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Article

Importing and Firm Productivity in Ethiopian Manufacturing

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Abstract

This paper investigates the causal relationship between importing and firm productivity. Using a rich dataset from Ethiopian manufacturing over the period 1996–2011, I find that most firms rely on production inputs from the world market. These firms are better performing as shown by significant, economically large import premia. I also find strong evidence of self-selection of more productive firms into importing which is indicative of sizable import market entry costs. To examine the causal effect of importing on firm productivity, I use a model in which the static and dynamic effects of importing are separately estimated. The estimation results provide support to learning-by-importing. However, the productivity gains are small in size compared to similar findings in other studies. I provide some evidence in support of firms' limited absorptive capacity in explaining the small productivity gains.

JEL classification: F14, L60

Keywords: imported inputs, self-selection, learning-by-importing, absorptive capacity, ethiopia

International knowledge flows are considered fundamental components of globalization. Several studies identify foreign direct investment, trade, migration, and others as important channels of international linkages and knowledge spillovers across countries. A pioneering contribution by Coe and Helpman (1995) on trade-driven international R&D spillovers documents significant R&D knowledge transfer across OECD countries. In a follow-up paper, Coe, Helpman, and Hoffmaister (1997) show that the knowledge spillovers are not limited to developed countries in that developing countries substantially benefit from R&D investments elsewhere.

Research in the field point out differences in physical and human capital, policy, institutional quality, and relative backwardness from the technological frontier as important determinants of the pace and size of technology diffusion across countries. For example, Acharya and Keller (2009) find that the contribution of international R&D spillovers to productivity normally exceeds that of domestic R&D, and the technology transfers are asymmetric across countries due to differences in geographical distance between

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trading partners and the nature of goods traded. Acemoglu and Zilibotti (2001) emphasize that technology and skill mismatches lead to productivity differences across countries even when they have equal access to technology. Coe, Helpman, and Hoffmaister (2009) demonstrate the importance of institutional factors on the degree of R&D spillovers. No (2009) shows that the extent of international R&D spillovers depends on production structure, pattern of international trade, and national innovative and absorptive capacities of countries.

Studies have also investigated the role of different channels of these international linkages and knowledge spillovers mostly using aggregate data and adopting cross-country regressions. However, restricting these investigations only to countries and industries masks varying roles of different technology transfer channels given that firms are characterized by marked heterogeneity in terms of global orientation, productivity, size, and factor intensity and payment even in narrowly defined industries. With increasing recognition of firm heterogeneity, the scope of research on globalization, mainly international trade, has expanded to include firms and products besides countries and industries. Consequently, the trend in the empirical international trade literature has been characterized by a surge in using microeconomic data.

Despite such a surge, prominent focus has been on the export side of international trade. It is only recently that studies have started looking into importing. A common feature of these studies is that there is a positive, statistically significant and quantitatively large correlation between firm productivity and importing. However, the evidence on the causal relationship is mixed. For instance, Kasahara and Lapham (2013) for Chile, Vogel and Wagner (2010) for Germany, and Serti, Tomasi, and Zanfei (2010) for Italy find evidence of self-selection of more productive firms into importing, whereas Forlani (2010) for Ireland and Smeets and Warzynski (2013) for Denmark find no supportive evidence. Findings on learning-by-importing is also inconclusive. Kasahara and Rodrigue (2008) for Chile, Smeets and Warzynski (2013) for Denmark, Halpern, Koren, and Szeidl (2015) for Hungary, Forlani (2010) for Ireland, Dovis and Milgram-Baleix (2009) and Augier, Cadot, and Dovis (2013) for Spain, and Lööf and Andersson (2010) for Sweden find evidence of productivity gain from importing. On the contrary, Muendler (2004) for Brazil, Vogel and Wagner (2010) for Germany, Van Biesebroeck (2008) for Colombia and Zimbabwe find weak evidence. These mixed results are partly attributable to methodological choices or inherent differences in the nature of the import-productivity nexus across countries and over time.

Partly due to data unavailability, the new empirical international trade literature is also characterized by neglect of firms in low-income countries. There are only a few studies on manufacturing firms in Sub-Saharan African countries. Mengistae and Pattillo (2004) find the existence of export productivity premia. Similarly, Van Biesebroeck (2005) shows that exporters are better performing, and there is a productivity gain from exporting. Bigsten et al. (2004) provide weak evidence of self-selection into the export market but strong evidence of learning-by-exporting. Relatedly, Bigsten and Gebreeyesus (2009) find selection of more productive firms into exporting as well as post-entry productivity improvement. Foster-McGregor, Isaksson, and Kaulich (2014) document that firms simultaneously exporting and importing are the most productive.

The aforementioned studies on firms in African countries exclusively focus on the relationship between exporting and productivity.[1] This is despite the significant role of imports in these economies. For instance, imports of goods and services form around 28 percent of Ethiopian GDP over the period 1996–2011, whereas the corresponding figure for export is 13 percent. Further, Ethiopian manufacture imports and exports constitute around 70 percent and 9 percent of the total merchandise imports and exports, respectively. In addition, the mixed results on importing and firm productivity can be attributed to

1 A study by Foster-McGregor, Isaksson, and Kaulich (2014) is an exception in which it compares productivity differences of firms importing besides exporting. One caveat of this study is its use of cross-sectional data, and therefore it neglects the dynamics over time.

inherent differences in the nature of the relationship across countries and over time. This calls for further accumulation of empirical evidence which contributes to our understanding of the effect of international trade within the context of least developed countries.

In view of mixed results on the import behavior of firms, this paper investigates the causal link between importing and firm productivity using a rich dataset from Ethiopian manufacturing over the period 1996–2011. Ethiopia makes an interesting case. First, the sector is relatively technologically backward indicating great potential for technology transfer from other countries. Second, the country trades dominantly with technologically advanced economies making international knowledge spillover a possibility and trade an important conduit for such a spillover; 55 percent of Ethiopia's imports come from these countries. Third, manufacture imports constitute 70 percent of the import trade of the country, and more than 60 percent of the manufacturing firms rely on imported inputs. This provides an opportunity to investigate whether such a heavy reliance on imported inputs is translated into productivity gains. Lastly, despite these potentials, the sector faces a shortage of skilled workforce that can potentially limit the extent to which firms benefit from imported inputs.

A simple description of the Ethiopian data displays that importing is the most common form of trade participation, and there is a positive, statistically significant, and economically large import premia. In determining the direction of causality in the relationship between importing and productivity, I test for commonly known hypotheses—productive firms become importers, and importing makes firms productive.

The main element of the first hypothesis is that there are significant market entry costs in import markets, and it is only firms which are sufficiently productive enough that succeed in entering imports markets. To empirically test this, I consider a subsample of firms which were not importing in the past and estimate the pre-entry import productivity premium between future importers and non-importers. The results of this exercise reveal a positive and significant import premium, and, therefore, provide evidence of self-selection of more productive firms into importing.

To examine whether or not there is a productivity gain from becoming an importer through lower prices, more varieties and better qualities of inputs, and other forms of exposure to foreign technology, I distinguish between local and imported varieties of material inputs in the production function. Also, I treat import participation as an additional state variable which determines the evolution of a firm's productivity as well as its exit and investment decisions. As an identification strategy, I exploit within-firm changes in importing status as a source of variation and structurally estimate parameters of the production function and productivity evolution equation. The estimation results show that there are dynamic productivity gains (1.1–1.2 percent) in the period after becoming importer, albeit a momentary adverse effect at the beginning. In the long-run, these effects amount to a productivity improvement of 3.5–4.9 percent. In addition, if the expenditure share of imported inputs doubles, productivity increases by 2.1 percent immediately, 0.7 percent in the period after, and 4–22 percent in the long-run.

