Importing and Firm Productivity in Ethiopian Manufacturing*

Kaleb Girma Abreha†

Department of Economics and Business
Aarhus University

November 19, 2014

Abstract

In this paper, I investigate 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 source capital and intermediate goods 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, highlighting substantial 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 evidence of learning–by–importing. However, the small sizes of the productivity gains suggest the limited absorptive capacity of firms in the economy.

JEL Codes: F14; L60

Keyword: Imported inputs, self–selection, learning–by–importing, Ethiopia

*I would like to thank the Tuborg Foundation for generous financial support. The usual disclaimer applies.
†Contact: Fuglesangs Allé 4, 8210 Aarhus V, Denmark; E-mail: kgab@econ.au.dk

1 Introduction

International knowledge spillovers 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 document 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.

Subsequent studies have investigated the importance of different channels of international linkages and knowledge spillovers mostly using aggregate data and adopting cross-country regressions. Recently, 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. The asymmetry emanates from differences in geographical distance between trading partners and nature of goods traded. Other studies point out physical and human capital, policy and institutional quality, and relative backwardness from the technological frontier as important determinants of the pace and size of technology diffusion across countries. Acemoglu and Zilibotti (2001) show that technology and skill mismatches lead to productivity differences across countries even when they have free access to technology. Coe, Helpman, and Hoffmaister (2009) show the importance of institutional factors on the degree of R&D spillovers. No (2009) show that the scope and magnitude of international R&D spillovers depend on both production structure, pattern of international trade (in terms of volume and trading partners), national innovative and absorptive capacities of countries.

However, restricting these investigations only to countries and industries masks varying roles of different technology transfer channels given that firms in those industries are characterized by enormous heterogeneity in terms of global orientation, productivity, size, factory intensity and payment. 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 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 started looking into importing, and its relationship with other firm activities such as exporting. 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; Serti, Tomasi, and Zanfei (2010) and Castellani, Serti, and Tomasi (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 the opposite. Evidence on learning–by–importing is also inconclusive. Kasahara and Rodrigue (2008) for Chile; Smeets and Warzynski (2013) for Denmark; Halpern, Koren, and Szeidl (2009) 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 provide 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 of productivity gain from importing. These mixed results are partly attributable to methodological choices or inherent differences in the nature of the import–productivity nexus across countries and overtime. Therefore, a complete understanding of the causal relationship calls for further accumulation of empirical evidence from different countries.

Partly due to data unavailability, the new empirical trade literature is also characterized by neglect of firms in low income countries with the exception of few studies. Mengistae and Pattillo (2004) find export productivity premia for Ethiopia, Ghana and Kenya. Bigsten et al. (2004) provide weak evidence of self–selection of firms into export market but strong evidence of learning–by–exporting for firms in Cameroon, Kenya, Ghana and Zimbabwe. Similarly, a study by Van Biesebroeck (2005) on Sub–Saharan manufacturing firms from Burundi, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Tanzania, Zambia, and Zimbabwe show that exporters are better performing, and there is a productivity gain from exporting. Relatedly, Bigsten and Gebreeyesus (2009) document evidence of self–selection of more productive firms into the export market as well as productivity improvement after entry in Ethiopian manufacturing. Foster-McGregor, Isaksson, and Kaulich (2014) analyze firm productivity differences in 19 Sub-Saharan African countries and show that those simultaneously exporting and importing are the most productive whereas their domestic counterparts are the least productive.

The aforementioned studies on African manufacturing firms exclusively focus on the relationship between firm productivity and exporting.[1] For instance, even though the Ethiopian manufacturing sector has been a subject of several empirical investigations, importing behavior of firms in the sector has been ignored. This is puzzling given the dominant role of imports in the foreign trade of the country. Import of goods and services form around 28% of GDP over the period 1996–2011 whereas the corresponding figure for exports is 13%. During the same period manufacture imports and exports constitute around 70% and 9% of the total merchandise imports and exports respectively. This provides a rationale for analyzing import behavior of firms as an essential step towards a complete understanding of the nature of and gains from international trade at firm and aggregate level in the context of a least developed country.

In this paper, I investigate the casual link between importing and productivity using firms in Ethiopian manufacturing. I use a rich dataset over the period 1996–2011. In the analysis, I

[1] An exception is a study by Foster-McGregor et al. (2014) which investigates productivity differences of firms importing besides exporting. One caveat of this study is its use of cross–sectional data, and therefore neglects the dynamics overtime.

distinguish between domestic and imported inputs in the production function, and treat import as additional state variable determining firm exit and investment decisions as well as evolution of their productivity. With such a specification it is possible to disentangle the static and dynamic effects of importing. The descriptive statistics show that the majority of the firms are globally active, and importing is the most common form of global activity. Second, I find a positive, statistically significant and economically large import premia confirming previous findings that importing firms are better performing. Third, I provide evidence of self-selection of more productive firms into importing in line with the fact that there are substantial sunk and fixed costs of importing. Lastly, I show that there are dynamic productivity gains from importing albeit a momentary adverse effect at the beginning. However, the small size of the productivity gain highlights the limited absorptive capacity of firms in the economy.

This paper is related to several contributions on firm 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 et al. (1997). Methodologically, I follow Kasahara and Rodrigue (2008) in the specification of the structural model. Unlike their study, possibilities of firm level technology spillovers via imported inputs are studied in the context of a least developed country with a different macroeconomic environment, factor and product markets and at a different stage of economic development. By focusing on a typical least developed country, I accommodate not only the potentials of technology transfer but also the absorptive capacity of a country in determining the size and pace of trade–related international knowledge spillovers. In this respect, this paper is linked to a strand of literature in economic growth such as Acemoglu and Zilibotti (2001) that show a technology and worker skill mismatch leading to productivity differences even when countries have free access to technology. It is also related to Los and Timmer (2005) study on the pace of assimilation of spillovers of appropriate of technology as an explanation of productivity differences across countries. At microeconomic level, this study is connected to recent contributions by Yasar and Morrison Paul (2007) and Yasar and Morrison Paul (2008) investigating different channels of technology transfer, and Yasar (2013) and Augier et al. (2013) examining firm absorptive capacity and productivity effects of imported inputs. Unlike these studies, I consider the latest decade where the world experienced a surge in trade in intermediate goods.[2] I also exploit 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 firms are missing. In this respect, this study provides the first evidence.

The rest of the paper is organized as follows. Section 2 provides background information on sectoral composition and international trade structure of Ethiopian economy. Section 3 presents

[2] According to UNCTAD (2014) report, trade in intermediate goods totaled 7 trillion USD and accounted for 40% of the world trade in 2011.

the data source and establishes a set of stylized facts. Section 4 provides evidence on selection of firms into importing. Section 5 develops a theoretical framework and an empirical strategy to examine any productivity gain from importing. It also discusses the estimation results. Section 6 concludes.

2 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 experienced a highly fluctuating growth pattern—ranging from -3.46% in 1998 to 13.57% in 2004. However, the economy enjoyed nearly decades of rapid economic growth especially after 2003, albeit starting from a rather low level. It expanded on average by 7.62% 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.

2.1 Sectoral composition

Ethiopian economy is highly agriculture based. Table 1 shows that 48.02% of the value added in the economy come from agriculture. However, the sector experienced a decline in its contribution to aggregate output from 55.35% in 1996 to 45.57% in 2011. This decline is due to relatively slower sectoral growth rate—5.74% in agriculture; 6.60% in manufacturing, and 10.30% in the service sector over the years 1996–2011. Owing to heavy reliance on rain fed agriculture, the growth rate in the sector has been characterized by extreme fluctuations ranging from -10.48% in 2003 to 16.96% in 1996. Regarding the manufacturing sector, Ethiopia has a very narrow industrial base. The share of the sector is very small, below 10%, for all the periods under the study. Despite its strong growth performance, the contribution of the sector to the value added in the economy has declined recently. On the other hand, the service sector experienced consistently high growth rate and saw its contribution rising overtime.

Table 2 summarizes the characteristics of the trade sector. We see that exports and imports constitute, on average, 12.99% and 28.01% of total output in the economy. These sectors registered rapid, yet fluctuating, growth rates; 12.13% and 12.77% respectively. These growth rates signify the increase in the share of exports and imports from 9.35% and 16.43% in 1996 to 17% and 32.14% in 2011 respectively showing increasing openness and growing integration to the global economy. It is also important to note that the integration is dominantly through imports. We also 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%, whereas manufacture imports constitute a significantly higher proportion, 70.18%. While the share of manufacture exports remains more or less stable, the share of manufacture imports declined significantly from 84.49% in 1996 to 67.13% in 2011.

2.2 Geographic orientation

Figure 1 shows the regional distribution of Ethiopian foreign trade. Trade is mainly concentrated in high income countries in Europe and North America. The country trades 69.10% of the exports and 55.54% of the imports with these high income economies. 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%, 6.07%, and 3.60% respectively. The respective figures for imports are 4.88%, 12.36%, and 8.40%. Trade with countries in Latin America and Caribbean, and Sub-Saharan Africa is very small and expanded only incrementally overtime. We also observe the declining importance of traditional markets namely high income economies, and the growing importance of trade partners in Asia particularly on the import trade.

