

Foreign Direct Investment and Knowledge Diffusion in Poor Locations: Evidence from Ethiopia *

Girum Abebe, Margaret McMillan, Michel Serafinelli[†]

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Abstract

We quantify foreign direct investment (FDI) spillovers by comparing changes in total factor productivity (TFP) among domestic plants in “treated” districts that attracted a large greenfield foreign plant and “untreated” districts where greenfield FDI was licensed but not yet operational. Treated and untreated districts have similar trends in TFP prior to the opening of the large greenfield foreign plant. Over the four years starting with the year of the opening, TFP in domestic plants is 8% higher in treated districts. We obtain qualitatively similar results using an alternative identification strategy that exploits the assignment of land for FDI by the Ethiopian Government. We also find evidence that the foreign plants attract new economic activity to the receiving districts. Further, using a survey module designed by us, we show that knowledge is transferred from FDI to domestic plants through: (i) labor flows from FDI to domestic plants; (ii) learning by observation and; (iii) customer and supplier relationships.

Keywords: Foreign Direct Investment, productivity, firm-to-firm labor mobility, localized knowledge spillovers.

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[†]Authors’ affiliations: EDRI, Ethiopia; Tufts/NBER; U of Toronto

1 Introduction

The gaps in productivity between developed and developing countries are large; the poorer the country, the larger the gap. Foreign direct investment (FDI) could be a powerful tool for reducing these productivity gaps. Standard means of raising productivity such as investments in education and health are obviously important but they are costly and typically take a long time to bear fruit. By contrast on-the-job training and other types of learning by doing could be less costly and have more immediate payoffs (Romer, 1992). Many developing countries including Ethiopia have policies designed to attract FDI (Harrison and Rodriguez-Clare, 2010).

Despite their theoretical and practical importance, the existence and magnitude of knowledge spillovers from foreign to domestic plants in poor countries are considered open questions. In a review of the literature on FDI spillovers, Harrison and Rodriguez-Clare (2010) argue that there is little evidence of spillovers among plants in the same line of business and a lot of evidence of spillovers between foreign plants and their suppliers. However, they also note that much of the literature suffers from a lack of proper identification because FDI is likely to be attracted to the most productive industries and the most productive plants. There is also very little systematic evidence on the mechanisms by which knowledge is transferred from FDI to domestic plants (Poole 2013, Balsvik 2014, Newman et al 2015).

In this literature, interactions between foreign and domestic plants are typically classified into horizontal and vertical spillovers. Horizontal spillovers occur between plants classified in the same industry while vertical spillovers occur between foreign plants and their suppliers or their customers (Harrison and Rodriguez-Clare, 2010). While these definitions are analytically useful, they may be too restrictive. For example, Poole (2008) finds evidence of knowledge sharing through labor movements from foreign to domestic plants irrespective of industry. Moreover, recent evidence indicates that managerial skills which are not a priori

industry specific are a key determinant of plant productivity (Bloom and Van Reenen, 2007). For example, human resource management in the textile industry may not be that different from human resource management in the food and beverages industry.

The key question is whether knowledge from foreign plants can be assimilated by domestic plants through observation and imitation. When put in these terms, the similarity between research that investigates knowledge diffusion between foreign and domestic plants and research on agglomeration externalities becomes evident. For example, Duranton and Puga (2004) explain that geographic proximity plays a key role in the acquisition of skills and that one of the benefits of clustering is that it facilitates learning.¹ Thus, one may expect that the externalities stemming from the presence of foreign plants would be obtained first by nearby domestic plants, and maybe slowly diffuse to other, more distant domestic plants. This is likely to be the case for instance if trained employees move from a foreign plant to a neighboring domestic plant or if the foreign plant uses a product, production process, managerial technique, organizational form, or export market formerly unknown to domestic plants. We might also expect knowledge spillovers to be more important in poor countries where productivity is extremely low.

This paper has two objectives. First, we test for and quantify the magnitude of spillovers from FDI in manufacturing by estimating how the productivity of domestic plants changes when a large greenfield foreign plant opens in an Ethiopian district (Woreda). We estimate augmented Cobb-Douglas production functions that allow the TFP of domestic plants to depend on the presence of the new foreign plant using plant-level data from Ethiopia's Annual Census of Manufactures. Second, we examine the mechanisms by which knowledge is transferred using a survey designed by us and administered as part of the manufacturing census by Ethiopia's Central Statistical Agency in 2013. The module contains a host of questions

¹Greenstone, Hornbeck and Moretti (2010) quantify these agglomeration spillovers by comparing changes in total factor productivity (TFP) among incumbent plants in "winning" counties that attracted a large manufacturing plant and "losing" counties that were the new plant's runner-up choice.

designed to identify linkages between foreign and domestic plants. We consider several different forms of knowledge transfer including: (i) labor flows from FDI to domestic plants; (ii) learning by observation and; (iii) customer and supplier relationships.

Because the foreign plant's location decision is made to maximize profits, the chosen district may differ substantially from an average or randomly chosen district, both at the time of opening and in future periods. District characteristics that affect the foreign and domestic plant's TFP and that are difficult to measure include local transportation infrastructure, current and future costs of factors of production, quality of the workforce, presence of intermediate input suppliers, and any other local cost shifters. Valid estimates of the plant opening's spillover effect must account for these characteristics directly or indirectly.

We use two alternative strategies to identify the causal relationship between the opening of an foreign plant and domestic plants' productivity. First, we compare changes in TFP among domestic plants in "treatment" districts to changes in TFP in "control" districts. Treatment districts are defined as districts in which a large greenfield foreign plant opened. Using administrative data from the Ethiopian Investment Commission, we define a control district as a location in which an foreign plant in the same industry and around the same time, applied for a license, got approval but then did not open the plant during the period in which the foreign plant was operating in the treated district.² The pre-trends in the treatment and control districts look similar; this finding is consistent with our identifying assumption that plants in the control districts form a valid counterfactual for the plants in the treated districts. Our baseline estimates show an increase in TFP for local domestic plants following the opening of a greenfield FDI plant. Over the four years starting with the year in which the foreign plant opens the average increase in the TFP of domestic plants is 8 percent. These results are robust to alternative specifications addressing the issue of the endogeneity of inputs, and are not driven by attrition of domestic plants, government expenditures, or changes in

²As explained below, bureaucratic hurdles, foreign currency shortages and financing issues are the most cited explanations why there exists a lag in investment translations.

the intensity of capital usage. In addition, the estimated FDI effect does not appear to reflect higher output prices. We also find that following the entry of the foreign plant in a district there is an increase in the number of domestic plant openings.

Our second identification strategy exploits the government designation of locations for greenfield foreign plants, in combination with an event study research design. We consider as valid events the openings of foreign plants reporting that their location was allocated by the authorities – information which is reported in our knowledge transfer survey. Our research design then compares the TFP of domestic plants within a district before and after the opening. The regions targeted by the government are arguably non-random. In particular the government often targets regions with lower levels of pre-existing investment.³ However, the exact geographic location within a broader region in many cases seems to be determined by idiosyncratic characteristics, such as the timing of availability of land. Moreover, there is often uncertainty about the exact year in which the foreign plant will start production. We estimate our econometric model with and without the never treated localities; in the latter case identification comes from the differential timing of treatment onset among the treated localities. The estimates using this second research design are qualitatively similar to those using the first research design.⁴

Having found evidence of spillovers between foreign and domestic plants that are geographically close, we use information from the knowledge transfer survey to explore the mechanisms driving the productivity increases. Overall, evidence from the survey clearly indicates the existence of knowledge diffusion. Labor flows from FDI to domestic plants emerges as a clear mechanism, but there is also suggestive evidence of a role for backward and forward linkages in the supply chain, and for horizontal linkages that occur as a result

³We include region trends in all our specifications.

⁴We conduct a falsification test in order to verify that our results do not capture a general pattern in local outcomes following designation of plant locations according to government plans of regional development, unrelated to the presence of a large foreign plant. We consider the entry of large *domestic* plants that report "Did not choose the location, was allocated by the authorities". We fail to reject the null hypothesis of no local impact of these domestic openings.

of more casual interactions. A great deal of the horizontal type linkages are sometimes referred to as communication externalities in the agglomeration literature and consist of things like face-to-face meetings, word-of-mouth communications and direct interactions between skilled workers from different plants (Charlot and Duranton, 2004; Fons-Rosen 2012).

Our work contributes to the literature on knowledge spillovers from FDI. The resulting evidence has been mixed, with studies in developed countries more likely to show evidence of positive FDI effects than those in developing countries. Overall, because of non-trivial measurement challenges, disagreement remains over the existence and magnitude of these effects. Additionally, although a large body of work has been devoted to estimating the effect of FDI on the productivity of host country plants (see for example, Haddad and Harrison (1993); Aitken and Harrison (1999); Javorcik (2004) and Haskel, Pereira and Slaughter (2007), Blalock and Gertler, (2008), Keller and Yeaple (2009), Kosová (2010)) we still have very little direct evidence on the mechanisms at work. Exceptions are the work by Javorcik (2004) and Newman et al (2015) who find evidence that plants in supply relationships with foreign plants experience enhanced productivity and the work by Poole (2008) who finds evidence that labor linkages lead to productivity gains.

Our work also contributes to the empirical literature which examines the productivity advantages of agglomeration. Although there is evidence, mostly from analysis using data for developed countries, that significant advantages of agglomeration exist, the jury is still out over the nature of the microeconomic mechanisms that can account for these advantages (Rosenthal and Strange, 2003; Ellison, Glaeser, and Kerr, 2010; Arzaghi and Henderson, 2008; Greenstone, Hornbeck and Moretti (2010); Combes, Duranton, Gobillon, Puga, and Roux, 2012; Baum-snow, 2013).

The remainder of this paper is organized as follows. Section II presents our conceptual framework and a simple model. Section III presents the data. Section IV presents our estimating frameworks and econometric evidence on productivity spillovers. Section V presents

evidence from the knowledge transfer module. Section VI concludes.

2 Theoretical Framework

Our goal is to identify how the opening of a foreign plant affects domestic plants' productivity, profits, and input use. Drawing on the large literature on this topic, we begin by reviewing the theory of linkages between domestic and foreign plants. We distinguish between linkages that are mediated through market mechanisms such as increases in input prices and externalities which are not mediated through market mechanisms such as knowledge spillovers. This is an important distinction because the existence of externalities can be a justification for subsidies to foreign plants from host country governments. A comparison between these theories and the literature on agglomeration reveals an overlap that we exploit in our empirical work. We end this section with a simple model that makes this overlap clear and which guides our empirical work.

2.1 Theories of Linkages between Foreign and Domestic plants

The extant literature on linkages between foreign and domestic plants tends to group linkages into the following categories: vertical linkages and horizontal linkages. Horizontal linkages are defined as interactions between foreign and domestic plants that operate in the same industry. Vertical linkages are defined as linkages between foreign firms and the plants to which they sell (forward linkages) and the plants from which they source inputs (backward linkages).

Horizontal linkages are thought to operate through a variety of channels. The first channel is direct competition between foreign and domestic plants in output markets and input markets. The second channel is often referred to as the knowledge spillover channel and occurs in a variety of ways including labor sharing, observation, informal communication

and technology licensing. Empiricists typically look for these linkages between foreign and domestic plants in the same industry since two plants producing similar products are more likely to compete in output and input markets and since knowledge about production processes in foreign plants are thought to be more useful to domestic plants in the same industry. However, it is clear that horizontal linkages need not be confined to plants in similar industries. For example, plants in different industries are likely to compete for the same pool of unskilled workers and workers trained in management practices such as accounting and bookkeeping have skills that could be applied in a wide range of industries.

Vertical linkages are thought to operate primarily between foreign plants and their domestic suppliers. The logic for the existence of such spillovers is that foreign plants have an incentive to upgrade both the quality of the inputs purchased domestically as well as the efficiency with which they are produced in order to boost their own profits. Javorcik (2010) explains that there is quite a lot of empirical evidence to support this hypothesis. Abebe and Schaefer (2014) provide a nice example of this in the context of the Ethiopian leather industry. They explain that the recent entry of Chinese investment in the tanning sector has demonstrated that low grade skins and hides that were previously rejected could in fact be used with the correct technology. This technology has allowed domestic plants to utilize hides and skins that were previously thrown away. Forward linkages between foreign and domestic plants could occur if foreign plants engage in activities such as product demonstration or installation for domestic plants which purchase products from foreign plants.