The estimated productivity gains are relatively small compared to similar studies from other developed and developing countries. There are at least two explanations. First, it may be the case that trade in capital goods rather than materials is the main channel for technology diffusion. Second, importing firms may have limited absorptive capacity, which refers to the ability and effort such as skill intensity and R&D investment to exploit the knowledge embodied in imported inputs.

Testing the empirical validity of these alternative explanations is hindered by lack of information on trade in capital goods as well as R&D expenditures at the firm level. To this end, absorptive capacity is approximated by the share of skilled workers in a firm's workforce as well as their share in the total wage bill. A cross-sectional quantile regression shows that imported inputs are associated with higher productivity in firms with greater absorptive capacity. Additionally, I use a structural approach to estimating the productivity evolution equation with absorptive capacity and import participation. This approach exploits within-firm changes in absorptive capacity and importing status over time. I find a statistically significant difference in learning-by-importing in high- and low-absorptive capacity firms, which is around 1.4–3.1 percent. This indicates that mere access to technology is not a sufficient condition for knowledge transfer, and absorptive capacity plays a role and partly explains why there is limited range and slow pace of technology transfer to firms in least developed countries.

This paper is related to studies on firm heterogeneity, international trade, and economic growth literature. It is related to the large and growing literature on firm heterogeneity and international trade pioneered by Bernard and Jensen (1995). It is also related to trade-driven international knowledge spillovers literature pioneered by Coe and Helpman (1995) and Coe, Helpman, and Hoffmaister (1997). Methodologically, I adopt the standard practice, especially follow Kasahara and Rodrigue (2008), in estimating the production function and productivity equation. It is also connected to contributions by Yasar and Paul (2007) and Yasar and Paul (2008) investigating different channels of technology transfer, and Yasar (2013) and Augier, Cadot, and Dovis (2013) examining absorptive capacity and productivity effects of imported inputs.

Unlike previous studies, this paper examines selection into importing and learning-by-importing by focusing on a country at the initial stage of economic development. Further, it considers the latest decade where the world experienced a surge in trade in intermediate goods. It also exploits the panel structure and longer time dimension of the data, which is rarely available for African manufacturing. To the best of my knowledge, related studies on African manufacturing are missing, and this study provides the first evidence.

The rest of the paper is organized as follows. Section 1 provides background information on the Ethiopian economy. Section 2 presents a theoretical framework of import participation. Section 3 describes the data and establishes a set of stylized facts. Section 4 addresses the empirical procedure used to test self-selection and learning-by-importing hypotheses, and section 5 discusses the estimation results. Section 6 concludes.

1. Overview of Ethiopian Economy

Ethiopia is one of the least developed countries according to the World Bank economic classification of countries. Typical of a least developed country, the economy has experienced a highly fluctuating growth pattern ranging from −3.46 percent in 1998 to 13.57 percent in 2004. However, the economy enjoyed nearly decades of rapid economic growth, especially after 2003; it expanded by 7.62 percent annually over the period 1996–2011. Below is a brief presentation of the salient features of the economy in terms of distribution of economic activities and reallocations across sectors.

Sectoral Composition

Table S1.1 in the supplementary online appendix shows that agriculture remains the most important sector of the economy, and it contributes 48.02 percent of the value added in the economy. However, the sector experienced a decline in its contribution to the aggregate output from 55.35 percent in 1996 to 45.57 percent in 2011. This decline is due to a relatively slower sectoral growth rate: 5.74 percent in agriculture, 6.60 percent in manufacturing, and 10.30 percent in the service sector over the years 1996–2011. On the other hand, Ethiopia has a narrow industrial base, and manufacturing constitutes less than 10 percent of aggregate output during the sample period. Despite its strong growth performance, the contribution of the sector to value added in the economy has declined recently. In contrast, the service sector experienced a consistently high growth and saw its contribution rising over time.

Table S1.2 in the supplementary online appendix reports that exports and imports constitute, on average, 12.99 percent and 28.01 percent of total output in the economy. These sectors registered rapid, yet fluctuating, growth rates: 12.13 percent and 12.77 percent, respectively. These growth rates signify the increase in the share of exports and imports from 9.35 percent and 16.43 percent in 1996 to 17 percent and 32.14 percent in 2011, respectively, showing increasing openness and growing integration to the global economy. We observe that the integration is dominantly through imports. Furthermore, we see the widening of the country's trade deficit over the years despite comparable export and import growth rates. In terms of traded items, manufacture exports constitute a very small portion of the overall merchandise export (9.08 percent), whereas manufacture imports constitute a significantly higher proportion (70.18 percent). While the share of manufacture exports remains more or less stable, the share of manufacture imports declined significantly from 84.49 percent in 1996 to 67.13 percent in 2011.

Geographic Orientation

Ethiopian international trade is mainly concentrated in high-income countries in Europe and North America (see fig. S2.1 in the supplementary online appendix). These economies are destination to 69.10 percent of the overall exports and source of 55.54 percent of imports of the country. Given that advanced economies account for the largest share of R&D in the world, the concentration of trade with these countries makes trade a likely conduit for international knowledge spillover. Middle Eastern and Northern African, East Asian and Pacific, and Central and South Asian countries are the next important destinations for exports constituting 14.03 percent, 6.07 percent, and 3.60 percent, respectively. The corresponding figures for imports are 4.88 percent, 12.36 percent, and 8.40 percent. Trade with countries in Latin America and the Caribbean, and Sub-Saharan Africa is very small and expanded only incrementally over time. Interestingly, we observe the declining role of traditional markets, namely high-income economies, and the growing importance of trade partners in Asia especially on the import side.

To sum up, it is shown that the fundamental aspects of Ethiopian economy have not undergone major structural changes. However, there have been some shifts in terms of sectoral output composition, geographical orientation of international trade, and overall openness. These changes cause firms to adapt their behavior under different domestic and global economic circumstances. The forthcoming sections deal with the nature and effects of firms' participation in international trade primarily focusing on importing.

2. A Theoretical Framework for Importing

Technology

The production technology of firm i at time period t is given by:

$$Y_{i,t} = A_{i,t} K_{i,t}^{\beta_k} L_{i,t}^{u\beta_u} L_{i,t}^{s\beta_s} E_{i,t}^{\beta_e} \left[\int_0^{N(d_{i,t})} m(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}\beta_m} ; \theta > 1 \tag{1}$$

where $Y_{i,t}$ refers to output, $A_{i,t}$ technology parameter, $K_{i,t}$ capital, $L^u_{i,t}$ and $L^s_{i,t}$ unskilled and skilled labor, $E_{i,t}$ energy and $m(j)$ a composite of domestic and foreign of intermediate goods. The β's are elasticities of output with respect to inputs of production; $\theta > 1$ elasticity of substitution between any two intermediate goods, and $N(d_{i,t}) = N^d_{i,t} + d_{i,t} N^f_{i,t}$ where $N^d_{i,t}$ and $N^f_{i,t}$ denote the number of domestically produced and imported intermediate goods respectively, and $d_{i,t} = 1$ is an indicator function if the firm uses imported intermediates. This specification closely follows Kasahara and Rodrigue (2008), in which different varieties of intermediate goods are treated as horizontally differentiated with no quality difference.

