warzynski (2012) find that exporters' mark-ups increase upon export entry and thus the revenue productivity advantage of exporters is driven by their ability to charge higher mark-ups. None of these studies however explicitly examines the impact of price heterogeneity on the leaning effects of exporting.

Smeets and Warzynski (2013) is to my knowledge the only paper that examines the causal effect of exporting on the productivity of firms while addressing the price bias. Using Danish manufacturing firm-level data sets, they find that correcting for price bias leads to a higher learning effects. However, unlike the current paper, their finding is inconsistent with recent evidences that exporting firms produce high quality products and thus charge higher prices (Kugler and Verhoogen, 2012; Iacovone and Javorcik, 2012). Their analysis moreover focuses on the context of a developed country, so the results might not be valid for developing countries. In this regard, this paper is the first of its kind to provide empirical evidence on the impact of price effects in measuring productivity gains due to exporting for firms in a Sub-Saharan African country.

Third, the finding of the paper on the price premium of exporters complements the recent literature that emphasises the importance of quality as a source of competitiveness in international markets (Baldwin and Harrigan, 2011; Hallak and Sivadasan, 2013). For example, Gervais (2015) finds that product quality is more important than physical productivity in determining US firms' decision to export. With the same view, Brooks (2006) and Chen et al. (2008) argue that quality upgrading is particularly relevant for developing country firms to succeed in international markets as they need to satisfy the standards required by foreign countries, especially the developed ones.

Finally, this paper also contributes to the productivity literature that has long recognised the input and output price bias in estimating productivity (Klette et al., 1996; Grieco et al., 2016; Atalay, 2014). Other studies examine the implications of this bias in understanding productivity difference among firms and the resulting intra-industry reallocation of resources (Foster et al., 2008; Haltiwanger, 2016; Siba and Söderbom, 2011). In this regard, the results of this paper offer some important insights into the possible productivity bias that may occur in the absence of detailed price data, especially for future

studies focusing on firms in developing countries.

The remainder of the paper is organised as follows. Section 2 outlines the conceptual framework of the paper focusing on the implications of price heterogeneity in estimating productivity. Section 3 presents the empirical models and identification strategies. Section 4 provides the description of the data along with some facts that help interpret the empirical results. Section 5 presents the empirical results and section 6 concludes.

## 2 Conceptual Framework

This section shows how ignoring price differences across firms affects productivity estimates and its implication on the estimated relationship between export and productivity. To illustrate the problem, consider a logarithmic representation of a Cobb-Douglas production function:

$$q_{it} = \sum_x \beta_x x_{it} + \vartheta_{it} \quad (1)$$

where  $q_{it}$  is a measure of output,  $x$  is a vector of inputs (labor, material and capital),  $\beta$  is a vector of parameters to be estimated,  $\vartheta_{it} = \omega_{it} + \epsilon_{it}$ ,  $\omega_{it}$  measures “true” total factor productivity,  $\epsilon_{it}$  is unexpected productivity shock,  $i$  is a firm index and  $t$  is a time index.

Since productivity measures output differences that cannot be explained by input differences, obtaining an accurate productivity estimate requires output and input quantities. However, such detail information is not typically available in many data sets. The standard practice by researchers is therefore to deflate firm-level sales and input expenditures by industry-level price indices (often provided by statistical offices) and then using the deflated values as a proxy for quantities. Thus, the production function actually estimated in empirical studies is the following

$$\tilde{r}_{it} = \sum_x \beta_x (\tilde{x}_{it} + p_{it}^x - \bar{p}_{kt}^x) + (p_{it} - \bar{p}_{kt}) + \omega_{it} + \epsilon_{it} \quad (2)$$

where  $\tilde{r}_{it}$  is firm-level deflated revenue,  $\tilde{x}_{it}$  is deflated input expenditures,  $p_{it}$  is firm specific output price ;  $\bar{p}_{kt}$  is the average industry price of industry  $k$  that the firm belongs to,  $p_{it}^x$  is firm specific price of input  $x$ ,  $\bar{p}_{kt}^x$  is average industry-level input price. This revenue based production function contains output and input price errors capturing the deviations of firm-specific input and output prices from the industry average prices, respectively.<sup>3</sup>

The presence of these price errors raises important concerns regarding the estimation

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<sup>3</sup>For simplicity, much of the discussion in this paper focuses on the output price bias. However, the effect of the input price bias is addressed in the robustness checks of the empirical analysis.

of productivity using revenue deflated by industry price index. First, the correlation of the omitted firm specific price with the choice of inputs leads to biased estimates on the input coefficients and thus productivity (Klette et al., 1996; Levinsohn and Melitz, 2002). Second, since the error term contains the price bias, productivity will be badly measured and it closely related to profitability that depends not only on productive efficiency but also on other firm specific factors such as price and mark-ups (De Loecker and Goldberg, 2014).

Third and most relevant to the question that this paper aims to address is that, since the pricing strategies of firms vary depending on their export status, not accounting for price differences would lead to wrong conclusions. For example, if a firm charges a price level above the average industry price, the use of deflated revenue as a proxy for quantity output results in higher output for a given input of the firm. This in turn overstates the productivity of high pricing firms. Indeed, Foster et al. (2008) find that the revenue productivity of young firms entering into a market is underestimated simply because, on average, they charge lower prices than incumbent firms. Siba and Söderbom (2011) find similar evidence using Ethiopian manufacturing data in which new firms have lower demand and price than established firms and thus lower revenue productivity. The evidence from these studies suggests that lower revenue productivity for a group of firms could be due to their relatively low output prices. By the same token, the recent evidence that exporters on average charge higher prices than non-exporters such as Kugler and Verhoogen (2012) and Iacovone and Javorcik (2012) implies that the use of revenue deflated by a common deflator as a measure of output in estimating productivity would result in a disproportionately higher revenue productivity for exporters.

Following Smeets and Warzynski (2013), this paper examines the impact of price heterogeneity on the estimated relationship between export and productivity by comparing the results obtained with and without correcting for the price bias. More precisely, I estimate two versions of production function using firm revenue deflated by industry-level price index and firm revenue deflated by a firm-specific price as alternative measures of output. The productivity estimate obtained from industry price deflated revenue is the most commonly used measure of productivity and contains price bias while the second measure obtained from firm price deflated revenue is free from price bias and indicates a firms' real productive efficiency. As in Foster et al. (2008) the first productivity measure is referred to as revenue productivity (TFPR) and the second is referred to as physical productivity (TFPQ).

### 3 Identification Strategy

Following the pioneer study of Clerides et al. (1998), subsequent empirical studies identify the learning effects of exporting by regressing productivity measure on firms' export history:

$$\omega_{it} = \psi export_{it-1} + \varphi controls + \varepsilon_{it} \quad (3)$$

where  $export_{it-1}$  is a dummy for the firm previous year export status,  $controls$  is a set of firm characteristics and  $\varepsilon_{it}$  is an *iid* error term. The reason behind this specification is that firms are heterogeneous in their underlying productivity; and if firms learn from foreign markets, their previous export participation should increase their current productivity. Thus, a positive and significant  $\psi$  indicates the presence of learning effect.

