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GLOBALIZATION AND TECHNOLOGY TRANSFER IN ETHIOPIA: THEIR IMPACT ON DOMESTIC EMPLOYMENT AND SKILLS

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Globalization and Technology Transfer in Ethiopia: Their Impact on Domestic Employment and Skills

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Abstract

There is a dearth of research on the impact of technological change on employment in the context of least developed countries (LDCs) embarking on globalization, which enhances the prospect of direct technological imports or embodied technological transfer. Using a sample of 1,940 enterprises from Ethiopia over the period 1996–2004 and deploying System Generalized Method of Moments (GMM-SYS), this paper attempts to establish the nature of manufacturing employment in Ethiopia and the role played by trade and FDI in determining employment. The empirical results obtained lend support to globalization having a labour–augmenting effect, increasing total manufacturing employment. The two-equation dynamic framework implemented to analyse enterprise-level employment trends by skill level provides some evidence of skill-bias specific to enterprises with higher share of foreign ownership and those that that are located in the vicinity of the capital city. Exporters are not found to benefit from "learning by exporting".

Keywords: Employment, skills, globalization, FDI, trade, technological change, Ethiopia.
JEL Classifications: O33, F16, L60, O55, C33

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1. Introduction

Economic theory acknowledges the immense role played by technology in stimulating economic progress and development. However, the consequences of technological change and its direct and indirect impact on the dynamics of labour markets remains a matter of debate. A large amount of literature has studied the effect of technological progress on prouctivity and employment in developed countries, the leaders in technological innovation (for recent surveys see Mohnen and Hall, 2013, on the link between innovation and productivity; Vivarelli, 2014, on the link between innovation and employment). Developing countries, viewed as followers in terms of technology and innovation, have also had a significant share of studies where focus has been mainly on the effect of technology transfers on employment and skill distribution. However, little research has looked into the impact of technology on labour in the least developed countries (LDCs) that have liberalized their trade and have opened their economies to direct technological imports or embodied technological transfers.

Technological development is very low in LDCs, and most of them rank lowest according to various international technology and innovation indices such as the Technological Achievement Index, and the Innovation Capability Index (UNCTAD, 2007). However, as many of these countries have adopted trade liberalization policies over the past 20 years, they face a major challenge in how to increase the knowledge and technology intensity of their economies in order to be able to compete in national and international markets. In a study on technology transfer and skill accumulation in LDCs, Mayer (2000) shows that, overall, technological integration of LDCs has increased, though the disparities between the different countries are quite significant. However, he argues that LDCs need human capital to absorb and integrate the improved access to technology, as well as adequate economic policies and supporting institutions that encourage the amounts and types of modern technology that LDCs can import.

Within this context, the present paper aims to study the effect of globalization and technology transfer on manufacturing employment in a LDC, as well as investigating the existence of skill biased technological change. In particular, this study takes the case of the Ethiopian manufacturing sector for the period 1996-2004. Ethiopia is one of the least developed countries in the world today. In 1991 it adopted a national structural adjustment program and moved away from an import-substitution strategy adopting an open trade system. Therefore, it provides a suitable opportunity for testing the hypothesis of a possible diffusion of the skill bias in a LDCs setting.

The paper has three main novelties vis-à-vis previous literature in the area. First, it is one of the few papers studying the impact of trade openness and technology transfer in an LDC context. Second to our knowledge – it is the first paper investigating these issues in the Ethiopian context. Third, it adopts an econometric setting which can jointly assess the quantitative and qualitative (both absolute and relative skill bias) impact of globalization and technology transfer (see Section 5).

The rest of the paper is organized into six sections. Section 2 discusses the relevant literature. Section 3 sheds light on the process of trade liberalization in Ethiopia and presents some descriptive evidence on the manufacturing sector and its employment evolution. Section 4 presents the data used in the empirical analysis. Section 5 specifies the empirical model and defines the variables used in the regression analysis. Section 6 presents and discusses the results obtained. Finally, Section 7 concludes the paper with a summary of the main findings and their implications.

2. The literature

According to economic theory, technological change allows to produce the same amount of output with a lower amount of production factors, namely capital and labour. However, what economic textbooks represent as technological change is only the "direct" effect of innovation. Indeed, the economic discipline - since its foundation - has tried to dispel the concerns about the direct harmful effects of technological change pointing out the market mechanisms able to counterbalance the direct impact of process innovation (see Vivarelli, 1995; Petit, 1995; Vivarelli and Pianta, 2000; Pianta, 2005 and Vivarelli, 2013 for an extensive analysis).

Five main compensation mechanisms work to offset technology's labour-saving effects through: (1) additional employment in the capital goods sector where new machines are being produced, (2) decreases in prices resulting from lower production costs on account of technological innovations, (3) new investments made using extra profits due to technological change, (4) decreases in wages as a consequence of the initial job losses, and (5) new products created using new technologies.

Compensation mechanisms can be hindered – or even annihilated - by the existence of important market failures and institutional drawbacks. For instance, labour-saving technologies can spread around in the capital goods sector as well, so limiting the power of the compensation " via new machinery"; moreover, the new machines can be implemented simply by substituting the obsolete ones (scrapping), involving no compensation in jobs. Similarly, the effectiveness of the mechanism "via decrease in prices" depends on the hypothesis of perfect competition and on the value of the demand elasticity (Sylos Labini, 1969). By the same token, the compensation mechanism "via new investments" also relies on the strong assumption that the accumulated profits due to technical change are entirely and immediately translated into additional investments, while it should be taken into account that the economic agents' expectations can imply a delay in the translation of additional profits into "effective demand" (Pasinetti, 1981).Moreover, the intrinsic nature of the new investments does matter; if these are capital-intensive and labour-saving, compensation will be particularly limited. Also the mechanism "via a decrease in wages" is controversial. On the one hand, a decrease in wages can induce firms to hire additional workers; but, on the other hand, the decreased aggregate demand lowers the employers' expectations and so leading to the hiring of fewer workers. Finally, even though new products can be considered the more powerful way to counterbalance labour-saving process innovations, different "technological paradigms" (see Dosi, 1982; Dosi and Nelson 2013) are characterized by different clusters of new products, which in turn have very different impacts on employment. The relative balance between the labour-saving effect of process innovations and the labour-intensive impact of product innovations can vary considerably depending on differences in historical periods and institutional framework.