To sum up, it is shown that the fundamental aspects of Ethiopian economy have not undergone major structural changes. However, there were sizable changes in terms of sectoral output compositions and geographical orientations of international trade. Increasing overall openness of the economy along with the dominance and increasing importance of imports in the economy is particularly observed. These changes cause firms to adapt their behavior under different domestic and global economic circumstances. To this end, rigorous analyses of firm behavior in terms of market entry and exit decisions as well as the subsequent outcomes are required for a complete understanding of the nature, determinants and effects of international trade.

3 Basic facts from Ethiopian manufacturing

In this section, I describe the data source and the variables defined. I also summarize the nature of firm international trade primarily focusing on importing activity.

3.1 Data description

The dataset used in this paper come from the Central Statistical Agency of Ethiopia. The agency conducts annual large and medium scale survey of firms engaged in manufacturing activities. Classification of economic activities as manufacturing is based on ISIC–Rev.3 classification, and includes industries 15–37 at 2–digit ISIC. The survey covers all firms with at least 10 employees and that 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 available information on initial stock, investment, value sold and depreciated using the perpetual inventory method. Information on local and imported material inputs, and 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. Finally, I deflate all nominal values using the consumer price index available from the World Development Indicators database.

To have enough 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 with zero or unreported value of production, capital stock, material input, energy expense, number of employees, and other inconsistencies to consider only firms with real economic activity. I also exclude firms appearing only once during the period under study. In the final dataset there are 2,350 firms belonging to 12 industries and constituting 12,510 firm–year observations.

3.2 Stylized facts

Here, I provide a simple description of the data that characterizes the international trade activities of Ethiopian firms.

Fact 1 There is substantial variation in firm trade participation across industries.

Table 3 shows large differences in firm export and import participation across industries. In 1996, textiles (20.83%), leather product (21.43%), wood products (7.69%), and wearing apparel (6.67%) were industries of relatively high export market participation rate. In contrast, food and beverage (2.34%); non-metallic products (1.96%), and furniture (1.85%) had very low export participation rate. In the extreme case, there were no exporters in the printing and publishing, chemicals, rubber and plastic, and fabricated metals industries. In 2011, there has been a dramatic increase in the export participation rate of firms in each of the industries except the furniture industry. For instance, participation rate increased to 20.20% in food and beverage, 50.00% in textile, 45.90% in leather products, and 21.05% in chemical industries.

There are also substantial heterogeneities in firm import participation across industries. In 1996, chemicals (100%), rubber and plastic (100%), fabricated metals (89.47%), and textiles (83.33%) comprised industries of very high import participation rate. On the contrary, participation rate was as low as 21.57% in the case of non-metallic products industry. Over the 15–year window, food and beverage, leather products, chemicals, rubber and plastic, and fabricated metals saw their import participation rate decline while the remaining industries experienced a rise.

Comparing export and import participation rates, we observe that importing is the most common activity, where 69.74% of firms import while the corresponding figure for export is 5.86%

over the period 1996–2011. These characteristics are against findings from manufacturing sectors of developed countries, where the incidence of exporting is more common and importing is rarer.[3] In terms of dynamics overtime, we see that firms have become more globally engaged through exporting while slightly lower fraction of firms import. Export participation increased from 4.72% in 1996 to 14.77% in 2011, and import participation declined from 67.87% in 1996 to 64.89% in 2011. In general, there are clear indications of increasing presence of firms in the world market mainly due to more firms have started serving export markets.

Fact 2 There are significant trade activity premia.

I divide firms into four mutually exclusive groups based on their exporting and importing activity—domestic (neither exporting nor importing); export only (serving domestic and export markets but not importing); import only (serving domestic market, and importing), and both (serving domestic and export markets, and importing). To estimate the activity premium, I run the following regression equation:

$$y_{it} = \beta_0 + \beta_1 Exp_{it} + \beta_2 Imp_{it} + \beta_3 Both_{it} + Controls_{it} + \delta_t + \tau + \epsilon_{it}$$

where y_{it} refers to several performance indicators such as value added, capital, material, and others. Exp_{it}, Imp_{it}, and $Both_{it}$ are dummy variables taking a value of 1 if the firm is export only, import only or both respectively. In the regression, I control for year δ_t and industry τ fixed effects as well as employment size (except for the last two indicators). All the estimates measure average percentage differences relative to domestic firms. Table 4 shows that two–way trading firms are the most productive whose production activity 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 exporting firms are more productive, capital intensive and larger in size compared to importing firms. I find that export only firms not necessarily use more energy per worker and hire more skilled workers. I also find that import only firms are less capital intensive, and they not necessarily use more material per worker.

Fact 3 There is high persistence in firm trade status.

Table 5 presents transition probabilities highlighting the dynamics of firm activities in terms of scope. There is high state dependence of firms engaged in the domestic market (67.19%), importing only (84.30%) and exporting and importing (76.95%). There is exceptionally low incidence of state dependence among export only firms; 33.75%. Firms engaged in either exporting or importing are more likely to add importing (38.75%) but less likely to add exporting (1.71%) as additional activity compared to firms engaged in neither of the activities; 31.40% and 2.10% to start importing

[3] Findings by Bernard et al. (2007) for a large economy the U.S. and Eriksson, Smeets, and Warzynski (2009) for a small open economy Denmark are typical cases of greater export participation rate in the manufacturing sectors of developed countries.

and exporting respectively. We here note the unexpectedly low probability of adding exporting as additional firm activity. Furthermore, firms doing both are less likely to abandon any of these activities compared to those engaged in only one of them. These firms abandon exporting, importing or both with a probability of 16.43%, 10.62%, and 4.01% respectively. In contrast, firms only exporting (importing) abandon exporting (importing) with a probability of 13.75% (13.76%). Finally, the last row summarizes the average of the cross-sectional distribution of firms. It shows that there is a very high incidence of firm involvement in international trade; 71.41% of the firms are active in the world market via exporting, importing or both.

To further highlight the extent of state dependence in firm activities, I run a probit regression of current import status on current period value added per worker $lp_{i,t}$, capital stock k_{it}, share of skilled workers l_{it}, previous period import M_{it-1} and export X_{it-1} statuses, and year δ_t and industry τ fixed effects.

$$Pr(M_{it} = 1) = \Phi\left(\beta_0 + \beta_1 lp_{it} + \beta_2 k_{it} + \beta_3 l_{it} + \beta_4 M_{it-1} + \beta_5 X_{it-1} + \delta_t + \tau + \epsilon_{it}\right)$$

Table 6 shows the marginal effects from the probit regressions. We see that productivity, capital stocks, and previous history of export and import are positively and significantly correlated with current period trade status of firms. This implies that those firms with higher productivity and capital intensity are more likely to become exporters and importers. Statistical significance of previous period trade status of firms shows the presence of market entry costs and complementarity between exporting and importing. The fact that current period import status is significantly correlated with previous history of export market participation strongly suggest that those with export market experience are able to absorb at least part of the import market entry costs, and therefore more likely to import. Another plausible explanation is significant productivity gains from exporting further driving the self-selection of firms into importing.[4] However, the complementary effect of importing in terms of increasing the likelihood of exporting is weak as seen from the insignificance of previous importing decision in the export participation regression.

4 Selection into importing

The empirical facts in the previous section establish that importing firms are on average more productive. They also indicate that there are substantial market entry costs associated with importing. One possible explanation of these empirical facts is that more productive firms self–select themselves into importing markets. To test the empirical validity of this argument, I plot the productivity distribution of firms years prior to some of them start importing. Figure 2 shows the plot of the probability and cumulative densities of firm productivities on the vertical axis,

[4] Previous findings on African firms show substantial learning–by–exporting. In Ethiopian case, using the same data source Bigsten and Gebreeyesus (2009) document a significant productivity gain of 15-26% from exporting over the period 1996–2005.

and a normalized firm productivity in log scale on the horizontal axis. Here, the normalization is achieved by dividing the actual firm productivity by industry average to which the firm belongs with the objective of accounting for possible industry idiosyncrasies, and the relative position of a given firm in the industry. The first panel depicts that the density function of importing firms lies to the right of the productivity density of non-importing firms for all the time lags considered. Relatedly, in the second panel the cumulative density function of importing firms lies below that of non-importing firms. These features of the productivity distributions indicate that importing firms were more productive before becoming importers compared to firms currently not importing. This result imply that there is selection of more productive firms into importing activity, in accordance with the presence of substantial market costs of importing.

To use a standard approach in testing the self–selection hypothesis, I run a regression of lagged values of productivity lp_{it-s} measured by value added per worker, on current import status M_{it}, and control variables such as firm capital k_{it-s}, share of skilled workers l_{it-s}, export market participation $X_{i,t-s}$ as well as year δ_t and industry τ fixed effects.

$$lp_{it-s} = \beta_0 + \beta_1 M_{it} + \beta_2 k_{it-s} + \beta_3 l_{it-s} + \beta_4 X_{it-s} + \delta_t + \tau + \epsilon_{it} \ ; \ s = 1, 2, 3$$

Table 7 presents estimates of percentage differences in productivity between current importers and non-importers periods prior to becoming importers. I find a positive and highly significant estimate for the current period dummy implying that these firms were actually more productive even before they start importing.