Empirical studies that estimate the total factor productivity effects of exporting most commonly follow a two-step procedure. First, they estimate productivity from a production function and then regress the productivity measure estimated from the first stage on previous export status. The main concern of using this two-step approach is that if firms make the export decision and input choices simultaneously, omitting export status from the production function in the first stage could result in inconsistent input coefficients and the effects of exporting on productivity. To address this issue, this paper follows Van Biesebroeck (2005) strategy where the export status is augmented in the production function so that the input and export status coefficients will be estimated simultaneously. By including export status in the production function and assuming that productivity evolves according to a first order autoregressive process, we can obtain the following dynamic production function

$$q_{it} = \alpha q_{it-1} + \sum_x \beta_x x_{it} + \psi export_{it-1} + s_{it} + \gamma_t + \psi_i + \varepsilon_{it} \quad (4)$$

where  $q_{it}$  and  $q_{it-1}$  are the log of output of the firm in period  $t$  and  $t-1$ ,  $\sum_x \beta_x = (\beta_l, \beta_m, \beta_k)$  are the coefficients of labor ( $l$ ), material ( $m$ ) and capital ( $k$ ), respectively,  $s_{it}$  and  $\gamma_t$  capture industry-specific and year-specific intercepts respectively,  $\psi_i$  is unobserved firm-specific effect,  $\varepsilon_{it}$  is an *iid* error term.

Following recent studies, this paper addresses the well known econometric issue of endogeneity of inputs and export status by applying the system Generalised Method of Moments (GMM) estimator of Blundell and Bond (1998) that allows for persistency of productivity and firm heterogeneity.<sup>4</sup> However, the literature also recognises that the

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<sup>4</sup>The system GMM estimator has been widely employed in recent empirical studies examining the impact of exporting on productivity in the African context (Bigsten and Gebreeyesus, 2009; Van Biesebroeck, 2005). This method has a number of advantages. System GMM estimator could provide consistent parameter estimates for the potentially endogenous regressors, specifically for inputs and export. Trans-

direction of causalities might run from productivity to exporting in which more productive firms self-select into exporting. The presence of self-selection into exporting makes it difficult to identify the effect of exporting by simply comparing the post export entry productivity of exporters and non-exporters. This is because exporters and non-exporters differ even in the absence of exporting and one cannot observe how exporting firms would have performed had they not exported.

The matching approach is one possible solution to the selection problem. The basic idea of matching is to find nonparticipants (non-exporters) that are similar to the participants (exporters) in all relevant pre-treatment (pre-exporting) observable characteristics. When the relevant differences between exporters and non-exporters are captured in the observable characteristics, matching can yield an unbiased estimate of the exporting effect. Following Girma et al. (2004), this paper uses a propensity score matching (PSM) technique to identify firms with similar propensity of exporting based on their observable characteristics. The propensity score is obtained by estimating an export decision equation. The closest non-exporter match for each exporting firm is established using nearest-neighbourhood approach based on the probability of exporting (propensity score). After the matching process, the learning effect is estimated by running equation 4 using the matched sample only.

## 4 Data and key facts

### 4.1 Data

The data used for the analysis come from the annual Ethiopian Large and Medium Scale Manufacturing Enterprise Census run by the Central Statistical Agency of Ethiopia (CSA). The manufacturing census covers all major manufacturing sectors in all regions of the country based on 4-digit international standard industrial classification (ISIC). The data used here covers periods from 1996 to 2005, at annual interval. The unit of observation in the sample is plant and all plants with 10 or more employees that use power-driven machinery are covered in the survey.<sup>5</sup> All plants are uniquely identified and the data contain detailed information including total sales value, value of exports, number of permanent and temporary employees, book value of fixed assets, current and

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forming the equation by first differencing, the fixed firm-specific effect is removed. The autocorrelation problem that arises due to the presence of the lagged output is accounted by instrumenting its first difference with its past levels. Further, using simulated sample of firms, Van Biesebroeck (2007) shows that system GMM provides the most robust estimates in the presence of measurement errors and technological heterogeneity, which are typical to many developing countries scenarios.

<sup>5</sup>Though the unit of observation in the data is plant, most Ethiopian manufacturing firms have a single plant and the distinction between firm and establishment is somehow blurred. Thus, firm and plant will be used interchangeably throughout the paper.

initial paid-up capital from domestic (private and public) and foreign sources, quantity and value of raw materials, costs of energy and other inputs and establishment year of the firm.

The unique feature of the data is that it contains plant-product level information on value and quantity of sales in domestic and foreign markets. Plants report up to 9 product lists and CSA provides certain codes for these products which are defined consistently across sector and years. For example, the list of products in the beverage sector (3-digit ISIC 155 ) are liquor, wine, beer, malt, lemonade (soft drinks) and mineral water. The data also provides standard unit of measurement such as litre and kilogram for each product depending on the sector which allows to measure quantity output in comparable measurement units. This information is used to construct firm-level variables used in this paper.

Export: first firms are grouped as exporter and non-exporter based on whether they export in the current period. For detailed analysis, they are further grouped into continuous exporters, never exporters, export starters and others. The first two are firms that report positive and zero export sales throughout the sample period, respectively. Exporter starters are those that start to export at some point in the sample period and continues to export through the end. The other group includes firms that change their export status more than once (switchers) and those that quit exporting.

Production inputs: total labour is computed as the sum of permanent employees and year-equivalent temporary workers. Capital stock is measured by the reported net book value of assets at the beginning of the year. Material is measured as the sum of plant expenditures on raw materials and energy. The real values of raw material and energy are obtained by deflating their nominal values using their respective deflator before they are summed together.

Firm specific prices: firm-level output price is constructed using product-level quantity and sales value information reported by firms. To do so, first the price of each product  $h$  of firm  $i$  at time  $t$  is computed as:

$$P_{hit} = \frac{V_{hit}}{Q_{hit}} \quad (5)$$

where  $P$  is price,  $Q$  is standardised quantity sales,  $V$  is sales value.

Then firm-level price is computed as a weighted mean of the prices of the products that the firm produces:

$$P_{it} = \sum_{h=1}^n P_{hit} \left( \frac{V_{hit}}{V_{it}} \right) \quad (6)$$

where  $V_{it}$  is the total sales value of the firm, other variables are defined as above. As can be seen, the weight is the share of each product from the total sales value of the firm, thus

more weight is given for the core products of the firm in computing the firm-level price.

Firms also provide quantity and value information on the list of raw materials used in production. Therefore, a firm specific raw material price is computed using a similar approach as used in computing output price. Nevertheless, since this information suffers from missing data, it is only used as a robustness check.

Other variables: public ownership present if public contributes in the paid-up capital of the firm. Firm age measures the number of years that the firm exists in the market.