Assume that both domestic and foreign intermediate goods are produced and used symmetrically. That is $\bar{m}$ units of each intermediate good variety j are used, and the total material input used by firm i in time period t is $M_{i,t} = N(d_{i,t})\bar{m}$. After rearranging the terms, the production function is now given by:

$$
\begin{aligned}
Y_{i,t} &= A_{i,t}N(d_{i,t})^{\frac{\beta m}{\theta-1}}K_{i,t}^{\beta k}L_{i,t}^{u\beta u}L_{i,t}^{s\beta s}E_{i,t}^{\beta e}M_{i,t}^{\beta m} \\
&= e^{(\omega_{i,t}+\epsilon_{i,t})}N(d_{i,t})^{\frac{\beta m}{\theta-1}}K_{i,t}^{\beta k}L_{i,t}^{u\beta u}L_{i,t}^{s\beta s}E_{i,t}^{\beta e}M_{i,t}^{\beta m} \qquad (2)
\end{aligned}
$$

where $e^{(\omega_{i,t}+\epsilon_{i,t})}N(d_{i,t})^{\frac{\beta m}{\theta-1}}$ is a residual term of the production function. The residual term consists of a component, which represents the impact of imported intermediate inputs due to variety effect $N(d_{i,t})^{\frac{\beta m}{\theta-1}}$, a firm's total factor productivity $\omega_{i,t}$ and unobserved shock $\epsilon_{i,t}$ which denotes, say, measurement error. Upon imposing a specific functional form on the evolution equation of $\omega_{i,t}$, it is possible to capture learning-by-importing; the effect on productivity of imported inputs one period after the firm starts importing.

Decision Problem

Comparable to the setup in the Olley and Pakes (1996) model, a firm faces the following decision problems at the beginning of each time period. It first compares the sell-off value of exit with the continuation value of operation. If the firm decides to exit, it gets a sell-off value of Φ. If the firm stays in, it chooses levels of freely variable inputs labor and energy, and makes capital investment and import decisions.

Assuming that current investment is productive in the next period, capital evolves according to $k_{i,t} = (1-\kappa)k_{i,t-1} + i_{i,t-1}$, where κ is the rate of depreciation. Firm productivity is known to firms and follows, conditional upon survival $\chi_{i,t}$, a controlled first-order Markov process $\omega_{i,t} = E[\omega_{i,t}|\omega_{i,t-1}, d_{i,t-1}, \chi_{i,t} = 1] + \zeta_{i,t}$. The maximum expected discounted reward for a firm at a time period is given by the Bellman equation:

$$
\begin{aligned}
v(\omega_{i,t}, k_{i,t}, d_{i,t-1}) = max\{\Phi_{i,t}, max_{d_{i,t},i_{i,t}}\{\pi t(\omega_{i,t}, k_{i,t}, d_{i,t}) - C_k(k_{i,t}, i_{i,t}) - C_d(d_{i,t}, d_{i,t-1}) \\
+ \beta \int v(\omega_{i,t+1}, k_{i,t+1}, d_{i,t})dF(\omega_{i,t+1}, k_{i,t+1}, d_{i,t}|\omega_{i,t}, k_{i,t}, d_{i,t}, \chi_{i,t} = 1)\}\} \qquad (3)
\end{aligned}
$$

where $\omega_{i,t}$, $k_{i,t}$ and $d_{i,t}$ refer to the state variables, $\pi(.)$ indirect profit function, $C_k(.)$ investment cost function, $C_d(.)$ sunk or fixed costs of using imported intermediates depending on previous period import status, and β the discount factor. Solving the above dynamic programming problem of firm i yields three policy functions: exit rule $\chi_{i,t} = \omega_{i,t} > \underline{\omega}_t(k_{i,t}, d_{i,t-1})$, discrete import $d_{i,t} = d_t(\omega_{i,t}, k_{i,t}, d_{i,t-1})$, and investment demand $i_{i,t} = i_t(\omega_{i,t}, k_{i,t}, d_{i,t-1})$ functions. The dependence of the policy functions on the import variable follows from treating import participation as a state variable. This formulation is to capture any dynamic productivity effect of imported intermediates.

3. Data Description

Data Source

The dataset used in this paper comes from the Central Statistical Agency of Ethiopia. The agency conducts annual large and medium-scale surveys of firms engaged in manufacturing activities. Grouping of economic activities as manufacturing is based on ISIC-Rev.3 classification and includes industries 15–37 at two-digit ISIC. The survey covers all firms with at least ten employees and which use power-driven machinery during the period 1996–2011. The dataset provides detailed information on the level of production, local and export sales, input usage, employee composition, and asset structure of firms. I define gross output as revenue generated from local and export sales. I construct the capital variable by exploiting the information on initial stock, investment, value sold, and depreciated using the perpetual inventory method. Information on local and imported material inputs as well as energy is also available. Using information on employees, I differentiate between skilled workers: unpaid working proprietors; active partners and family workers, and administrative and technical employees, and unskilled workers: apprentice and production workers. Because the number of seasonal and temporary workers is infrequently reported, the measure of labor input is confined to the number of working proprietors; apprentices, and permanent employees. Because data on production price index spanning the sample period are unavailable, I deflate all nominal values using the GDP deflator extracted from the World Development Indicators database.[2]

To have sufficient within-industry variation, I regroup those industries with very few firms as other manufacturing. This group comprises firms in tobacco, paper, basic metals, machinery and equipment, office equipment, electrical machinery, and motor vehicles industries. I exclude firms which appear only once during the sample period and with zero or unreported sales and any of the factor inputs. The final dataset comprises 2,350 firms and 12,510 firm-year observations.

Stylized Facts

Below is a presentation of salient characteristics of Ethiopian firms' international trade activities.

Fact 1. There Is a Substantial Variation in Firm Trade Participation across Industries

Table 1 displays large differences in firm export and import participation rates across industries. In 1996, textiles (20.83 percent), leather products (21.43 percent), wood products (7.69 percent), and wearing apparel (6.67 percent) were industries with relatively high export market participation rates. In contrast, food and beverage (2.34 percent), non-metallic products (1.96 percent), and furniture (1.85 percent) had very low export participation rates. In 2011, there has been a dramatic increase in the export participation rate in all except the furniture industry. For instance, the participation rate increased to 20.20 percent in food and beverage, 50.00 percent in textile, 45.90 percent in leather products, and 21.05 percent in chemical industries.

Likewise, there are substantial variations in firm import participation across industries. Over the 15-year window, food and beverage, leather products, chemicals, rubber and plastic, and fabricated metals saw their import participation decline while the rest experienced a rise.

We observe that importing is the most common activity in which 69.74 percent of firms participate as opposed to exporting (5.86 percent). This is against findings from developed countries where the incidence

Table 1. International Trade Participation of Firms in Ethiopian Manufacturing

Industry	1996			2011			1996–2011	
	# Firms	% Exporters	% Importers	# Firms	% Exporters	% Importers	% Exporters	% Importers
Food and beverage	128	2.34	64.06	307	20.20	58.31	5.46	59.89
Textiles	24	20.83	83.33	12	50.00	91.67	26.95	71.10
Wearing apparel	15	6.67	66.67	19	21.05	73.68	13.56	75.72
Leather products	42	21.43	80.95	61	45.90	70.49	32.01	82.24
Wood products	13	7.69	69.23	12	16.67	75.00	1.85	51.08
Printing and publishing	32	0.00	71.88	48	2.08	87.50	0.13	85.27
Chemicals	28	0.00	100	38	21.05	89.47	2.77	93.35
Rubber and plastic	12	0.00	100	65	3.08	92.31	0.43	95.29
Non-metallic products	51	1.96	21.57	95	3.16	22.11	1.49	26.29
Fabricated metals	19	0.00	89.47	39	2.56	82.05	1.23	85.55
Furniture	54	1.85	57.41	95	0.00	65.26	0.58	79.10
Others	27	0.00	92.59	35	14.29	82.86	2.57	92.00
Total manufacturing	445	4.72	67.87	826	14.77	64.89	5.86	69.74

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia.

2 The results (not shown in the paper) do not change if the consumer price index is used instead. This is expected given that the correlation coefficient between the two indexes is well above 0.95.

of exporting is more common and importing is rarer among manufacturing firms.[3] We notice that overall export participation rose from 4.72 percent to 14.77 percent whereas import participation slightly declined from 67.87 percent to 64.89 percent between 1996 and 2011.