The standard approach focuses only on a single moment of the productivity distribution. To further establish the self-selection argument, I undertake the Kolmogorov-Smirnov test. This test uses all the information in the empirical productivity distribution. Th tests proceeds as follows. Let $x_1, x_2, ..., x_{n_1}$ and $x_{n_1+1}, x_{n_1+2}, ..., x_{n_1+n_2}$ be random samples of size n_0 and n_1 independently drawn from the cumulative distribution functions $\Omega_0(x)$ and $\Omega_1(x)$. The distribution functions $\Omega_0(x)$ and $\Omega_1(x)$ represent the cumulative productivity densities of importing and non-importing firms respectively. To test whether the two distributions are identical, I do the two–tailed test of the null hypothesis $H_0 : \Omega_1(x) - \Omega_0(x) = 0$ against the alternative $H_1 : \Omega_1(x) - \Omega_0(x) \neq 0$ where $x \in \mathbb{R}$. In this case the test statistics is given by $D^* = \underset{x}{max}(|\Omega_1(x) - \Omega_0(x)|)$. Similarly, the first order stochastic dominance of the productivity distributions is checked by testing the null hypothesis $H_0 : \Omega_1(x) - \Omega_0(x) = 0$ against the alternative $H_1 : \Omega_1(x) - \Omega_0(x) \leq 0$ where $x \in \mathbb{R}$. In this case the test statistic becomes $D^* = \underset{x}{max}(\Omega_1(x) - \Omega_0(x))$. In both cases Ω_0 and Ω_1 are replaced by the empirical distribution functions $\Omega_{n_0} = \frac{\sum \mathbb{I}(i : x_i \leq x)}{n_0}$ and $\Omega_{n_1} = \frac{\sum \mathbb{I}(i : x_i \leq x)}{n_1}$ respectively.[5]

The Kolmogorov-Smirnov test results are shown in Table 8. From the two–tailed test, we reject the null hypothesis that currently importing and non-importing firms have the same productivity distribution. Relatedly, the one–tailed test fails to reject the null hypothesis that the productivity

[5] For a discussion on the test procedure, see Delgado, Farinas, and Ruano (2002).

distribution of importing firms stochastically dominates that of the non-importing counterparts. 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.

Generally, summaries from the transition matrix, and estimates from the probit and least squares regressions indicate that there are substantial market entry costs leading to self-selection of more productive firms into importing.

5 Learning–by–importing

In this section, I test the learning–by–importing hypothesis by adopting a structural approach that addresses several estimation issues. Here, I distinguish between a static and dynamic effects of importing and estimate them separately.

5.1 Technology

I closely follow Kasahara and Rodrigue (2008) and specify the production technology of firm i at time period t as:

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

where Y_{it} refers to output; K_{it} capital; L_{it}^u and L_{it}^s unskilled and skilled labor respectively; E_{it} energy; $m(j)$ a composite of domestic and foreign of intermediate goods; β's are elasticities of output with respect to inputs of production; $\theta > 1$ elasticity of substitution between any two intermediate goods, and $N(d_{it}) = N_{it}^d + d_{it} N_{it}^f$ where N_{it}^d and N_{it}^f denote the number of domestically produced and imported intermediate goods respectively, and $d_{it} = 1$ is an indicator function if the firm uses imported intermediates.[6] In this specification, I treat different varieties of intermediates goods as horizontally differentiated with no quality difference. Finally, the variable A_{it} is the total factor productivity term unobserved by the econometrician.

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

$$Y_{it} = A_{it} N(d_{it})^{\frac{\beta_m}{\theta-1}} K_{it}^{\beta_k} L_{it}^{u\,\beta_u} L_{it}^{s\,\beta_s} E_{it}^{\beta_e} M_{it}^{\beta_m} \tag{2}$$

where $ln(A_{it}) = \frac{\beta_m}{\theta-1} ln(N(d_{it})) + \omega_{it} + \epsilon_{it}$ is total factor productivity which comprises a static

[6] It is not possible to distinguish between imports of intermediate and capital goods in the data. However, this is without loss of generality for intermediate goods constitute the greatest share of international trade.

component due to variety effect of intermediates $\frac{\beta_m}{\theta-1}ln(N(d_{it}))$; a dynamic component capturing learning–by–importing ω_{it}, defined to be unobserved firm productivity, and unobserved shock ϵ_{it}.

5.2 Decision problem

As in Olley and Pakes (1996) model, at the beginning of each time period a firm faces three decision problems. First, it 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, it chooses levels of freely variable inputs labor and energy, and makes capital investment and import decisions. That is, capital evolves according to $K_{it} = (1-\delta)K_{it-1} + I_{it-1}$; assuming current investment will be productive in the next period. Firm productivity is known to firms and follows, conditional upon survival χ_{it}, a controlled first order Markov process $\omega_{it} = E\left[\omega_{it} \mid \omega_{it-1}, d_{it-1}, \chi_{it} = 1\right] + \zeta_{it}$. The maximum expected discounted reward for a representative firm at time period t is given by the Bellman equation:

$$\begin{aligned}\mathcal{V}\left(\omega_t, k_t, d_{t-1}\right) = max\Bigg\{\Phi_t, \max_{d_t, I_t}\Big\{&\pi_t(\omega_t, k_t, d_t) - C_k\left(k_t, I_t\right) - C_d\left(d_t, d_{t-1}\right) \\ &+ \beta \int \mathcal{V}\left(\omega_{t+1}, k_{t+1}, d_t\right) dF\left(\omega_{t+1}, k_{t+1}, d_t \mid \omega_t, k_t, d_t, \chi_t = 1\right)\Big\}\Bigg\}\end{aligned} \tag{3}$$

where ω_t, k_t, d_t refers 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 $\chi_{it} = \underline{\omega}_t > \omega_{it}(k_{it}, d_{it-1})$; discrete import $d_{it} = d_t(\omega_{it}, k_{it}, d_{it-1})$, and investment demand $I_{it} = I_t(\omega_{it}, k_{it}, d_{it-1})$ functions. The dependence of the policy functions on import variable follows from treating previous period import decision as a state variable. Its inclusion as additional state variable is to capture any dynamic productivity effects of imported intermediates.

5.3 Empirical strategy

I now present the empirical procedure used to estimate parameters of the production function and transition equations of the model. Logarithmic transformation of the production function and inclusion of the discrete import variable d_{it} to capture the static effects of imported intermediate $\frac{\beta_m}{\theta-1}ln(N(d_{it}))$ yields

$$y_{it} = \beta_k k_{it} + \beta_u l^u_{it} + \beta_s l^s_{it} + \beta_e e_{it} + \beta_m m_{it} + \beta_d d_{it} + \omega_{it} \tag{4}$$

From a controlled first–order Markov process of productivity and assuming a linear approximation, we have

$$\begin{aligned}\omega_{it} &= E\left[\omega_{it} \mid \omega_{it-1}, d_{it-1}, \chi_{it}=1\right] + \zeta_{it} \\ &= \tau + \rho\,\omega_{it-1} + \gamma\, d_{it-1} + \zeta_{it}\end{aligned} \tag{5}$$

where the error term ζ_{it} is independent of ω_{it-1} and d_{it-1} and with a known distribution. In the productivity equation, we condition on survival probability to control for endogenous selection of firms in the data.[7] 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 productivity. On the other hand, $\gamma > 0$ suggest a dynamic productivity gain, and the long-run effect can be summarized as $\frac{\gamma}{1-\rho}$.

I adopt the 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 $m_{it} = m_t(k_{it}, \omega_{it}, d_{it})$. Under certain regulatory conditions, we can express the unobserved productivity in terms of observed capital, material inputs and import variables as $\omega_{it} = \omega_t(m_{it}, k_{it}, d_{it})$. The resulting estimating equation is given by:

$$y_{it} = \beta_u l^u_{it} + \beta_s l^s_{it} + \beta_e e_{it} + \varphi_t(m_{it}, k_{it}, d_{it}) + \epsilon_{it} \tag{6}$$

where $\varphi_t(m_{it}, k_{it}, d_{it}) = \beta_k k_{it} + \beta_m m_{it} + \beta_d d_{it} + \omega_t(m_{it}, k_{it}, d_{it})$. I estimate equation (6) by least squares in which $\varphi_t(.)$ is approximated using third order polynomial function. In the regression, I also control for industry and time fixed effects. In so doing, β_u, β_s and β_e are consistently estimated. I also recover $\varphi_t(k_{it}, m_{it}, _{it})$. Then, I run a probit regression of $P_{it} = Pr(\chi_{it} = 1) = \chi_t(m_{it}, k_{it}, k_{it-1}, d_{it-1}))$ where $\chi_t(.)$ is approximated linearly in its arguments. The probit estimation yields predicted survival probabilities of firms $\hat{P}_{it}$ for a given level of capital, productivity, and previous period import status.