Table 1 presents the number of firms in each period and the size (output and employment) of firms in the sample period. The number of firms covered in the census increased over time from 623 in 1996 to 997 in 2004.<sup>6</sup> On the other hand, the average number of employees decreased over time. One possible reason for this declining trend of average employment can be the disproportionate increase in small firms on the sample over time. In fact, the large gap between the median (137) and the mean (28) indicates a high skewness of the size distribution towards the left, reflecting the dominance of small firms in the manufacturing sector. The mean of the manufacturing output mostly increases over time, though its distribution skewed towards the left.

Table 1: Output and Employment over time

Year	No. Firms	Employment		Output	
		Mean	Median	Mean	Median
1996	623	149.77	22.67	880.90	55.10
1997	697	139.03	23.90	822.64	51.38
1998	725	130.79	23.00	846.13	53.82
1999	725	131.50	24.00	960.84	62.52
2000	739	131.78	26.00	1055.41	68.06
2001	722	122.16	27.29	1033.96	67.11
2002	883	118.05	24.00	864.18	52.83
2003	939	113.16	25.25	926.93	55.29
2004	997	107.75	27.25	1063.65	73.50
2005	763	245.21	78.50	1494.61	201.67
Average		137.07	28.00	996.94	67.03

The entries for output are in '0000.

Table 2 presents the manufacturing size and export participation by industry defined at 2-digit ISIC classification. On average, food and beverages, textile, wearing apparels and tanning and dressing of leather products together accounted for 65% of the total employment and 58% of the total production of the Ethiopian manufacturing industry.

<sup>6</sup>The exceptional drop in the sample size in 2005 is because of CSA's decision in this year to sample firms that produce bakery (ISIC 1541) instead of taking the entire firms in this sub-sector. Therefore, bakery producers are not included in the empirical analysis of this paper for consistency reason.

Of these, food and beverages appears to be the most important sector producing 40% of the output value and providing jobs for 29% of the labor force in the manufacturing sector. The textile industry equally employs about one third of the manufacturing labor although its contribution to the total output remains below 10%. The Ethiopian manufacturing sector is characterized by very low export performance in which only 4.7 % of firms export about 2% of the total manufacturing output. Nevertheless, the export participation varies considerably across industries where tanning and leather (26%), textiles (19%) and wearing apparel (9%) are the top three export oriented sectors followed by food and beverage producers (4.5%). The tanning and leather industry also leads in terms of export intensity by exporting 20% of the total output of the sector. The gap in export intensity across sectors is significant. For example, the second top export sector, the textile industry, follows far behind the leather industry by exporting only 4% of its total output.

Table 2: Export, output and employment by 2-digit industry

[ISIC] Industry	Obs.	% of ex- porters	Export inten- sity	% share of the in- dustry from the total manufacturing		
				Output	Labor	Export value
[15] Food Products and Beverages	2225	4.45	1.08	39.68	28.82	21.76
[16] Tobacco Products	10	10.00	0.04	3.12	0.85	0.02
[17] Textiles	340	18.53	3.95	8.90	24.70	9.72
[18] Wearing Apparel, except fur apparel	275	8.73	1.83	0.73	3.81	0.22
[19] Tanning and Dressing of Leather	563	26.29	20.22	8.78	7.55	67.79
[20] Wood and Products of Wood and Cork	187	1.07	0.55	0.63	1.60	0.02
[21] Paper, Paper Products	71	1.41	0.06	1.77	1.56	0.00
[22] Publishing and printing	535	0.37	0.19	3.15	4.62	0.00
[24] Chemicals and chemical products	412	0.49	0.24	6.01	4.95	0.01
[25] Rubber and plastics products	313	0.32	0.01	5.18	3.85	0.01
[26] Other non-metallic mineral products	880	1.14	0.21	8.95	7.82	0.16
[27] Basic metals	84	0.00	0.00	5.34	1.36	0.00
[28] Fabricated metal products	539	0.56	0.03	2.08	2.83	0.01
[29] Machinery and Equipment n.e.c.	114	0.88	0.46	0.09	0.27	0.01
[31] Electrical machinery and apparatus n.e.c.	12	0.00	0.00	0.01	0.06	0.00
[34] Motor vehicles, trailers and semi-trailers	82	3.66	0.85	4.08	1.13	0.24
[36] Furniture; manufacturing n.e.c.	1171	0.34	0.29	1.49	4.21	0.03
Total	7813	4.66	2.14			

Having introduced the overall manufacturing sector of Ethiopia, the empirical analysis of this paper focuses on plants that operate in the food (except bakery), beverages, textile, wearing apparel and leather producing sectors. First, the main interest is the analysis of export activities, so it is essential to concentrate on these export oriented sectors. Second,

firms in other sectors do not provide appropriate information such as standardized comparable units of measurement required to estimate unbiased quantity output. Third, these are the most important sectors in the country’s manufacturing industry, accounting for over 58% of the total manufacturing output and employment (see Table 2). Furthermore, restricting the analysis to these sectors enables a direct comparison with the results of this paper with the findings of the earlier papers by Bigsten and Gebreeyesus (2009) that uses the same industries as the current paper. Firms that do not report output and input information are also excluded. This data cleaning procedure yields 2448 observations that will be used in the main analysis of the paper.

#### 4.2 *Key facts established in the data*

##### (i) *Exporters are different*

This section checks whether the data replicate the main systematic differences between exporters and non-exporters established in the literature. This is carried out by regressing the log of various plant characteristics and the alternative productivity measures on export status while controlling for plant size, year and industry dummies. The results are presented in Table 3. The upper panel of the table shows the premium of exporters compared to non-exporters. When we look at the various firm characteristics, the export coefficient is mostly positive and significant at 1%, showing their superior performance even after controlling for firm size. Exporters on average employ 170% more workers and 56% more capital than non-exporters. Exporters also generate 30% more revenue and charge 22% higher prices for their output than non-exporters.

The same is true for the revenue based productivity measure where exporters appear to be about 20% more productive than non-exporters.<sup>7</sup> These results are consistent with the earlier findings for firms in Sub-Saharan African countries where the export premium for various characteristics lies in a range of 260% to 28% (Van Biesebroeck, 2005). However, the result shows no significant physical productivity difference between exporters and non-exporters. Intuitively, these results suggest that productivity efficiency is not the main driver of export decision and that other sources of firm heterogeneity such, as price, plays a crucial role.

The lower panel of the table presents the premium of different types of exporters. Compared to never exporters, continuous exporters and export starters employ 235% and 192% more labor, respectively. Other exporters (switchers and exiters) and continuous

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<sup>7</sup>The revenue productivity is obtained by using firm revenue deflated by industry-price index obtained from CSA as a measure of output. Whereas, physical productivity is obtained by using firm revenue deflated by firm-specific price as a measure of output. Industry level input deflator is also used to correct for input price bias. The estimation is carried out using System GMM estimator for each 2-digit ISIC separately.