Fact 2. There Are Significant Trade Activity Premia

Table 2 reports estimates of average difference of export-only (serving domestic and export markets but not importing); import-only (serving domestic market and importing), and two-way (active in domestic and export markets and importing) firms relative to those which are neither exporters nor importers. It is shown that two-way firms are the most productive whose production activity is characterized by intensive use of capital, material, energy, and skilled workers. These firms are also the largest in size. Among firms partially engaged in trade, we see that export-only firms are more productive, capital-intensive, and larger in size compared to import-only firms. The estimates indicate that export-only firms do not necessarily use more energy per worker and hire more skilled workers. Further, import-only firms are less capital-intensive, and they do not use more material per worker as compared to domestic firms.

Table 2. Export and Import Activity Premia

	Export-only	Import-only	Two-way
TFP	23.559***	5.500***	32.446***
	(0.061)	(0.015)	(0.034)
Output per worker	46.020***	8.211***	77.311***
	(0.106)	(0.028)	(0.042)
Capital per worker	43.952**	−14.790***	39.440***
	(0.173)	(0.045)	(0.078)
Material per worker	39.449**	4.146	68.109***
	(0.129)	(0.026)	(0.040)
Energy per worker	4.701	7.838	38.321***
	(0.150)	(0.048)	(0.130)
Employment size	170.102***	40.020***	612.849***
	(0.159)	(0.024)	(0.064)
Sh. of skilled worker	−1.753	4.407***	13.058***
	(0.091)	(0.014)	(0.019)

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia.

Note: Trade activity premia show average percentage performance differences between trading and domestic firms, and they are obtained by estimating $y_{i,t} = \beta_0 + \beta_1 Exp_{i,t} + \beta_2 Imp_{i,t} + \beta_3 Twoway_{i,t} + Control_{i,t} + \delta_t + \tau + \epsilon_{i,t}$ where $y_{i,t}$ denotes total factor productivity, output, capital, material, energy, employment size, and share of skilled workers. $Exp_{i,t}$, $Imp_{i,t}$, and $Twoway_{i,t}$ are dummy variables taking a value of 1 if a firm is export-only, import-only, or two-way, respectively. Employment size (except for the last two indicators) is included as control variable besides the year δ_t and industry τ fixed effects. Bootstrapped standard errors with 500 replications in parentheses. $^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

Fact 3. There Is High Persistence in Firm Trade Status

Table 3 presents transition probabilities of firm activities in terms of scope. There is a high state dependence of firms engaged in the domestic market (67.19 percent), import-only (84.30 percent), and two-way (76.95 percent). There is an exceptionally low incidence of state dependence among export-only firms: 33.75 percent. Firms engaged in either exporting or importing are more likely to add importing (38.75 percent) but less likely to add exporting (1.71 percent) as an additional activity compared to firms engaged in neither of the activities: 31.40 percent and 2.10 percent, respectively. We notice here a rather low probability of starting exporting as an additional firm activity. Furthermore, two-way firms are less likely to abandon any of the activities compared to their export-only and import-only counterparts.

3 Studies by Bernard et al. (2007) for a large economy (the US) and Eriksson, Smeets, and Warzynski (2009) for a small open economy (Denmark) are typical cases of greater export participation rate in the manufacturing sector.

Table 3. Transition Probabilities of Firm Activities

		Status $t+1$			
		Domestic	Export-only	Import-only	Two-way
Status t	Domestic	67.19	1.41	30.71	0.69
	Export-only	13.75	33.75	13.75	38.75
	Import-only	13.76	0.22	84.30	1.71
	Two-way	4.01	6.61	12.42	76.95
	Cross-sectional Average	28.59	1.14	64.86	5.40

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia.

It is worth mentioning that the high persistence of firms' activities can be problematic when estimating the relationship between import participation and firm productivity. This is because there may be little variation in the data. However, this is not an issue in this paper. In this regard, table 4 reports that 1,413 (60.13 percent) firms do not change their importing status: they either import or never use imported inputs throughout the sample period. In contrast, 937 (39.87 percent) firms change their importing status at least once, and 512 (27.78 percent) firms switch their import participation more than once during the same period. The data therefore contain sufficient within firm variation in importing status required for identification.

Table 4. Firms Switching Their Importing Status

Switching frequency	# Firms	% Firms
0	1,413	60.13
1	425	18.09
2	282	12.00
3	96	4.09
4	68	2.89
5	26	1.11
5+	40	1.71
–	2,350	100

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia.
Note: Switching frequency refers to the number of times a firm changes its importing status over the sample period.

4. Empirical Strategy

This section addresses the econometric strategy applied in testing the main propositions of the paper. A descriptive reduced-form regression is used to investigate whether or not there is selection of more productive firms into importing. A structural approach to estimating parameters of the production function and productivity equation is followed to test the learning-by-importing hypothesis. Furthermore, the role of absorptive capacity in determining the productivity effect of importing is analyzed by running a cross-sectional quantile regression as well as modifying the structural approach used in estimating the learning effect. The rationales behind and details of the empirical approach are presented below.

Any form of entry into new activity or market entails non-negligible costs. In a similar manner, import participation involves substantial sunk and fixed costs, and it is expected that only firms which are sufficiently productive will succeed in becoming importers. Hence, there is self-selection of productive firms into importing. On the other hand, importing firms can experience post-entry productivity improvement following their import participation associated with increased variety of intermediates, better quality of imported inputs, or transfer of technology.

To empirically test the self-selection hypothesis, I consider a subsample of firms with no importing history and estimate the pre-entry import productivity premium between future importers and non-importers.[4] For this purpose, I run a regression of lagged values of productivity $\omega_{i,t-s}$ on current import status $M_{i,t}$ and control variables such as firm's capital holding $k_{i,t-s}$, employment size $l_{i,t-s}$, export market participation $X_{i,t-s}$ as well as year δ_t and industry τ fixed effects:

$$\omega_{i,t-s} = \beta_0 + \beta_1 M_{i,t} + \beta_2 k_{i,t-s} + \beta_3 l_{i,t-s} + \beta_4 X_{i,t-s} + \delta_t + \tau + \epsilon_{i,t} \; ; \; s = 1, 2, 3 \tag{4}$$

where a positive and significant estimate of β_1 shows a pre-entry productivity premium and confirms selection of productive firms into importing.

Since $\omega_{i,t}$ is not observed in the data, it has to be estimated, and this requires estimating output elasticities of the production function and parameters of the productivity Markov process. Logarithmic transformation of the production function in equation (2) and inclusion of the discrete import variable $d_{i,t}$ to capture the static effects of imported intermediates $\frac{\beta_m}{\theta-1} ln(N(d_{i,t}))$ yields:

$$y_{i,t} = \beta_k k_{i,t} + \beta_u l^u_{i,t} + \beta_s l^s_{i,t} + \beta_e e_{i,t} + \beta_m m_{i,t} + \beta_d d_{i,t} + \omega_{i,t} + \epsilon_{i,t} \tag{5}$$

Under a linear first-order Markov process of productivity, we have

$$\begin{aligned} \omega_{i,t} &= E[\omega_{i,t} | \omega_{i,t-1}, d_{i,t-1}, \chi_{i,t} = 1] + \zeta_{i,t} \\ &= \tau + \rho\, \omega_{i,t-1} + \gamma\, d_{i,t-1} + \zeta_{i,t} \end{aligned} \tag{6}$$

where the innovation term $\zeta_{i,t}$ is independent of $\omega_{i,t-1}$ and $d_{i,t-1}$ and with a known distribution. In the productivity equation, I condition on survival probability $\chi_{i,t} = 1$ to control for endogenous selection of firms in the data. Equations (5) and (6) allow us to test both the static and dynamic effects of importing on firm output and productivity. That is, if $\beta_d > 0$, it implies that using imported intermediates immediately improve output for a fixed quantity of inputs in production. On the other hand, $\gamma > 0$ indicates a dynamic productivity gain, and the effect in the long-run is summarized as $\frac{\gamma}{1-\rho}$.

