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

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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 of domestic plants is 8% higher in treated districts. Using an alternative identification strategy that exploits the assignment of land for FDI by the Ethiopian Government, we obtain similar results. We also find evidence that the foreign plants attract new economic activity to the receiving districts. Domestic firms report that exposure to foreign firms improves: (i) production processes; (ii) managerial and organizational practices and; (iii) knowledge about exporting. This learning takes place through formal and informal channels.

Keywords: Foreign Direct Investment, productivity, firm-to-firm labor mobility, localized knowledge spillovers. JEL: F21; R10; D24

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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 Rodríguez-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 Rodríguez-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 foreign to domestic plants (Balsvik, 2011; Poole, 2013; Newman, Rand, Talbot, and Tarp, 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 Rodríguez-Clare, 2010). While these definitions are analytically useful, they may be too restrictive. For example, Poole (2012) 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, 2010). 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. A geography based approach is also supported by our data; the evidence in Figure 1 indicates that more than 90% of domestic firms in labor, customer and supply linkages with foreign firms are physically located in a geographic area with FDI.

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 trans-

[1] Greenstone, 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.

ferred 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 designed to identify linkages between foreign and domestic plants. We consider several different forms of knowledge transfer including: (i) labor flows from foreign 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 a 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 restricted-access administrative data from the Ethiopian Investment Commission, we define a control district as a location in which a 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 foreign 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

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

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 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.[3] 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.[4] However, the exact geographic location within a broader region is typically determined by the timing of the 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.[5]

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 foreign to domestic plants

[3] In this respect, our paper is also related to the growing literature on place-based policies (Glaeser and Gottlieb, 2008; Kline, 2010; Kline and Moretti, 2014; Neumark and Simpson, 2015).

[4] We include region trends in all our specifications.

[5] 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.

emerges as a clear mechanism, but there is also suggestive evidence of a role for learning by observation and backward and forward linkages in the supply chain.

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); Haskel, Pereira, and Slaughter (2007); Blalock and Gertler (2008); Keller and Yeaple (2009); Kosova (2010); Fons-Rosen, Kalemli-Ozcan, Sørensen, Villegas-Sanchez, and Volosovych (2013); Fons-Rosen, Kalemli-Ozcan, Sorensen, Villegas-Sanchez, and Volosovych (2017) - we still have very little direct evidence on the mechanisms at work. Exceptions are the work by Javorcik (2004) and Newman, Rand, Talbot, and Tarp (2015) who find evidence that plants in supply relationships with foreign plants experience enhanced productivity and the work by Poole (2012) 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 these kinds of 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 (2008) 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) increased 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. In particular, a model by Rosenthal and Strange (2004) raises that domestic plants are more likely to be affected by FDI when they are geographically and economically close to foreign plants, and closer to the time when foreign plants open in a locality.

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, economic 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.

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:

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

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 geographic proximity between domestic and foreign plants, the economic 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, 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 relatively flat horizontal labor supply curve at a 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:

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

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:

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

If domestic plants are price takers, and factors are employed until their marginal value product equals their price, equation (3) simplifies to the following:

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

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, economic, temporal – to foreign plants.

These insights encourage an empirical analysis which takes into account the proximity of foreign 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 (Chole, 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 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 in the late 1980s, the restrictions on private sector investment were gradually 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 (EIC, 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 enterprises and to their workers. In practice, however, enforcement mechanisms are weak.[6]

3.2 Data and Descriptive Statistics

This study uses two data sources: plant-level manufacturing census data for the years 1997-2013 collected by the Central Statistical Agency (CSA), and a knowledge transfer survey module designed by us. We describe these data below.

Manufacturing Census The source of manufacturing plant data is the annual Large and Medium Scale Manufacturing (LMSM) Establishment Census of the CSA. 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).[7] The available information includes employment,

[6]For 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 schemes would thus not only build local production and managerial capacity but also help reduce repatriation of foreign currencies.

[7]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

material and non-material inputs, capital stock, sales, geographic location, date of plant establishment, and asset ownership. It is worth pointing out that with these records it is possible to construct a genuine panel of manufacturing plants. We faced three main challenges trying to link plant identifiers (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. See Section A.I for details on the data construction. Figure A.1 shows the count of plants and the total employment by year in the matched CSA sample. Table A.1 reports descriptive statistics.

Technology Transfer Survey The survey module contains a set of questions on FDI-domestic plant interactions for 1,708 manufacturing plants belonging to the CSA dataset, interviewed in February 2014.[8] An English translation of the document used in the survey is available at this link. To 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, etc.)

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. In 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.

[8]In 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.

in answering our survey . For the years before our survey module, we define as foreign the 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.2 shows that foreign plants 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.2 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 create opportunities for less expensive or advanced technological and managerial practices to diffuse from foreign 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 foreign plants. Around 7 % of domestic plants are labor-linked, 3 % are backward-linked and 3.5 % are forward-linked.

Administrative Data For the first research design, we use restricted-access administrative data from the Ethiopian Investment Commission. This dataset contains the list of licensed

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

FDI manufacturing investment projects during our sample period. It includes information on the date of permit, the industry, the location and the status of the investment (whether or not it is operational).

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 a foreign plant is added to a district. The underlying idea is that, presumably the benefits from FDI would be localized at least initially, with domestic plants in the same district to be better placed to benefit from FDI presence. The primary identification challenge is that foreign companies do not select the location for their greenfield plants randomly. Foreign 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 infrastructure) 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 a 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 a 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 a foreign plant actually invested. For each treatment district, at least one control district is chosen as a location where a 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. 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 (Geiger and Moller, 2015, p.44). [10]

Delays related to foreign currency shortages and financing issues are also sometimes cited as explanations as to why there exists a lag in investment translations - see Altenburg (2010), USDOC (2017) and Moller and Wacker (2015). As we show below, 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

[10] For a similar discussion see Chen, Geiger, and Fu (2015)

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:

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

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 material 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 (2018).