Table 3: Difference between exporters and non-exporters

	labor	capital	revenue	price	revenue productivity	physical productivity
Ref: Non-exporters						
export	1.71*** (0.10)	0.56*** (0.17)	0.30*** (0.09)	0.22** (0.09)	0.19*** (0.07)	-0.22 (0.24)
R-squared	0.28	0.43	0.74	0.29	0.15	0.82
Ref: Never exporters						
continuous exporter	2.35*** (0.14)	0.09 (0.25)	0.31** (0.13)	0.42*** (0.13)	0.22* (0.12)	-0.21 (0.48)
export starter	1.92*** (0.09)	0.28* (0.17)	0.43*** (0.09)	0.21** (0.09)	0.17*** (0.06)	-0.36 (0.27)
other exporters	1.58*** (0.08)	1.05*** (0.15)	-0.00 (0.08)	0.70*** (0.08)	0.01 (0.06)	-0.64*** (0.21)
No of obs	2,448	2,448	2,448	2,448	2,448	2,448
R-squared	0.41	0.44	0.75	0.32	0.15	0.82

All the models control for log of employment, full set of year and industry dummies. Clustered standard errors reported in parenthesis and \*\*\*:  $p < 1\%$ ; \*\*:  $p < 5\%$ ; \*:  $p < 10\%$ .

exporters charge 70% and 20% higher price, respectively. Starters also have a 20% price premium. Nevertheless, it appears that the capital of continuous exporters is not different from never exporters. Similarly, there is no significant difference between other exporters and never exporters in terms of sales revenue. The general picture drawn from this analysis is that firms that export at some point in time outperform those that never export.

Looking at the productivity measures, the result shows that export starters and continuous exporters outperform never exporters in terms of revenue productivity. Continuous exporters show a 22% export premium whereas starters have a 17% export premium. Other exporters however are not different from never exporters. This suggests that, in quantitative terms, the export premium mainly comes from export starters and continuous exporters. When using physical productivity, the export coefficients for starters and continuous exporters are no longer significant. Rather, other exporters appear to be 63% less efficient than never exporters. This result is the reflection of the larger price premium of this group of firms and suggests that the inferior physical efficiency of exporters comes from the relative inefficiency of firms that switch between export and domestic markets or those that exit from the market.

### *(ii) Price heterogeneity*

The interest here is to show the extent to which prices vary across firms within an industry. Figure 1 plots the standard deviations (SD) and the difference between the 75th and 25th percentile of the price distribution (inter-quartile ranges) of the log of firm-level price by 4-digit ISIC. The interquartile range (IQR) is 50% or more in eleven out

of eighteen sectors. However, there is variation on the dispersion of prices across sectors. Firms that produce spirits (ISIC 1551) show the lowest variation in price (about 10%) while wearing apparel manufacturers (ISIC 1810) show the highest price variation of 260%. To get a more representative idea of the spread of price, I also compute the deviations of each firm price from the industry mean. Again we can observe significant deviations from the industry mean price across industries that range from 10% in manufacturers of animal feed (ISIC 1533) to 140% in the manufacturers of wearing and apparel (ISIC 1810). The observed large within-industry price variation suggests that the use of firm revenue deflated by aggregate price as a proxy for quantity would remove an important source of heterogeneity in estimating productivity.

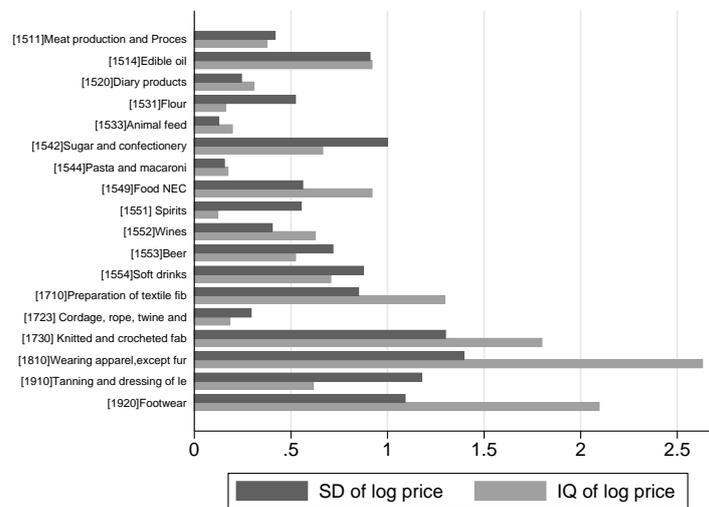


Figure 1: Price dispersion

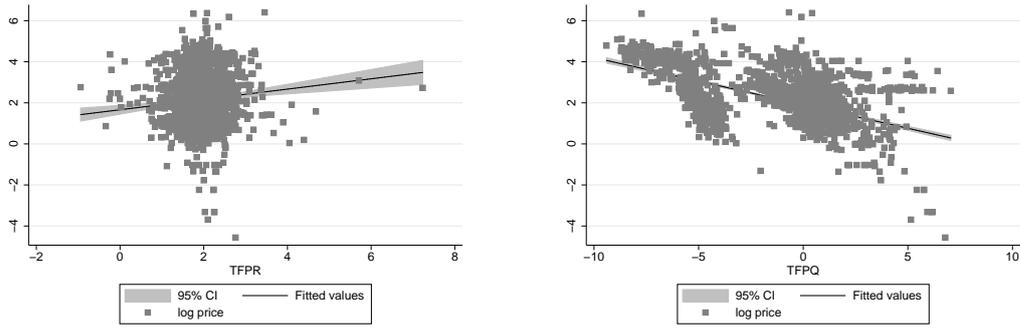
*(iii) Price is decreasing in physical efficiency*

Figure 2 shows the relationships between the two measures of productivity and output price. From the left panel of the figure, we can see a positive correlation between revenue productivity and price, though the patten of the plots shows less variability. On the other hand, the right hand side plot clearly shows that price is decreasing in efficiency suggesting that more efficient (and thus low cost) firms charge lower prices than less efficient (high cost) firms. These results are similar to the findings of Foster et al. (2008).

## 5 Econometric Analysis

### 5.1 Selection into foreign markets

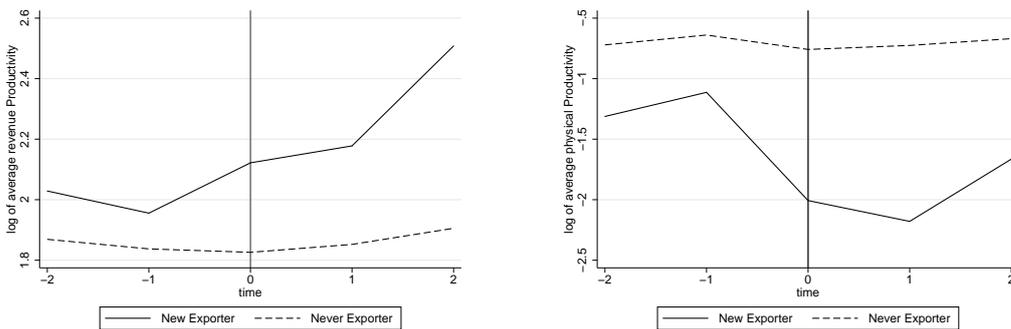
Before looking at the learning effect of exporting, this section examines the presence of self-selection into export by comparing the pre-export-entry productivity of export starters



(a) Revenue productivity and price. (b) Physical productivity and price.