2.2 FDI Linkages and Theories of Agglomeration

Agglomeration economies are the benefits that come when plants and people locate near one another in cities and industrial clusters (Glaeser, 2010). Some of the benefits of agglomeration that have been highlighted by researchers in this area are: (i) labor market pooling; (ii) reduced transportation costs; (iii) increased likelihood of knowledge spillovers; (iv) in-

creased access to local amenities and; (v) natural advantages or productive amenities like access to natural resources. An implication of this literature for research on linkages between foreign and domestic plants is that domestic plants which are 'closer' to foreign plants are more likely to benefit (or be harmed by) FDI.

A paper by Rosenthal and Strange (2004) is especially helpful in thinking about the overlap between the two literatures in that it clarifies what it would mean for a foreign plant to be close to a domestic plant. Rosenthal and Strange (2004) model the benefits of agglomeration at the establishment level as Hicks neutral technological progress which is a function of: (i) the geographic distance between establishments; (ii) the technological distance between establishments and; (iii) the temporal distance between establishments. It is not difficult to see that these concepts are useful for thinking about linkages between foreign and domestic plants. In particular, this model raises the possibility that foreign and domestic plants are more likely to be linked when they are geographically close to one another, when they are in similar industries and closer to the time when foreign plants open in a locality.

In more recent work, Greenstone, Hornbeck, and Moretti (2010) argue that some of the reasons why plants might benefit from locating in close proximity to one another include: (i) reduced transportation costs and; (ii) increased likelihood of knowledge spillovers. The idea that geographic proximity reduces transportation costs between two plants suggests that a foreign and a local plant which are in close geographic proximity might be more likely to trade with one another on account of transportation costs. This could result in both lower input costs and an increased likelihood of knowledge spillovers between the two plants. All of these insights suggest a model of the interactions between foreign and domestic plants that takes into account the geographic distance between foreign and domestic plants.

2.3 A Simple Model

Our model adapts insights from Rosenthal and Strange (2004) and Greenstone, Hornbeck and Moretti (2010). Like GHM (2010) and for the sake of simplicity, we focus on the case of Hicks neutral technological progress. Instead of focusing on the number of plants in a county, we allow linkages between domestic and foreign plants to depend upon the geographical, technological and temporal distance between foreign and domestic plants. Thus, we are not strictly testing for agglomeration economies; instead we are using relevant insights from this literature to set up our model.

Following both Rosenthal and Strange (2004) and GHM (2010) we assume that all domestic plants use a production technology that employs labor, capital, land and other material inputs to produce a nationally traded good whose price is normalized to one. Domestic plants choose the amount of inputs to maximize the following expression:

$$\max_{L,K,T} f(A, L, K, T) - wL - rK - qT,$$

where w , r , and q are input prices and A is a productivity shifter. A includes all factors that affect the productivity of labor, capital and land equally such as knowledge spillovers from FDI.

We model A as a function of the geographical proximity between domestic and foreign plants, the technological proximity between domestic and foreign plants and the temporal proximity between domestic and foreign plants. To keep the equation manageable, we denote these three distances as lower case p but in our empirical work, we will distinguish between these three types of distance. Thus we can write the expression for A in the following way:

$$A = A(p) \tag{1}$$

We define factor neutral knowledge spillovers as the case in which an increase in the proximity of domestic to foreign plants increases the knowledge spillovers from foreign to domestic plants so that $\partial A/\partial p > 0$.

We define $L^*(w,r,q)$ as the optimal level of labor inputs, given market wages, the cost of capital and the cost of industrial land. Similarly, we define $K^*(w,r,q)$ and $T^*(w,r,q)$ as the optimal levels of capital and land respectively. In equilibrium, L^* , K^* and T^* are chosen so that the marginal product of each of the three factors is equal to its price. In Ethiopia, the markets for credit and land cannot be characterized as perfectly competitive. Instead, land and capital are typically allocated through a central mechanism with subsidies to both domestic and foreign plants in the manufacturing sector. According to the urban land lease proclamation, along with religious institutions and embassies, investments in the manufacturing sector are entitled to easy and cheap access to land directly from the government (FDRE, p. 6229, 2011). Credit is also subsidized by the Development Bank of Ethiopia (DBE) through its generous 70 (loan):30 (equity) loan policy for priority sectors which include manufacturing (AfDB, 2014). Thus, in our optimization, we do not allow the prices of land or capital paid by domestic plants to be influenced by the distance between foreign and domestic plants. Instead we take the prices of land and capital as exogenous.

However, we allow for wages to depend on the proximity of domestic plants to foreign plants. The extent to which wages would rise as foreign firms enter local labor markets in Ethiopia is unclear. Job opportunities in Ethiopia's formal sector are limited and unemployment is high. At the same time, labor productivity in Ethiopia's traditional sectors is very low. Taken together, these facts suggest a horizontal labor supply curve at a relatively low level of wages. Indeed cheap labor is one of the reasons foreign firms are drawn to Ethiopia. On the other hand, the literature provides ample evidence from other albeit more developed countries that foreign firms pay a wage premium. Thus, domestic plants in close proximity to foreign plants may be forced to pay higher wages to keep or attract labor, especially in

managerial or administrative positions.

Summarizing, we allow w to vary as a function of p writing this as $w(p)$ and we take r and q as fixed by the central government. Note that although the prices of land and capital are set centrally, plants still choose quantities to employ in the production process. Thus, we can write equilibrium profits in the following way:

$$\begin{aligned} \pi^* = & f[A(p), L^*(w(p), r, q), K^*(w(p), r, q), T^*(w(p), r, q)] + \\ & -w(p)L^*(w(p), r, q) - rK^*(w(p), r, q) - qT^*(w(p), r, q) \end{aligned} \quad (2)$$

Equation (2) makes it clear that domestic plants' profits, TFP and wages depend on their proximity to foreign plants.

To understand the relationship between domestic plants' profits and changes in domestic plants' proximity to foreign plants, we totally differentiate equilibrium profits. This yields the following expression:

$$\frac{d\pi^*}{dp} = \frac{\partial f}{\partial A} \frac{\partial A}{\partial p} + \frac{\partial w}{\partial p} \left\{ \left[\frac{\partial L^*}{\partial w} \left(\frac{\partial f}{\partial L} - w \right) - L^* \right] + \left[\left(\frac{\partial K^*}{\partial w} \right) \left(\frac{\partial f}{\partial K} - r \right) \right] + \left[\left(\frac{\partial T^*}{\partial w} \right) \left(\frac{\partial f}{\partial T} - q \right) \right] \right\} \quad (3)$$

If domestic plants are price takers and all factors of production are paid their marginal product, equation (3) simplifies to the following:

$$\frac{d\pi^*}{dp} = \frac{\partial f}{\partial A} \frac{\partial A}{\partial p} - \frac{\partial w}{\partial p} L^* \quad (4)$$

Equation (4) makes it clear that being closer to foreign plants has two opposing effects on domestic plants. If there are knowledge spillovers from foreign plants to domestic plants, the first term in equation (4) will be positive raising the profits of domestic plants. The second

term in equation (4) represents the negative effect that foreign plants could have on domestic plants if being close to foreign plants implies an increase in wages that domestic plants must pay to keep labor. Note that although we did not include material costs in our specification, this result would generalize to the cost of other inputs. In other words, the demand by foreign plants for material inputs which are produced locally could raise the prices of these inputs.

2.4 Empirical Predictions

The simple framework above leads to predictions that inform our empirical analysis. In particular, the opening of a foreign plant may change:

1. the TFP of domestic plants;
2. the entry of domestic plants in a location - new manufacturing domestic plants may choose to locate in the districts receiving FDI to gain access to these productivity advantages and;
3. input prices and in particular wages.

In addition, our framework makes it clear that the magnitude of these effects are increasing in the domestic plants proximity – geographic, technological, temporal – to foreign plants. These insights encourage an empirical analysis which takes into account the proximity of FDI plants to domestic plants.

3 Background and Data

3.1 Background

The first recorded presence of FDI in the Ethiopian manufacturing sector dates back to the turn of the 20th century. In the first half of the 20th century, most of the new investment in the

country was dominated by foreign capital (Eshetu, 1995). Coinciding with the consecutive five year development plans between 1957 and 1974, the imperial regime enacted several investment proclamations and tax codes to promote the flow of both foreign and domestic investment towards the manufacturing sector. While private domestic investment slightly increased in this period, the manufacturing sector was largely dominated by foreign nationals. FDI inflows have increased in subsequent decades until coming to an abrupt end in 1974 with the overthrow of the imperial regime by the military junta, also called the *Derg*.

The socialist economic system adopted by the military government led to the introduction of severe restrictions on private capital thereby driving away both existing and prospective FDI. With the collapse of the *Derg* regime, the restrictions on private sector investment have been lifted and more market-friendly policies, such as the privatization of state owned enterprises and liberalization of both domestic and international trade, were introduced in the early 1990s.

In the same vein, during the past decades, there have been several reforms targeted at attracting foreign capital to the country. With the objective of creating a favorable investment environment for private businesses, the investment proclamation, for example, has been revised seven times between 1996 and 2014, and three times between 2008 and 2014. The revisions removed a myriad of restrictions on business areas open to foreign investment and introduced generous incentives for investors entering into the manufacturing and export sectors. Crucially, the first comprehensive industry strategy paper that carved out an important role for FDI in the industrialization effort of the country was drafted in 2002/03. More recently, FDI appears to increasingly flow from emerging countries, such as China, Turkey and India (Ethiopian Investment Commission, 2016).

In the government's recent five year development program called the Growth and Transformation Plan (GTP II) attracting quality FDI, defined as investments that generate positive spillover effects towards the local economy through both direct and indirect linkages, has

been identified as a key priority to transform the manufacturing sector (FDRE, 2016). Moreover, in the investment proclamation, there is a stipulation that foreign plants must transfer technology to local enterprise and to their workers. In practice, however, enforcement mechanisms are weak.⁵

3.2 Data and Descriptive Statistics

This study uses two data sources: manufacturing plant data for the years 1997-2013 collected by the Central Statistical Agency (CSA), and a knowledge transfer survey module designed by us. The source of manufacturing plant data is the annual Large and Medium Scale Manufacturing (LMSM) Establishment Census of the CSA.⁶ It consists of enterprises engaged in “the mechanical, physical, or chemical transformation of materials, substances, or components into new products and the assembling of component and parts of manufactured products” (CSA, 2015). In principle, any formal manufacturing plant in the country that employs at least 10 people and uses electricity in its production process forms part of the target population. In practice, out of the 20,711 plant-year observations, 5,445 feature a number of employees smaller than 10. These are observations for plants that at some point reach 10 employees (and therefore enter the business directory that CSA compiled as a “framework” for the census) but then have a lower number of employees at the date in which they are re-surveyed.⁷ The available information includes ownership type, employment, material and non-material inputs, capital stock, sales, geographic location, date of plant establishment. It is worth pointing out that with these records it is possible to construct a genuine panel of

⁵For example, the employment of expatriate workers is permitted conditional on the pledge by employers to transfer production and management skills to local workers. Such skills transfer schemes are aimed at replacing highly paid expat professionals with trained Ethiopian workers. Successful skills transfer scheme would thus not only build local production and managerial capacity but also help reduce repatriation of foreign currencies.

⁶The manufacturing census data has been used by several researchers to address a range of research questions (e.g., Bigsten and Gebreeyesus, 2007, 2009; Shiferaw et al., 2015; Hjort and Poulsen 2017)

⁷In the TFP estimation, we remove domestic plant-year observations with remarkably high or low values (outside the 1% - 99% range) for the number of employees.

manufacturing plants. See Section A.I for details on the data construction.