After estimating equation (6) and recovering $\phi_{it} \equiv \hat{\varphi}_t(k_{it}, m_{it}, _{it}) = \beta_k k_{it} + \beta_m m_{it} + \beta_d d_{it} + \omega_{it}$, I substitute ϕ_{it} in (5) and obtain the following estimating equation:

$$\begin{aligned}\phi_{it} = \tau + \beta_k k_{it} + \beta_m m_{it} + \beta_d d_{it} + \rho(\phi_{it-1} - \beta_k k_{it-1} - \beta_m m_{it-1} - \beta_d d_{it-1}) \\ + \gamma d_{it-1} + \Omega_t(\phi_{it-1} - \beta_k k_{it-1} - \beta_m m_{it-1} - \beta_d d_{it-1}, P_{it}) + \psi_{it}\end{aligned} \tag{7}$$

where $\Omega_t(.)$ is included to control for firm attrition in the data, and $\psi_{it} = \zeta_{it} + \epsilon_{it}$ is a composite error term. Equation (7) is estimated by non-linear least squares technique. For the purpose of comparison, I also estimate equation (7) without correcting for endogenous selection of the firms.

To investigate whether intensive use of foreign varieties improves productivity, I invoke the symmetry assumption regarding the production and employment of intermediate goods. From

[7] Gebreeyesus (2008) find an annual firm turnover rate of (average of entry and exit rates) 22% over the years 1996-2003 in Ethiopian manufacturing. This strongly suggests the need to account for firm attrition in the data.

the assumption, it follows that the ratio of imported to total intermediate inputs is given by: $\frac{M_{it}^f}{M_{it}} = \frac{N_{it}(1)\bar{m} - N_{it}(0)\bar{m}}{N_{it}(1)\bar{m}} = \frac{N_{it}(1) - N_{it}(0)}{N_{it}(1)}$. 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. Introducing this ratio into the production function and productivity equation, we obtain:

$$y_{it} = \beta_k k_{it} + \beta_u L_{it}^u + \beta_s L_{it}^s + \beta_e e_{it} + \beta_m m_{it} + \beta_d n_{it} + \omega_{it} \tag{8}$$

$$\begin{aligned} \omega_{it} &= E\left[\omega_{it} \mid \omega_{it-1}, n_{it-1}, \chi_{it} = 1\right] + \zeta_{it} \\ &= \tau + \rho\, \omega_{it-1} + \gamma\, n_{it-1} + \zeta_{it} \end{aligned} \tag{9}$$

where $n_{it-1} = log\left(\frac{M_{it-1}^f}{M_{it-1}}\right)$, and estimation proceeds in the same way as in a discrete import variable case.

To summarize, the parameter vector of interest $\theta = (\theta_y, \theta_\omega)$ comprises production function parameters on capital, unskilled and skilled labor, energy and material $\theta_y = (\beta_k, \beta_l, \beta_s, \beta_e, \beta_m, \beta_d)$, and productivity transition parameters $\theta_\omega = (\rho, \mu)$.

5.4 Result

This section discusses the least square (OLS), fixed effects (FE) and Levinsohn–Petrin (LP) estimation results.

Columns (1)–(4) of Table 9 presents parameter estimates where import is treated as a discrete variable. The OLS results in column (1) shows 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 discrete import variable is positive and significant implying that there is productivity gain due to importing, approximately 6.18%. It is well known that least squares estimation of production functions is plagued by endogeneity problems. Assuming time invariant firm effects, demeaning of the estimation equation yields a new estimating equation free of endogeneity. Under this assumption, I run the fixed effects regression and the results are shown in column (2). The FE estimates are very close to their OLS counterparts in terms of sign and statistical significance. However, there are size differences between them. As expected, FE estimates on capital, skilled labor and material inputs are lower than the OLS estimates. The only exception is the estimate on unskilled labor which becomes higher with FE estimation suggesting that there was downward bias in OLS estimate for unskilled labor. From the FE estimates we see that there are no immediate, significant productivity gains from using imported inputs, albeit a positive estimate.[8]

Least squares and fixed effects regression impose restrictive assumptions. Consistent estimation of the parameters using OLS requires that no correlation between freely variable inputs and seri-

[8] Consistent estimation of the input elasticities under OLS and FE prevents the estimation of ρ and γ.

ally uncorrelated firm productivity whereas FE assumes firm-specific, time invariant unobserved productivity. Additionally, with these techniques it is not possible to endogenize productivity and distinguish between static and dynamic gains. To overcome these limitations and to introduce a richer structure, I use adopt the LP estimation algorithm.

In columns (3) and (4), LP estimates of the coefficients on freely variable inputs are similar to OLS and FE estimates in their statistical significance. However, the LP estimates 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 probit model. The estimate are shown in columns (3) and (4) respectively. They are very similar in statistical significance, direction and magnitude. They show that firms experience immediate decline in productivity due to importing, 0.8%. This is not unexpected in the light of previous findings that showed firms might need to adjust their production structure to benefit from the availability of cheaper and probably better imported intermediates. It is also shown that there is strong state dependence in the evolution of productivity, $\rho = 0.78$ and 0.65, and there are dynamic productivity gains due to importing, 1.1–1.2%. Long-run effects of imported intermediates predict a firm productivity improvement around 3.5–4.9%.

In columns (5)–(8) I present the estimation results in which import is treated as how intensive is the use of foreign varieties among importing firms. Both the OLS and FE estimates display similar patterns as their counterparts in the discrete cases. The only exception is the significance of the import variable under FE regression. The LP estimates show that a 1% increase in the share of imported input increases firm productivity by 0.02% immediately and 0.01% in the period after. In the long-run, the productivity gain from importing is approximately 0.04–0.22%. Note that the long–run productivity gain increases substantially when endogenous selection of firms is addressed in the estimation.

To see the time path, I simulate the productivity evolution of a hypothetical firm overtime. In the simulation, I use the LP estimates while ignoring the unobserved shocks firms experience in each period. Figure 3 shows the evolution of productivity of a firm that start importing at period 1 and continues to do so then after. We see that the firm experiences a momentary decline in productivity. However, after some time period the firm adjusts its production structure and be able to enjoy productivity gains from importing. We observe that correction of endogenous selection of firms gives rise to a rapidly converging path, albeit to a lower level. In Figure 4, 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 0.47% of the materials used in production, which is the average import share in the data. We observe a significant productivity improvement overtime. We notice that correcting for the survival probability of firms makes a substantial difference.

All in all results from the estimation exercise show that there are significant productivity gains from importing. When considering the import participation of firms only, we expect overall productivity improvement ranging from zero as in FE estimation to 3.5-4.9% as in LP estimation. Considering how intensive the employment of imported intermediate affects productivity, we see that there are both immediate and long term benefits associated with more intensive use of imported inputs.

The main results of the above empirical investigations highlights the fact that even though there are temporary declines in productivity, the firm ultimately benefits by importing, and even more so if it intensifies the relative employment of imported varieties vis-à-vis the domestic ones. However, given the fact that trade is concentrated in technologically advanced countries—56% of the Ethiopian import trade, significant portion of firms are importing—70%, and a production process characterized by intensive use of imported inputs—around 50% of the material is imported, the estimated productivity gains are relatively small. This strongly suggests the limited absorptive capacity of firms in the economy.

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 firms have been greatly neglected partly due to the lack of detailed accounting information and trade statistics. Even among a handful of existing studies, utmost focus has been on exporting. In this respect, the literature on African manufacturing remains largely incomplete, especially in light of high import–to–GDP ratios and import share of manufacture in these economies. In this paper, with the objective of filling this void in the literature, I use 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 feature shows that there is heavy reliance on imported intermediates and capital goods, partly due to limited availability of domestically manufactured inputs. Additionally, I find a positive link between importing and productivity, and other firm dimensions.

Examination of the direction of causality in the import–productivity relationship show that more productive firms self–select themselves into importing indicating significant sunk and fixed costs of importing. Additionally, to test the causal effect of importing on firm productivity, I use a framework in which the static and dynamic effects are estimated separately. The results provide evidence of learning–by–importing albeit an initial temporary decline. Furthermore, intensive use of imported inputs is associated with greater productivity improvement among importing firms.

However, the small size of the productivity gains demonstrate the limited absorptive capacity of firms in the economy. This feature is consistent with findings, mostly in economic growth literature, which emphasize the mismatch between human capital of domestic workers and technological sophistication of imported inputs in hindering international knowledge spillovers in the case of least developed countries.

References

Acemoglu, D., & Zilibotti, F. (2001). Productivity Differences. *Quarterly Journal of Economics*, *116*(2), 563–606.

Acharya, R. C., & Keller, W. (2009). Technology Transfer Through Imports. *Canadian Journal of Economics*, *42*(4), 1411–1448.