Beyond the *quantitative* effect of new technologies on employment, it is also important to single out and investigate the *qualitative* effect of technological change. The literature on the complementarity between technological change and skilled labour has put forward the hypothesis of "skill biased technological change" (SBTC), which was initially proposed by Griliches (1969) and Welch (1970). The hypothesis supports the view that new technologies - to be implemented effectively and efficiently - require suitable skills (and vice versa, see Piva and Vivarelli, 2009).

The first to explore SBTC empirically were Berman, Bound and Griliches (1994) who provided evidence for the existence of strong correlations between within industry skill upgrading and increased investment in both computer technology and R&D in the U.S. manufacturing sector between 1979 and 1989. Stemming from this seminal contribution, several further empirical studies have confirmed the occurrence of a widespread SBTC in the US (see Autor, Katz and Krueger 1998; Katz and Autor, 1999); France (Caroli and Van Reenen, 2001); Spain (Aguirregabiria and Alonso-Borrego, 2001); Italy (Piva, Santarelli and Vivarelli 2005) and other OECD countries (Machin and Van Reenen, 1998).

While most of the literature on the quantitative and qualitative employment impact of technological change is centred on the developed economies, in recent times some attention has also been devoted to the specificities of the middle-income and low-income developing countries (DCs). In what follows, the relevant literature is investigated, starting from the relationship between technology and employment (Section 2.1) and then moving to the diffusion of SBTC into the DCs (Section 2.2)

2.1 Innovation and employment

Technological change in DCs is mainly imported and innovation is inherently connected with trade, foreign direct investments (FDI) and consequent international technology transfer (Acemoglu, 2003; Piva, 2003; Keller, 2004). Globalization can imply a substantial technological up-grading in DCs through opening different channels.

On the one hand, a developing country can implement embodied technological change (ETC) through the importation of "mature" machineries (including second-hand capital goods, see Barba Navaretti, Solaga and Takacs, 1998) from more industrialized countries. On the other hand, a late starter DC can enjoy the "last comer" benefit of jumping directly on a relatively new technology (Perkins and Neumayer, 2005)[2].

[2] An example can be the diffusion of mobile telecommunications in Sub-Sahara African countries, where the traditional telephone networks are largely limited to urban areas.

Moreover, in addition to a direct effect through ETC, imports and FDI inflows may generate technological spillovers in favour of domestic firms which can absorb new imported technologies through labour mobility, input-output relationships and reverse engineering (see Coe and Helpman, 1995; Coe, Helpman and Homaister, 1997).

Finally, technological catch-up may be induced by exporting to richer countries both through substituting/replacing outdated technologies in the exporting sectors and through the development of entirely new businesses characterized by process and product innovations (see Kim, Park and Lee, 2013). The aim here is satisfying a more sophisticated demand coming from the industrialized countries ("learning by exporting", see Keller, 2001; Epifani, 2003; Melitz, 2003; Yeaple 2005).

All in all, technology transfer in favour of DCs involves productivity gains[3] which can be harmful to the local DC's employment level. In particular, the dominant role of the imported ETC implying labour-saving process innovation can drastically reduce the domestic demand for labour.

However, as discussed in Taylor (2004), the final employment outcome depends on the balance between labour productivity gains and output growth induced by domestic demand, trade and FDI[4]. The final employment outcome is a matter of the effectiveness of price and income compensation mechanisms and their possible drawbacks discussed above that may be crucial in the context of DCs (see Hall and Heffernan, 1985).

2.2 Skill-biased technological change

From a theoretical perspective both globalization (through the Heckscher-Ohlin theorem and its Stolper-Samuelson corollary, HOSS hereinafter) and technological change can be responsible for the observed pattern of increased relative demand for skilled labour in the developing world (see above).

Two processes are supposed to have opposite effects in this regard (see Lee and Vivarelli, 2004, 2006a and 2006b for an extensive analysis). On the one hand new technologies shift the labour demand in favour of more skilled workers. On the other hand, the HOSS mechanism predicts that a DC trading with skill-abundant richer economies should specialize in the production of unskilled-labour intensive goods, and therefore experience a relative increase in the demand for unskilled labour.

However, if the HOSS assumption of homogeneous production functions and identical technologies between countries is relaxed, then international openness may facilitate technology transfer from industrialized to developing countries through the different channels

[3] On this the empirical evidence is unequivocal, see, for instance: Coe and Helpman, 1995; Helpman and Homaister, 1997; Mayer, 2000; Schiff and Wang, 2006.
[4] In his study, Taylor (2004) found out that in seven DCs out of eleven, output per capita in the traded goods sectors grew less rapidly than labour productivity, so implying job losses.

discussed in the previous section. This implies that globalization and technological change are complementary rather than alternative mechanisms, both resulting in an increase in the demand for skilled workers (see Vivarelli, 2004 and Lee and Vivarelli, 2006b for an extensive analysis). Robbins (1996 and 2003) and Robbins and Gindling (1999) call the effect of in-flowing technology resulting from trade liberalization the "*skill-enhancing trade (SET) hypothesis*". Their idea is that trade accelerates the flows of physical capital (and embodied technology) to the South, inducing rapid adaptation to the modern skill-intensive technologies currently used in the North.

Turning our attention to the empirical literature, while a large body of work has documented the relevance of the SBTC hypothesis for advanced countries, there is a dearth of empirical evidence for developing countries. However, Berman and Machin (2000 and 2004) found that SBTC had been transferred rapidly from the developed world to at least the middle-income DCs. Meschi and Vivarelli (2009) found a significant inequality-enhancing effect of trade with more advanced countries on middle-income DCs, possibly related to technological transfer and skill-enhancing trade. Almeida (2009) reached similar conclusion using firm-level data for East Asia[5].

The evidence from country-specific studies also points to the link between trade, FDI, technology transfer and skill-upgrading. For instance, Hanson and Harrison (1999), using data on Mexican manufacturing plants, found that firms receiving FDI acquire technology through licensing agreements or imported materials, and tend to hire more skilled workers (see also Feenstra and Hanson, 1997). Similarly, Fajnzylber and Fernandes (2009) found that increased levels of international integration were associated with an increased demand for skilled labour in a cross-section of Brazilian firms. Görg and Strobl (2002) analysed a panel of manufacturing firms in Ghana over the '90s; their estimates revealed that while the purchase of foreign machinery for technological purposes significantly raised the relative demand for skilled labour, a greater participation in world markets via exporting activities was not found to have any effect.