The survey module contains a set of questions on FDI and FDI-domestic plant interactions for 1,708 manufacturing plants belonging to the CSA dataset, interviewed in February 2014⁸To bolster the analysis, in June 2016, we visited several plants and interviewed managers about the history of their enterprises and their current operations. In the following months, we also conducted targeted interviews with officials at the Ministry of Industry and the Ethiopian Investment Commission, and with owners and managers at foreign and domestic plants. We classify as FDI all plants that report a nationality of main owner (or owners if the plant is a joint venture) other than "Ethiopian" (e.g. Chinese, Indian) in answering our survey . For the years before our survey module, we define as foreign plants for which at least 5 percent of assets are foreign owned (Aitken and Harrison, 1999)⁹ . For FDI presence to generate productivity spillovers, a plant-specific advantage should be observed at foreign plants that could be the basis for knowledge transfer to other local plants. In Table 1 we directly compare plant size, performance and technology indicators between domestic and foreign plants in 2013. foreign plants on average employ more workers than domestic plants and feature significantly larger value added per worker. foreign plants are also more likely to export than local plants, to conduct in-house research and development (R&D), to hold internationally recognized patents and to use foreign technology licenses for their product or in production processes. Table A.1 shows that FDI pay significantly higher wages for workers in higher-skilled occupations and that their production workforce is on average better educated. The evidence in Table 1 and Table A.1 is important for establishing the potential for knowledge transfer in Ethiopia. As discussed at length in section 2, linkages are important conduits of technology diffusion and spillover effects. Horizontal and vertical interactions in the input and product markets creates opportunities for less expensive or advanced tech-

⁸In February 2014, these manufacturing plants were asked *both* the questions from the CSA usual survey instrument (whose answers represent the observations for year 2013) and the questions from our survey module.

⁹Aside from asset ownership , the earlier CSA survey module did not ask detailed questions on the nature of ownership including nationality of the owner.

nological and managerial practices to diffuse from FDI to domestic plants. In our analysis, we characterize linkages between domestic and foreign plants in three ways. We define domestic plants as (a) labor-linked, if they have employed former workers of foreign plants; (b) backward-linked, if they directly sell their products to foreign plants; and (c) forward-linked, if they procure materials or inputs directly from FDI plants. Around 7 % of domestic plants are labor-linked, 3 % are backward-linked and 3.5 % are forward-linked.

4 Estimating the magnitude of FDI spillovers

We now turn to an econometric analysis with the goal of estimating augmented Cobb-Douglas production functions that allow the TFP of domestic plants to depend on the presence of FDI in the district (Woreda) - see Figure A.2 for a map which shows Woreda boundaries. Specifically, we evaluate the changes in TFP when an foreign plant is added to a district. The underlying idea is that, presumably the benefits from FDI would be localized at least initially, with close-by domestic plants to be better placed to benefit from FDI presence than plants further away. The primary identification challenge is that FDI companies do not select the location for their greenfield plants randomly. FDI companies' objective is to maximize profits and their location decision depends on local cost shifters (such as the quality of the labor force and transportation infrastructures) which are likely to be correlated with the TFP of domestic plants, and are often difficult to quantify. Consequently, a simple contrast of the TFP of domestic plants in districts where a greenfield foreign plant opens with the TFP of domestic plants in districts where an foreign plant does not open would probably produce biased estimates of FDI spillovers. We address this empirical challenge in two ways. First, we compare districts where an FDI plant actually invested to districts in which an foreign plant (in the same industry and around the same time) applied for a license, got approval but then did not open the plant during the period in which the foreign plant was operating in the

treated district. Second, we exploit the government designation of locations for greenfield foreign plants, in combination with an event study research design.

4.1 Actual vs Planned FDI Investments

4.1.1 Research Design, Econometric Model and Descriptive Statistics

We compare changes in TFP among domestic plants in “treatment” districts to changes in TFP in “control” districts. We define treatment districts as those districts where an foreign plant actually invested. For each treatment district, at least one control district is chosen as a location where an foreign plant in the same industry and around the same time, applied for a license, got approval but then did not open the plant during the period (going from one up to four years) in which the foreign plant was observed operating in the treatment district. We use restricted data from the Ethiopian Investment Commission; the algorithm used to find control districts is described in Section A.II. The identifying assumption is that the domestic plants in the control districts represent a valid counterfactual for the domestic plants in the treatment districts, after conditioning on plant fixed effects, industry by year fixed effects, and other control variables. Regarding the patterns of "conversion" from the investment stage to operational phase, the World bank concludes that:

Currently 2 out of 3 potential FDI firms do not reach the operational state. Even though an One Stop Shop service is operational its effectiveness record is mixed. Bureaucratic hurdles continue to affect project implementation [...]. Further research is needed to identify those factors that facilitate the conversion of successful FDI in Ethiopia (pag 44, Fourth Ethiopia Economic Update "Overcoming constraints in the manufacturing sector", July 2015 by World Bank).¹⁰

¹⁰For a similar discussion see Chen, Geiger & Fu 2015

Delays related to foreign currency shortages and financing issues are also sometimes cited as explanations why there exists a lag in investment translations - see Altenburg (2010), U.S. Department of Commerce (2017) and Moller & Wacker (2015). As we show below, in the years before the foreign plant opening, plants in treatment and control districts were similar along several key dimensions, and there were not significant differences in TFP trends. This evidence supports the validity of our identifying assumption. Even if we cannot draw definite conclusions regarding the validity of our research design, we believe that the identifying assumptions are less stringent with our strategy than when using regression adjustment to compare the TFP of domestic plants in districts with new entrants to the other (nearly 300) districts in our data featuring manufacturing activity, or employing a matching approach based on observables. The regression equation that forms the basis of our empirical analysis on the sample of domestic plants is:

$$\ln(Y_{pidrt}) = \beta_L \ln(L_{pidrt}) + \beta_K \ln(K_{pidrt}) + \beta_M \ln(M_{pidrt}) + \delta 1(OPENING)_p + (5) \\ + \kappa 1(\tau \geq 0)_t + \varphi [1(OPENING)_p \cdot 1(\tau \geq 0)_t] + \alpha_p + \mu_{it} + Trend_{rt} + \varepsilon_{pidrt},$$

where p references plant, i industry, d district, r region and t year; Y_{pidrt} is the value of total plant production, and we allow the total number of employees L_{pidrt} , total capital inputs K_{pidrt} and materials inputs M_{pidrt} to have separate impacts on output; we also allow for permanent differences across plants α_p , and a stochastic error term ε_{pidrt} . We report results with and without allowing for industry-specific time-varying shocks μ_{it} . The dummy $1(OPENING)$ is equal to one if plant p is located in a treatment district; τ denotes year, but it is normalized so that the year of the foreign plant opening is $\tau = 0$; the variable $Trend_{rt}$ is a region-specific trend. A concern for the validity of our interpretation of the estimates arises from the observation that the dependent variable in the econometric model is the *value* of output. Therefore, the estimated spillover effect may reflect higher output prices rather

than higher productivity. We explore this possibility in Section 4.3. We report standard errors clustered at the district level. Given that the number of districts is equal to 27, we also report the p-values obtained using wild bootstrap (Wu 1986) with null imposed, as recommended by Cameron, Gelbach, and Miller (2008) - we use the *boottest* Stata routine developed by Roodman (2017).

Our aim is to identify a substantial shock to the district's economy. We therefore require a large relative increase in local employment. In order to qualify as a usable FDI manufacturing opening, we impose that the FDI plant's labour force is at least 100 employees or constitutes at least 1% of total employment in local manufacturing in $\tau = 0$ or $\tau = 1$. We also impose that the location is not assigned by the government. Table A.2 displays descriptive information on the 12 usable openings. We have a total of 27 districts, 15 of which are controls. Openings tend to be in food and beverages (5), chemicals and chemical products (3), and other non-metallic mineral products (3). Table 2 displays the means of plant-level variables across districts in the year before the opening. These means are shown for treatment and control districts in columns 1 and 2 respectively. The percentage change in these variables between 2 years and 1 year before the opening are also shown. Column 3 reports the p-value from a test of equality between columns 1 and 2. Column 4 reports the p-values obtained using the procedure recommended by Cameron, Gelbach, and Miller (2008). This exercise offers a chance to evaluate the soundness of the empirical strategy, as measured by preexisting observable plant characteristics. To the extent that these observable features are balanced among treated and control districts, this lends support to the research design. The table shows that plants in treated districts tend to be older (2 years). This difference is significant at 10% when clustering at the district level, and not significant when using the Cameron, Gelbach, and Miller (2008) procedure. There are not significant differences in output, capital, the number of employees, output per worker, capital per worker. Overall we conclude that the covariates are balanced between plants in treatment and control districts.

4.1.2 Main Results

Figures 1 and 2 plot the estimated coefficients from a version of equation 5 where the natural log of output is regressed on the natural log of inputs, year by two-digit industry fixed effects, plant fixed effects, and the event time indicators. The sample is restricted to include only plant by year observations within the period of interest (where τ ranges from -4 through 3). Figure 1 reports the yearly difference between estimated mean TFP in treatment and control districts, with confidence intervals. The displayed coefficients on the event time dummies in Figure 2 indicate yearly mean TFP in treatment districts and control districts, relative to the year before the foreign plant opened. In the years before the opening of the new plant, treatment and control districts do not have significantly different trends in productivity. This evidence brings support to the validity of the research design. Starting in the year of the FDI opening, there is a sharp upward break in the difference in TFP between the treatment and control districts.

Table 3 shows the estimated φ in equation 5. Column 1 reports baseline estimates. Column 2 allows for industry-specific time-varying shocks μ_{it} and is therefore the preferred specification. The estimates imply an increase in TFP of approximately 8 percent. Estimates are similar when domestic plants are required to be in the data for at least 3 years prior to the event (Column 3; this addresses concerns related to the endogenous opening of new plants and compositional bias). In Column 4 we introduce case fixed effects - we refer to the treatment district and accompanying control district(s) associated with each plant opening as a “case”. Results are again similar.

4.2 Making use of government designation of locations

4.2.1 Research Design, Econometric Model and Descriptive Statistics

In order to implement this second empirical strategy, we asked plant managers what the most important reason for choosing the location for the production facility was. We consider as valid events for our identification strategy the openings of foreign plants reporting "Did not choose the location, was allocated by the authorities"¹¹. We now provide some institutional background to the investment land allocation process. Both federal and regional offices are in many cases involved in the process. In an email interview (Dec 23, 2015), the General Director of Policy and Program Studies at the Ministry of Industry explained how the ministry, after receiving a request from a potential investor often contacts a Regional office responsible for investment land administration. The Regional office then provides information on the land availability. The regions targeted by the federal government are arguably non-random. In particular, in order to foster equitable regional growth, the government often targets regions (outside Addis and its surrounding areas) with lower levels of pre-existing investment (FDRE, 2012). However, the exact district within a broader region in many cases appears to be determined by idiosyncratic characteristics, such availability of land at the time. As pointed out to us by the General Director of Policy and Program Studies in the same email interview, in no case is the process coercive. An investor can always refuse to carry on with the investment or choose some other location instead.¹² However, the fact that plant managers report that location was not chosen but allocated provides support to our strategy of using government designation to obtain some quasi-experimental variation in the treatment. Moreover, there is often uncertainty in which year the foreign plant will start production.

¹¹The other possible answers are "Cheap labour", "Good infrastructure", "Located close to raw materials and input suppliers", "Located close to customers", "Located close to producers of similar products", "Expected that many more producers would be located in this site", "Others (specify)".

¹²If the investor is interested in the location, negotiations take place on the price and terms of lease. Note that in Ethiopia land is publicly owned and both local and foreign plants can enter into lease-hold or rental arrangements to acquire land for investment.

In the words of a manager at an foreign plant:

It was not up to us to choose the location for our company. The government gave us the location that we have now. That is the case in many cases. [...] After asking for the land, we just waited for the responses of the government. After a long time they gave us the location. [...] The time we waited was two years. [...] This is because of the procedures that the offices of the government follow which often take time. [...] It has taken them long time to identify a location for us. That is because they were also looking for locations and land for many other investors and companies at that time. [...] I didn't think that it would take such a long period of time to get a land for investment (Jan 10, 2017).