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 foreign manufacturing opening, we impose that the foreign 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.3 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. 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 and plant level average wage (constructed as total wage bill divided by the number of employees). Overall we conclude that the covariates are balanced between plants in treatment and control districts.

4.1.2 Main Results

Figures 2 and 3 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 2 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 3 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 mean shift parameter φ in equation 5 in the mean shift row. 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, which addresses concerns related to the endogenous opening of new plants and compositional bias (Column 3).

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

[11] The 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)”.

Director of Policy and Program Studies at the Ministry of Industry explained how the ministry, after receiving a request from a potential investor typically 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, 2011). However, during our period of analysis, the exact district within a broader region is typically determined by the timing of availability of land. 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 quasi-experimental variation in the treatment. Moreover, there is often uncertainty in which year the foreign plant will start production.

In the words of a manager at a 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).

[12]If 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 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 as in Kline (2011), whose exposition we follow here. This design allows us to test for the presence of district-specific pre-trends in the outcome of interest and to recover any dynamics of the opening effect. Our main approach is to 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:

$$\ln\left(Y_{pidrt}\right) = \beta_L \ln\left(L_{pidrt}\right) + \beta_K \ln\left(K_{pidrt}\right) + \beta_M \ln\left(M_{pidrt}\right) +_{\tau} \beta_\tau D^{\tau}_{drt} + \alpha_p + \mu_{it} + Trend_{rt} + \varepsilon_{pidrt} \tag{6}$$

where D^{τ}_{drt} 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:

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

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 restrictions[13]:

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

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. In our data 36% of FDI manufacturing openings report the location 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 $\tau = 1$.[15] 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.[16] Table A.4 displays descriptive information on the 17 usable openings. We have a total of 223 control districts of which 206 are never treated[17]. 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 at the beginning of our panel, and also the year before the earliest event. Table A.5 displays these means for 2006, that is the middle of our panel.[18] These means are shown for districts that experience the event

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

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

[15]In our data 39% of these large FDI manufacturing openings report the location to be assigned by the government.

[16]Specifically we exclude districts that receive such openings in $\tau = (-3,3)$.

[17]We exclude never-treated districts receiving the opening of a large foreign plant whose location was not "allocated by the authorities".

[18]This is the year before the fourth event. Since we want to explore the balancing of covariates pre-treatment, we remove from the set of treated, the three districts which experience the event before 2006.

and for never-treated districts in columns 1 and 2 respectively. 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 numbers should be interpreted cautiously because, as shown in Figure A.1, we have fewer plants in the matched CSA sample and therefore more noise in the first half of the panel. If this concern is set aside, the numbers show that the plants in treated districts tend to have lower levels of capital per worker (significant at 10%) in 1998, though not in 2006. The difference in 1998 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, output per worker and plant-level average wages.

4.2.2 Main Results

Figure 4 plots the estimated β_τ coefficients from estimating Equation (6).[19] There is no pre-treatment 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 4 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 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 perspec-

[19]We include industry-year fixed effects.

tive, 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.[20] 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 5). 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

The main empirical result so far is that after the opening of a large foreign plant, the TFP of domestic plants is significantly higher in treated districts. We now investigate the sensitivity of this finding 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 coefficients 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

[20] We obtain these quantities using the cross-sectional plant-level data from the LMSM 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, p. 589).

the econometric literature on production function (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg, Caves, and Frazer, 2015). The results across the 6 specifications, shown in Table A.6, 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 this 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 plants 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:

$$\ln\left(Deaths_{drt}\right) =_{\tau} \beta_{\tau} D^{\tau}_{drt} + \alpha_d + \psi_t + Trend_{rt} + \varepsilon_{drt} \;. \tag{7}$$

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).

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 to the main ones. 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.[21] 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.[22] 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. We do 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).

Government expenditures The federal and local governments in some cases set up worker training funds, construct new roads, and make other infrastructure investments around the time of entry of a foreign plant. It is possible that these investments benefit domestic plants

[21] Since 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.

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

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 diff-in-diff coefficient φ is 0.12 (significant at 5% level) both when controlling for government total capital expenditures and government construction expenditures. 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).

Falsification Test Lastly, we conduct a falsification test in order to verify that our results using our second research design 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 gain access to these productivity advantages. Motivated by this observation, we estimate, using the first research design:

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

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:

$$Births = {}_{\tau}\beta_{\tau} D^{\tau}_{drt} + \alpha_d + \psi_t + Trend_{rt} + \varepsilon_{drt}. \tag{9}$$

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.[23] 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 and wages at incumbent domestic plants Section A.III reports the results of the analysis of the FDI effects on the number of employees and the wage at incumbent domestic plants.

5 Evidence from the Survey Module

In this section, we analyze responses to our survey module in order to better understand the mechanisms behind the productivity increases we reported in Section 4. We begin by reporting answers to questions about the changes experienced by domestic plants as a result

[23]Estimates are qualitatively similar when (a) using $Log(Births)$ as dependent variable; and (b) using the count weighted by the value of total plant production at entry.

of FDI. We then classify domestic plants according to how they are linked to foreign plants and examine modes of technology transfer by linkage. Finally, we examine the benefits associated with FDI as reported by domestic plants.

Table 7 displays 6 FDI-related outcomes of domestic plants. While all of the reported changes displayed in the table may lead to an increase in the productivity of domestic plants, only the first four outcomes qualify as externalities; using a technology licensed from a foreign plant and changing production technologies due to foreign competition are mediated through market mechanisms. However, in the case of Ethiopia, it may be that domestic plants would not learn about the availability of these technologies if foreign plants were not physically present in the country. This could be because Ethiopia is relatively remote, travel is expensive and access to the internet is still very spotty. To the extent that these things are true, there may be an information externality associated with the presence of FDI.