Other papers have instead underlined the skill-enhancing effects of exporting activity, which makes the adoption of new technologies profitable for more firms (Yeaple, 2005), induces quality upgrading (Verhoogen, 2008; Fajnzylber and Fernandes, 2009) and offers opportunities to acquire knowledge of international best practice (Bigsten *et al*., 2004).

Finally, at least for middle-income DCs, together with imported technologies and exports, domestic R&D and innovation may play a relevant role, as it is the case for the most advanced countries. Meschi, Taymaz and Vivarelli (2011) showed that SET was an important factor in explaining the rise of the skilled labour cost share, but together with domestic R&D. By the same token, Araújo, Bogliacino and Vivarelli (2011) also found evidence in support of both the

[5] By the same token, Conte and Vivarelli (2011), using a direct measure of embodied technological transfer, found that imported skill-biased technological change is one of the determinants of the increase in the relative demand for skilled workers in DCs.

role of SET and domestic technology in determining the skill-upgrading trend of the Brazilian manufacturing labour force.

2.3 Hypotheses to be tested

In the light of what is discussed in the previous sections, the empirical tests put forward in this study will investigate the roles of the different channels through which globalization and technology transfer can affect employment both quantitatively and qualitatively in a typical low income country, Ethiopia. This will be achieved using firm-level microdata, analysed through a dynamic labour demand equation extended to take into account technology, trade and FDI (see next sections).

3. The Data

The study relies on data from the Ethiopian "Annual Survey of Large and Medium Scale Manufacturing Industries" conducted by the Central Statistical Authority of Ethiopia. The survey covers 1,940 enterprises, and has a total of 7,050 observations for the period between 1996 and 2004. It includes formal private and public enterprises employing at least 10 employees. The enterprises are classified according to the "International Standard Classification", ISIC Rev.3. The final sample used in the empirical analysis comprises only private sector firms that have reported to employing both production and administration workers. Firms that were not monitored for at least two consecutive years were also excluded from the final sample, since the main regression methodology (see section 5) relies on lagged values of the regressors for identification purposes.[6]

The dataset contains a wide range of information about the enterprises generated from the 8-section survey questionnaire. Information on the type of activity of the enterprises, their employees and wages, inputs and output volumes, investments and license fees, and the major problems they face, are included in the dataset. All monetary variables are expressed in 1996 Birr, the Ethiopian currency, and have been deflated using GDP and CPI deflators as appropriate. Employment is measured as the number of workers in each quarter of the Ethiopian year. Total employment was therefore calculated as the annual average of these quarters. Employment is also divided into two categories, "administrative and technical employees" and "production workers". The former is defined as the salaried directors and managers, technicians, superintendents, research workers, draftsmen and designers, engineers, chemists, architects, accountants, book-keepers, office machine operators, receptionists, sales men, delivery personnel, guards and other office staff. As for the production workers, they

[6] This sample selection criterion has led to a reduction in the final sample size vis-à-vis other studies that have used this dataset, namely, Bigsten, Gebreyeesus, and Soderbom (2009), and Bigsten and Gebreyeesus (2007).

include workers directly engaged in production i.e., persons engaged in fabricating, processing, assembling, maintenance, repair, janitorial, record keeping and other associated activities.

4. The manufacturing sector in Ethiopia

4.1 Trade reform in Ethiopia

Ethiopia's economy followed an import-substitution regime under the Imperial government, which lasted until 1974. Foreign capital played a major role in the process of industrialization during the 1950's up till the 1970's; foreign private (full or majority) ownership reached 52% by 1974 with a total of 143 firms (Shiferaw, 2005). In 1950 the country witnessed its first economic development program, part of which was an attempt to boost industrialization. In this respect, the government introduced a scheme aimed at inducing foreign investment, technology, skills and management in the manufacturing sector. However, as most manufacturing was owned by private foreign nationals, small local enterprises did not benefit from this reform scheme until it was further changed in the 1960's. The changes included assisting local SMEs in both manufacturing and non-manufacturing sectors (for recent studies investigating the role of innovation in SMEs, see Piga and Vivarelli, 2003; Ortega-Argilés, Vivarelli and Voigt, 2009; Voigt and Moncada-Paternò-Castello, 2012). Nonetheless, the overall role of the Imperial government can be described as a facilitating rather than managing role.

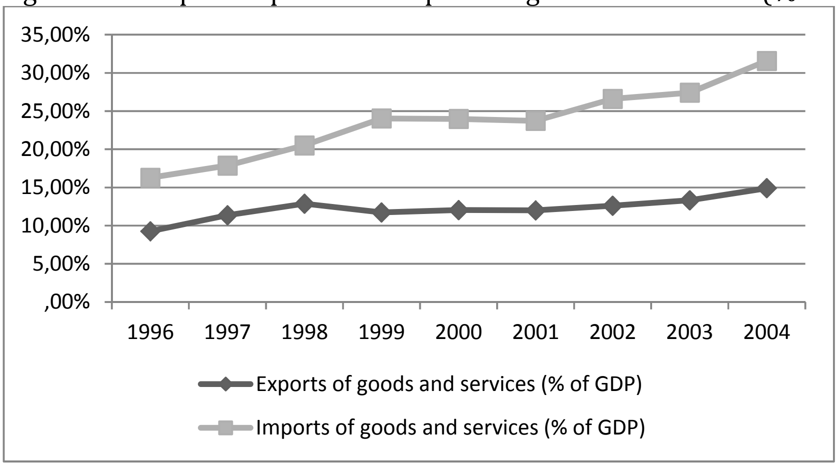
The year 1974 marked the end of the monarchy era through a coup d'état, which led to the establishment of a military council called the Derg, which adopted Socialist ideology. The regime continued to operate within the import-substitution strategy. The Derg nationalized all large and medium private manufacturing enterprises. The management of these enterprises was assigned to a small number of corporations that controlled prices and output quantities. Industrialization took place mainly through high tariffs, and the establishment of a few large enterprises that controlled factor markets and allowed state owned enterprises to gain preferential access to credit, foreign exchange and skilled labour. This came in parallel with a weakening of private manufacturing and restricting private investment.