In general, the local TFP impact of the entry of the foreign plants may be identified provided that there are no district-specific pre-trends in the outcomes of interest, a condition that appears to be satisfied in the data. We evaluate the local impact of FDI using an "event-study" research design. This design allows us to test for the presence of district-specific pre-trends in the outcome of interest and recovering any dynamics of the opening effect. In the main results we compare the "treated" districts both to districts that have not yet been treated and districts that will never be treated during our sample period. We then re-estimate our econometric model without the never treated localities, so that identification comes from the differential timing of treatment onset among the treated. The regression equation that forms the basis of our empirical analysis is:

$$\ln(Y_{pidrt}) = \beta_L \ln(L_{pidrt}) + \beta_K \ln(K_{pidrt}) + \beta_M \ln(M_{pidrt}) + \sum_{\tau} \beta_{\tau} D_{drt}^{\tau} + \alpha_p + \mu_{it} + Trend_{drt} + \varepsilon_{pidrt}, \quad (6)$$

where D_{drt}^{τ} are a sequence of "event-time" dummies indicating that the foreign plant opened

(in district d) τ periods ago (where τ may be negative). Formally:

$$D_{drt}^\tau \equiv I[t - e = \tau],$$

where $I[.]$ is an indicator function for the expression in brackets being true, and e is the year of the plant entry. Therefore the β_τ coefficients characterize the time path of TFP relative to the date of the foreign plant opening for treated districts. The results are obtained by estimating Equation (6) by OLS, including a series of event-time dummies along with dummies for the plant and region-specific trends. We report results with and without including industry-year fixed effects. We normalize the first lead (-1 in event time) to zero, so that all post-event coefficients can be interpreted as treatment effects. We also put in place the endpoint restrictions¹³:

$$\beta_\tau = \begin{cases} \bar{\beta} & \text{if } \tau \geq 3 \\ \underline{\beta} & \text{if } \tau \leq -4 \end{cases}$$

These endpoint coefficients give different weight to districts experiencing the entry of the foreign plant early or late in the sample period.¹⁴ Therefore, in discussing the effect of the opening, we concentrate on the event-time coefficients falling within $\tau = 0$ and $\tau = 2$ that are identified off of a nearly balanced panel of districts. In order to qualify as a usable FDI manufacturing opening, we impose the following criteria. First, the location has to be assigned by the government. Second, the FDI plant's labour force is at least 100 employees or constitutes at least 1% of total employment in local manufacturing in $\tau = 0$ or $\tau = 1$. Third, the opening is not preceded or followed by the entry of FDI whose location was chosen by the plants' owners (i.e. non "allocated by the authorities") and employing at least either 100 employees or 1% of the local manufacturing labour force. Specifically we exclude districts that receive such openings in $\tau = (-3,3)$. Table A.3 displays descriptive information on the

¹³This constraint aids to diminish some of the collinearity between the year and event-time dummies.

¹⁴Notice that the sample of treated districts is unbalanced in event time.

17 usable openings. We have a total of 223 control districts of which 206 are never treated¹⁵. Openings tend to be in non-metallic mineral products (8), food and beverages (4), and wood, furniture and paper (3). Figure A.3 displays the geographic distribution of treated districts. Table 4 displays the means of plant-level variables across districts for 1998, that is the year before the earliest treatment. These means are shown for districts that experience the event and for never-treated districts in columns 1 and 2 respectively. The percentage change in these variables between 1997 and 1998 are also shown. Column 3 reports the p-value from a test of equality between columns 1 and 2. Column 3 reports the t-statistics from a test of equality between columns 1 and 2. This exercise offers a chance to evaluate the soundness of the empirical strategy, as measured by preexisting observable plant characteristics. To the extent that these observable features are balanced among the two sets of districts, this should lend support to the research design. The table shows that the plants in treated districts tend to have lower levels of capital per worker (significant at 10%). This is consistent with the government targeting regions with lower levels of pre-existing investment. There are not significant differences between the two groups in plant age, output, capital, number of employees and output per worker.

4.2.2 Main Results

Figure 3 plots the estimated β_τ coefficients from a regression of the form given in Equation (6).¹⁶ There is no pretreatment trend in the coefficients but a rather sharp upward break in TFP of local domestic plants after the entry of a government-assigned foreign plant. While the general pattern in Figure 3 is quite clear, some of the individual β_τ coefficients are not estimated very precisely. We therefore offer more formal tests of the null hypothesis that the FDI plant entry has no impact on local plants' TFP. To increase statistical power, in Table

¹⁵We exclude never-treated districts receiving the opening of a large foreign plant whose location was non "allocated by the authorities".

¹⁶We include industry-year fixed effects.

5 we follow the approach in Kline (2011) and test hypotheses about the average of the β_τ coefficients over the period between $\tau = 0$ and $\tau = 2$. Column 1 reports baseline estimates. Column 2 allows for industry-specific time-varying shocks μ_{it} and is therefore the preferred specification. The estimated average increase over the three years starting with the year of the opening is 16 percent. To put the size of the estimated impact of the FDI opening in perspective, we compute the portion of total variation in average manufacturing TFP explained by the FDI opening. TFP varies a great deal across Ethiopian districts. A 16 percent increase in TFP corresponds to moving from the 10th percentile of the district-level TFP distribution to the 25th percentile; put differently, it corresponds to a 0.3-standard-deviation increase in the distribution of district TFP.¹⁷ The FDI openings we consider are a key occurrence for these districts, and the implied change in the relative standing of districts is arguably sizable but not improbable. When we drop the never treated localities, the patterns are qualitatively similar (Column 3 of Table 5; Figure 4). The patterns are qualitatively similar also when we require domestic plants in treated districts to be in the data for at least 3 years prior to the event (Column 4 of Table 5).

4.3 Validity and Robustness

We now investigate the sensitivity of our results to various specifications, and explore several possible alternative explanations for the estimated effects.

Transmission bias A significant conceptual concern is the possibility of ‘transmission bias’, which arises from plants’ reaction to unobservable productivity shocks when making input choices (Eberhardt and Helmers, 2010). Unlike the typical estimation of plant level production functions, our goal is to obtain a consistent estimate of the event-study co-

¹⁷We obtain these quantities using the cross-sectional plant-level data from the LSM Census for 2001 (the midpoint of our sample period). Specifically, log output is regressed on log inputs and a complete set of districts dummies. We then look at the distribution of the district dummies, which represent the average productivity among all plants in a particular district (GHM, pag 589).

efficients corresponding to the FDI entry, so transmission bias is important only to the extent that it causes biased estimates of these coefficients (GHM p.583). In order to explore the significance of transmission bias in our setting, we employ the most popular estimators in the econometric literature on production function (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Akerberg, Caves, and Frazer, 2015). The results across the 6 specifications, shown in Table A.4, are qualitatively similar to the main results.

Attrition of Sample Plants A gap in attrition in the sample of domestic plants in treatment and control districts could contribute to the measured gap in TFP among survivors after the FDI opening. The evidence suggests that a gap in attrition is unlikely to explain our finding of positive FDI effects in treatment districts. We find that, in the sample used in Section 4.1, similar numbers of treatment and control districts remained in the sample at its end: 52 percent in treatment districts and 54 percent in control districts (i.e., the number of plants at $\tau = 3$ as a fraction of the number of plants at $\tau = 0$).

Regarding the sample used in Section 4.2, we estimate:

$$\ln(Deaths_{drt}) = \sum_{\tau} \beta_{\tau} D_{drt}^{\tau} + \alpha_d + \psi_t + Trend_{rt} + \varepsilon_{drt}. \quad (7)$$

The estimated average of the event study coefficients over the three years starting with the year of the opening is 0.25 and not significant (s.e. 0.46).

Government expenditures The federal and local governments in several cases set up worker training funds, construct new roads, and make other infrastructure investments around the time of entry of an foreign plant. It is possible that these investments benefit domestic plants in addition to the foreign plant. To examine this possibility, we control for government total capital expenditures and government construction expenditures. Using the first research design, the estimated φ is 0.12 when controlling for government total capital expenditures

and 0.12 when controlling for government construction expenditures (significant at 5% level in both cases). Using the second research design, the estimated average of the event study coefficients over the three years starting with the year of the opening is 0.20 when controlling for total expenditures and 0.19 when controlling for construction expenditures (significant at 10% level in both cases).

Changes in the intensity of capital usage If the capital stock in treated districts was used below capacity, then incumbent plants may react to the FDI opening by growing the intensity of their capital usage and therefore increase production (GHM p. 585). To explore this possibility, we control for the ratio of the dollar value of energy usage (which is increasing in the use of the capital stock) to the capital stock. The estimates are qualitatively similar. Specifically, using the first research design, the estimated φ is 0.08 (*s.e.*0.05). Using the second research design, the estimated average of the event study coefficients over the three years starting with the year of the opening is 0.19 (significant at 10% level).

Changes in the Price of Plant Output As mentioned above, another concern for the validity of our interpretation of the estimates arises from the observation that the dependent variable in the econometric model is the *value* of output. The theoretically correct dependent variable in a productivity study is the *quantity* of output, but, due to data limitations, this study (and most of the empirical literature on productivity in a large sample of plants) uses price multiplied by quantity. Therefore, the estimated spillover effect may reflect higher output prices rather than higher productivity. To explore this possibility we adopt two approaches. First, we remove domestic plants in a supply link with the new entrant, plants for which output price effects might be largest. The estimates are qualitatively similar to those in Section 4.1 and 4.2. Specifically, using the first research design the estimated φ is

0.27 and significant at conventional levels.¹⁸ When using the second research design, the estimated average of the event study coefficients over the three years starting with the year of the opening is 0.097 (*s.e.* 0.062).

Second, we follow GHM and investigate whether the TFP increase is bigger for plants that sell more locally. Specifically, in our survey we have asked domestic plants the distance to the most important customer.¹⁹ This allows us to estimate a version of equation (3) that interacts $1(OPENING)$, $1(\tau \geq 0)$ and $[1(OPENING) \cdot 1(\tau \geq 0)]$ with this distance. This regression does not find that the TFP increase is bigger for plants that sell more locally. Specifically, the coefficient of the interaction of $[1(OPENING) \cdot 1(\tau \geq 0)]$ with this distance is equal to -0.0002 and not significant (*s.e.* 0.0004).

Falsification test Lastly, we conduct a falsification test in order to verify that our results do not capture a general pattern in local outcomes following designation of plant locations according to government plans of regional development, unrelated to the presence of a large foreign plant. We consider the entry of large *domestic* plants that report "Did not choose the location, was allocated by the authorities". We fail to reject the null hypothesis of no local impact of these domestic openings. The estimated average of the event study coefficients over the three years starting with the year of the opening is -0.002 and not significant (*s.e.* 0.052).

4.4 Further Analysis

Do the foreign plants attract new economic activity? Baseline estimates showed positive TFP changes for local domestic plants following the opening of the new foreign plant. Thus, new manufacturing domestic plants may choose to locate in the districts receiving FDI to

¹⁸Since we observe the presence of a supply link only in the last year we focus on the sample that survives until the end of our sample period.

¹⁹Across all sample plants, the median distance is 10km, the 75th percentile is 50km.

gain access to these productivity advantages. Motivated by this observation, we estimate, using the first research design:

$$\begin{aligned} Births_{jdr,t} = & \delta 1(OPENING)_{dj} + \\ & + \kappa 1(\tau \geq 0)_{jt} + \varphi [1(OPENING)_{dj} \cdot 1(\tau \geq 0)_{jt}] + \alpha_d + \psi_t + Trend_{rt} + \varepsilon_{jdr,t}, \end{aligned} \quad (8)$$

where *Births* is either the simple count of new domestic plants or the count weighted by the number of employees at entry, and ψ_t is a year effect. The regression equation using the second research design is:

$$Births = \sum_{\tau} \beta_{\tau} D_{drt}^{\tau} + \alpha_d + \psi_t + Trend_{rt} + \varepsilon_{drt}. \quad (9)$$

Table 6 presents the results. Although the FDI effect is not estimated precisely in two out of the four specifications, it is always positive. In terms of magnitude the range is between 0.14 and 0.54 of a standard deviation.²⁰ Overall, these results are consistent with the estimated increases in TFP since it appears that the foreign plants attracted new economic activity in the manufacturing sector to the receiving districts.