Definitional issues aside, Table 7 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 imitate 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 U.S. 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 report acquiring technology from their FDI customers and suppliers, albeit with lower proportions (outcomes 3-4).

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).[24] Overall, 17.8% of plants report at least one of the first 4 outcomes, and 24.6 % report at least one of

[24]FDI 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.

the 6 outcomes.

To better understand the relationship between linkages and technology transfer we examine three modes of technology transfer by linkage type in Table 8. The information in Table 8 is organized in the following way. Across the top we classify domestic plants according to the types of linkages defined in Section 3.2. Plants that report none of these three linkages may or may not be in direct competition with foreign plants. For each type of linkage, we report the share of plants reporting a technology transfer mode for linked plants and non-linked plants. For example, column (1) of Table 7 indicates that 37% of domestic plants in a labor link with foreign plants directly adopted production processes by observation while 11% of plants not in a labor link with foreign plants also adopted production processes by observation. The p-value of the difference between the two numbers is reported in column (3) and indicates that plants in a labor linkage are statistically significantly more likely to adopt production processes by observation than plants not in a labor linkage.

In general, columns (10) – (12) show that domestic plants in formal links with foreign plants are more likely to: (i) adopt production processes by observing foreign plants; (ii) use technology licensed from foreign plants and; (iii) change production technologies due to competition from foreign plants. However, the evidence in column (11) also indicates that 9% of domestic plants not in a formal relationship with foreign plants report adopting production processes through observation, 8% report using technology licensed from foreign plants and 10% report changing production technologies due to competition from foreign plants. In total, 26% of domestic plants report technology improvements associated with the presence of FDI; 69% of this technology transfer took place through formal linkages while the remaining 31% of the technology transfer occurred outside formal linkages. These findings are consistent with those of Charlot and Duranton (2004) who, using data for France, find evidence of various forms of communication externalities: face-to-face meetings, word-of-mouth communication and direct interactions between skilled workers from different plants.

The evidence on labor linkages presented in these tables also 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 market [25] : knowledge is partly embedded in workers and diffuses when workers move between 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 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. They report that 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 reported only positive outcomes associated with FDI. This is because we are trying to get at the mechanisms behind the increases in TFP that we documented in Section 4. However, as pointed out by Aitken and Harrison (1999), foreign plant entry may pull demand from domestic plants forcing them to spread their fixed costs over a smaller number of produced units, thereby raising average costs. Row 1 of Table A.7 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 foreign plant entry, domestic plants may be left to hire infe-

[25] There exist at least two reasons why geographic proximity might be important for observed worker flows. 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 Bó, 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 (2017) 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.

rior workers. Row 2 of Table A.7 shows that 6% of domestic plants report facing competition from foreign plants in the local labor market. If foreign plants poach high-ability employees from domestic plants, the quality of the workforce in domestic plants may decrease. Row 3 of A.7 shows that 8% of domestic plants report having lost skilled workers to FDI. This evidence is consistent with research that finds detrimental effects of FDI.

However, the overall positive effects we report in Section 4 suggest that on average the benefits of FDI to domestic plants outweigh the costs. In addition, we find that the total value of production by domestic plants increases after the entry of foreign plants in a locality mitigating the concerns raised by Aitken and Harrison (1999).

6 Concluding Remarks

This paper makes three main contributions. First, by comparing changes in TFP among domestic plants in "treated" districts that attracted a large greenfield foreign plant and "untreated" districts where greenfield FDI in the same industry was licensed but not yet operational causal estimates of the magnitude of knowledge spillovers are identified. These estimates are comparable to estimates obtained using an alternative identification strategy that exploits the quasi random assignment of land to foreign investors by the Ethiopian government. Over the four years starting with the year of the foreign plant opening, the TFP of domestic plants is 8% higher in treated districts. We also find evidence that foreign plants attract new economic activity to recipient districts.

Second, we provide direct evidence on the ways in which knowledge is transferred from foreign to domestic firms and on the types of knowledge that is transferred. Domestic firms report that they adopt technology from foreign firms through: (i) learning by observation; (ii) hiring workers who previously worked at foreign firms; (iii) direct contact via customer and supplier relationships; (iv) licensing technology from foreign firms and; (v) competitive pressures. Although this learning is more common when domestic firms engage with foreign firms through labor or customer and supplier linkages, the evidence indicates that knowledge transfer through more informal channels is also important. Knowledge about production processes is the most common type of benefit associated with FDI but domestic firms also learn from foreign firms about managerial and organizational practices and logistical aspects of the supply chain, including exporting. This evidence underscores the usefulness of an empirical strategy that moves beyond the confines of industrial classifications.

Third, domestic firms do not appear to pay higher labor costs in order to obtain these productivity spillovers. The finding that average labor costs do not rise with the entry of foreign firms is consistent with Arthur Lewis's description of unlimited supplies of labor in underdeveloped countries (Lewis, 1954). This analysis is necessarily limited by the nature of the employment data and further research is needed to identify the possibility that labor costs for skilled labor increased. In addition, although domestic firms do report some competition from foreign firms, the TFP estimates reveal that on average FDI entry raised TFP.

This paper has demonstrated knowledge transfer from foreign to domestic firms in Ethiopia's manufacturing sector. It has also demonstrated the mechanisms by which knowledge is transferred. The results underscore the importance of locating foreign firms in close proximity to domestic firms. The results also provide some support for the Ethiopian government's industrial policy although more research is needed to quantify the cost of the incentives provided to foreign firms and to compare these costs with the benefits of knowledge spillovers.