At the end of the 1980's, Ethiopia began to gradually move away from the communist-inspired controlled economy to a more market-oriented economy. With the new Transitional Government of Ethiopia (TGE) coming to power in 1991, the country's economic structure underwent major transformations vis-à-vis the preceding Derg era. The TGE undertook policy reform steps including privatization, trade opening and market deregulation. In June 1993, the government launched a structural adjustment program under the auspices of the World Bank and the African Development Fund. A comprehensive trade reform was set up that aimed at dismantling quantitative restrictions and gradually reducing the levels of import tariffs and export taxes, as well as non-tariff barriers and import licensing requirements. Export promotion schemes were introduced. Custom tariffs were substantially reduced through a six-stage reform implemented between 1993 and 2003. In the first round, the maximum tariff was reduced from 230% to 80%. The next rounds led to a further gradual reduction that reached 35% in 2003 (Bigsten *et al,* 2009). In 2001 the Export Trade Duty Incentive Scheme was established. It included duty draw-backs, vouchers, and bonded manufacturing warehouses, where exporters are refunded 100% of any duty paid on raw materials. To further encourage exporters to acquire foreign technology and expertise, the government also issued directives in 2004 to reduce taxes and other costs on salaries paid to foreign experts (Bigsten and Gebreeyesus, 2007). Even though the post 1991 period witnessed significant economic liberalization, it is important to emphasize that the State continued to play a prominent role in the Ethiopian economy over this period. Land remains a public property in Ethiopia; and the State still fully controls some key sectors of the economy such as telecommunication and IT, while it plays a dominant role in other sectors such as banking, insurance and transportation. The prevailing development strategy is also spearheaded by the State. Indeed, the growth performance witnessed in recent years is driven by extensive public sector investments, particularly in the energy and road transport sectors (see WB 2013a and 2013b; IMF 2013).[7]

Figure 1 below shows the GDP share of both exports and imports, which increased as a result of these changes in the country's trade policy. Exports increased from 9.3% of GDP in 1996 to 14.9% in 2004, an increase of around 60%. Imports increased from 16.3% in 1993 to 31.6%, a much a larger increase of 94%, hence the gap between exports and imports is increasing. It is worth noting in this respect that ICT imports' share of total imports has been increasing rapidly, where ICT imports formed 5% of all good imports in 2000 and increased to around 9% in 2004, indicating an increasing demand for high technology communication and computing systems that possibly reflect an upgrading in the production and/or management processes in the various economic sectors in Ethiopia.

[7] See also recent commentaries by The Economist such as http://www.economist.com/news/middle-east-and-africa/21584037-government-expands-mobile-phone-network-tightens-its-grip-out-reach

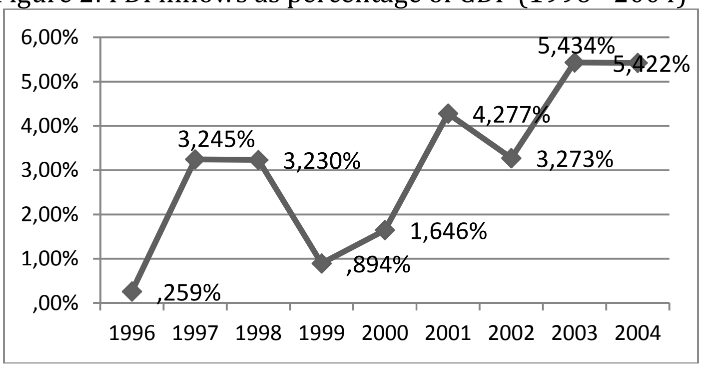
Figure 1: Ethiopia's exports and imports of goods and services (% of GDP)



Source: World Development Indicators (WDI) - 2013

Trade liberalization was accompanied by financial market liberalization and a large devaluation of the Birr. Since then, the exchange rate has been increasingly market driven. Most price controls and restrictions on private investments have also been lifted and a large wage of privatization took place. This has also led to the increase in FDI inflows as presented in Figure 2 below. There was a drop in these inflows between 1998 and 2000 as a result of the Eritrean - Ethiopian war, but they increased rapidly after the end of the conflict and peaked in 2003-2004 at around $550million[8]. Of the FDI projects licensed by 2003, 46.6% were in manufacturing and processing; 40.7% in trade, hotels and tourism; and 12.7% in agriculture and mining (UNCTAD, 2004).

Figure 2: FDI inflows as percentage of GDP (1996 - 2004)



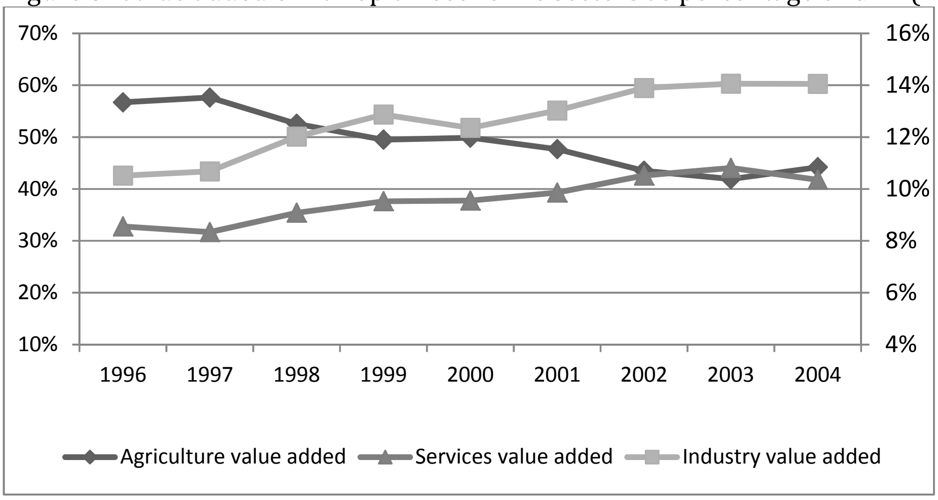
Source: World Development Indicators (WDI) - 2013

[8] Figure from UNCTAD stat

4.2 The Ethiopian manufacturing sector: size and employment

Ethiopia's industrial base remains to be quite small compared to other developing countries, as well as with respect to other national economic sectors. The GDP share of the industrial sector increased from 10.7 % in 1996 to 14.1 % in 2004 as Figure 3 below depicts.

Figure 3: Value added of Ethiopian economic sectors as percentage of GDP (1996 - 2004)



Source: World Development Indicators (WDI), 2013

However, this share is still much lower than sub-Saharan African average of 31.8 % (Bigsten and Gebreeyesus, 2008). The share of agriculture in the national value added has been decreasing steadily, though it still constitutes more than 40% of the country's output value added, while the share of industry and services have both been rising at similar rates.