Employment at incumbent domestic plants Section A.I reports the analysis of the FDI effects on the number of employees at incumbent domestic plants.

5 Inside the black box of FDI spillovers

In this section, we analyze tabulations of responses to our survey module, with the goal of providing direct evidence on the interaction between foreign and domestic plants.

We begin by reporting answers to the questions on changes experienced by domestic

²⁰Estimates are qualitatively similar when (a) using $\text{Log}(Births)$ as dependent variable; and (b) using the count weighted by the value of total plant production at entry.

plants due to the entry of FDI. Then we report answers to questions which can allow us to understand how the reported changes differ depending on the degree of linkages between domestic and foreign plants. Finally we report answers to a question on the extent to which domestic plants benefit from hiring workers from foreign plants.

Table 7 displays 6 FDI-related outcomes of domestic plants. While all of the reported changes displayed in the Table may lead to increase in the productivity of domestic plants, only the first four outcomes can be considered as indications of knowledge spillovers. The Table indicates that 12.5 % of domestic plants directly adopted production processes by observing foreign plants in the same industry (outcome 1). The vast majority of plants that imitated foreign plants indicate that foreign plants did not try to block the learning from happening - a finding consistent with those in von Hippel (1987)'s case-study of the US steel minimill industry. Table 7 also shows that about 7 % of domestic plants report that the employment of former workers of foreign plants generated positive effects (outcome 2). Domestic plants also reports acquiring technology from their FDI customers and suppliers albeit with lower proportions (outcomes 3-4).

These tabulations of responses support the hypothesis of important changes taking places for domestic plants. Evidence from our targeted interviews also supports such hypothesis. In the words of a manager at an foreign plant:

We have provided trainings and other assistance for domestic plants that are engaged in the production of liquid soap. Besides we have also provided trainings for chemistry students of different universities. We also exchange raw materials with other domestic soap factories (Jan 12, 2017; in-person interview).

Another manager at a different FDI pointed out:

We have, for instance, provided training for one smaller enterprise. The training was about mechanical issues and how they can operate machineries that are used

for processing textile products. In addition we have also carried out a number of experience sharing events with another garment and textile producing company. We also exchange employees and labour force with another company in the sector that is found near to our location (Jan 10, 2017; in-person interview).

The remainder of Table 7 shows that around 10% of domestic plants use technology licensed from foreign plants (outcome 5) and that 15% of domestic plants changed their production technologies as the result of competition from foreign plants (outcome 6).²¹ Overall, 17.8% report at least one of the first 4 outcomes, and 24.6 % of plants report at least one of the 6 outcomes.

We now turn to investigate how the reported changes differ depending on the degree of linkages between domestic and foreign plants. Table 8 shows that the probability of domestic plants reporting to have adopted production processes by observing foreign plants is significantly larger for labor-linked, backward-linked and forward-linked plants. The same is true for the probability of reporting the use of technology licensed from FDI plants .

Next we explore the extent to which domestic plants benefit from hiring workers from foreign plants. Table 9 reports the perceived benefits experienced by domestic plants that employed skilled workers from FDI plants: 65 percent of the domestic plants report having changed production technologies as a result of hiring from foreign plants; this hiring is also perceived as helpful to obtain managerial, organizational and exporting knowledge, although less frequently. The evidence in Table 9 lends support to the idea that the strong localized aspect of knowledge spillovers discussed in the agglomeration literature arises – at least in part – from the propensity of workers to change jobs within the same local labor market²²: knowledge is partly embedded in workers and diffuses when workers move be-

²¹FDI presence can stimulate higher competition and innovation in procurement and marketing techniques as well as product quality encouraging domestic plants to adopt better production technologies to attenuate the heightened risk of elimination from the market.

²²There exist at least two reasons why geographic proximity might be important for observed worker flows.

tween plants. These findings are in line with previous evidence from developed countries. Serafinelli (2017) finds evidence of labor market-based knowledge spillovers in the Veneto region of Italy. In a case study of the British Motor Valley, (Henry and Pinch, 2000, p.5) argue that

as personnel move, they bring with them knowledge and ideas about how things are done in other plants helping to raise the knowledge throughout the industry...The crucial point is that whilst this process may not change the pecking order within the industry, this ‘churning’ of personnel raises the knowledge base of the industry *as a whole within the region*. The knowledge community is continually reinvigorated and, synonymous with this, so is production within Motor Sport Valley.

In a similar vein, (Saxenian, 1994, p.37) maintains that the geographic proximity of high-tech plants in Silicon Valley is associated with a more efficient flow of new ideas ("When engineers moved between companies, they took with them the knowledge, skills, and experience acquired at their previous jobs").

So far in this section, we have discussed reported changes that may lead to improvement of the productivity of domestic plants. However, as pointed out by Aitken and Harrison (1999), entering foreign plants may pull demand from domestic plants, which, in reducing output, would spread their fixed costs over a small number of produced units and therefore

First, distance may act as a barrier for workers’ job mobility because of commuting costs or idiosyncratic preferences for location. Descriptive statistics in Combes and Duranton (2006) show that labor flows in France are mostly local: about 75% of skilled workers remain in the same employment area when they switch plants. The degree of geographical mobility implied by this figure is small, since the average French employment area is comparable to a circle of radius 23 kilometers. In Dal Bo’, Finan and Rossi (2013), randomized job offers produce causal estimates of the effect of commuting distance on job acceptance rates. Distance appears to be a very strong (and negative) determinant of job acceptance: applicants are 33% less likely to accept a job offer if the municipality to which they are assigned is more than 80 kilometers away from their home municipality. The estimates in Manning and Petrongolo (2013) also suggest a relatively fast decay of job utility with distance. Another reason geographical proximity may be an important determinant of job mobility is that the plant’s informational cost of identifying the “right” employee are larger across localities than within them. A similar argument can be made for the informational costs for workers.

experience an increase in average cost. Row 1 of Table A.5 shows that 11.5% of domestic plants report critically important product market competition from foreign plants. The productivity of domestic plants may also be affected by competition in the labor market. As a result of FDI entry, domestic plants may be left to hire inferior workers. Row 2 of Table A.5 shows that 6% of domestic plants report facing competition from foreign plants in the local labor market. If the foreign plant poaches high-ability employees from domestic plants, the quality of the workforce in domestic plants may decrease. Row 3 of Table A.5 shows that 8% of domestic plants report having lost skilled workers to FDI.

The evidence in Section 4 of productivity increases is more in line with the picture of positive effects given by Table 7 than the one of negative effects given by Table A.5.²³

6 Concluding Remarks

This paper presents direct evidence on the way in which knowledge is transferred from foreign plants to domestic plants using a knowledge transfer module designed by us and administered during the annual census of manufacturers by the Central Statistical Agency of Ethiopia. While we cannot completely rule out the possibility that at least some of the estimated effect reflects correlated unobservables, the overall evidence lends support to the hypothesis of positive FDI spillovers.

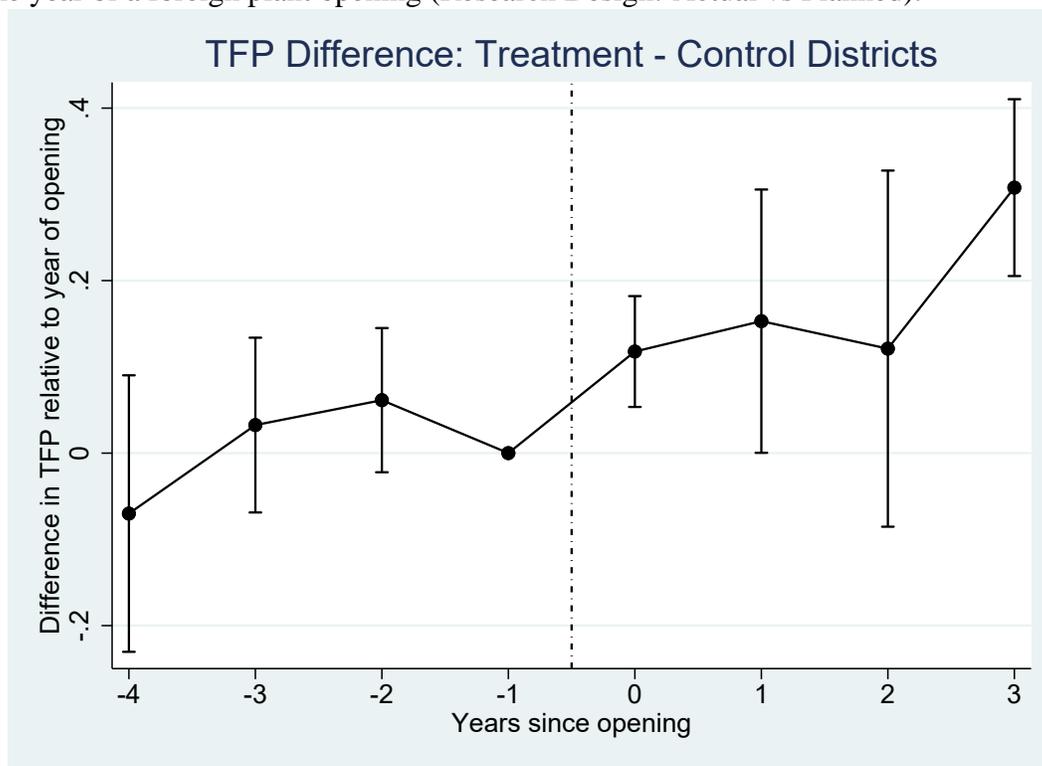
²³Regarding the specific point that entering foreign plants may cause domestic plants to cut production, we find that total value of production by domestic plants increases after the entry of foreign plants in a locality.

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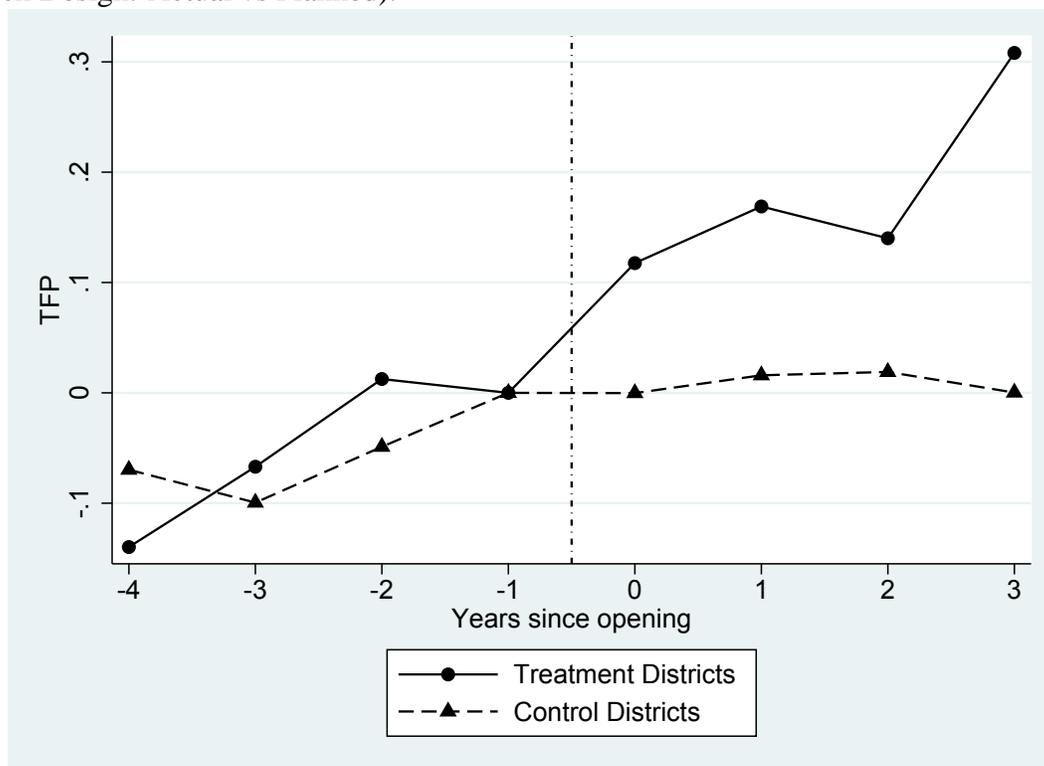
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Figure 1: Difference in domestic plants' productivity in treated vs control districts, relative to the year of a foreign plant opening (Research Design: Actual vs Planned).