Figure 2: The correlation between total factor productivity and firm price.

and never-exporters. Figure 3 shows the dynamics of average revenue productivity (on the left) and physical productivity (on the right). The horizontal axis plots a time frame where it is zero at export entry. The negative values indicate the period prior to entry while the positive values indicate periods after entry. For never exporters, the time scale is the median years that they exist in the sample. It is apparent that new exporters are more revenue productive than never exporters throughout the time windows considered. The starters also increase their revenue productivity in the run-up phase and after export entry. This suggests the presence of self-selection into export. Nevertheless, new exporters show lower physical productivity than never exporters both before and after export entry. A closer look at the dynamics further shows that physical productive efficiency of future exporters drops one year prior to entry, and continues to fall until the first year of export. It seems that their physical productivity starts to recover after the first year of export experience.



(a) Revenue productivity dynamics. (b) Physical productivity dynamics.

Figure 3: The productivity trajectory of new exporters and never exporters

Next, I check whether the pattern observed in the graphs remains valid after controlling for various firm characteristics. This is carried out by regressing productivity dated at some years before export entry on export status at export entry period and other control

variables (Bernard and Jensen, 1999; ISGEP, 2008). The idea is that if higher productivity firms self-select into foreign markets, future exporters should show higher productivity than never-exporters several years before the former begin to export. However, this exercise does not establish a causal relationship. Table 4 presents the results. The table shows that export starters had higher revenue productivity than never-exporters up to three years prior to export entry, suggesting that high revenue firms self-select into export (columns 1-3). A closer look on the timing shows that export starters outperformed since three years prior to their foreign market entry, though the largest gap is observed two years before entry. Specifically, future exporters have 23% higher revenue productivity premium two years prior to entry than firms that never export. The finding on the ex-ante productivity difference is in line with the well-established empirical regularity in this literature that more (revenue) productive firms self-select into foreign markets. However, what is more interesting is that there is no statistically significant physical productivity difference between new exporters and never exporters up to three years prior to export entry (Columns 4-6). This suggests that productive efficiency is not the main driver behind firms decision to export, instead other firm-specific demand side factors embodied in firms revenue are more important.

Table 4: Productivity difference between new exporters and never exporters prior to export entry

	revenue productivity			physical productivity		
	1 year before exporting	2 years before exporting	3 years before exporting	1 year before exporting	2 years before exporting	3 years before exporting
Ref: never exporters						
Export starters	0.15** (0.07)	0.23*** (0.08)	0.21** (0.08)	-0.44 (0.39)	-0.41 (0.32)	-0.38 (0.35)
No of obs	1,518	1,164	904	1,518	1,164	904
Of which starters	183	157	134	183	157	134
No of firms	369	277	222	369	277	222
R-squared	0.13	0.13	0.11	0.82	0.82	0.82

All the models control for log employment and full set of year and industry dummies. Robust standard errors clustered at firm-level in parenthesis and \*\*\*: p<1%; \*\*: p<5%; \*: p< 10%.

## 5.2 The impact of exporting on firm productivity

Table 5 presents the results on the productivity effect of exporting from dynamic production function estimates that directly incorporates past export status. The table reports tests to determine the validity of the system GMM estimator used for the analysis.<sup>8</sup> The first is the Hansen test of overidentifying restrictions with the null hypothesis

<sup>8</sup>Although the preferred estimator is system GMM, I also estimated the model using OLS, fixed effect and two-step first-difference GMM estimators for comparative purpose. TableC.10 in the appendix

that instruments are valid. The difference Sargan test checks the validity of the additional exclusion restrictions that arise from the level equations of the system GMM model. A further test is the Arellano-Bond test for autocorrelation of errors, with a null hypothesis of no autocorrelation (Arellano and Bond, 1991). The model is estimated using two-step GMM procedure in which the reported standard errors are robust and Windmeijer (2005) finite-sample corrected.<sup>9</sup> All the specifications passed the overidentifying restriction test ensuring the validity of the instruments. Similarly, the difference Sargan test confirms the validity of the additional exclusion restrictions. The rows for AR(1) and AR(2) report the p-values of Arellano and Bond test for first-order and second-order serial autocorrelation in the first-differenced residual. As expected, the test suggests high first order autocorrelation, but not second order autocorrelation in all the models. Overall, the test results suggest proper model specifications. Industry and year fixed effects are controlled for in all the specifications, but the coefficients are not reported for brevity.

Columns 1 and 2 report the results using firm-level sales revenue deflated by industry deflator as a dependent variable. The positive and significant coefficient for lag export status suggests that previous export activity shifts the production function out. More precisely, exporting appears to increase revenue productivity by 15%. This result supports the notion of learning effect of exporting on revenue productivity. Column 2 controls for the export experience of firms in addition to past export status. Export experience is statistically insignificant while the significance and sign of other variables remain the same, albeit a drop in export coefficient by 4%. This result is qualitatively and quantitatively similar to the findings of Bigsten and Gebreyesus (2009) that use the same data and apply the same methodology. Using a similar approach, Van Biesebroeck (2005) finds a positive and significant effect of export with the coefficient ranging from 20% to 38% for sub-Saharan Africa firms.

After confirming the evidence established by earlier studies using revenue based productivity, the main interest of this paper is to examine whether the productivity gains associated with export remains in place after price variations across firms embodied in revenue productivity is removed. This is carried out using price corrected revenue as a measure of output. As can be seen in column 3 the coefficient of lagged export status becomes statistically insignificant. Controlling export experience in column 4 does not change this result suggesting no evidence of learning effect on physical productivity.

The input coefficients deserve some comments. In all specifications, the lag output coefficient is positive and significant suggesting the persistence of productivity. As ex-

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present results from the alternative estimators. Overall, the results obtained from the various estimators are consistent with the the system GMM results.

<sup>9</sup>The estimation is carried out using xtabond2 stata package (Roodman, 2003).