Estimation of equation (5) by ordinary least squares raises econometric issues due to the endogeneity of input choices given that a firm does not make input decisions independent of its productivity. The endogeneity problem does not go away even if one uses fixed effects regression. For this purpose, I adopt the widely used estimation algorithm developed by Levinsohn and Petrin (2003) in which material inputs are used as a proxy for unobserved firm productivity. I exploit the relationship that demand for material inputs depends on observed capital and unobserved productivity $m_{i,t} = m_t(k_{i,t}, \omega_{i,t}, d_{i,t})$. Under the monotonicity of $m_t(.)$, the unobserved productivity can be expressed in terms of the observable capital, material inputs, and import as $\omega_{i,t} = \omega_t(m_{i,t}, k_{i,t}, d_{i,t})$, and the estimating equation becomes:

$$y_{i,t} = \beta_u l^u_{i,t} + \beta_s l^s_{i,t} + \beta_e e_{i,t} + \varphi_t(m_{i,t}, k_{i,t}, d_{i,t}) + \epsilon_{i,t} \tag{7}$$

where $\varphi_t(m_{i,t}, k_{i,t}, d_{i,t}) = \beta_k k_{i,t} + \beta_m m_{i,t} + \beta_d d_{i,t} + \omega_t(m_{i,t}, k_{i,t}, d_{i,t})$. I estimate equation (7) by least squares in which $\varphi_t(.)$ is approximated using a third-order polynomial function and with industry and time fixed effects included. In so doing, β_u, β_s and β_e are consistently estimated. This is because the source of correlation between the freely variable inputs and a firm's productivity has now been controlled by the polynomial approximation, and these inputs are uncorrelated with $\epsilon_{i,t}$ by construction. Because $k_{i,t}$, $m_{i,t}$

4 Roberts and Tybout (1997) provide alternative estimation framework to inspect the existence of market entry costs and the resulting selection effect.

and $d_{i,t}$ are collinear with the terms in the polynomial approximation, β_k, β_m and β_d are unidentified in this stage.

The identification assumptions to estimate β_k, β_m and β_d crucially depends on timing. Since $k_{i,t}$ is determined at $t-1$, it is uncorrelated with the innovation term in productivity, $\zeta_{i,t}$, giving rise to an exogenous variation in $k_{i,t}$ used for identifying β_k. Because the firm chooses $m_{i,t}$ at the same time $\omega_{i,t}$ is observed, $m_{i,t}$ is not independent of $\zeta_{i,t}$. However, $\zeta_{i,t}$ is uncorrelated with $m_{i,t-1}$ since $m_{i,t-1}$ is decided at $t-1$, and this condition is used to estimate β_m. Identification of β_d comes from the orthogonality between $\zeta_{i,t}$ and $d_{i,t-1}$. That is, even if $d_{i,t}$ is correlated with $\omega_{i,t}$, the innovation term $\zeta_{i,t}$ should have no correlation with $d_{i,t-1}$ which was decided at $t-1$.[5]

After estimating equation (7) and recovering $\phi_{i,t} \equiv \hat{\varphi}_t(k_{i,t}, m_{i,t}, \omega_{i,t}) = \beta_k k_{i,t} + \beta_m m_{i,t} + \beta_d d_{i,t} + \omega_{i,t}$, I run a probit regression of $P_{i,t} = Pr(\chi_{i,t} = 1) = \chi_t(k_{i,t}, k_{i,t-1}, d_{i,t-1}))$ where $\chi_t(.)$ is approximated linearly in its arguments. This gives firms' predicted survival probabilities $\hat{P}_{i,t}$ for a given level of capital, productivity, and previous period import status.

Afterwards, I substitute $\phi_{i,t}$ in (6) and obtain the following estimating equation:

$$\begin{aligned}\phi_{i,t} = \tau + \beta_k k_{i,t} + \beta_m m_{i,t} + \beta_d d_{i,t} + \rho(\phi_{i,t-1} - \beta_k k_{i,t-1} - \beta_m m_{i,t-1} - \beta_d d_{i,t-1})\\ + \gamma d_{i,t-1} + \Omega_t(\phi_{i,t-1} - \beta_k k_{i,t-1} - \beta_m m_{i,t-1} - \beta_d d_{i,t-1}, \hat{P}_{i,t}) + \zeta_{i,t}\end{aligned} \tag{8}$$

where $\Omega_t(.)$ is included to control for firm attrition in the data. Equation (8) is estimated by a non-linear least squares technique.

It is important to mention that in order to identify γ, there is a need to deviate from the typical Levinsohn–Petrin (LP) estimation algorithm and consider an $AR(1)$ productivity process. This is because γ cannot be separately identified when the productivity process is approximated by high order polynomial function in $\omega_{i,t-1}$ and $d_{i,t-1}$. On the other hand, identification of β_d is achieved by having a third-order polynomial approximation of the productivity process, as is typically the case in the LP estimation technique.

To examine whether or not intensive use of foreign varieties improves productivity, I invoke the symmetry assumption regarding the production and employment of intermediate goods. From the assumption, it follows that the ratio of imported to total intermediate inputs is given by: $\frac{M^f_{i,t}}{M_{i,t}} = \frac{N_{i,t}(1)\bar{m} - N_{i,t}(0)\bar{m}}{N_{i,t}(1)\bar{m}} = \frac{N_{i,t}(1) - N_{i,t}(0)}{N_{i,t}(1)}$. This ratio can be interpreted as the fraction of imported inputs both in number and value in the total material input used in the production. By introducing this ratio into the production function and productivity equation, we obtain:

$$y_{i,t} = \beta_k k_{i,t} + \beta_u L^u_{i,t} + \beta_s L^s_{i,t} + \beta_e e_{i,t} + \beta_m m_{i,t} + \beta_d n_{i,t} + \omega_{i,t} \tag{9}$$

$$\begin{aligned}\omega_{i,t} &= E[\omega_{i,t} | \omega_{i,t-1}, n_{i,t-1}, \chi_{i,t} = 1] + \zeta_{i,t}\\ &= \tau + \rho\, \omega_{it-1} + \gamma\, n_{i,t-1} + \zeta_{i,t}\end{aligned} \tag{10}$$

where $n_{i,t-1} = \log\left(\frac{M^f_{i,t-1}}{M_{i,t-1}}\right)$. And, the identification assumptions and estimation steps proceed in the same way as in the case of discrete import participation.

The last step of the empirical procedure involves analyzing whether or not learning-by-importing is higher for firms with greater absorptive capacity. A firm's absorptive capacity is measured by the share of skilled workers in its workforce. As an additional measure, I also use the share of wages of skilled workers

5 Ackerberg, Caves, and Frazer (2015) argue that using the moment conditions in the residuals of $\zeta_{i,t}$ instead of $\zeta_{i,t} + \epsilon_{i,t}$ yields precise and more stable estimates. This is due to the additional variance term associated with. $\epsilon_{i,t}$ Further, they point out identification issues in the first stages of the algorithms developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003).

in the firm's total wage bill of the firm. The latter is motivated by the findings of Fox and Smeets (2011) who show that wages potentially capture the quality of workers used in the production process.