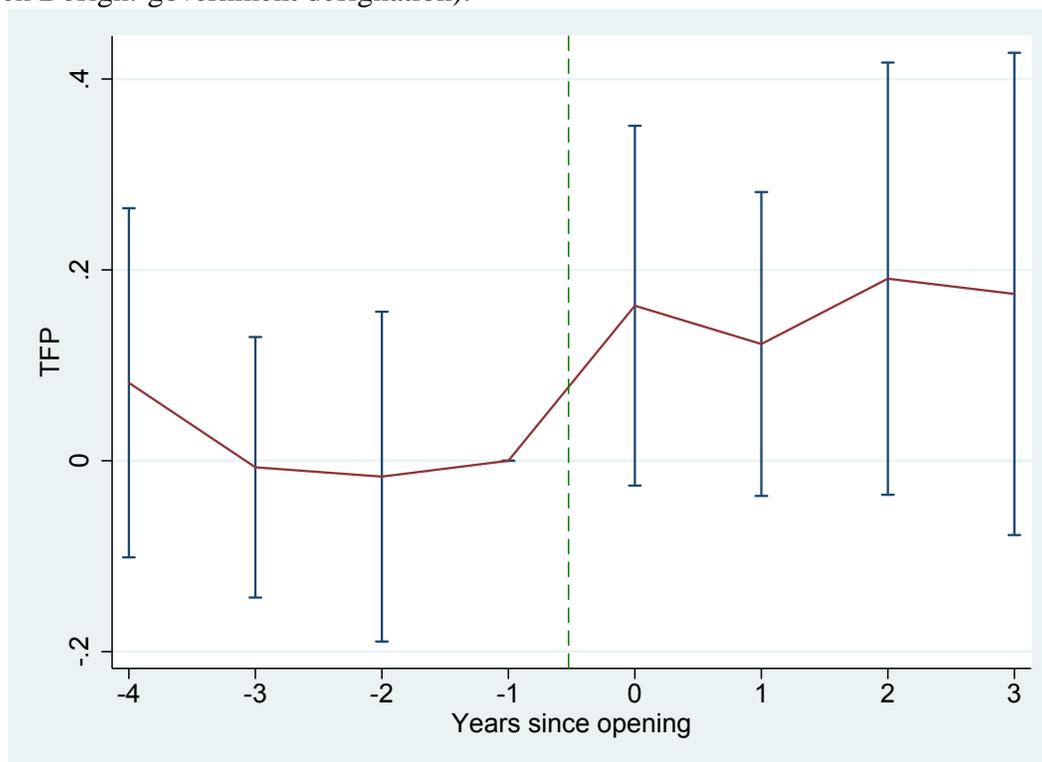
Note: The figure plots point estimates for leading and lagging indicators for the large foreign plant opening. The omitted category is one period prior to the large foreign plant opening. Vertical bars correspond to 95 percent confidence intervals with district-clustered standard errors.

Figure 2: Domestic plants' productivity, relative to the year of a foreign plant opening (Research Design: Actual vs Planned).



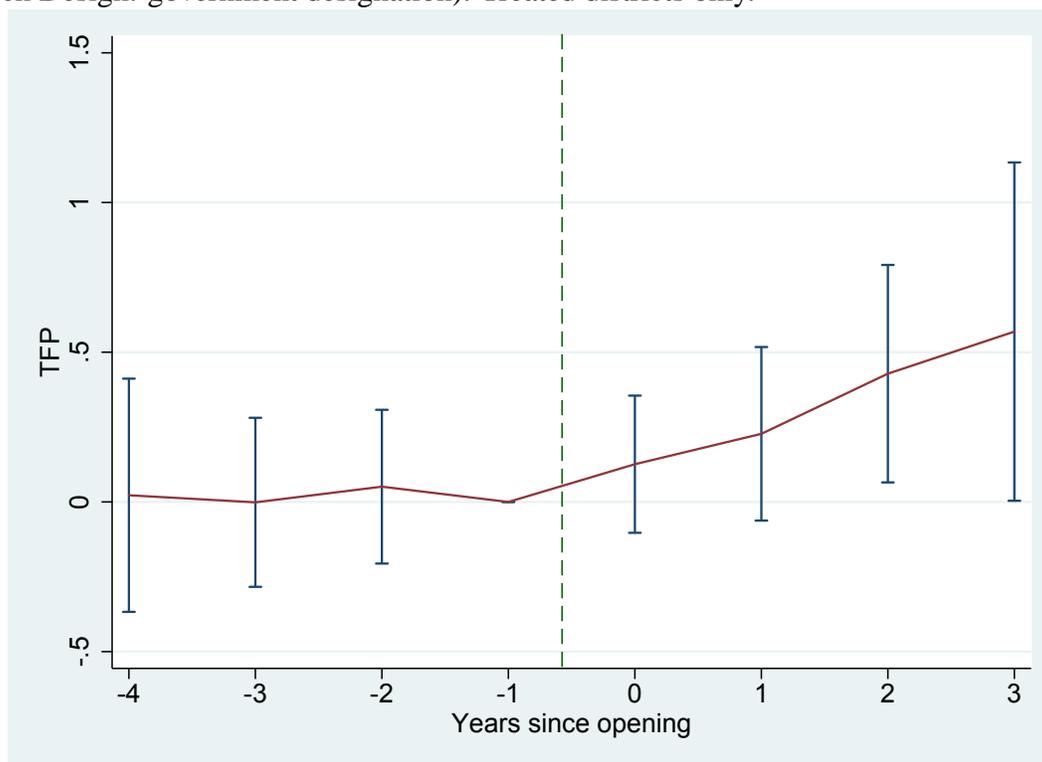
Note: The figure plots point estimates for leading and lagging indicators for the large foreign plant opening. The omitted category is one period prior to the large foreign plant opening.

Figure 3: Domestic plants' productivity, relative to the year of a foreign plant opening (Research Design: government designation).



Note: The figure plots point estimates for leading and lagging indicators for the large foreign plant opening. Event time indicator "-4" set to 1 for periods up to and including 3 periods prior to the event and 0 otherwise. Event time indicator "+3" set to 1 for all periods 3 periods after the event and 0 otherwise. The omitted category is one period prior to the large foreign plant opening. Vertical bars correspond to 95 percent confidence intervals with district-clustered standard errors.

Figure 4: Domestic plants' productivity, relative to the year of a foreign plant opening (Research Design: government designation). Treated districts only.



Note: The figure plots point estimates for leading and lagging indicators for the large foreign plant opening. Event time indicator "-4" set to 1 for periods up to and including 3 periods prior to the event and 0 otherwise. Event time indicator "+3" set to 1 for all periods 3 periods after the event and 0 otherwise. The omitted category is one period prior to the large foreign plant opening. Vertical bars correspond to 95 percent confidence intervals with district-clustered standard errors.

Table 1: Size, performance and technology indicators by ownership type (2013)

	(1) Full Sample	(2) FDI	(3) Domestic	(4) <i>p</i> -value of diff. (2)-(3)
Number of workers	86.7	150.1	72.7	0.00
Value added per worker	143	188	133	0.06
Percent of output sold to FDI (%)	2.9	5.1	2.4	0.00
Percent of plants that export	5.6	14.2	3.7	0.00
Percent share of export in total sales	2.5	6.6	1.8	0.00
Conducted R & D in the last three years	7.1	11.0	6.3	0.00
Hold internationally recognized patent	1.9	4.2	1.4	0.00
Use technology licensed from abroad	10.8	13.6	10.2	0.08
Number of observations	1,708	310	1,398	

Note: Author's compilation based on CSA census and FDI survey module. All monetary amounts are in 1000s of birr.

Table 2: Plant Characteristics by Treatment Status, One Year Prior to a foreign plant Opening (Research Design: Actual vs Planned).

	Treatment Districts	Control Districts	p-value (1)-(2) (Clustered)	p-value (1)-(2) (Cameron et al)
	(1)	(2)	(3)	(4)
Output	12230	11325	.78	.77
Capital	4932	6404	.5	.53
Employees	82.1	93.2	.51	.57
Plant Age	12.9	11	.08*	.11
Output per Worker	120.72	125.14	.84	.84
Capital per Worker	75	62.7	.43	.47

P-values in Col 3 are calculated from standard errors clustered at the district level. P-values in Col 4 are obtained using the bootstrap procedure the procedure developed by Cameron et al (2008). All monetary amounts are in 1000s of birr.

Table 3: Changes in Domestic plants' productivity, following an foreign plant opening (Research Design: Actual vs Planned).

	(1)	(2)	(3) At least 3 years	(4) Case FE
logK	0.063*** (0.018)	0.059*** (0.016)	0.051*** (0.015)	0.051*** (0.015)
logM	0.567*** (0.056)	0.564*** (0.059)	0.552*** (0.061)	0.552*** (0.061)
logL	0.258*** (0.064)	0.255*** (0.062)	0.273*** (0.062)	0.273*** (0.062)
Treatment X After	0.046 (0.040) [0.204]	0.082 (0.048)* [0.099]*	0.109 (0.045)** [0.029]**	0.116 (0.048)** [0.029]**
After	-0.028 (0.039)	-0.062 (0.051)	-0.067 (0.051)	-0.073 (0.053)
Year by 2-digit industry FE	NO	YES	YES	YES
Year Dummies	YES	NO	NO	NO
Observations	10,822	10,822	9,265	9,265
Adjusted R-squared	0.906	0.907	0.908	0.908

The table reports results from estimating eq. (5). Plant FE and region trends are always included. Standard errors clustered at district level in parentheses. For the variable of interest, the interaction term "Treatment*After", we report in brackets the p-value obtained using the bootstrap procedure the procedure developed by Cameron et al (2008). In Column 3 incumbent domestic plants in treated districts are required to be in the data for at least 3 years prior to the event. Column 4 uses the sample of Column 3 and adds case FEs.

Table 4: Plant Characteristics by Treatment Status, One Year Prior to first foreign plant Opening (1998); Research Design: Government Allocation.

	(1) Treated Districts	(2) Never-Treated Districts	(3) (1)-(2) t-stat
Output	20706	6437	0.94
Capital	6426	5904	0.14
Employees	215	68	1.6
Plant Age	11.2	10.2	0.58
Output per Worker	58.6	68	0.63
Capital per Worker	31.9	50.8	1.74*

Reported t-statistics are calculated from standard errors clustered at the district level. All monetary amounts are in 1000s of birr.

Table 5: Domestic plants' productivity: average of the event-study coefficients between $\tau = 0$ and $\tau = 2$ (Research Design: Government Allocation).

	(1)	(2)	(3)	(4)
Average change	0.109 (0.055)**	0.159 (0.087)*	Treated Only 0.261 (0.136)* [0.050]*	At least 3 years 0.286 (0.162)* [0.080]*
Year by 2-digit industry FE	NO	YES	YES	YES
Year Dummies	YES	NO	NO	NO
Observations	4799	4799	968	569
Number of Districts	223	223	17	13

This Table accompanies Figure 3. Estimates taken from specification of form given in Equation (1). "Average change" refers to the average of the coefficients in periods $t = 0, 1,$ and 2 . Column 3 drops the never treated localities. Column 4 reports estimates from the specification of Column 3 but incumbent domestic plants are required to be in the data for at least 3 years prior to the event. For Column 3 and 4, we report in brackets the p-value obtained using the bootstrap procedure the procedure developed by Cameron et al (2008). Plant FE and region trends are always included.

Table 6: New economic activity following an foreign plant opening.