Table 5: The effect of export on firm productivity: Full sample

	Industry deflator		Firm deflator	
$\ln(\text{output}_{it-1})$	0.15*** (0.02)	0.16*** (0.02)	0.22*** (0.04)	0.24*** (0.04)
$\ln(\text{labor}_{it})$	0.08** (0.04)	0.09** (0.04)	0.01 (0.08)	0.06 (0.09)
$\ln(\text{material}_{it})$	0.81*** (0.03)	0.81*** (0.03)	0.73*** (0.06)	0.74*** (0.06)
$\ln(\text{capital}_{it})$	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.03)	-0.02 (0.02)
$\text{export}_{it-1}$	0.15** (0.06)	0.11** (0.05)	0.01 (0.17)	0.01 (0.12)
$\text{export} - \text{years}_{it}$		-0.01 (0.03)		-0.09 (0.07)
No of obs.	1841	1841	1841	1841
No of firms	414	414	414	414
R-squared				
<i>P values</i>				
AR(1)	0.004	0.004	0.000	0.000
AR(2)	0.175	0.173	0.252	0.243
Hansen test of overid.	0.458	0.447	0.681	0.706
Diff-in-Hansen test	0.568	0.610	0.734	0.598

The instruments for the first difference in the GMM estimators are first lag and earlier for inputs and second lag and earlier for output, export status and export experience. The standard errors are robust finite sample corrected on two-step estimates where \*\*\*:  $p < 1\%$ ; \*\*:  $p < 5\%$ ; \*:  $p < 10\%$ . The P values of the different tests are presented at the end of the table. All the models control for full set of year and industry dummies.

pected, the coefficient of material is positive and significant despite the output measure used. Although the labour coefficient has the expected sign and significance in the revenue production function, surprisingly it is either negative or at best statistically insignificant in the quantity based production function. One possible explanation for this insignificant coefficient for labour could be associated with the fact that this production function controls output price bias only leaving aside some possible heterogeneity in input prices. This issue is addressed in the robustness checks. Similarly, the estimated coefficient for capital has an unexpected sign, though it is not insignificant. One possible explanation can be that the available capital stock data used in the estimation may not be good enough to identify variations in the flow of capital service used in the production process of firms and thus underestimates the contribution of capital (Harper, 1999). However, the available data do not allow to estimate capital service in this paper. The insignificant capital coefficient is still consistent with the general experience of studies that proxy capital service with capital stock measure (Ornaghi, 2008).

Table 6: The effect of export on firm's productivity: Correcting for selection bias

	Industry deflator		Firm deflator	
$\ln(output_{it-1})$	0.37*** (0.07)	0.37*** (0.08)	0.63*** (0.08)	0.61*** (0.08)
$\ln(labor_{it})$	0.03 (0.05)	0.04 (0.04)	0.11 (0.12)	0.14 (0.13)
$\ln(material_{it})$	0.64*** (0.09)	0.62*** (0.08)	0.59*** (0.13)	0.59*** (0.13)
$\ln(capital_{it})$	0.02 (0.03)	0.03 (0.02)	-0.01 (0.05)	-0.01 (0.05)
$export_{it-1}$	0.19** (0.08)	0.14* (0.08)	-0.05 (0.14)	-0.09 (0.15)
$export - years_{it}$		0.01 (0.02)		0.01 (0.03)
No of obs.	657	657	657	657
No of firms	192	192	192	192
R-squared				
<i>P values</i>				
AR(1)	0.004	0.005	0.026	0.026
AR(2)	0.335	0.333	0.450	0.426
Hansen test of overid.	0.321	0.416	0.228	0.333
Diff-in-Hansen test	0.159	0.252	0.336	0.307

The instruments for the first difference in the GMM estimators are from first to third lag for inputs and second and third lag for output, export status and export experience. The standard errors are robust finite sample corrected on two-step estimates where \*\*\*:  $p < 1\%$ ; \*\*:  $p < 5\%$ ; \*:  $p < 10\%$ . The P values of the different tests are presented at the end of the table. All the models control for full set of year and industry dummies.

### 5.3 Addressing selection bias

Now, I turn to examining the robustness of the learning effect to correcting selection bias by applying the matching method. The main aim of the matching processes is constructing a counterfactual group from non-exporters with a closer distribution of observable characteristics as exporters. This is first performed by estimating firms probability to export using first lag of firm size, capital intensity, firm age, public ownership, industry and productivity and time effects as regressors, following Bigsten and Gebreyesus (2009); Roberts and Tybout (1997).<sup>10</sup> In estimating the propensity score, I use logistic regression with 5 nearest-neighbours matching imposing a common support. Both revenue productivity and physical productivity are used as outcome variables alternatively. The matching procedure yields a total of 657 matched observations of which 247 are exporters. Column 1 of the TableA.9 in the appendix reports the results on the probability

<sup>10</sup>The estimation is carried out using psmatch2 stata package package (Leuven et al., 2015).

to export. Table 6 presents the learning effect using the matched sample. Columns 1 and 2 report the export effects in revenue production function. Even after correcting for the selection bias, the results indicate the presence of learning effects on revenue productivity. This is true despite controlling for export experience. Specifically, previous year export participation leads to 14% outward shift in the productivity.<sup>11</sup> However, when price bias is removed, the learning effect of export on productivity disappears (Columns 3 and 4). This is similar to the results obtained when using the full (matched and unmatched) sample, again suggesting that price is the main mechanism through which export affects the measured productivity.

#### 5.4 Robustness check

##### (i) Export starters and never-exporters

The analysis so far uses all the types of exporters without differentiating export starters, continuous exporters and export switchers and exiting firms. The main concern here is that such analysis may compare continuous exporters themselves at different periods and the results may be influenced by occasional exporters (Alvarez and Lopez, 2005). Therefore, the sensitivity of the main findings obtained above are checked by considering only export starters and never exporters, disregarding continuous exporters and other exporters. Table 7 reports the results. Columns 1 and 2 show the results based on the full sample of never exporters and export starters. The coefficient of previous year export status appears to be positive and significant for revenue productivity while it is negative and significant for physical productivity.

To address the potential selection bias, a matched sample of export starters and never exporters is constructed using propensity score matching by estimating the probability of starting to export, where the dependent variable indicates whether a firm is an export starter. Thus, the matched sample is comprised of export starters and never exporters with a comparable propensity to start exporting. Column 2 of TableA.9 in the appendix presents the results of the decision to start exporting. Turning to the learning effect, columns 3 and 4 of Table 7 report the results based on the matched sample. Again, the coefficient of the lag of export status appears to be positive and significant for revenue productivity while it is negative and significant for physical productivity. This suggests that export starters increase their revenue productivity after entering into foreign markets while decreasing their physical productivity. This finding is intuitive. The fierce international market competition requires new exporters to incur additional costs to improve their product quality leading to higher cost per output produced (lower productive efficiency). Still, as these firms are able to sell their quality output at a higher price,

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<sup>11</sup>TableC.11 in the appendix reports the results for the matched sample using alternative estimators.

they generate more revenue (and thus revenue productivity) than firms that solely serve the domestic market. The overall result here corroborates the finding that the effect of exporting on firm performance comes through price effect. Nevertheless, comparing these results with results in Tables 5 and 6 suggests that the gains of exporting on revenue productivity is substantially larger for export starters than the whole group of exporters. Furthermore, export starters appear to be less efficient compared with firms that have never participated in foreign markets.