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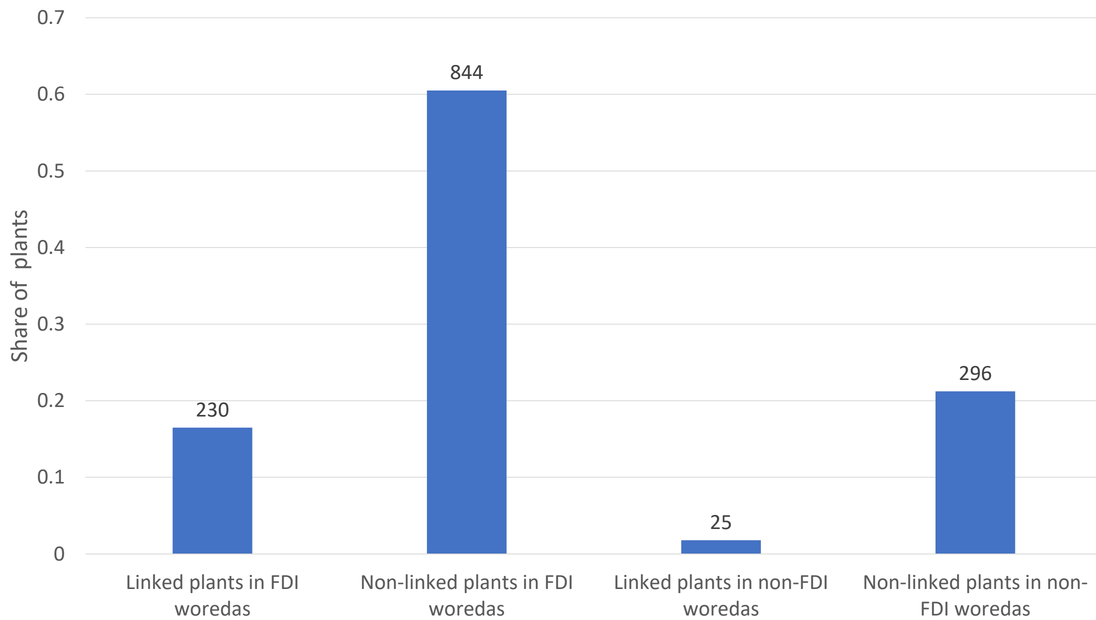
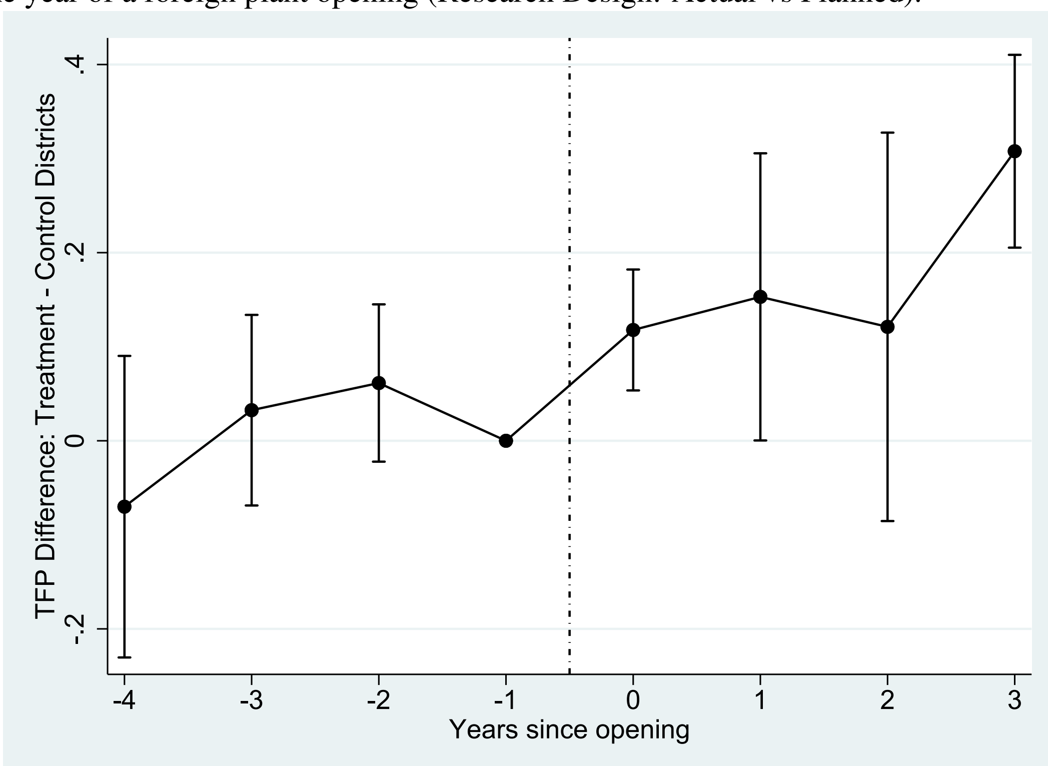
Figure 1: Domestic Firms' Linkages by Proximity to FDI