	Births (1)	Weighted by L (2)
Panel A: Research Design: Actual vs Planned		
Treatment X After	4.093 (2.706) [0.1410]	303.534 (129.333)** [0.0260]**
Observations	212	212
Mean y	10.94	529.2
SD y	28.79	1704
Panel B: Research Design: Government Allocation		
Average change	1.763* (0.924)	77.75 (60.84)
Observations	1358	1358
Mean y	1.28	45.31
SD y	2.75	227.6

The table reports results from estimating eq. (8) and eq. (9). Dependent variable in Column 1 is the simple count of new domestic plants; in Column 2 is the count weighted by the number of employees at entry. "Average change" refers to the average of the coefficients in periods $t = 0, 1,$ and 2 . Standard errors clustered at district level in parentheses. For the interaction term "Treatment*After", we report in brackets the p-value obtained using the bootstrap procedure the procedure developed by Cameron et al (2008). Year Dummies, Districts FE and Region Trends always included.

Table 7: FDI-related outcomes of domestic plants (% of domestic plants)

(1) Directly adopted production processes by observing foreign plants in same industry	12.6
foreign plants did not try to prevent the observation/adoption (% of plants answering "YES" to above question)	77.3
(2) Benefited from employing Former FDI workers	7.2
(3) Technology transfer from FDI customers	4.5
(4) Technology transfer from FDI suppliers	1.79
(5) Use technology licensed from foreign plants	10.2
(6) Changed production technologies due to competition from FDI	15.3
At least one of the above outcomes (1) to (4)	17.8
At least one of the above outcomes (1) to (6)	24.6
Number of observations	1,398

Note: Author's compilation based on and FDI survey module

Table 8: Linkages and FDI-Related Outcomes of domestic plants. (% of domestic plants)

	Labor-Link			Backward-Link			Forward-Link		
	Yes	No	<i>p</i> -value of difference between (1) and (2)	Yes	No	<i>p</i> -value of difference between (4) and (5)	Yes	No	<i>p</i> -value of difference between (7) and (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Directly adopted production processes by observing foreign plants in same industry	37.1	10.7	0.00	23.8	11.4	0.00	26.7	11.6	0.00
Use technology licensed from foreign plants	30.9	8.54	0.00	16.7	9.45	0.01	17.8	9.57	0.00
Number of observations	98	1,300		46	1,352		49	1,349	

Note: Author's compilation based on FDI survey module

Table 9: Reported benefits from employing skilled workers from foreign plants (% of domestic plants)

Changed production technologies	65.3
Changed managerial practices	7.14
Adopted better organizational structure	7.14
Obtained knowledge of how to export	9.18
Experienced other benefits	11.22
Number of observations	98

Note: Author's compilation based on FDI survey module

Appendix

A.I Dataset construction

We faced three main challenges trying to link IDs across years: 1) verifying that, pre-2011/12, unique IDs were consistent across years, that is, that they identify the same plant across the different rounds; 2) doing the same for the 2011/12 and 2012/13 rounds independently of the pre-2011/12 data, and; 3) linking plants between these two separate datasets.

During the first stage of creating the panel we checked the consistency of the existing unique plant ID numbers across pre-2011/12 and post 2011/12 rounds – independently, as there is no ID variable in the raw data to link plants between these two set of rounds. For each period (pre- or post- 2011/12), we pooled together all rounds and used as much information in the data as possible to determine the validity of the existing unique plant IDs. We relied on any information available on phone numbers, location of the plant (e.g. region, zone, woreda, etc.),²⁴ the Ethiopian Electric Power Corporation (EEPCO) number of the plant, and the P.O. box number.

As a further consistency check, we used the business directory that CSA compiled as a “framework” for the census for 2008/09.²⁵ This list is compiled by CSA every year with data from different ministries and government agencies as a reference to identify which plants exist and should be part of the data for the year was compiled by CSA. The list includes the name and plant number that CSA assigns to each plant during that round, as well as phone number and locational information (i.e. region, zone, woreda, town, etc.). This information

²⁴CSA is only concerned with gathering and publishing data at the regional level and not at the level of smaller geo-political units (like zones or woredas). As a result, enumerators are only required to fill-in information about the establishment’s region, effectively leaving the option open for the enumerator to record or not the rest of the locational information of the establishment. Thus, it is not uncommon to see, for the same establishment, years for which all locational information is complete and years for which only the region was recorded.

²⁵Unfortunately, similar lists for other rounds of the LMSM are not available. According to the Director of the Business Statistics Directorate, due to changes in management and issues with the storing of data, the lists for other years have been lost.

was useful to determine which plant numbers may be duplicated or incorrect, at least circa 2008/09.

While there is typically no electronic record of the plant's name in the database, it is possible to compile this information directly from the paper questionnaires. CSA's staff went through all available paper questionnaire that CSA had in storage, collected plant's name from each paper questionnaire, and linked plants across available years using this information.²⁶ This effort was crucial in creating the panel identifiers for two reasons. First, it provided a link between the pre- and post-2011/12 rounds. Second, it provided us with additional information to validate unique plant IDs for rounds between 2008/09 and 2010/11.

During the final stage we evaluated the different matches obtained from all methods described above and determined which matches were valid. This was done using Stata to the extent possible but, in most cases, a visual inspection of the validity of each match was necessary to ascertain the match provided by Stata. If matches did not seem valid then, a case-by-case match was done manually. If no valid match was found, the observation was left unmatched and a new unique ID was created for those plants. Figure A.1 show the count of plants and the total employment by year in the matched CSA sample.

A.II Algorithm used to find control districts

Our analysis in Section 4.1 required us to find at least one control district for each treatment one. We implemented an algorithm based on information on industry and time of approval of a FDI project. Let τ^{lic-tr} denote year, but be normalized so that the year when the FDI project got approved (in a treatment district) is $\tau^{lic-tr} = 0$. Our algorithm consisted of the following steps.

1. For each treatment district (characterized by a given year of approval of the project

²⁶Unfortunately, CSA staff was only able to retrieve paper questionnaires for the last 5 rounds of the LMSM – it is CSA's policy to store paper questionnaires for no more than 5 years.

and a given industry) look for a control in the same year and with an foreign plant in same 4-digit industry (i.e. a district where an FDI plant in the same 4-digit industry and in the same year got approval but then did not open the plant during the period in which the foreign plant was operating in the treatment district)

2. If you cannot find one, look for a control in the same year in same 3-digit industry
3. If you cannot find one, look for a control in the same year in same 2-digit industry
4. If you cannot find one, look for a control district where the project was approved between $\tau^{lic} = -1$ and $\tau^{lic} = 1$ (in the same 4-digit industry)
5. If you cannot find one, look for a control district where the project was approved between $\tau^{lic} = -1$ and $\tau^{lic} = 1$ (in the same 3-digit industry)
6. And so on for $\tau^{lic} \in [-2, 2]$ and $\tau^{lic} \in [-3, 3]$, until $\tau^{lic} \in [-3, 3]$ and same 2-digit industry
7. For the foreign plants which start operation but have a missing year of licence, assume the year of the licence is $\tau^l = \tau - 3$.²⁷
8. Repeat steps 1-6 using the second list of treatment districts obtained in step 7
9. If multiple control districts are identified, keep them
10. If in a given year there are two treatment districts and one usable control district, pick randomly one treated district and discard the other
11. If in a given year there are three treatment districts and two usable control districts, pick randomly two treated districts and discard the third. Assign randomly the two control districts to the two treatment districts

²⁷Three years is the mean lag between licence and entry in the sample of FDI plants (a) whose labour force is at least 100 employees or constitutes at least 1% of total employment in local manufacturing in $\tau = 0$ or $\tau = 1$; and (b) whose location is not assigned by the government. See Figure ??.

A.I Further Analysis

Employment at incumbent domestic plants What are the FDI effects on the number of employees at incumbent domestic plants? Using the first research design with (log) employment as dependent variable we estimate a significant positive effect of the FDI opening on employment. The estimated Diff-in-Diff coefficient is equal to 0.22 and significant at 5% level when clustering at district level, and at 10% when using the Cameron, Gelbach, and Miller (2008) procedure. When using the second research design, the estimated average of the event study coefficients over the three years starting with the year of the opening is not significant (0.01 with s.e. 0.02).