The share of manufacturing in GDP is another indicator of the country's underdeveloped manufacturing base, which formed an average of only 5.4% of GDP for the period 1996-2004, rising from 5.13% in 1996 and reaching a peak in 2001 (5.72%), and declining to 5.32% in 2004[9]. Table 1 below shows the distribution of firms across the two-digit aggregation of the country's manufacturing sectors. The highest share of firms is within the food and beverages sector, followed by furniture production[10].

[9] Figures from WDI, 2013

[10] The largest output share is also that of the food products and beverages sector. The food, beverages, and textile sectors make up the largest shares of employment of around 27% each; thus together accounting for more than half of manufacturing employment. Contributing to only 9% of manufacturing output, and containing more than a quarter of employment, the textile sector seems to remain labour intensive. In contrast, the tanning and dressing leather contributes almost the same share of output (8.8%), but contains only 8% of labour; therefore, this sector seems to be moving away from traditional labour intensive production processes and towards more mechanized systems. Similar analysis can also be made looking at the non-metallic mineral products sector.

Table 1: Distribution of forms by 2 digit ISIC

Manufacturing Sector	Total firms	Share of output	Share of employment
Food products and beverages	28.5%	40.2%	27.1%
Tobacco products	0.1%	3.6%	1.1%
Textiles	4.3%	9.0%	27.1%
Wearing apparel; dressing and dyeing of fur	3.5%	0.7%	4.6%
Tanning and dressing of leather	7.1%	8.8%	8.1%
Wood and of products of wood and cork	2.4%	0.6%	1.5%
Paper and paper products	0.9%	2.4%	1.6%
Publishing, printing and reproduction of recorded media	6.6%	2.8%	4.8%
Chemicals and chemical products	5.1%	6.1%	4.4%
Rubber and plastics products	3.8%	5.1%	3.9%
Other non-metallic mineral products	11.5%	8.4%	6.2%
Basic metals	1.0%	4.5%	1.5%
Fabricated metal products, except machinery and equipment	6.6%	1.7%	2.7%
Machinery and equipment	1.5%	0.1%	0.3%
Electrical machinery and apparatus.	0.2%	0.0%	0.1%
Motor vehicles, trailers and semi-trailers	1.0%	4.6%	1.0%
Furniture	15.7%	1.5%	4.1%
Total	100.0%	100.0%	100.0%

Source: Author's calculations from the *Annual Survey of Manufacturing Industry*

Employment in the manufacturing sector was steadily increasing over the period 1996 - 2004 (Table 2), for both skilled and unskilled workers. This was however happening in parallel with a decrease in average employment, which reflects a decline in firm size. The share of skilled workers witnessed a sharp increase from 27.7% in 1996 to 35.8% in 1997. It has remained more or less stable since then, with some fluctuations around its 1997 level. The overall change in the skill mix may be indicative of the presence or, at least, the beginning of skill bias within the manufacturing sector.

Table 2: Employment and percentage of skilled workers in manufacturing 1996 – 2004

Year	Total employment	Mean employment	Share of skilled workers
1996	7,281	131.8623	27.7%
1997	13,495	109.6907	35.8%
1998	17,113	114.4901	36.1%
1999	20,459	110.6722	34.5%
2000	25,283	108.5062	33.1%
2001	23,968	103.7757	35.6%
2002	28,028	94.49525	34.4%
2003	29,549	89.61639	35.8%

Source: Author's calculations from the *Annual Survey of Manufacturing Industry*

Higher levels of total employment seem to be associated with higher shares of foreign ownership in Ethiopian manufacturing enterprises overall, as can be seen from Table 3 below. Higher share of foreign ownership is also generally associated with higher average number of administrative or skilled workers.

Table 3: Mean total employment, administration and production workers by foreign share in private enterprises

Foreign share in paid up capital	Mean number of employees	Mean Admin workers	Mean Product workers
0%	41.4	13.7	27.4
0 to 10%	70.5	29.3	41.2
10 to 20 %	91.9	34.5	57.4
20 to 40 %	121.8	77.8	44.0
40 to 60%	60.0	14.1	45.9
more than 60%	142.2	63.7	78.5

Source: Author's calculations from the *Annual Survey of Manufacturing Industry*

5. The Empirical Model

The starting point of the empirical analysis is a perfectly competitive industry that assumes a constant elasticity of substitution (CES) production function of the following form[11].

$$Y = T\,[(AL)^{\sigma-1/\sigma} + (BK)^{\sigma-1/\sigma}]^{\sigma/\sigma-1} \qquad (1)$$

Y is output, L and K are the standard inputs of labour and capital respectively; T is a Hicks-neutral technology parameter (movements in T leave the capital-labour ratio constant), A is labour augmenting Harrod-neutral technology, and B is capital augmenting Solow-neutral technical change. By setting real wages equal to the marginal productivity of labour, the following first order condition equation for labour demand is obtained.

$$\ln L = \ln Y - \sigma \ln (W) + (\sigma - 1) \ln A \qquad (2)$$

σ measures the elasticity of substitution between capital and labour (Van Reenen, 1997), and W represents real wages. This setting is further extended by including some proxy variables for the unobserved labour-augmenting technology component (A).

In addition, relevant costs in labour adjustments and persistence in the employment evolution call for transforming the model from a static to a dynamic one (as standard in the literature, se Arellano and Bond, 1991; for a recent application see Lachenmaier and Rottman, 2011); therefore, a lagged employment variable is added to the equation, and it takes the following final extended form:

$$EMP_{it} = \alpha + \beta EMP_{it-1} + \delta W_{it} + \gamma Y_{it} + \eta INV_{it} + \mu FOR_{it} + \lambda EXP_{it} + \omega LOC_{it} + (u_{it} + \varepsilon_i) \qquad (3)$$

[11] The choice of this production function is consistent with previous empirical literature studying the employment effects of technological change and assuming a perfect competition setting (see Van Reenen, 1997, Conte and Vivarelli 2010),

All variables are expressed in natural logarithms. Standard to panel data analysis, the error term is composed of the idiosyncratic error component (u_{it}) and the time invariant firm fixed effects component (ε_i). EMP is the number of employed workers in firm *i* at time *t*. W represents the real wages of workers, and Y is the real output of each firm. INV captures the share of investment out of total output. A positive coefficient of this variable is an indicator that the mechanism of compensation through investment is indeed at work.