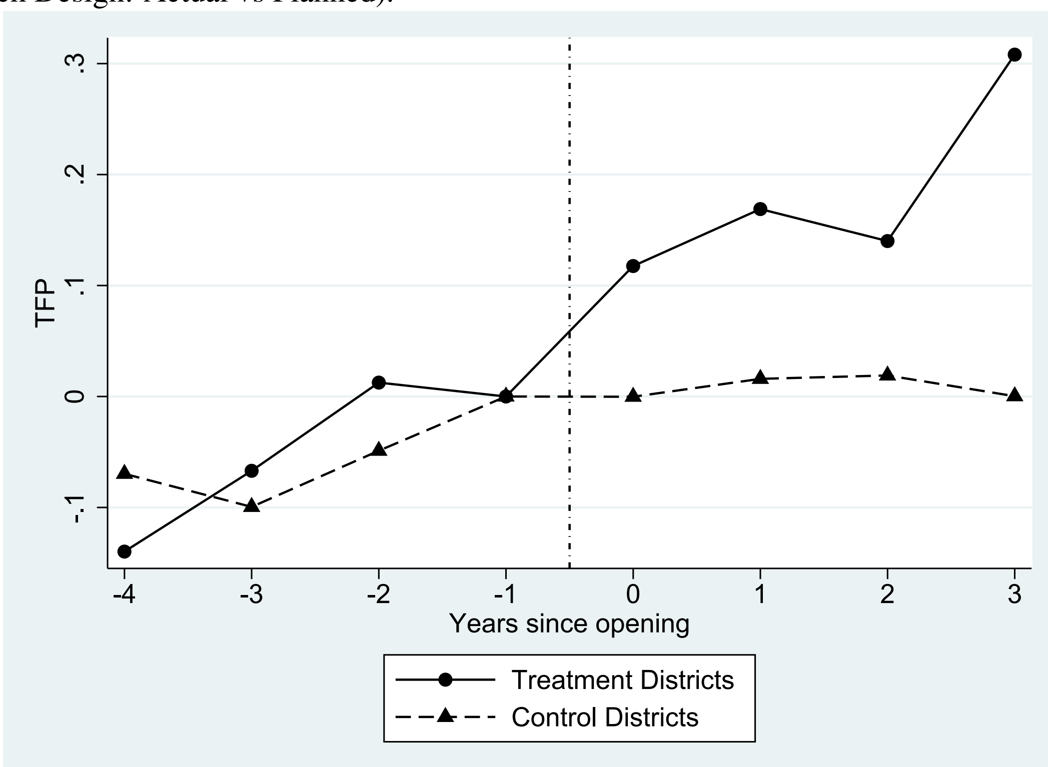
The Figure shows the count of domestic plants with customer, supply, or labor linkages to FDI plants by whether an FDI plant is located in the same woreda.

Figure 2: Difference in domestic plants' productivity in treated vs control districts, relative to the year of a foreign plant opening (Research Design: Actual vs Planned).



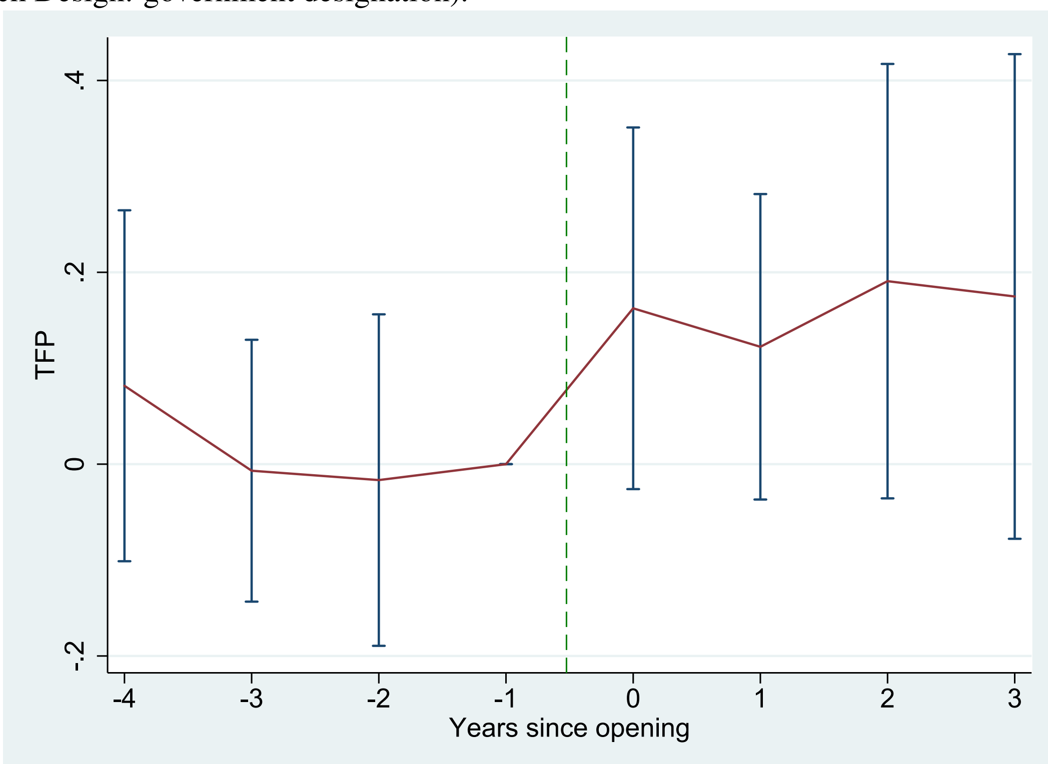
Note: The figure plots point estimates for leading and lagging indicators for the large foreign plant opening. The omitted category is one period prior to the large foreign plant opening. Vertical bars correspond to 95 percent confidence intervals with district-clustered standard errors.