A.I Additional Figure and Tables

Figure A.1: CSA Matched Sample

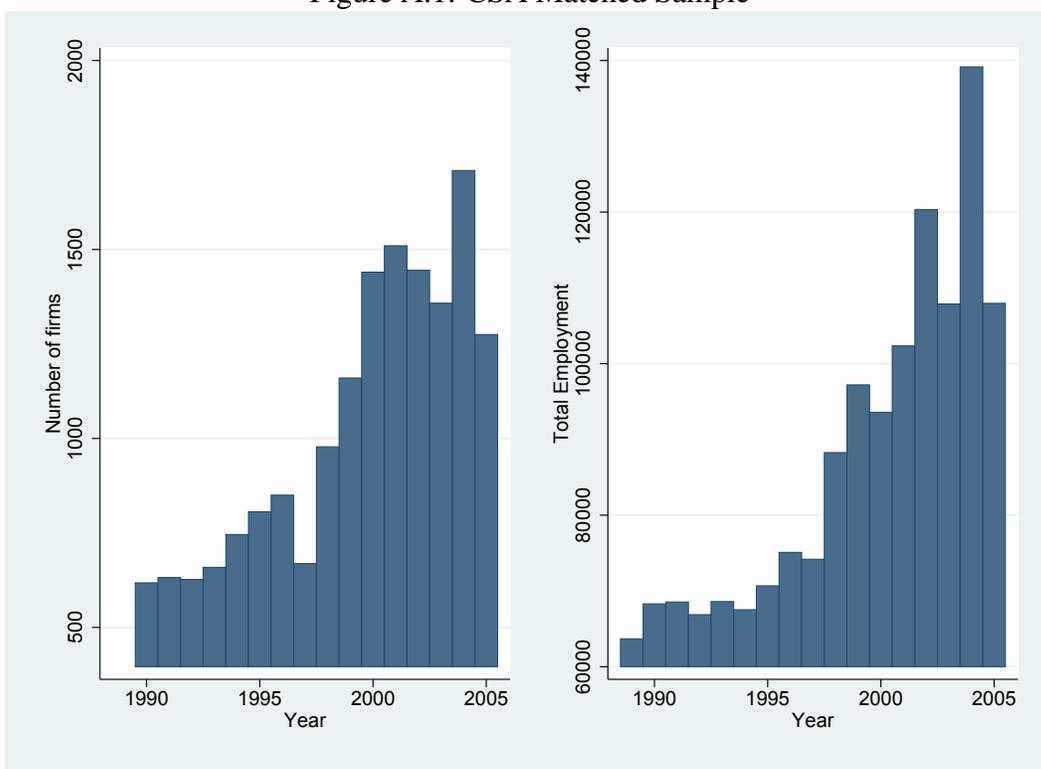
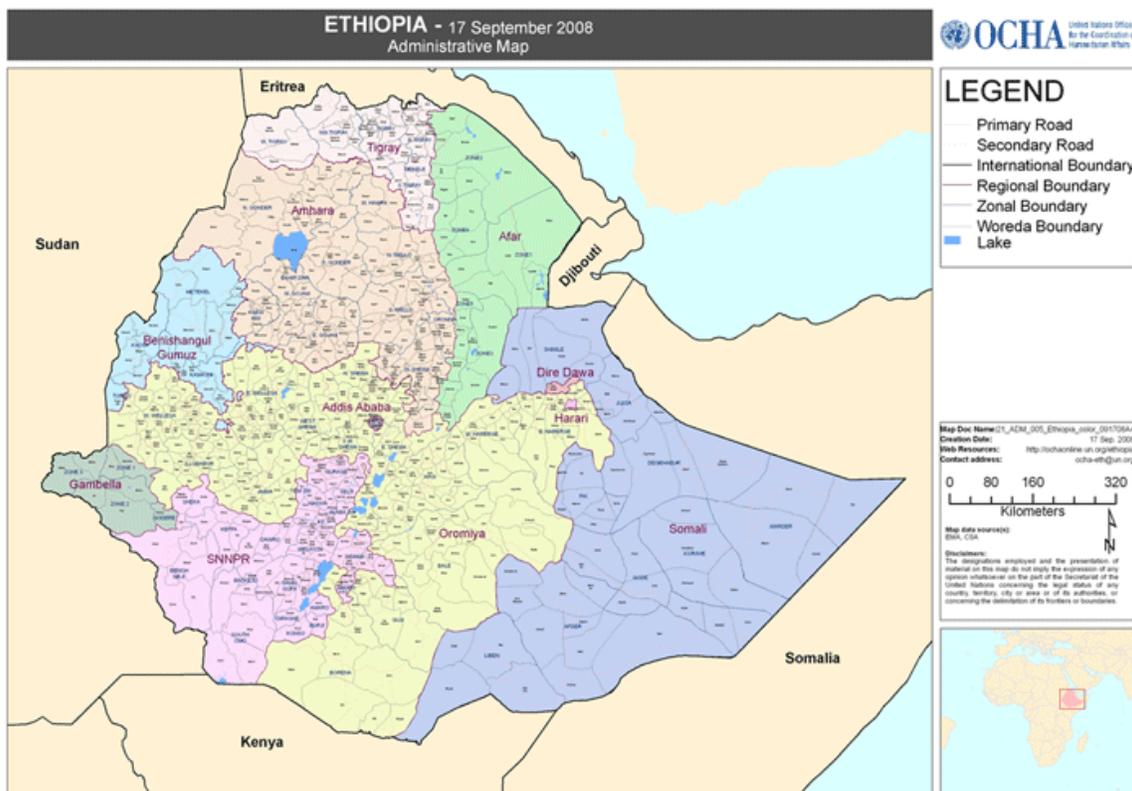
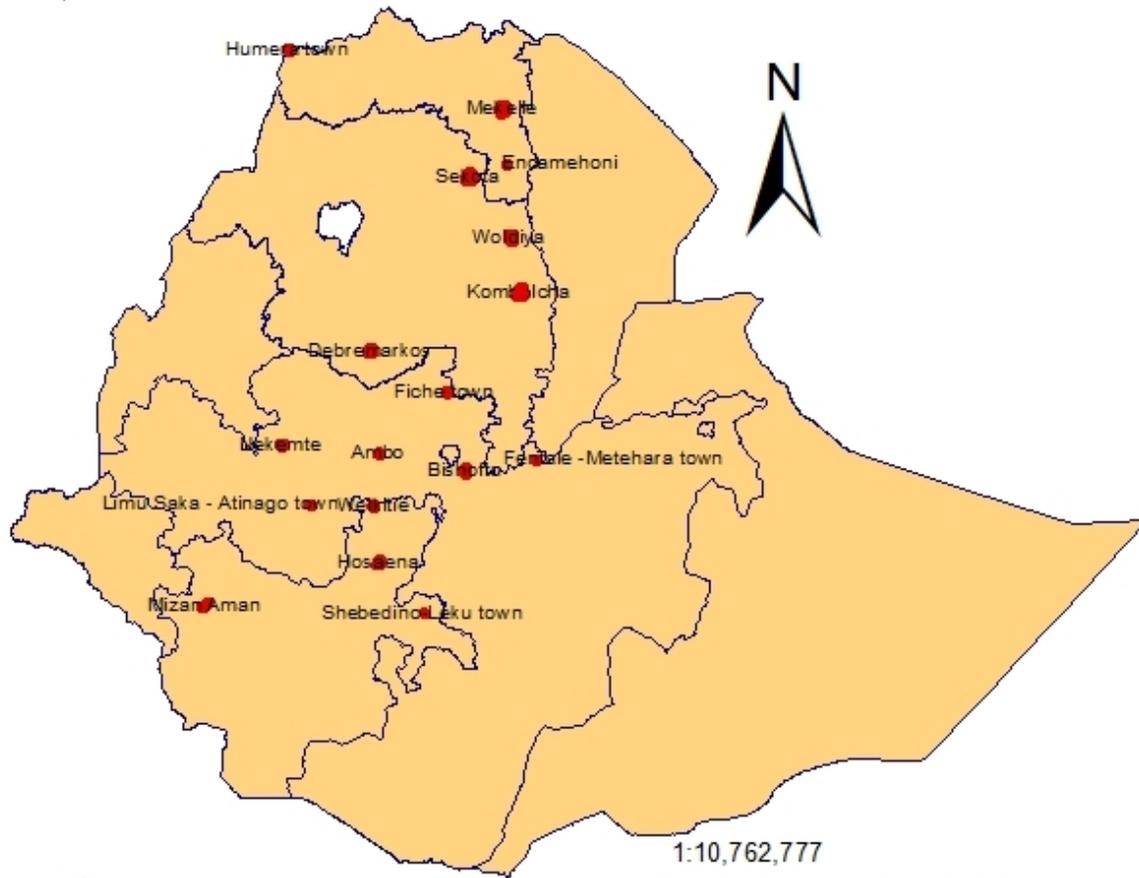


Figure A.2: Administrative Map of Ethiopia



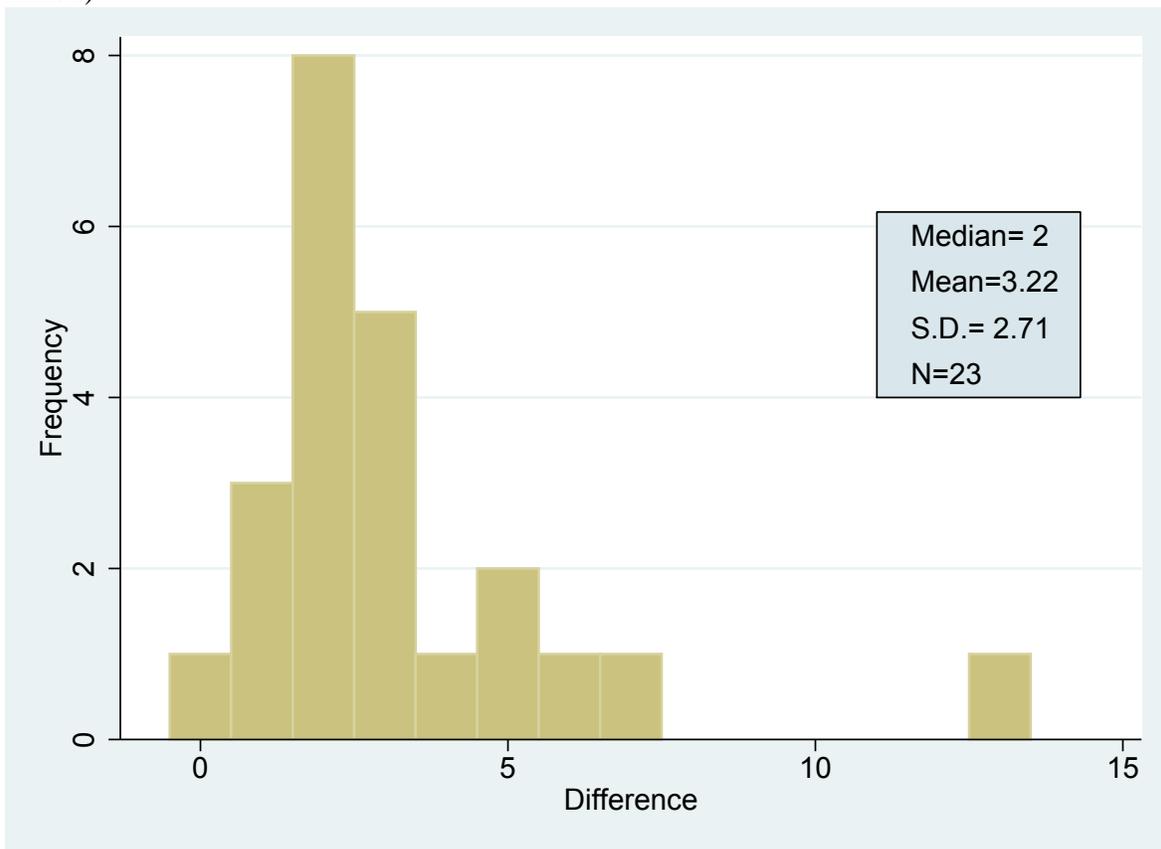
Source: UN Office for the Coordination of Humanitarian Affairs:

Figure A.3: Geographic distribution of treated districts (research design: government designation)



Red circles denote the treated districts. Dark lines denote regional boundaries.

Figure A.4: Geographic distribution of treated districts (research design: government designation)



Red circles denote the treated districts. Dark lines denote regional boundaries.

Table A.1: Wages and workforce education by ownership type, sample means

	FDI	Domestic	<i>p</i> -val
Number of workers	187	81	0.00
Production workers			
Monthly wage	1,706	1,464	0.38
Years of schooling	9.88	9.53	0.01
Percent with TVET diploma	19.5	16.7	0.02
Supervisor Foremen and quality control personnel			
Monthly wage	2,081	1,849	0.13
Years of schooling	12.0	11.8	0.23
Marketing workers			
Monthly wage	2,389	2,075	0.00
Years of schooling	12.3	12.1	0.10
Administrative Staff			
Monthly wage	2,606	1,920	0.00
Years of schooling	12.3	12.0	0.09
Managers including low level managers			
Monthly wage	5,674	4,840	0.00
Years of schooling	14.5	14.3	0.58
Number of observations	310	1,398	

Note: TVET is Technical and vocational education training. All monetary amounts are in 1000s of birr.

Author's compilation based on CSA census and FDI survey module

Table A.2: Sample of FDI Opening and Districts (Research Design: Actual vs. Planned)

FDI Openings	12
Number of controls per treatment district:	
1	9
2	3
Reported year of foreign plant opening	
2004-2007	5
2008-2010	7
foreign plant industries:	
Food & beverages	5
Chemicals & chemical products	3
Non-metallic mineral products	3
Motor vehicles	1
foreign plant characteristics:	
# Employees	113.71 (187.00)
Share of local labor market (%)	9.91 (18.48)

58
This Table displays descriptive information on the usable openings and districts used in the first research design. The algorithm used to find control districts is described in Section A.II. The values for Employees and Share of local labor market are the average between $\tau = 0$ and $\tau = 1$. Standard deviations are shown in

Table A.3: Sample of FDI Opening and Districts (Research Design: Government Allocation)

Sample FDI openings	17
Never-treated districts	230
Reported year of foreign plant opening:	
1999-2005	3
2006–2012	14
foreign plant industries:	
Non-metallic mineral products	8
Wood, furniture & paper	4
Food & beverages	3
Basic metals	1
Chemicals & chemical products	1
foreign plant characteristics:	
# Employees	51.29 (90.06)
Share of local labor market (%)	18.69 (16.35)

This Table displays descriptive information on the usable openings and districts used in the second research design. The values for Employees and Share of local labor market are the average between $\tau = 0$ and $\tau = 1$. Standard deviations are shown in parentheses

Table A.4: Changes in Domestic plants' productivity, following an foreign plant opening, Robustness to Specifications Addressing Transmission Bias

	Investment- Capital Interactions (1)	Materials- Capital Interactions (2)	Materials- Capital and Materials- Labor Interactions (3)
Panel A: Research Design: Actual vs Planned			
Treatment X After	0.295*** (0.085)	0.100** (0.046)	0.093** (0.044)
Observations	5,541	10,822	10,822
Panel B: Research Design: Government Allocation			
Average change $\tau = 0 - 2$	0.124 (0.139)	0.168* (0.086)	0.162** (0.082)
Observations	3,240	6,230	6,230

Dependent variable: Log(Output). The table reports results from fitting several versions of eq. (3) and eq. (6). Column 1 controls for a fourth-degree polynomial function of log capital and log investment and the interaction of both functions (see Olley and Pakes 1996). Column 2 includes the same controls as col. 1 but replaces log investment with log materials (see Levinsohn and Petrin 2003). Column 3 adds interactions between log materials and log labor to the controls in col. 2 (see Ackerman et al. 2015). "Average change $\tau = 0 - 2$ " refers to the average of the coefficients in periods $t = 0, 1,$ and 2 . Standard errors clustered at district level in parentheses. Industry X Year Dummies, Plant FE and Region Trends always included.

Table A.5: Competition from FDI in Product and Labor Market (% of domestic plants)

(1) Product market competition
from foreign plants critically important 11.5

(2) Faced Competition
in the local labor market 5.9

(3) Lost skilled workers
to foreign plants 7.7

Number of observations 1,398

Note: Author's compilation based on FDI survey module