Absorptive capacity is now included in the productivity process by reformulating equation (6) as follows:

$$\omega_{i,t} = \tau + \rho\,\omega_{i,t-1} + \gamma\, d_{i,t-1} + \mu\, abs_{i,t-1} + \lambda\, d_{i,t-1} \times abs_{i,t-1} + \zeta_{i,t} \quad (11)$$

where $abs_{i,t-1}$ is dummy variable taking 1 if a firm's absorptive capacity is above a certain threshold level in which it is considered high-absorptive capacity and 0 otherwise. $\mu + \lambda$ captures the difference in learning-by-importing between high- and low-absorptive capacity firms.

As an additional test on the productivity effect of importing, I explore whether firms have different output elasticities based on their absorptive capacities. For this purpose, I use a sample splitting technique developed by Hansen (2000). This technique simultaneously estimates the output elasticities of different regimes and the threshold level of absorptive capacity that divides them. It is also tested if the elasticities for the regimes are statically different from one another. See the supplementary online appendix for details on Hansen's technique.[6]

5. Estimation Results

Selection into Importing

Table 5 presents estimates of percentage differences in productivity between current importers and non-importers periods prior to some of them becoming importers. It is shown that the estimate on the current period import dummy variable is positive and highly significant. Furthermore, fig. S2.2 in the supplementary online appendix shows the plot of the probability and cumulative densities of a normalized firm productivity.[7] We see that the productivity distribution of importers lies to the right relative to that of non-importers for all the time lags considered. A Kolmogorov-Smirnov test also confirms that importers' productivity distribution is stochastically dominant.

Table 5. Self–Selection into Importing

	$\omega_{i,t-3}$		$\omega_{i,t-2}$		$\omega_{i,t-1}$	
$M_{i,t}$	12.032***	11.218***	9.485***	8.772***	10.110***	9.602***
	(0.018)	(0.015)	(0.023)	(0.014)	(0.013)	(0.013)
$X_{i,t-3}$	—	29.500***	—	—	—	—
		(0.039)				
$X_{i,t-2}$	—	—	—	28.463***	—	—
				(0.021)		
$X_{i,t-1}$	—	—	—	—	—	23.287***
			—			(0.030)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj.R^2	0.486	0.490	0.486	0.490	0.495	0.498
Obs.	5,832		7,118		9,020	

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia. Bootstrapped standard errors with 500 replications in parentheses. $^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

6 I do not exploit the panel structure of the data. This is due to unavailability of an estimator in the case of unbalanced panel data. Although Hansen (1999) develops an estimator for a non-dynamic balanced panel, adjusting the Ethiopian data to a balanced panel is inappropriate due to high firm turnover rate. Gebreeyesus (2008) documents that the Ethiopian manufacturing exhibits a turnover rate of 20-22 percent annually.

7 Industry average is used to normalize firm productivity to account for industry idiosyncrasies and a firm's relative position in the industry.

These results provide support to the argument that the current importers were more productive than their non-importing counterparts even before the former started importing. This selection of more productive firms into importing is in accordance with and suggestive of substantial market entry costs of importing.

Learning-by-Importing

Columns (1)–(6) of table 6 present parameter estimates where importing is treated as a discrete variable. The ordinary least squares (OLS) results in column (1) show that all estimates of the output elasticities are positive and significant. The magnitudes of these elasticities are also consistent with most findings in the productivity estimation literature. Importantly, the coefficient on the discrete import variable is positive and significant implying that there is an effect of approximately 6 percent on firm output. Column (2) reports fixed effects (FE) estimates which are close to their OLS counterparts in terms of sign and statistical significance despite size differences. Specifically, FE estimates on capital, skilled labor, and material inputs are smaller whereas the estimate on unskilled labor becomes larger. We see that there is no immediate, significant impact on firm output because of imported inputs.

Consistent estimation using OLS requires no correlation between freely variable inputs and serially uncorrelated firm productivity while FE assumes firm-specific, time-invariant unobserved productivity. To relax these restrictive assumptions and impose richer structure in the form of endogenous productivity process and static and dynamic gains of importing, the LP algorithm is applied.[8]

The $AR(1)$ estimates of the coefficients of freely variable inputs in columns (3) and (4) are similar to OLS and FE estimates in their statistical significance. However, they are smaller than their OLS counterparts but larger than FE estimates except for unskilled labor. Coefficients on capital, material inputs, and import are estimated first without controlling for survival probability of firms and then after taking into account firm survival using the predicted probabilities from a probit regression of exit. They are rather similar in statistical significance, direction, and magnitude and show that firms experience an immediate decline in productivity due to importing, 0.8 percent. This is not unexpected in the light of previous findings showing that firms might need to adjust their production structure to benefit from the availability of cheaper and probably better imported intermediates.[9]

It is also shown that there is a strong persistence in the evolution of productivity, $\rho = 0.78$ and 0.65, and there are dynamic productivity gains due to importing, 1.1–1.2 percent. Long-run effects of importing predict a firm productivity improvement around 3.5–4.9 percent. Furthermore, to overcome potential identification issue associated with estimating β_d, the LP estimation technique is implemented. The results are given in columns (5) and (6), and they are identical to those reported in columns (3) and (4).

In columns (7)–(12), I present the estimation results in which import is treated as a continuous variable depending on how intensive is the use of foreign varieties among importing firms. Both the OLS and FE estimates display similar patterns as in the discrete import case. The only exception is the significance of the import variable under FE regression. The $AR(1)$ estimates show that a 100 percent increase in the share of imported input increases firm productivity by 2.1 percent immediately and 0.7 percent in the period after. The respective LP estimates indicate a 15.5–18.5 percent productivity improvement. In the long run, the productivity gain is approximately 4–22 percent. Note that addressing the endogenous selection of firms increases the long-run productivity gain substantially.

8 Consistent estimation of the output elasticities under OLS and FE prevents the estimation of ρ and γ.

9 Smeets and Warzynski (2013) find a temporary decline yet a continual improvement in firm productivity due to importing among Danish manufacturing firms.