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



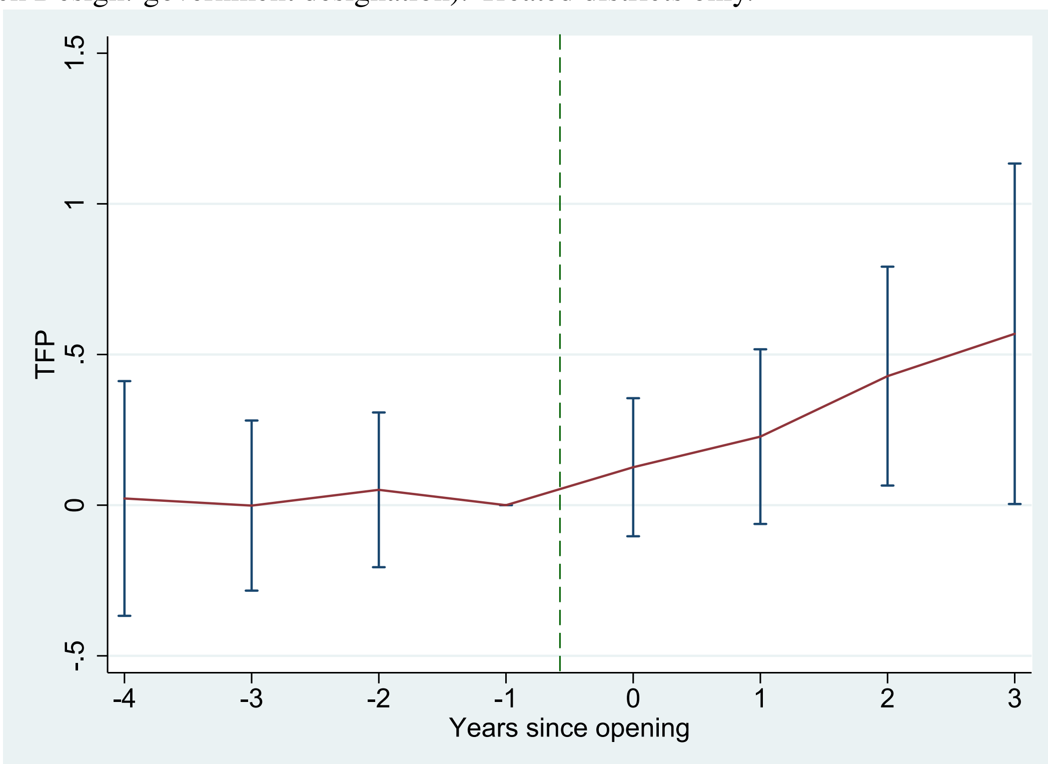
Note: The figure plots point estimates for leading and lagging indicators for the large foreign plant opening. The omitted category is one period prior to the large foreign plant opening.

Figure 4: 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 5: 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) p-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	12,230	11,325	.78	.77
Capital	4,932	6,404	.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
Plant-level Average Yearly Wage	6,649	5431	.11	.18

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, Gelbach, and Miller (2008). All monetary amounts are in 1000s of birr.

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

	(1)	(2)	(3) At least 3 years
logK	0.063***	0.059***	0.051***
	(0.018)	(0.016)	(0.015)
logM	0.567***	0.564***	0.552***
	(0.056)	(0.059)	(0.061)
logL	0.258***	0.255***	0.273***
	(0.064)	(0.062)	(0.062)
Mean Shift	0.046	0.083	0.110
	(0.039)	(0.048)*	(0.044)**
	[0.204]	[0.099]*	[0.029]**
Year by 2-digit industry FE	NO	YES	YES
Year Dummies	YES	NO	NO
Observations	10,822	10,822	9,265
Adjusted R-squared	0.906	0.907	0.907

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 mean shift, we report in brackets the p-value obtained using the bootstrap procedure the procedure developed by Cameron, Gelbach, and Miller (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.

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	20,706	6,437	0.94
Capital	6,426	5,904	0.14
Employees	215	68	1.60
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*
Plant level average yearly wage	3.35	3.53	0.40

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) Treated Only	(4) At least 3 years
Average change	0.109 (0.055)**	0.159 (0.087)*	0.261 (0.136)* [0.050]*	0.286 (0.162)* [0.080]*
Year by 2-digit industry FE	NO	YES	YES	YES
Year Dummies	YES	NO	NO	NO
Observations	4,799	4,799	968	569
Number of Districts	223	223	17	13

This Table accompanies Figure 4. 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, Gelbach, and Miller (2008). Plant FE and region trends are always included.

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

	Births	Weighted by L
	(1)	(2)
	Panel A: Research Design: Actual vs Planned	
Mean Shift	4.093	303.534
	(2.706)	(129.333)**
	[0.1410]	[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*	77.75
	(0.924)	(60.84)
Observations	1,358	1,358
Mean y control	1.28	45.31
SD y control	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 developed by Cameron, Gelbach, and Miller (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 Change of Technology by Domestic Plants

	Labor link			Customer link			Supply link			Any link		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Yes	No	p-value of diff.	Yes	No	p-value of diff.	Yes	No	p-value of diff.	Yes	No	p-value of diff.
Directly adopted production processes by observing FDI plants in the same industry	.37	.11	.00	.27	.12	.00	.24	.11	.00	.28	.09	.00
Use technology licensed from foreign plants	.31	.09	.00	.18	.10	.01	.17	.09	.01	.20	.08	.00
Changed production technologies due to competition from FDI	.45	.13	.00	.39	.14	.00	.38	.13	.00	.38	.10	.00
N	97	1,298		90	1,305		125	1,270		255	1,140	

Labor linked firms are defined as those hiring a former FDI employee, supply-linked firms are defined as those selling at least 10% of output to FDI plants, and customer-linked firms are defined as those buying at least 10% of raw material from FDI plants. Columns compare firms reporting each type of linkage to those who do not.

Table 9: Reported Benefits from Domestic Firms' Linkages to FDI Firms

Benefit	Share of observations
Labor Linkages	
Production Technologies	0.65
Management and Organizational Practices	0.14
Knowledge of How to Export	0.09
Others	0.11
Customer Linkages	
Production Technologies	0.65
Management and Organizational Practices	0.17
Knowledge of How to Export	0.01
Others	0.16
Supply Linkages	
Product Design	0.40
Worker Training	0.19
Production Technologies	0.18
Logistics	0.11
Organization Structure	0.12
Any Linkage	
Production Technologies	0.45
Product Design	0.20
Management and Organizational Practices	0.13
Logistics Including Exporting	0.07
Worker Training	0.07
Others	0.08

Notes: The total number of firms included is equal to 179. Product design includes increases in the variety and quality of products. Worker training includes training of managers and those they supervise. Supply chain logistics includes better marketing and distrubution of products as well as supply chain management. Management and organizational practices include managerial practices, organizational structures and physical upkeep of premises.

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.),[26] 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.[27] 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

[26]CSA 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.

[27]Unfortunately, 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.[28] 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.

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 and a given industry) look for a control in the same year and with a foreign plant in

[28] Unfortunately, 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.