FOR represents the share of foreign ownership in a firm at a given time period. It is a measure of the degree of foreign investment that is expected to be a channel of technology transfer through the full or partial involvement of MNCs in the production processes of their partner enterprises. In this way, we will also be able to evaluate the skill-biased impact of FDI. A positive and significant coefficient of this variable would indicate that there is either a direct employment effect manifested through the fact that the MNCs themselves employ workers, or an indirect effect through increased demand for local suppliers' products that could contribute to increasing employment in local firms as well (Dunning and Fortanier, 2007). EXP is the export to output ratio. It is used to test whether exporting firms are in fact expanding their production. As mentioned earlier, exporting firms in middle and low income countries can be in fact "learning by exporting" (Keller, 2001), through obtaining efficiency gains, and acquiring knowledge of international best practices (Vivarelli, 2011). Positive and significant results for this variable would indicate that exporters within the Ethiopian manufacturing sector are indeed benefitting from this channel of technology transfer. LOC is a dummy variable for location. It takes the value of one if the firm is located in and around Addis Ababa, the capital, and zero if outside of the capital region. It is expected that larger and more technologically advanced firms are located in the capital area that is the business and financial centre in the country. Consequently, their location would have an employment enhancing effect, through higher competitiveness.

As the paper also aims to look into the phenomenon of skill bias within the Ethiopian manufacturing sector, the empirical model is extended to capture this effect, if present. This is performed through defining a separate labour demand equation for each group of skilled and unskilled workers. Equation (2) is therefore expressed for both types of labour of the following form:

$$\ln USL = \ln Y - \sigma \ln (USW) + (\sigma_{USL} - 1) \ln A_{USL} \qquad (4)$$

$$\ln SL = \ln Y - \sigma \ln (SW) + (\sigma_{SL} - 1) \ln A_{SL} \qquad (5)$$

where USL and SL are the numbers of unskilled labour and skilled labour, respectively measured by the amounts of production *vs* administrative workers . USW and SW are the real wages of unskilled and skilled labour.

As in the case of equation (3), equations (4) and (5) are extended to include the proxies for the various factors affecting labour-augmenting technologies within a dynamic specification:

$$USL_{it} = \alpha + \beta USL_{it-1} + \delta USW_{it} + \gamma Y_{it} + \eta INV_{it} + \mu FOR_{it} + \lambda EXP_{it} + \omega LOC_{it} + (u_{it} + \varepsilon_i) \quad (6)$$

$$SL_{it} = \alpha + \beta SL_{it-1} + \delta SW_{it} + \gamma Y_{it} + \eta INV_{it} + \mu FOR_{it} + \lambda EXP_{it} + \omega LOC_{it} + (u_{it} + \varepsilon_i) \quad (7)$$

All variables are expressed in natural logarithms, and they follow the definitions mentioned earlier in the section. The main advantage of using a two-equation setting rather than the standard cost share unique equation is that it allows for studying relative versus absolute skill bias. Absolute skill bias would appear when technology and openness related variables have a positive coefficient for skilled workers and negative coefficients for unskilled workers, while relative skill bias would appear when the coefficients for both skilled and unskilled workers are positive but differ in magnitude, whit the coefficients for unskilled workers being lower. In addition, this setting is more informative in exploring the employment dynamics of the different categories of workers separately.

The presence of firm-specific effects causes a correlation between the lagged dependent variable (EMP_{it-1}, USL_{it-1} or SL_{it-1}) and the individual fixed effect ε_i. Therefore, using the pooled OLS methodology would lead to upwardly biased and inconsistent coefficients of the lagged dependent variable, with a larger bias as the variance of the unobserved effect increases (Hsiao, 1986). Furthermore, the dynamic specification of the model implies that the assumption of strict exogeneity of the explanatory variables does not hold due to the presence of an endogenous first-order lagged dependent variable. Obtaining consistent and efficient estimators includes first transforming the original equations to eliminate the fixed effects and then applying instrumental variables estimations for the parameter of the lagged endogenous variable (Halaby, 2004). Andersen and Hsiao (1982) have developed a formulation for obtaining consistent FE-IV estimators by resorting to first differencing in order to eliminate the unobserved effect, and then two lags and beyond to instrumentalise the lagged dependent variable. However, more radical efficiency improvements have been obtained by Arrellano and Bond (1991), using GMM techniques as an alternative to the Andersen and Hsiao approach. In their model, the instrument matrix includes all previous level values of the lagged dependent variable, where they obtain the GMM-DIFF estimator. However, the GMM-DIFF estimator has been found to be weak in cases when: (1) there is a strong persistence over time, where the instruments are weakly correlated with the first difference variables, and (2) cross-sectional variability dominates time variability (Bond et al., 2001). Blundell and Bond (1998) have then put forward an efficiency improvement to the GMM-DIFF model by using additional moment conditions and obtaining the system GMM or GMM-SYS. In particular, they use moment restrictions of a simultaneous system of first-differenced equations and the equations in level. In the first-differenced equations they use the lagged level values of the variables as instruments (similar to the GMM-DIFF estimator), and in the level equations they use differences as instruments. In the present empirical study, the GMM-SYS will be used due to the fact that it seems to fit best with the characteristics of the panel data and the nature of the empirical model. In particular, our longitudinal data are characterized by a larger cross-sectional (between variance equal to 1.003) than time variability (within variance equal to 0.1144). Moreover, as the table below depicts, time persistence is obvious for all the three categorizations of employment.

Table 4: Time persistence in the employment time series

	Total employment	Blue collar	White collar
AR (1)	0.896*** (0.000)	0.830*** (0.000)	0.860*** (0.000)

6. Results

The results from our empirical analysis are reported in Tables 5 to 7 below. Table 5 presents the OLS, FE and SYS-GMM estimators for the total employment equation. Although OLS is expected to result in upward biased estimates in the presence of firm specific effects and a dynamic specification, it forms an upper bound for the value of the estimate of lagged endogenous variable obtained in SYS-GMM. Similarly, the FE results are presented to provide a lower bound for the value of the mentioned estimator, since the fixed effects regression produces downward biased results. Time and sector dummies were included to control for unobserved shocks that may affect the variables. It is important to note that all the regressors are potentially endogenous, since they are largely dependent on firms' simultaneous decisions. Instrumenting for all regressors using the GMM orthogonality conditions is appropriate in this case.

Looking at the last column of table 5, the SYS-GMM shows a positive and significant value of lagged total employment coefficient, further asserting the persistence in the time series. The magnitude of this coefficient lies within the upper and lower bounds set by the OLS and FE estimators respectively. The total wage coefficient shows a negative and significant value, which is in line with the expected sign indicating a negative relationship between labour demand and wages.