Table 6. Production Function Parameters

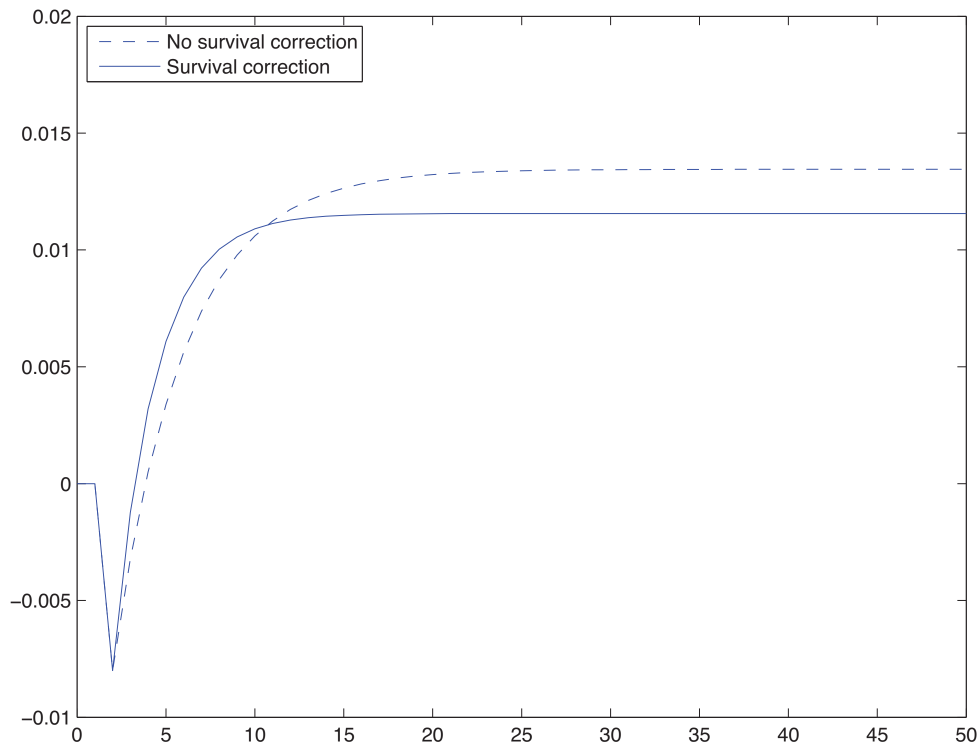
	Import participation						Import intensity					
	OLS	FE	AR(1)		LP		OLS	FE	AR(1)		LP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
β_u	0.136***	0.142***	0.115***		0.115***		0.112***	0.128***	0.115***		0.115***	
	(0.009)	(0.017)	(0.007)		(0.007)		(0.011)	(0.023)	(0.007)		(0.006)	
β_s	0.128***	0.089***	0.103***		0.103***		0.128***	0.071***	0.103***		0.103***	
	(0.009)	(0.016)	(0.007)		(0.007)		(0.013)	(0.019)	(0.007)		(0.007)	
β_e	0.100***	0.064***	0.091***		0.091***		0.074***	0.042***	0.091***		0.091***	
	(0.006)	(0.007)	(0.005)		(0.005)		(0.004)	(0.008)	(0.005)		(0.005)	
β_k	0.059***	0.033***	0.042***	0.043***	0.034***	0.033***	0.070***	0.040***	0.037***	0.038***	0.031***	0.029***
	(0.004)	(0.006)	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)	(0.008)	(0.002)	(0.002)	(0.002)	(0.002)
β_m	0.673***	0.567***	0.668***	0.669***	0.671***	0.668***	0.709***	0.571***	0.684***	0.685***	0.684***	0.681***
	(0.009)	(0.017)	(0.002)	(0.002)	(0.002)	(0.002)	(0.009)	(0.020)	(0.002)	(0.002)	(0.002)	(0.002)
β_d	0.060***	0.012	−0.008*	−0.008*	−0.008*	−0.010**	0.093***	0.103***	0.021***	0.021***	0.185***	0.155***
	(0.015)	(0.020)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.011)	(0.002)	(0.002)	(0.019)	(0.050)
P	—	—	0.777***	0.654***	—	—	—	—	0.811***	0.968***	—	—
			(0.008)	(0.046)					(0.009)	(0.056)		
Γ	—	—	0.011***	0.012***	—	—	—	—	0.007***	0.007***	—	—
			(0.004)	(0.004)					(0.001)	(0.001)		
Survival prob.	—	—	No	Yes	No	Yes	—	—	No	Yes	No	Yes
N	8,282	8,282	8,282		8,282		5,190	5,190	5,190		5,190	

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia. Bootstrapped standard errors with 500 replications in parentheses. *$p < .10$, **$p < .05$, ***$p < .01$.

To demonstrate the evolution of productivity under importing, I undertake a simple simulation of the path of productivity (loosely defined as $\beta_d d_{i,t} + \omega_{i,t}$) of a hypothetical firm over time. In the simulation, the $AR(1)$ estimates are used while the unobserved shocks firms experience in each period are ignored. Figure 1 shows the evolution of productivity of a firm that starts importing at period 1 and continues to do so afterwards. We see that the firm goes through a momentary decline in productivity. However, after some time, the firm adjusts its production structure and is able to enjoy the productivity gains from importing. We observe that correction of an endogenous selection of firms gives rise to a rapidly converging path, albeit at lower level. In fig. 2, I repeat the same exercise in which import intensity is considered instead. Here, the hypothetical firm starts using imported inputs at period 1 and these inputs constitute 47 percent of the materials used in production, which is the average import share in the data. We observe a significant productivity improvement over time. We notice that correcting for the survival probability of firms makes a sizable difference.

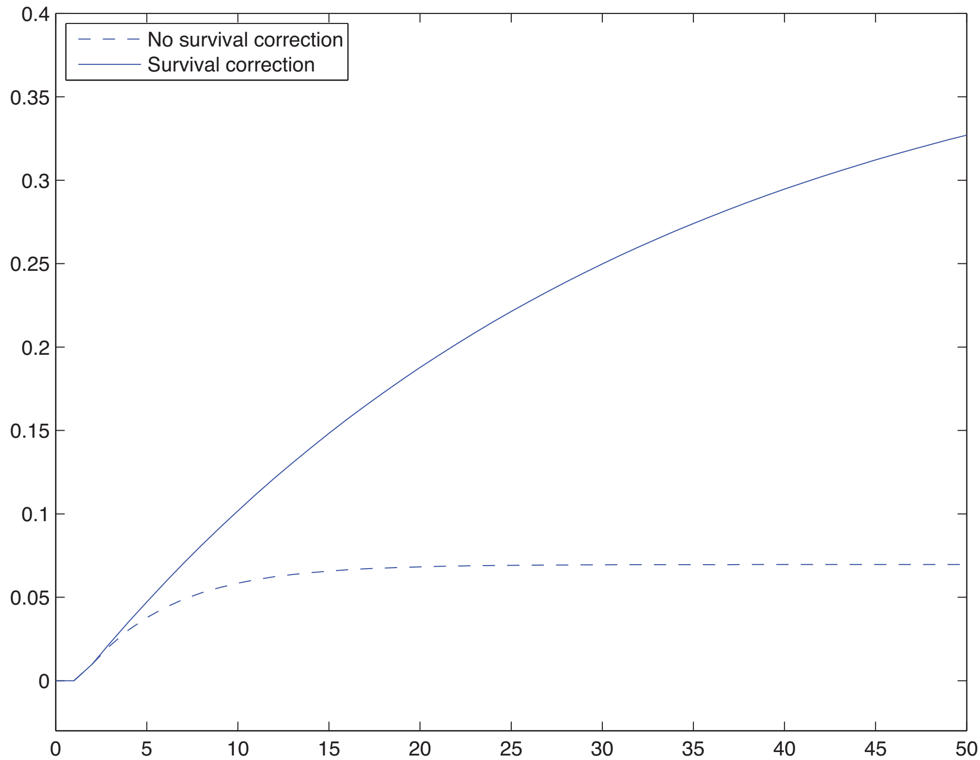
The above findings highlight the fact that although there are temporary declines in productivity, the firm ultimately benefits from importing and even more so if it intensifies the relative employment of imported varieties vis-à-vis the domestic ones. In view of findings from other developing countries, the productivity gains reported in this paper are small. For example, a comparable study by Kasahara and Rodrigue (2008) of Chilean manufacturing firms find a productivity improvement of 11.1 percent and 2.6 percent under the ordinary least squares and fixed effect regressions, respectively. Besides, using control function approach, they report a static (21.4 percent) and a dynamic (2.4–4.1 percent) productivity gains. Next, I address if

Figure 1. Productivity Effect of Importing: Import Participation



Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia

Figure 2. Productivity Effect of Importing: Import Intensity



Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia

absorptive capacity of firms explains the degree of post-entry productivity improvement firms experience due to import participation.

Absorptive Capacity

Table 7 presents estimation of the production function assuming $AR(1)$ productivity Markov process specified in equation (11). Notice that the differential effect of importing on productivity in high- and low-absorptive capacity firms is given by $\mu + \lambda$. Columns (1) and (2) report estimates in which the 25^{th} percentile of share of skilled workers is used as a cutoff to divide firms into high- and low-absorptive capacity. In the same manner, the estimates using 50^{th} percentile are shown in columns (3) and (4). We see no discernible difference as such between high- and low-absorptive capacity firms when it comes to productivity gain attributed to import participation. It looks like the evidence in support of absorptive capacity is weak.