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 $\tau^l = \tau - 3$. [29]
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

[29] Three 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.4.

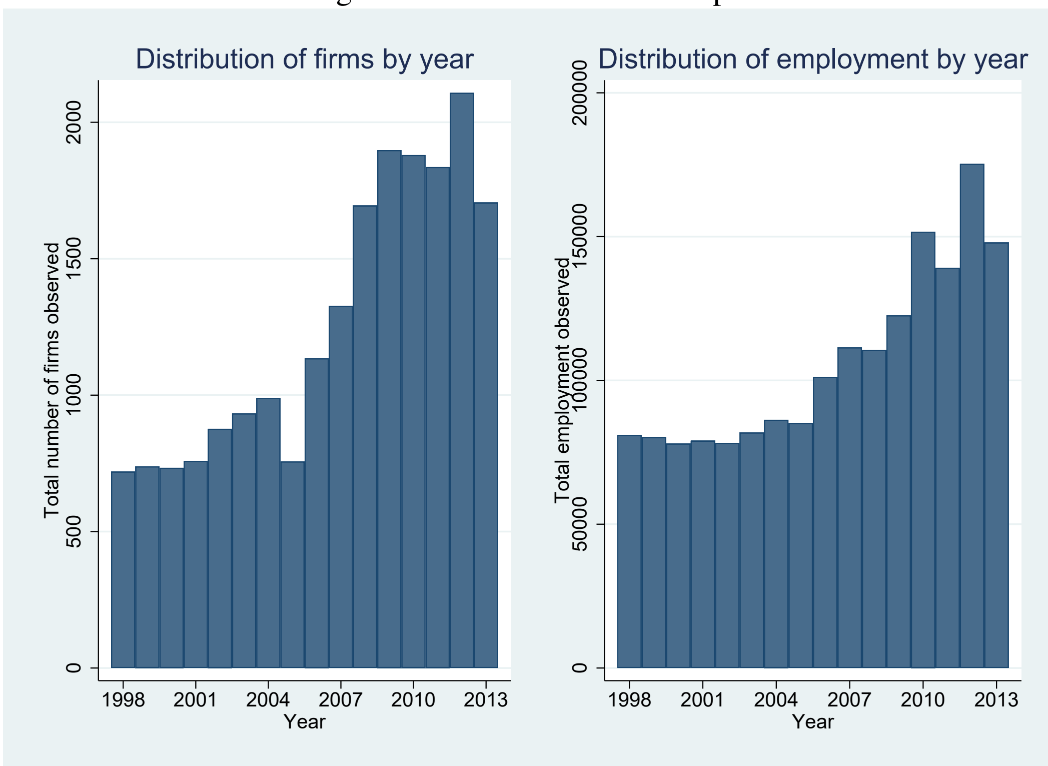
A.III Further Analysis

Employment and wages 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 (-0.05 with s.e. 0.09).

What are the FDI effects on wages? Our estimates should be interpreted cautiously because we do not have individual-level wage data and we are forced to use (log) plant level average wage. If this concern is set aside, the estimated Diff-in-Diff coefficient using the first research design with (log) plant level average wage as dependent variable is equal to -0.08 and not significant when clustering at district level (s.e. 0.07), nor 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 0.02 and not significant (s.e. 0.10).

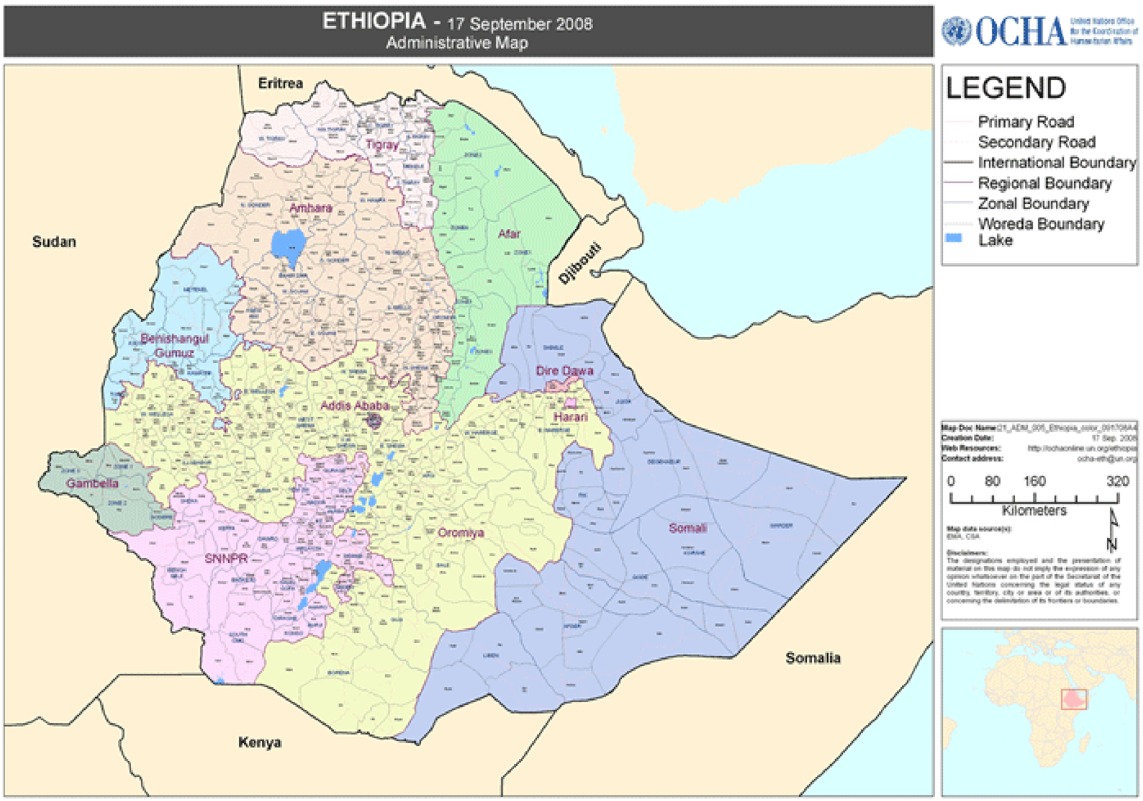
A.IV Additional Figures and Tables

Figure A.1: CSA Matched Sample



The Figure shows the count of plants and the total employment by year in the matched CSA sample.