Table 7: Post-exporting productivity difference between export starters and never-exporters

Dep. var	All sample		Matched Sample	
	Industry deflator	Firm deflator	Industry deflator	Firm deflator
$\ln(\text{output}_{it-1})$	0.13*** (0.02)	0.25*** (0.05)	0.28*** (0.08)	0.34** (0.16)
$\ln(\text{labor}_{it})$	0.10** (0.04)	0.04 (0.08)	0.21*** (0.06)	0.22** (0.11)
$\ln(\text{material}_{it})$	0.80*** (0.03)	0.69*** (0.07)	0.58*** (0.10)	0.64** (0.20)
$\ln(\text{capital}_{it})$	0.00 (0.01)	0.01 (0.03)	0.01 (0.02)	0.08** (0.04)
$\text{export}_{it-1}$	0.26** (0.13)	-0.68* (0.36)	0.30*** (0.09)	-0.26* (0.14)
No of obs.	1518	1518	262	262
No of firms	369	369	108	108
<i>P values</i>				
AR(1)	0.014	0.000	0.069	0.084
AR(2)	0.189	0.231	0.404	0.726
Hansen test of overid.	0.741	0.695	1.000	1.000
Diff-in-Hansen test	0.704	0.821	1.000	1.000

The instruments for the first difference in the GMM estimators are first lag and earlier for inputs and second lag and earlier for output, export status and export experience. The standard errors are robust finite sample corrected on two-step estimates where \*\*\*:  $p < 1\%$ ; \*\*:  $p < 5\%$ ; \*:  $p < 10\%$ . The P values of the different tests are presented at the end of the table. All the models control for full set of year and industry dummies.

(ii) *Alternative output measure*

A further robustness check with regard to the results on physical productivity is carried out using firm reported quantity output instead of firm sales divided by firm-level output price.<sup>12</sup> Column 1 in Table 8 presents the results. Again, the coefficient of previous year

<sup>12</sup>The firm-level quantity output of the firm is obtained by aggregating the product-level quantity that firms report. However, the reported product-level quantity suffers from missing data: for some of their products firms do not report the quantity of output they produce. On the other hand, the input information is at firm-level. Since estimating the production function directly using the available (firm-level) quantity data and the inputs would result in a biased estimates for those firms with missing

export status remains negative and insignificant suggesting no learning by exporting for physical efficiency. Also the distributions of productivity estimates obtained based on sales deflated by firm price and the reported quantity information are similar as shown in Figure B.4 in the appendix. The similar distribution patterns between the productivity measures from the two measures of output give confidence on using firm sales deflated by firm price as a proxy for quantity.

Table 8: The impact of exporting using alternative output measure and correcting for input price bias

Dep. var	Firm reported Quantity	Input price bias corrected	
		Firm deflator	Firm reported Quantity
$\ln(\text{output}_{it-1})$	0.25*** (0.04)	0.33*** (0.05)	0.32*** (0.05)
$\ln(\text{labor}_{it})$	0.04 (0.10)	0.28*** (0.09)	0.32*** (0.09)
$\ln(\text{material}_{it})$	0.70**** (0.07)	0.36*** (0.05)	0.35*** (0.05)
$\ln(\text{capital}_{it})$	-0.02 (0.03)	-0.01 (0.03)	-0.02 (0.03)
$\text{export}_{it-1}$	-0.07 (0.17)	-0.08 (0.16)	-0.14 (0.16)
No of obs.	1841	1841	1841
No of firms	414	414	414
<i>P values</i>			
AR(1)	0.000	0.000	0.000
AR(2)	0.273	0.482	0.426
Hansen test of overid.	0.481	0.307	0.308
Diff-in-Hansen test	0.528	0.601	0.463

The instruments for the first difference in the GMM estimators are first lag and earlier for inputs and second lag and earlier for output, export status and export experience. The standard errors are robust finite sample corrected on two-step estimates where \*\*\*:  $p < 1\%$ ; \*\*:  $p < 5\%$ ; \*:  $p < 10\%$ . The P values of the different tests are presented at the end of the table. All the models control for full set of year and industry dummies.

### (iii) Correcting for input price bias

As highlighted in the conceptual framework section, not only output price but also input (especially raw material) price bias might affect the estimated productivity measures and the subsequent analysis drawn using this measure. Some studies argue that addressing output price bias alone is problematic as it may cause wrong input coefficient estimates (Atalay, 2014; De Loecker et al., 2016). As high input price firms are more likely to charge high output prices and these two price biases work in opposite directions, standard revenue

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quantity data, I weighted all inputs when using quantity outputs. The weight is constructed as the share of the firm products that have quantity information from the total sales value of the firm.

based production function might produce reasonable input coefficients. This seems to be the case in some of the results reported in this paper. For example, in Table 5 the labor coefficient has the expected sign and significance in the revenue production function, but it becomes insignificant when output price is controlled for using quantity output. To check the sensitivity of the main results, columns 2 and 3 of Table 8 present the results that correct for material price bias using firm-specific raw material price reported by firms. Correcting for both input price and output price bias simultaneously results in the expected sign and significance for labor and material. On the other hand, the insignificant coefficient for capital persists throughout all the specifications even after correcting for input price bias. Nevertheless, the effect of exporting on physical productivity remains negative but insignificant, indicating the absence of learning effect in terms of physical productivity.

## 6 Conclusion

This paper re-examines the causal effects of exporting on productivity while taking into account price differences across firms. Empirical studies for a large number of countries establish that exporters are more productive than non-exporters and explain this evidence as a self-selection into export and (or) learning effect from exporting. Similarly, studies in the context of African firms find similar results. However, in most studies, productivity is estimated from a revenue based production function where firm output is measured by revenue (deflated by industry average price) instead of quantity, as data on physical output is rarely available. The resulting productivity therefore picks up price differences across firms in addition to efficiency differences. On the other hand, a more recent literature indicates that exporters charge higher prices than non-exporters as they produce higher quality products. This in turn makes it difficult to know whether exporters are actually more productive or they simply charge higher prices for their output than non-exporters. Thus, it obscures the channel through which participation in foreign markets affects firm's overall performance.

This paper exploits a rich data on quantity and prices on Ethiopian firms in the period 1996-2005. The empirical strategy involves splitting the price components that are confound in the traditional revenue-based measures of productivity and examines its implication on the estimated relationship between export and productivity.

The main results of the paper show that exporters are more productive than non-exporters in terms of revenue based productivity and this is explained by both self-selection and learning effects. These results are standard in the literature. Interestingly, correcting for price heterogeneity leads to an insignificant relationship between exporting and productivity. Specifically, when focusing on quantity-based measures of productivity,

exporters appear to be not different from non-exporters both before and after export entry. Further evidence shows that price is increasing in revenue productivity and decreasing in physical productivity, and on average exporters charge higher prices than non-exporters.

The overall results suggest that the main factors that determine firms selection into export is price and the effect of exporting on firm performance comes through its effect on price. This is inline with the finding of De Loecker (2011) where correcting for price heterogeneity in measuring productivity for Belgian textile producers significantly reduces the effect of trade liberalization from 8% to 2%. Similarly, De Loecker and Goldberg (2014) argue that exposure to trade forces firm to drop less profitable products thereby increase their overall profitable without significant efficiency gains. In a related study, De Loecker and Warzynski (2012) find that the revenue productivity advantage of exporters is driven by their ability to charge higher markups than non-exporters. With same argument, the finding that exporters on average charge higher prices than non-exporters implies that the price premium of exporters can (at least partly) explain learning effect we observed in revenue productivity. Nevertheless, identifying the underlying reasons for price differences across firms is out of the scope of this paper and clearly calls for further research.