Augier, P., Cadot, O., & Dovis, M. (2013). Imports and TFP at the Firm Level: The Role of Absorptive Capacity. *Canadian Journal of Economics*, *46*(3), 956–981.

Bernard, A. B., & Jensen, J. B. (1995). Exporters, Jobs, and Wages in US Manufacturing: 1976-1987. *Brookings Papers on Economic Activity. Microeconomics*, *1995*, 67–119.

Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2007). Firms in International Trade. *Journal of Economic Perspectives*, *21*(3), 105–130.

Bigsten, A., Collier, P., Dercon, S., Fafchamps, M., Gauthier, B., Willem Gunning, J., ... others (2004). Do African Manufacturing Firms Learn from Exporting? *Journal of Development Studies*, *40*(3), 115–141.

Bigsten, A., & Gebreeyesus, M. (2009). Firm Productivity and Exports: Evidence from Ethiopian Manufacturing. *Journal of Development Studies*, *45*(10), 1594–1614.

Castellani, D., Serti, F., & Tomasi, C. (2010). Firms in International Trade: Importers' and Exporters' Heterogeneity in Italian Manufacturing Industry. *World Economy*, *33*(3), 424–457.

Coe, D. T., & Helpman, E. (1995). International R&D Spillovers. *European Economic Review*, *39*(5), 859–887.

Coe, D. T., Helpman, E., & Hoffmaister, A. W. (1997). North-South R&D Spillovers. *Economic Journal*, *107*(440), 134–49.

Coe, D. T., Helpman, E., & Hoffmaister, A. W. (2009). International R&D Spillovers and Institutions. *European Economic Review*, *53*(7), 723–741.

Delgado, M. A., Farinas, J. C., & Ruano, S. (2002). Firm Productivity and Export Markets: A Non-parametric Approach. *Journal of International Economics*, *57*(2), 397–422.

Dovis, M., & Milgram-Baleix, J. (2009). Trade, Tariffs and Total Factor Productivity: The Case of Spanish Firms. *World Economy*, *32*(4), 575–605.

Eriksson, T., Smeets, V., & Warzynski, F. (2009). Small Open Economy Firms in International Trade: Evidence from Danish Transactions-level Data. *Nationaløkonomisk tidsskrift*, *147*(2), 175–194.

Forlani, E. (2010). Irish Firms' Productivity and Imported Inputs. *CORE Discussion Papers # 015*.

Foster-McGregor, N., Isaksson, A., & Kaulich, F. (2014). Importing, Exporting and Performance in Sub-Saharan African Manufacturing Firms. *Review of World Economics*, *150*(2), 309–336.

Gebreeyesus, M. (2008). Firm Turnover and Productivity Differentials in Ethiopian Manufacturing.

Journal of Productivity Analysis, *29*(2), 113–129.

Halpern, L., Koren, M., & Szeidl, A. (2009). Imported Inputs and Productivity. *CEFIG Working Papers # 08*.

Kasahara, H., & Lapham, B. (2013). Productivity and the Decision to Import and Export: Theory and Evidence. *Journal of International Economics*, *89*(2), 297–316.

Kasahara, H., & Rodrigue, J. (2008). Does the Use of Imported Intermediates Increase Productivity? Plant-level Evidence. *Journal of Development Economics*, *87*(1), 106–118.

Levinsohn, J., & Petrin, A. (2003). Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies*, *70*(2), 317–341.

Lööf, H., & Andersson, M. (2010). Imports, Productivity and Origin Markets: The Role of Knowledge-intensive Economies. *World Economy*, *33*(3), 458–481.

Los, B., & Timmer, M. P. (2005). The 'appropriate technology' Explanation of Productivity Growth Differentials: An Empirical Approach. *Journal of Development Economics*, *77*(2), 517–531.

Mengistae, T., & Pattillo, C. (2004). Export Orientation and Productivity in Sub-Saharan Africa. *IMF Staff papers*, 327–353.

Muendler, M.-A. (2004). Trade, Technology, and Productivity: A Study of Brazilian Manufacturers, 1986-1998. *CESifo Working Paper #1148*.

No, J. Y. A. (2009). International Transmission of Technology and Trade: The Role of Cross-country Heterogeneity. *International Economic Journal*, *23*(3), 427–446.

Olley, G. S., & Pakes, A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica*, *64*(6), pp. 1263-1297.

Serti, F., Tomasi, C., & Zanfei, A. (2010). Who Trades with Whom? Exploring the Links Between Firms' International Activities, Skills, and Wages. *Review of International Economics*, *18*(5), 951–971.

Smeets, V., & Warzynski, F. (2013). Estimating Productivity with Multi-product Firms, Pricing Heterogeneity and the Role of International Trade. *Journal of International Economics*, *90*(2), 237–244.

UNCTAD. (2014). *Key Trends in International Merchandise Trade*. New York and Geneva.

Van Biesebroeck, J. (2005). Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms. *Journal of International Economics*, *67*(2), 373–391.

Van Biesebroeck, J. (2008). The Sensitivity of Productivity Estimates: Revisiting Three Important Debates. *Journal of Business & Economic Statistics*, *26*(3), 311–328.

Vogel, A., & Wagner, J. (2010). Higher Productivity in Importing German Manufacturing Firms: Self-selection, Learning from Importing, or Both? *Review of World Economics*, *145*(4), 641–665.

Yasar, M. (2013). Imported Capital Input, Absorptive Capacity, and Firm Performance: Evidence from Firm-level Data. *Economic Inquiry*, *51*(1), 88–100.

Yasar, M., & Morrison Paul, C. J. (2007). International Linkages and Productivity at the Plant Level: Foreign Direct Investment, Exports, Imports and Licensing. *Journal of International Economics*, *71*(2), 373–388.

Yasar, M., & Morrison Paul, C. J. (2008). Foreign Technology Transfer and Productivity: Evidence from a Matched Sample. *Journal of Business & Economic statistics*, *26*(1), 105–112.

Table 1: Sectoral composition of Ethiopian economy

Year	GDP	Agriculture†		Manufacturing ‡		Service§	
	% Growth	% GDP	% Growth	% GDP	% Growth	% GDP	% Growth
1996	12.43	55.35	16.96	5.64	3.23	34.03	6.59
1997	3.13	58.87	2.00	7.96	2.97	27.83	4.51
1998	-3.46	53.54	-9.64	5.74	0.38	33.84	7.22
1999	5.16	49.60	3.40	6.25	8.71	37.10	8.31
2000	6.07	48.71	3.05	6.11	6.66	38.84	11.20
2001	8.30	46.56	9.62	6.35	3.81	40.32	4.37
2002	1.51	42.50	-1.88	6.33	1.81	43.51	5.89
2003	-2.16	40.93	-10.48	6.33	1.21	44.91	9.10
2004	13.57	43.17	16.94	5.97	7.27	42.68	4.72
2005	11.82	45.61	13.54	5.36	13.03	41.33	12.30
2006	10.83	46.80	10.91	5.10	10.30	40.44	12.92
2007	11.46	46.38	9.45	5.03	9.93	40.91	15.98
2008	10.79	49.40	7.50	4.49	9.26	39.44	16.68
2009	8.80	49.60	6.36	4.19	8.62	39.93	14.92
2010	12.55	45.64	5.13	4.38	9.21	43.97	17.04
2011	11.18	45.57	9.01	4.07	9.24	43.75	13.08
1996–2011	7.62	48.02	5.74	5.58	6.60	39.55	10.30

Source: World Development Indicators, World Bank

† Agriculture corresponds to ISIC–Rev.3 divisions 1–5.
‡ Manufacturing corresponds to ISIC–Rev.3 divisions 15–37.
§ Services correspond to ISIC–Rev.3 divisions 50–99.

Table 2: Components of Ethiopian international trade

Year	Export†			Import†			% Merchandise trade‡	
	Level	% GDP	% Growth	Level	% GDP	% Growth	Manuf. Export	Manuf. Import
1996	750.1	9.35	7.30	1,318.0	16.43	16.16	9.65	84.49
1997	992.0	11.99	32.26	1,559.5	18.84	18.33	6.76	66.61
1998	1,079.6	13.51	8.83	1,720.7	21.54	10.34	6.71	77.24
1999	1,015.6	12.09	-5.93	2,081.9	24.78	20.99	9.78	70.90
2000	1,083.6	12.16	6.69	2,158.5	24.22	3.68	13.43	65.19
2001	1,169.5	12.12	7.93	2,312.3	23.96	7.12	14.31	73.85
2002	1,249.3	12.75	6.83	2,635.4	26.90	13.97	11.38	64.03
2003	1,290.4	13.46	3.29	2,657.2	27.72	0.83	3.83	70.80
2004	1,635.8	15.02	26.77	3,475.4	31.92	30.79	4.58	71.97
2005	1,858.4	15.27	13.61	4,367.2	35.87	25.66	5.36	68.51
2006	1,893.7	14.04	1.90	4,991.0	36.99	14.28	13.75	76.41
2007	1,935.0	12.87	2.18	4,873.6	32.41	-2.35	9.01	60.18
2008	1,934.3	11.61	-0.04	5,236.0	31.43	7.44	8.65	71.53
2009	1,938.5	10.69	0.22	5,297.6	29.22	1.18	8.91	68.69
2010	2,826.3	13.85	45.80	6,882.5	33.73	29.92	10.37	65.27
2011	3,856.0	17.00	36.43	7,289.4	32.14	5.91	8.77	67.13
1996–2011	–	12.99	12.13	–	28.01	12.77	9.08	70.18

Source: World Development Indicators, World Bank.