Table 5: Regression results from the total employment equation

Dependent variable: Total employment	OLS	FE	SYS-GMM
Lagged total employment	0.710***	0.160***	0.352***
	(0.0112)	(0.0191)	(0.0653)
total wage	-0.144***	-0.313***	-0.262*
	(0.0171)	(0.0223)	(0.1450)
Real output	0.177***	0.184***	0.372***
	(0.0076)	(0.0114)	(0.0593)
investment / output ratio	0.00814	-0.0146**	0.0241***
	(0.0071)	(0.0074)	(0.0064)
Location dummy	0.0608***	0.0521	0.188***
	(0.0174)	0.0795)	(0.0484)
Foreign ownership share	0.0879**	-0.0236	0.170*
	(0.0412)	(0.0537)	(0.0996)
Export / output ratio	0.0161	-0.123	1.165*
	(0.0626)	(0.1700)	(0.5970)
Constant	-0.417***	2.751***	-1.054
	(0.1150)	(0.2240)	(0.9290)
time dummies	*yes*	*yes*	*yes*
sector dummies	*yes*	*no*	*yes*
Observations	2,816	2,816	2,816
Number of firms		865	865
R-squared	0.855	0.693	
Adjusted R-squared	0.853		
AR(1)			-7.51***
AR(2)			0.896
Wald test chi2			2131***
Hansen test			102.5

Notes: 1. Robust standard errors in brackets.
2. ***, **, and * indicate the statistical significance at the 1%, 5%, and 10%, respectively.

The rest of the regressors show positive coefficients reflecting employment-enhancing effects to varying levels of significance. The *output* explanatory variable shows that an expansion in output requires higher levels of employment. Similarly, the positive sign of the *investment* variable indicates that as the share of investment in total output increases, the demand for labour rises. This is a manifestation that at least part of firms' profits are being used for expanding their production capacity, thus the compensation channel via new investments might be at work in the manufacturing sector of Ethiopia (see Section 2). The *location* dummy variable is found to be highly significant and suggests that firms located in the capital region hire more workers vis-à-vis their counterparts in other regions. The *Foreign ownership* variable is also found to be weakly significant suggesting that firms with higher foreign share have a greater tendency to expand. Involvement in exporting activity is also found to have an employment enhancing effect, albeit being weakly significant, as can be gathered from the coefficient of the *export* ratio variable.

In terms of relative magnitude, it appears that the export variable has the highest impact since its coefficient is of the highest magnitude. On average, when firms are exporters, their labour demand increases by 116.5 percentage points. However, this effect is weakly (10%) significant. The location dummy has the second highest coefficient and is significant at 1%. Demand for labour by firms located in the capital region is found to increase by 19 percentage points.

A number of validity tests have been conducted to check the performance of the model and robustness of the results. The Wald test was used to test the overall significance of the independent variables. It rejected the null hypothesis of insignificant coefficients, thus confirming the joint significance of the variables and the robustness of the overall results. The Hansen test for over-identifying restrictions, where the null hypothesis is that of adequate instruments, failed to reject the null, thus confirming the adequacy of the instruments used. In addition, the Arellano and Bond (AR) test for autocorrelation was performed, which is found to support the consistency of the GMM estimators using t-2 instruments.

Another question this paper attempts to address is whether differential employment enhancing effect exists in the allocation of skilled and unskilled labour. Table 6 shows the results of the second set of regressions, where the demand for labour was studied for skilled labour and unskilled labour separately. As mentioned earlier, having two equations allows us to observe the relative versus absolute skill bias, if it exists.

Looking at the SYS-GMM results for both unskilled and skilled workers, the lagged employment variable is positive and significant for both types of workers. This, as in the case of total employment, affirms the time persistence of the series. In addition, the coefficients of both variables lie within the bounds set by OLS and FE results. The wage explanatory variables are also significant and in line with the expected negative sign. It is worth noting here that in terms of magnitude, the coefficient of unskilled workers is higher than that of skilled workers. A possible explanation for this may be that the demand for unskilled workers is more elastic given the ease with which such workers can be substituted vis-à-vis their skilled counterparts.

The coefficient of the *output* variable is positive and significant for both types of workers, with a slightly higher magnitude for skilled workers. The difference between these two coefficients however proved not statistically significant (refer to Table 7). Therefore, no conclusion regarding the presence of a relative skill bias can be asserted here. The *investment* variable shows similar results, positive and significant for both skilled and unskilled labour, with a higher magnitude for skilled labour. However, also in this case, the t-test for the significance of the difference between the two values is not significant (see Table 7, second row).

Table 6: Regression results from the skill specific employment equations for blue and white collar workers

Dependent variable	Unskilled workers			Skilled Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
Lagged production worker employment	0.606***	0.117***	0.295***			
	(0.0130)	(0.0203)	-0.0452			
Production worker wages	-0.232***	-0.334***	-0.448***			
	(0.0198)	(0.0252)	(0.0508)			
Lagged admin worker employment				0.696***	0.0790***	0.280***
				(0.0125)	(0.0209)	(0.0547)
Admin worker wages				-0.0996***	-0.253***	-0.311***
				(0.0180)	(0.0233)	-0.0486
Real output	0.232***	0.202***	0.406***	0.183***	0.151***	0.462***
	(0.0092)	(0.0158)	(0.0586)	(0.0099)	(0.0164)	(0.0505)
investment / output ratio	0.00652	-0.0143	0.0256***	0.0228**	-0.0117	0.0300***
	(0.0095)	(0.0106)	(0.0088)	(0.0103)	(0.0110)	(0.0065)
Location dummy	0.0469**	-0.0855	0.161***	0.116***	0.337***	0.312***
	(0.0227)	(0.1110)	(0.0438)	(0.0250)	(0.1160)	(0.0548)
Foreign ownership share	0.0913*	-0.0365	0.168	0.111*	-0.062	0.243**
	(0.0540)	(0.0753)	(0.1160)	(0.0585)	(0.0782)	(0.1230)
Export / output ratio	-0.0027	-0.07	1.144*	0.0509	-0.166	1.136
	(0.0823)	(0.2380)	(0.6570)	(0.0891)	(0.2470)	(0.7540)
Constant	-0.467***	2.413***	-0.369	-1.070***	1.724***	-2.473***
	(0.1460)	(0.2840)	(0.7590)	(0.1400)	(0.2830)	(0.5850)
time dummies	*yes*	*Yes*	*yes*	*yes*	*yes*	*yes*
sector dummies	*yes*	*No*	*yes*	*yes*	*no*	*yes*
Observations	2,816	2,816	2,816	2,816		2,816
Number of firms			865			865
R-squared	0.768	0.572		0.789	0.443	
Adjusted R-squared	0.765			0.787		
AR(1)			-8.227***			-9.661***
AR(2)			-1.411			1.466
Wald test chi2			1384***			1266***
Hansen			122.8			129.1