The analysis of this paper suggests that firms ability to produce efficiently at low cost is not enough for them to succeed in international markets. Thus, developing countries' export promotion policies that exclusively focus on efficiency with the aim of improving competitiveness need to be reconsidered, suggesting a policy shift from quantity to quality could be the right direction going forward.

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## Appendix A: Export decision

Table A.9: *Probability to export*

Dep. var	Probability to export	Probability to start export
$\ln labor_{it-1}$	0.93*** (0.09)	1.09*** (0.16)
$\ln(capitalintensity)_{it-1}$	0.22*** (0.07)	0.00 (0.11)
$\ln(age_{it-1})$	-0.43** (0.18)	-0.68** (0.31)
$public_{it}$	0.81*** (0.28)	1.20*** (0.42)
Industry	Yes	Yes
Year	Yes	Yes
Observations	1,835	1,513

The dependent variable in column 1 is equals to 1 if the firm exports in period  $t$ , and zero otherwise. In column 2 the dependent variable is 1 if the firm is export starter and zero if it is never-exporter. Standard errors reported in parenthesis and \*\*\*:  $p < 1\%$ ; \*\*:  $p < 5\%$ ; \*:  $p < 10\%$ .

## Appendix B: Revenue and physical productivity distribution

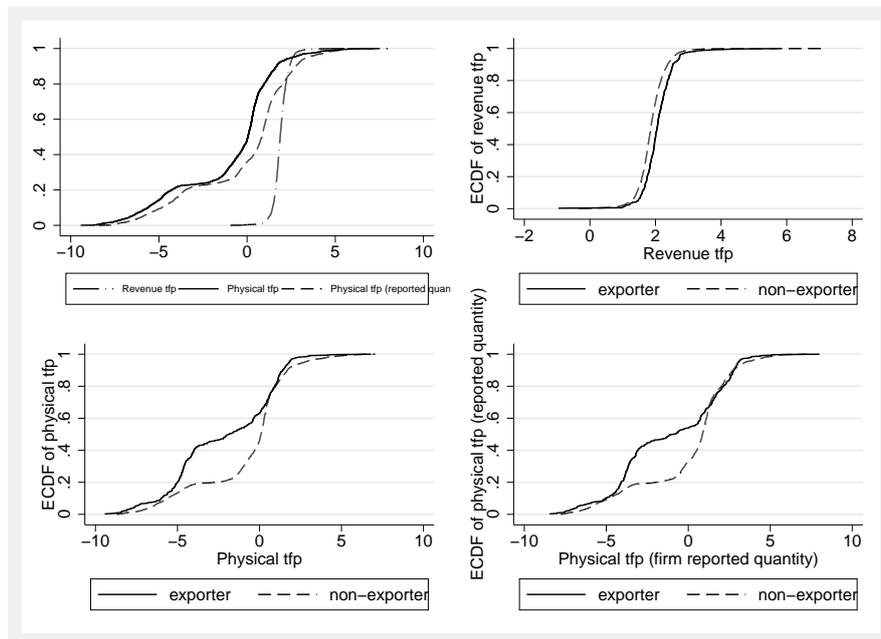


Figure B.4: Productivity distribution

## Appendix C: The impact of exporting using alternative estimators

Table C.10: The effect of export on firm's productivity: Full sample

	Industry deflator			Firm deflator		
	OLS	FE	Diff-GMM	OLS	FE	Diff-GMM
$\ln(\text{output}_{it-1})$	0.19*** (0.02)	0.10*** (0.01)	0.13*** (0.02)	0.65*** (0.03)	0.05** (0.02)	0.10** (0.04)
$\ln(\text{labor}_{it})$	0.13*** (0.02)	0.14*** (0.03)	0.11 (0.08)	-0.08** (0.03)	0.10* (0.05)	0.10 (0.11)
$\ln(\text{material}_{it})$	0.72*** (0.03)	0.76*** (0.02)	0.74*** (0.08)	0.39*** (0.04)	0.59*** (0.03)	0.58*** (0.07)
$\ln(\text{capital}_{it})$	0.01 (0.01)	0.01 (0.01)	-0.02 (0.01)	0.03* (0.02)	0.03* (0.02)	-0.02 (0.04)
$\text{export}_{it-1}$	0.13** (0.06)	0.08* (0.05)	0.12* (0.07)	-0.23** (0.11)	-0.02 (0.09)	0.10 (0.14)
$\text{export} - \text{years}_{it}$						
No of obs.	1841	1841	1397	1841	1,841	1397
No of firms	414	414	310	414	414	310
R-squared	0.97			0.90		
<i>P values</i>						
AR(1)			0.005			0.000
AR(2)			0.185			0.571
Hansen test of overid.			0.435			0.668
Diff-in-Hansen test			0.617			0.656

The instruments for the first difference in the GMM estimators are first lag and earlier for inputs and second lag and earlier for output and export status. The standard errors are robust finite sample corrected on two-step estimates where \*\*\*: p<1%; \*\*: p<5%; \*: p< 10%. The P values of the different tests are presented at the end of the table. All the models control for full set of year and industry dummies.

Table C.11: The effect of export on firm's productivity while addressing selection bias

	Industry deflator			Firm deflator		
	OLS	FE	Diff-GMM	OLS	FE	Diff-GMM
$\ln(\text{output}_{it-1})$	0.41*** (0.07)	0.32*** (0.03)	0.08 (0.06)	0.76*** (0.05)	0.14*** (0.04)	0.04 (0.08)
$\ln(\text{labor}_{it})$	0.10*** (0.03)	0.06 (0.06)	0.11 (0.09)	0.01 (0.06)	0.18 (0.12)	0.01 (0.13)
$\ln(\text{material}_{it})$	0.55*** (0.07)	0.41*** (0.03)	0.40*** (0.15)	0.37*** (0.08)	0.43*** (0.05)	0.38*** (0.14)
$\ln(\text{capital}_{it})$	-0.00 (0.02)	0.05** (0.02)	0.05 (0.03)	-0.01 (0.03)	-0.00 (0.04)	0.02 (0.04)
$\text{export}_{it-1}$	0.19*** (0.05)	0.15*** (0.05)	0.19* (0.10)	-0.06 (0.08)	0.15 (0.09)	0.09 (0.16)
$\text{export} - \text{years}_{it}$						
No of obs.	657	657	538	657	657	538
No of firms	192	192	160	192	192	160
R-squared	0.96			0.92		
<i>P values</i>						
AR(1)			0.010			0.046
AR(2)			0.623			0.400
Hansen test of overid.			0.990			0.989
Diff-in-Hansen test			0.971			0.974

The instruments for the first difference in the GMM estimators are from first to third lag for inputs and second and third lag for output and export status. The standard errors are robust finite sample corrected on two-step estimates where \*\*\*: p<1%; \*\*: p<5%; \*: p< 10%. The P values of the different tests are presented at the end of the table. All the models control for full set of year and industry dummies.