† Export and import of goods and services in million constant 2005 USD.
‡ Manufacture items comprise commodities in SITC–Rev.3 sections 5–8 excluding non–ferrous metals.

Table 3: 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

Table 4: Export and import activity premia

	Export only	Import only	Both
Output per worker	46.020***	8.211***	77.311***
	(0.110)	(0.027)	(0.060)
Capital per worker	43.952**	-14.790***	39.440***
	(0.150)	(0.052)	(0.088)
Material per worker	39.449**	4.146	68.109***
	(0.143)	(0.031)	(0.068)
Energy per worker	4.701	7.838**	38.321***
	(0.164)	(0.032)	(0.077)
Employment size	170.102***	40.020***	612.849***
	(0.121)	(0.023)	(0.059)
Sh. of skilled worker	-1.75	4.407***	13.058***
	(0.077)	(0.013)	(0.027)

Bootstrapped standard errors with 500 replications in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Transition probabilities of firm activities

		Status *t+1*			
		Domestic	Export only	Import only	Both
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
	Both	4.01	6.61	12.42	76.95
	All	28.59	1.14	64.86	5.40

Table 6: Probit estimation of export and import participation: marginal effects

	Export ($X_{i,t}$)		Import ($M_{i,t}$)	
	(1)	(2)	(3)	(4)
$lp_{i,t}$	0.004***	0.004*	0.016***	0.016***
	(0.002)	(0.002)	(0.004)	(0.003)
$k_{i,t}$	0.008***	0.007***	0.004**	0.003*
	(0.001)	(0.001)	(0.002)	(0.002)
$l_{i,t}$	-0.004	-0.004	0.009	0.009
	(0.003)	(0.003)	(0.006)	(0.007)
$X_{i,t-1}$	0.123***	0.123***	–	0.052***
	(0.004)	(0.004)		(0.020)
$M_{i,t-1}$	–	0.003	0.310***	0.309***
		(0.004)	(0.006)	(0.006)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Obs.	8,625		8,625	

Bootstrapped standard errors with 500 replications in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Self–selection into importing

	$lp_{i,t-3}$		$lp_{i,t-2}$		$lp_{i,t-1}$	
$M_{i,t}$	27.264***	25.991***	20.564***	19.429***	19.741***	18.902***
	(0.41)	(0.039)	(0.033)	(0.034)	(0.032)	(0.032)
$X_{i,t-3}$	-	45.628***	-	-	-	-
		(0.068)				
$X_{i,t-2}$	-	-	-	47.628***	-	-
				(0.062)		
$X_{i,t-1}$	-	-	-	-	-	37.744***
			-			(0.057)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj.R^2	0.421	0.424	0.433	0.436	0.455	0.457
Obs.	5,559		6,803		8,620	

Bootstrapped standard errors with 500 replications in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Kolmogorov-Smirnov test for equality of productivity distributions

Year	H_0:$\Omega_1(x)$-$\Omega_0(x)$= 0			H_0:$\Omega_1(x)$-$\Omega_0(x) \leq 0$		
	$lp_{i,t-3}$	$lp_{i,t-2}$	$lp_{i,t-1}$	$lp_{i,t-3}$	$lp_{i,t-2}$	$lp_{i,t-1}$
1997	-	-	0.223***	-	-	0.000
1998	-	0.193**	0.225***	-	-0.034	-0.003
1999	0.158*	0.174**	0.172***	-0.032	-0.011	-0.007
2000	0.231***	0.170**	0.150**	-0.008	0.000	-0.020
2001	0.155*	0.216***	0.205***	0.000	-0.010	-0.021
2002	0.171**	0.136*	0.170***	-0.020	-0.016	-0.007
2003	0.219***	0.201***	0.261***	-0.023	-0.003	-0.008
2004	0.176**	0.231***	0.168***	-0.006	-0.005	-0.004
2005	0.246***	0.194***	0.180***	-0.004	-0.009	-0.019
2006	0.214***	0.148***	0.201***	-0.012	-0.006	-0.013
2007	0.176***	0.213***	0.201***	-0.009	-0.006	-0.002
2008	0.162**	0.147***	0.145***	-0.015	-0.010	-0.019
2009	0.100	0.154***	0.145***	-0.015	-0.011	-0.005
2010	0.185***	0.156***	0.122**	-0.007	-0.023	-0.007
2011	0.173***	0.110	0.127**	-0.023	-0.006	-0.009

* $p < 0.01$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Production function parameters

	Import participation				Import intensity			
	OLS	FE	LP		OLS	FE	LP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
β_u	0.136***	0.142***	0.115***		0.112***	0.128***	0.115***	
	(0.008)	(0.017)	(0.007)		(0.011)	(0.020)	(0.007)	
β_s	0.128***	0.089***	0.103***		0.128***	0.071***	0.103***	
	(0.008)	(0.017)	(0.007)		(0.010)	(0.019)	(0.007)	
β_e	0.100***	0.064***	0.091***		0.074***	0.042***	0.091***	
	(0.006)	(0.007)	(0.005)		(0.006)	(0.007)	(0.005)	
β_k	0.059***	0.033***	0.042***	0.043***	0.070***	0.040***	0.037***	0.038***
	(0.004)	(0.006)	(0.001)	(0.001)	(0.005)	(0.007)	(0.002)	(0.002)
β_m	0.673***	0.567***	0.668***	0.669***	0.709***	0.571***	0.684***	0.685***
	(0.009)	(0.015)	(0.002)	(0.002)	(0.009)	(0.017)	(0.002)	(0.002)
β_d	0.060***	0.012	-0.008*	-0.008*	0.093***	0.103***	0.021***	0.021***
	(0.014)	(0.022)	(0.005)	(0.005)	(0.007)	(0.011)	(0.002)	(0.002)
ρ	-	-	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)
N	8,282				5,190			

Bootstrapped standard errors with 500 replications in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