Following Fox and Smeets (2011), who demonstrate how wages can potentially capture (unobserved) quality of workers, I repeat the above exercise by using the share of skilled workers in a firm's wage bill as a proxy for absorptive capacity. It is shown that there is a significant difference in the productivity implication of importing for high- and low-absorptive capacity firms, which is approximately 1.4–3.1 percent. Thus, it can be argued that absorptive capacity partly explains interfirm variations in terms of expected benefits from using imported inputs. It also provides some evidence as to why the overall

Table 7. Productivity and Absorptive Capacity

	Number of skilled workers				Wage bill of skilled workers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
β_l^u	0.115***		0.115***		0.128***		0.128***	
	(0.007)		(0.007)		(0.007)		(0.006)	
β_l^s	0.103***		0.103***		0.098***		0.098***	
	(0.007)		(0.007)		(0.006)		(0.006)	
β_e	0.091***		0.091***		0.073***		0.073***	
	(0.005)		(0.005)		(0.005)		(0.005)	
β_k	0.032***	0.032***	0.032***	0.032***	0.033***	0.031***	0.033***	0.031***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
β_m	0.660***	0.657***	0.660***	0.657***	0.645***	0.641***	0.646***	0.641***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
β_d	−0.003	−0.006	−0.002	−0.005	−0.003	−0.007	−0.003	−0.006
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
P	0.843***	0.799***	0.843***	0.798***	0.722***	0.551***	0.722***	0.556***
	(0.022)	(0.111)	(0.021)	(0.111)	(0.049)	(0.182)	(0.046)	(0.181)
Γ	0.001	−0.004	0.009	0.003	−0.004	−0.009	0.004	−0.002
	(0.008)	(0.008)	(0.006)	(0.006)	(0.008)	(0.008)	(0.005)	(0.005)
M	−0.001	−0.003	0.010	0.007	0.017**	0.012	0.018**	0.014**
	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)	(0.006)
Λ	0.009	0.007	−0.001	−0.003	0.014	0.008	0.004	−0.0001
	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)	(0.009)	(0.008)	(0.007)
$\mu + \lambda$	0.008**	0.004	0.009	0.004	0.031***	0.020***	0.022***	0.014***
Survival prob.	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	8,282		8,282		7,747		7,747	

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia. Bootstrapped standard errors with 500 replications in parentheses. *$p < .10$, **$p < .05$, ***$p < .01$.

learning-by-importing is limited in Ethiopian manufacturing consistent with low technology level of firms in the sector and shortage of highly skilled workers in the economy.

Table 8 reports the threshold regression estimates.[10] The threshold parameter η is estimated to be 0.403, and it exceeds the average and median absorptive capacity in the data implying that most firms have limited absorptive capacity. Based on the threshold value, the whole sample is split into two regimes, and then the output elasticities are estimated. We see that the coefficients on β_l, β_k, β_e and β_m do not vary across the two regimes and they therefore can be considered as regime-independent. The parameter of interest β_d is significant under both regimes, but its statistical significance and magnitude is greater for firms with absorptive capacity above the threshold value. This threshold effect is shown to be statistically significant. After controlling for the quantity of materials used in production, we see that importing is associated with 2.9 percent and 5.3 percent increases in output production in the first and second regimes respectively. These results are intuitive in shedding light on the impact of firms' absorptive capacity on learning-by-importing, although they mostly display cross-sectional relationships.

10 Estimation of the threshold regression is implemented using a Matlab code written by Bruce E. Hansen and available from the author's website: http://www.ssc.wisc.edu/bhansen/progs/progs_threshold.html. Last accessed: 17 Aug 2014.

Table 8. Threshold Regression

	Absorptive capacity $\leq \eta$		$> \eta$
Threshold Estimate η		0.403	
0.95 Confidence Interval		[0.375, 0.406]	
β_l	0.227***		0.238***
	(0.010)		(0.012)
β_k	0.050***		0.052***
	(0.004)		(0.005)
β_e	0.075***		0.111***
	(0.006)		(0.008)
β_m	0.700***		0.694***
	(0.008)		(0.012)
β_d	0.029**		0.052***
	(0.014)		(0.019)
R^2	0.922		0.935
Obs.	7,805		4,705
LM test for no threshold effect test statistic		316.115	
LM test for no threshold effect p–value		.000	

Source: Author's analysis based on data from the Central Statistical Agency of Ethiopia. Robust standard errors in parentheses. $^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

6. Conclusion

The vast majority of the literature on firm globalization has been restricted to advanced economies and a few developing countries in Asia and Latin America. African manufacturing has been greatly neglected because of lack of available accounting information and trade statistics at the firm level. In order to fill this void in the literature, this paper uses a unique panel dataset from Ethiopian manufacturing. A simple description of the data uncovers that most firms source production inputs from the world market. This illustrates that firms heavily rely on imported inputs partly due to limited availability of domestically manufactured inputs. Additionally, I find a positive link between importing and productivity and other firm performance measures.

Examination of the direction of causality in the import-productivity relationship shows that more productive firms self-select themselves into importing, suggesting sizable market entry cost of importing. Relatedly, this paper finds evidence of learning-by-importing. In addition, it is found that intensive use of imported inputs is associated with a greater productivity improvement among importing firms.

Despite the pervasiveness of importing and intensive use of imported material inputs, the estimated productivity gains are relatively small. As one possible explanation, this paper resorts to absorptive capacity. The results reveal sizable differences in the expected productivity improvement between high- and low-absorptive capacity firms. In view of a least developed country's typical characteristics such as shortage of highly trained workforce and firms' limited investment in R&D and other complementary activities, the result on absorptive capacity somehow explains why the potentials of trade-driven technology transfer are confined only to few firms and to a lower degree.

In terms of policy implications, the studied firms have identified the availability of material inputs as one of the major constraints for their productive activities.[11] Tariff liberalization and particularly input tariffs can play an important role in this respect. Likewise, a reduction of non-tariff import trade barriers

11 As reported in table S1.7, a substantial number of firms (30 percent) point out shortage of material inputs as the first major factor for not being fully operational throughout the year as well as operating below full capacity.

as well as provision of better quality services by government bodies linked to import trade will allow firms to rely on the world market as an alternative source of inputs with a high degree of certainty.[12] On the other hand, enhancing interindustry linkages within and outside of the manufacturing sector can contribute to the development of local productive capacity and promote the availability of cheap local inputs. It is also necessary to design and implement incentive structures, financial and high quality support services in connection with innovation and R&D investments, regular worker training, and information and communication technology. In general, policy interventions aimed at building up firms' productive and absorptive capacities can be crucial in terms of facilitating trade-driven technology transfer to the manufacturing sector and overall economy.

Some limitations of this paper are mainly due to lack of sufficiently detailed data regarding firms' trade and investment activities and composition of workforce. Therefore, any ideal future research endeavor on the topic needs to obtain information on firms' import of capital goods in addition to intermediate materials. This can be insightful given the existence of a few findings on even more prominent role of capital goods (rather than intermediate goods) in channeling trade-driven knowledge transfer across countries. Further, there is need for a better metric for absorptive capacity beyond classifying workers into production and non-production. For this purpose, gathering information on human capital of employees, or at least number of workers by educational qualification, firms' expenditure on worker trainings, and R&D can be helpful. Moreover, unlike the normally observed complementarity between capital goods and skilled labor, it is not that straight forward to expect such complementarity to exist between intermediate inputs, which are dominantly raw materials, and skilled labor. An interesting avenue for future research would be to explore this relationship in the case of imported capital goods and the implication for productivity.

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12 Empirically, trade liberalizations are often associated with better firm outcomes. A series of prominent studies on developing countries document that episodes of input tariff liberalizations are causally linked with: productivity improvement (Amiti and Konings 2007); technology upgrading via importing capital goods (Bas and Berthou 2012, Bas and Berthou, 2017), and relaxing firms' technological constraints thereby improving performance as well as stimulating product innovation (Goldberg et al. 2009, Goldberg et al. 2010).

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