Notes: 1. Robust standard errors in brackets.
2. ***, **, and * indicate the statistical significance at the 1%, 5%, and 10%, respectively

The difference between the magnitudes of the *location* dummy variable is instead significant (see Table 7, third row). Therefore, location does exhibit a relative skill bias effect in that firms located in the capital and its vicinity not only hire more workers, but they have the tendency to hire more skilled workers. Proximity to the capital city is found to increase the demand for skilled labour by 31.2 percentage points as opposed to a 16.1 percentage points increase in the demand for unskilled workers (with both the coefficients statistically highly significant).

The share of foreign ownership is found to have significant effects only for skilled workers. Therefore, the employment enhancing effect of foreign ownership observed in the total employment equation stems mostly from the effect on the demand for skilled labour[12]. This leads us to the conclusion that firms with higher shares of foreign ownership exhibit an absolute skill bias effect, indicating that the FDI channel of technology transfer is at work in Ethiopia.

The *export* variable, contrary to expectations pertaining to a possible skill bias, is found to be barely significant for unskilled labour but insignificant for skilled labour. This is to say that the positive effect on total employment observed earlier originates mainly from higher demand for unskilled rather than skilled labour. Therefore, the process of "learning by exporting" is not obvious in Ethiopia, at least not for the time period considered, that was still characterized by a dominant role of an HOSS effect, with Ethiopian exports still stemming from traditional and low-skill intensive manufacturing sectors.

Looking at the results of table 6 from another perspective, we can analyse the results of each type of labour separately. For unskilled labour, the variable that appears to have the highest employment enhancing effect is the export variable. As the export to output ratio of a firm increases, it tends to increase its demand for unskilled labour by 114.4 percentage points. This indicates that the manufactured goods being exported follow production techniques that have not (yet) adopted more advanced labour-saving technologies.

The most prominent contributor to increasing demand for skilled labour appears to be real output. Therefore, firms that expand their entire production capacity to reach higher levels of output increase their demand for skilled labour by 46.2 percentage points. This however does not necessarily allow us to make conclusions regarding the technology levels of these expanding firms. As noted earlier, however, there is evidence of skill-bias associated with foreign ownership and being located in and around the capital city.

Table 7: t-statistic for comparing coefficients of the two equations

Variable	t -statistic	ρ value
Real output	0.72391	0.25
investment / output ratio	0.40057	0.5
Location dummy	2.15243**	0.025
Foreign ownership share	0.4436	0.5
Export / output ratio	0.008	0.5

The various diagnostic tests showed evidence supporting the robustness of the results. The Wald test rejected the null of insignificant estimator coefficients for both unskilled and skilled

[12] The t-test for the difference between the two coefficients of this variable is not found to be statistically significant due to the coefficient for unskilled labour being not significant.

labour demand equations. The Hansen test never rejected the null for either of the two equations, asserting the suitability of the instruments used. The AR tests also supported the overall validity of the model by providing evidence for a significant negative AR(1) and a non-significant AR(2).

7. Concluding remarks

This paper has conducted empirical investigations to establish the role played by globalization and technology transfer in determining employment evolution in the manufacturing sector of Ethiopia. To this end, the paper has studied the extent to which the level of overall manufacturing employment was determined by trade, FDI and technology; and if globalization and technology transfer played a role in instigating SBTC. The empirical analysis relied on manufacturing survey data for the period 1996-2004 and deployed alternative econometric estimators.

The findings in the paper lead to two main conclusions concerning the characteristics of manufacturing sector employment in Ethiopia. The first main conclusion pertains to the quantitative effect of globalization on total manufacturing employment at the firm-level. Specifically, trade and foreign ownership are found to have a labour–augmenting effect. Therefore, no negative employment effects of globalization are obvious in the Ethiopian manufacturing sector.

The investigation to determine whether the Ethiopian manufacturing sector exhibits the presence of a skill-bias lends some evidence to this effect. In particular, foreign ownership and proximity to the capital city are found to lead to a higher demand for skilled workers, as opposed to unskilled ones. The foreign ownership related finding thus suggests two things: first, the increase in total firm-level employment associated with foreign ownership stems mostly from the effect of foreign ownership on the demand for skilled labour; secondly, it lends some support to FDI-linked channels of a skill-biased technology transfer being in operation. The significant effect associated with being located in and around the capital city may suggest the presence of positive agglomeration effects. It may also be an indicator of the fact that the capital city and its hinterlands represent better synergies of infrastructure and technology.

In contrast, involvement in exporting activity is found to lead to higher demand for unskilled workers. This suggests that the effect of exporting activity on total firm-level employment is largely the result of its effect on unskilled labour. This finding is in contrast with the expectation of a possible skill bias involved by a process of "learning by exporting". However, at least for the time period considered in this study, it may well be that the Ethiopian manufacturing was still characterized by a dominant role of an HOSS effect, with exporting still stemming from traditional and low-skill intensive manufacturing activities.

The finding that FDI is the main channel through which skilled labour is demanded in the Ethiopian manufacturing may be of some interest from the viewpoint of policy making. In particular, the current extensive public sector investment in infrastructural projects (discussed in Section 4.1) may be something commendable in this respect, since availability of adequate infrastructure may be the missing element needed to attract FDI. On the other hand, the fact that the economy is still dominated by a State sector that is undertaking extensive investment activities may pose the risk of crowding-out relatively more technologically advanced FDI.

Finally, it is needless to state that a favourable investment climate that accords the private sector with the requisite credit and financial infrastructure, among others, is vital in attracting FDI and the development of the manufacturing sector. Equally, globalisation and technology transfer necessitate an educated and skilled labour force. A skill-shortage would not only undermine both technological upgrading and manufacturing employment, but it also risks thwarting the flow of FDI. There is thus a need to also devote particular attention to education and training policies in Ethiopia.

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