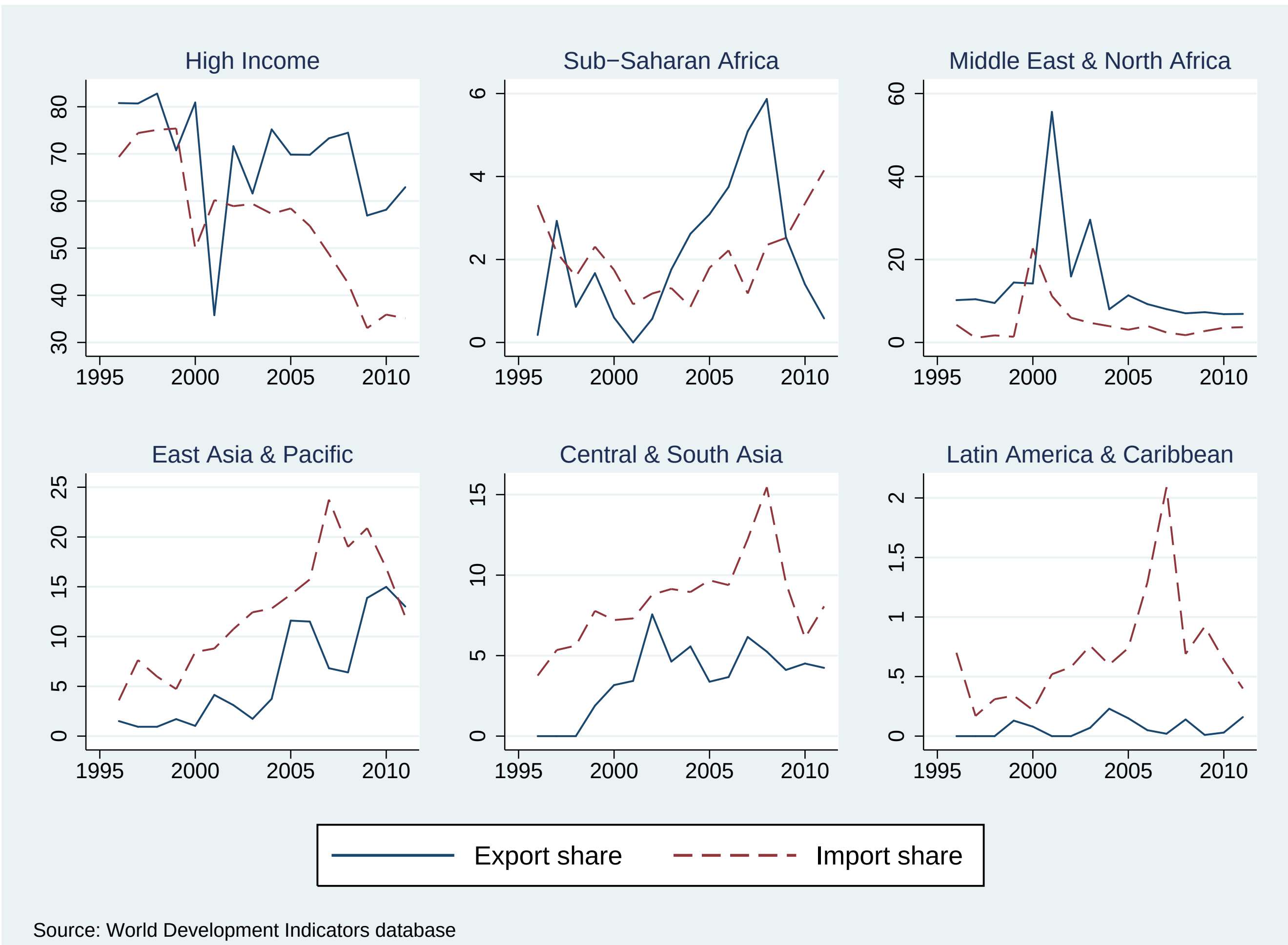

Figure 1: Geographical orientation of Ethiopian international trade

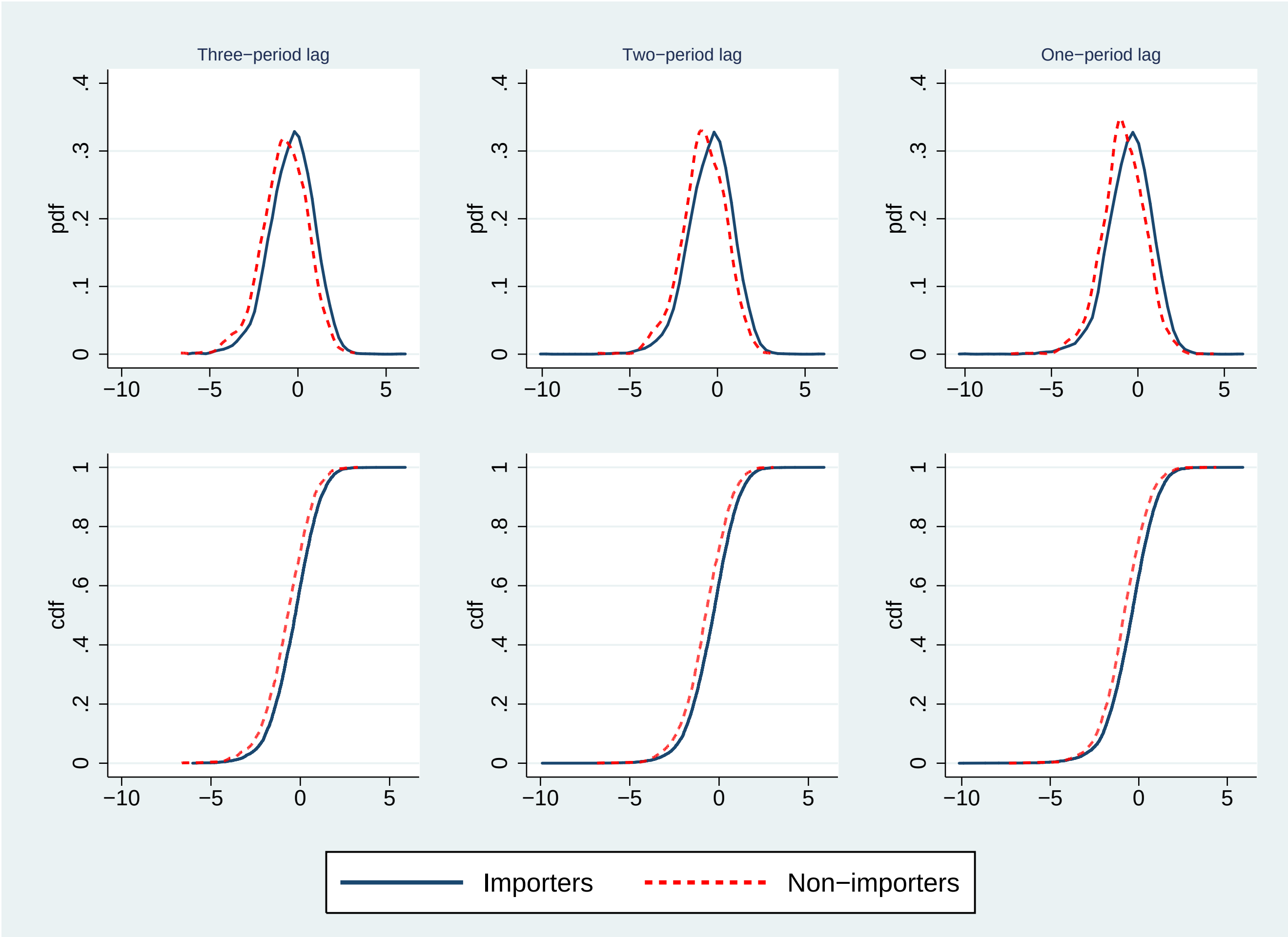

Figure 2: Productivity distribution by firm import status

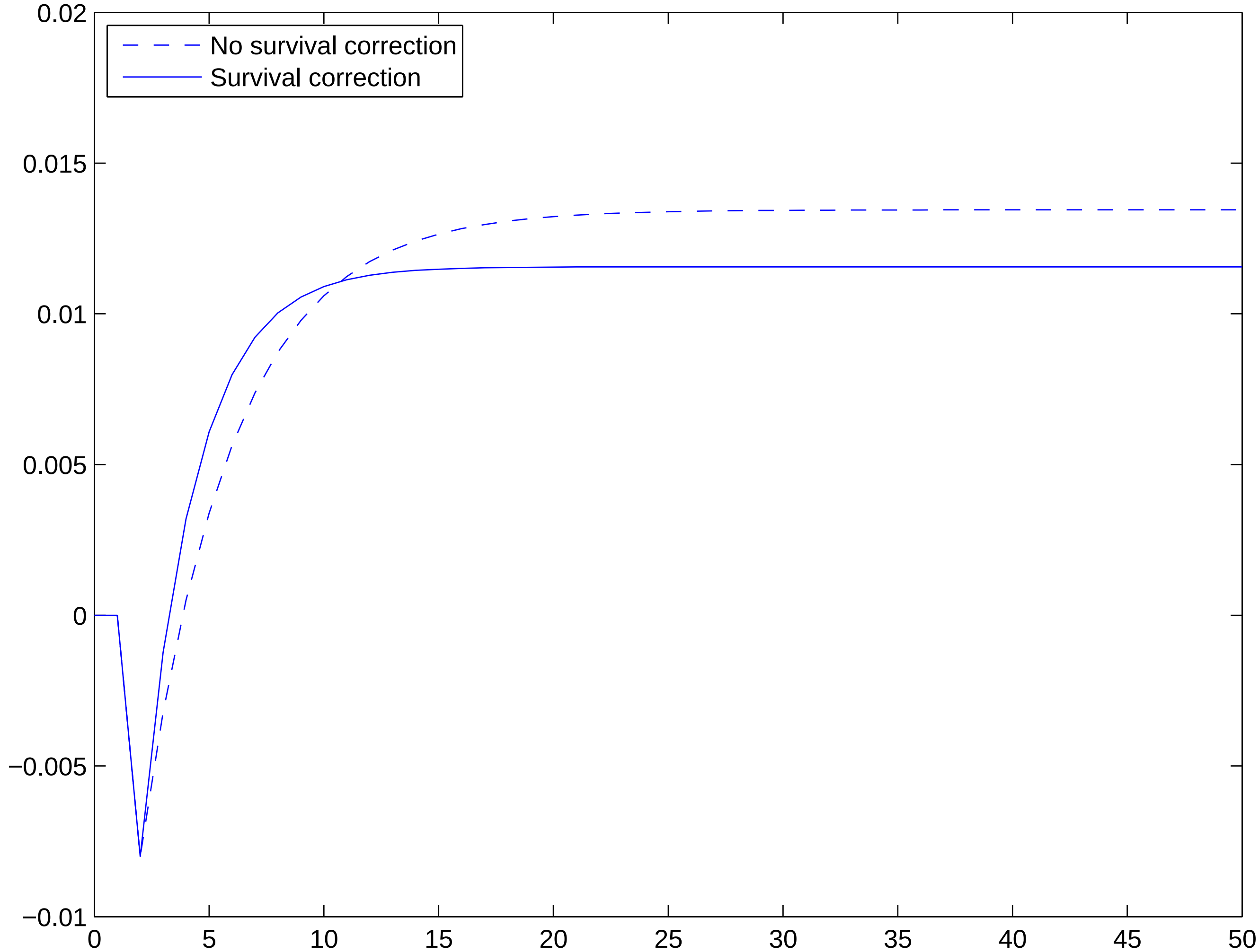

Figure 3: Productivity effect of importing: import participation

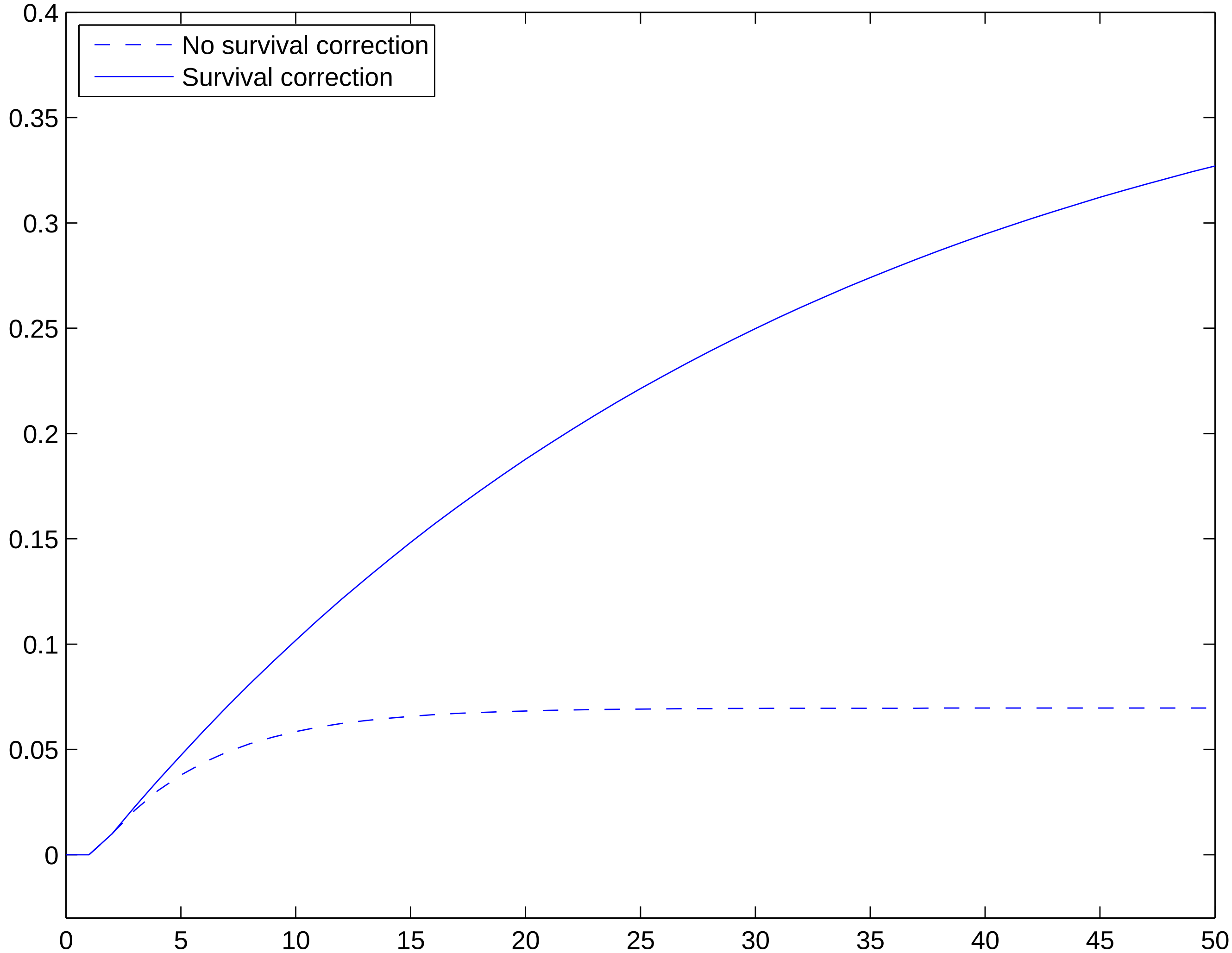

Figure 4: Productivity effect of importing: import intensity

Appendix

Data construction

The Central Statistical Agency of Ethiopia conducts annual survey of large and medium scale manufacturing firms. The scope of the survey is delimited to public and private establishments with at least 10 employees and use power–driven machinery. In the survey, an establishment is defined to be the whole of the premises under the same ownership or management with a specific location address. Below is a list of the definition of the variables used to construct the final dataset.

1. Gross value of production: includes the sales value of all products of an establishment net of changes in the inventory of finished goods, fixed assets, and others during the reference period. The value denotes the market price inclusive of indirect taxes but exclusive of subsidies.

2. Fixed capital assets: refers to assets with a productive life at least one year. It also includes production of fixed assets for a firm's own use. They are valued as the beginning period book value and new capital expenditures less the part sold, disposed and depreciated during the reference year.

3. Working proprietors, active partners and family workers: include all unpaid persons who actively participate in the operation of the establishment.

4. Administrative and technical employees: refers to salaried directors and managers, technicians, research workers, engineers, scientists, accountants, and other office staff.

5. Production workers: consists of persons directly engaged in fabricating, processing, assembling, maintenance, repair, and other associated activities.

6. Seasonal and temporary workers: include persons who are not regularly on the payroll of the establishment.

7. Basic wages and salaries: includes all payment made to employees during the reference year. It excludes commissions, bonuses, social security contributions, insurance, and professional and hardship allowances.

8. Materials: include all raw and auxiliary materials which are consumed during the reference year. Local raw materials refers to those produced locally, and imported raw materials those produced in other countries and obtained directly or from local source. These costs include factory gate purchase price, transport charges, taxes and other incidental costs.

9. Industrial cost: includes the cost of raw materials, fuels, electricity and other supplies consumed, cost of industrial services rendered by others, costs of goods bought and resold without any transformation.

Tables

Table A.1: Geographical orientation of Ethiopian merchandise exports

Year	High income[†]	Sub–Saharan Africa	Middle East & North Africa	East Asia & Pacific	Central & South Asia	Latin America & Caribbean	Others[‡]
1996	80.78	0.18	10.21	1.51	0.00	0.00	6.53
1997	80.70	2.93	10.42	0.94	0.00	0.00	3.64
1998	82.80	0.86	9.51	0.94	0.00	0.00	4.78
1999	70.76	1.67	14.45	1.71	1.89	0.13	9.40
2000	80.90	0.60	14.21	1.03	3.17	0.08	0.02
2001	35.79	0.00	55.58	4.14	3.43	0.00	1.07
2002	71.64	0.57	15.91	3.11	7.56	0.00	1.21
2003	61.61	1.76	29.58	1.74	4.63	0.07	0.62
2004	75.19	2.62	8.00	3.74	5.57	0.23	4.65
2005	69.85	3.09	11.36	11.60	3.38	0.15	0.57
2006	69.81	3.75	9.25	11.51	3.67	0.05	1.96
2007	73.31	5.09	8.04	6.82	6.16	0.02	0.55
2008	74.49	5.87	7.03	6.40	5.25	0.14	0.82
2009	56.93	2.54	7.30	13.88	4.11	0.01	15.23
2010	58.16	1.40	6.82	14.99	4.51	0.03	14.09
2011	62.94	0.58	6.88	13.02	4.24	0.16	12.19
1996–2011	69.10	2.09	14.03	6.07	3.60	0.07	4.83

Source: Word Development Indicators, World Bank.

[†] All high income countries in each region are excluded from their respective regions.

[‡] Includes trade with unspecified partners or with economies not covered by World Bank classification.

Table A.2: Geographical orientation of Ethiopian merchandise imports

Year	High income†	Sub–Saharan Africa	Middle East & North Africa	East Asia & Pacific	Central & South Asia	Latin America & Caribbean	Others‡
1996	69.36	3.31	4.25	3.59	3.76	0.70	13.62
1997	74.43	2.17	1.10	7.64	5.35	0.17	7.35
1998	75.10	1.59	1.70	5.98	5.62	0.31	7.56
1999	75.39	2.31	1.38	4.73	7.78	0.34	8.06
2000	49.93	1.75	22.70	8.45	7.21	0.22	9.73
2001	60.20	0.92	11.20	8.80	7.31	0.52	11.05
2002	58.92	1.18	5.95	10.75	8.79	0.58	13.84
2003	59.39	1.31	4.73	12.44	9.14	0.76	12.24
2004	57.29	0.86	3.93	12.82	8.95	0.60	15.56
2005	58.43	1.80	3.07	14.22	9.68	0.74	12.06
2006	54.72	2.22	3.97	15.74	9.38	1.29	12.68
2007	48.78	1.18	2.41	23.76	12.24	2.09	9.54
2008	42.61	2.35	1.76	19.01	15.46	0.69	18.12
2009	33.04	2.52	2.74	20.89	9.52	0.92	30.36
2010	35.91	3.35	3.53	16.89	6.10	0.64	33.58
2011	35.14	4.15	3.69	11.99	8.06	0.40	36.58
1996–2011	55.54	2.06	4.88	12.36	8.40	0.69	15.75

Source: Word Development Indicators, World Bank.

† All high income countries in each region are excluded from their respective regions.

‡ Includes trade with unspecified partners or with economies not covered by World Bank classification.