Figure A.2: Administrative Map of Ethiopia



Source: UN Office for the Coordination of Humanitarian Affairs:

Table A.1: CSA Matched Sample

Variable	Mean	(Std. Dev.)	Min.	Max.	N
Output	10,486	(27,715)	20.6	328,554	16,889
Capital	3,840	(9,140)	0.56	96,957	16,751
Employes	59.9	(106.7)	1	814	17,150
Plant Age	12.2	(12.4)	1	63	16,925
Output per Worker	156.3	(282.3)	2.70	2,552	16,889
Capital per Worker	60.7	(99.2)	0.20	736	16,751
Yearly Wage	7.56	(6.76)	0.65	53.3	17,126

Summary statistics from 6,321 unique plants, observed across all years (1996-2013). All monetary amounts in '000s of birr. Average Yearly Wage is the plant-level average yearly wage

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: Difference between year of entry and year of permit

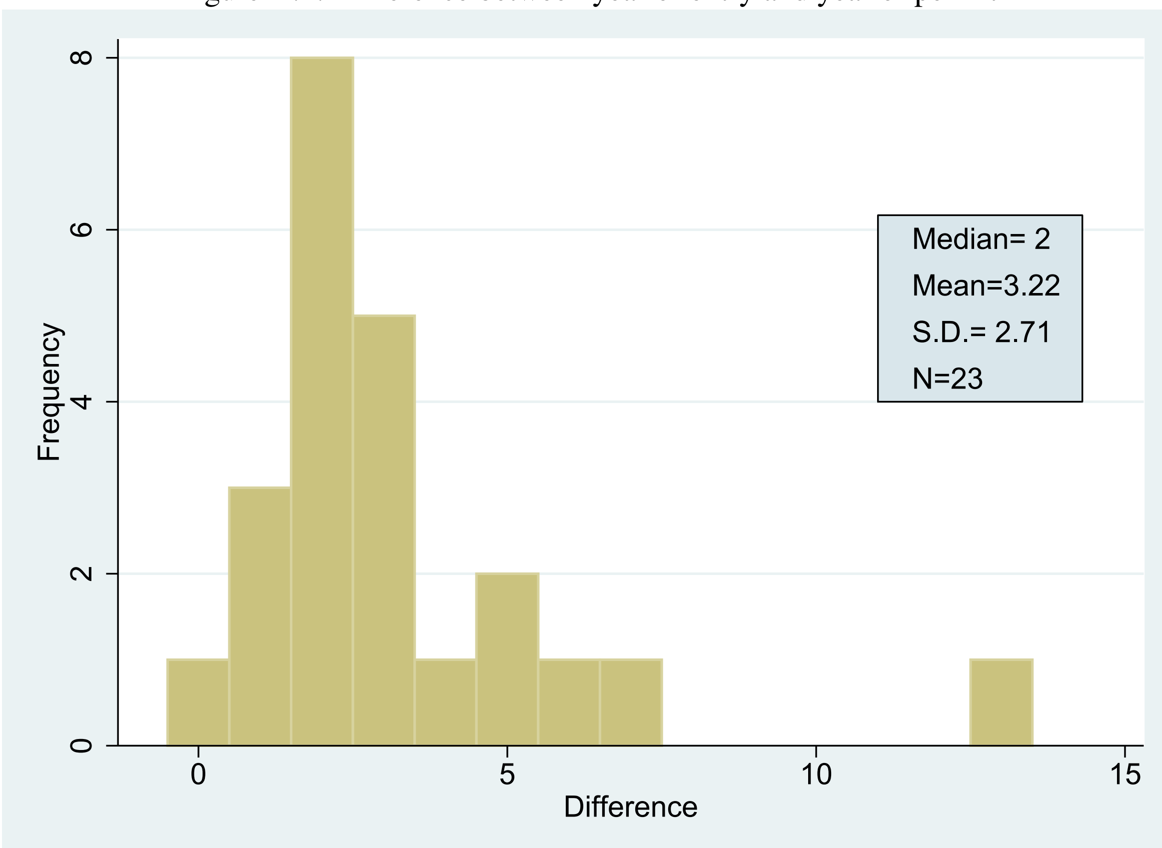


Table A.2: Wages and workforce education by ownership type, sample means

	FDI	Domestic	*p*-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 birr.
Author's compilation based on CSA census and FDI survey module

Table A.3: 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:	
# of Employees	113.71
	(187.00)
Share of local labor market (%)	9.91
	(18.48)

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 parentheses

Table A.4: Sample of FDI Opening and Districts (Research Design: Government Allocation)

Sample FDI openings	17
Never-treated districts	206
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.5: Plant Characteristics by Treatment Status, Year 2006; Research Design: Government Allocation.

	(1) Treated Districts	(2) Never-Treated Districts	(3) (1)-(2) t-stat
Output	21,065	9,099	0.82
Capital	5,748	7,413	0.44
Employees	99	49	1.08
Plant Age	9.7	9.4	0.31
Capital per Worker	48.5	58	0.58
Output per Worker	116	109.3	0.21
Plant-level Average Yearly Wage	4.92	4.53	0.59

Reported t-statistics are calculated from standard errors clustered at the district level. All monetary amounts are in 1000s of birr. 2006 is the year before the fourth event. Since we want to explore the balancing of covariates pre-treatment, we remove from the set of treated, the three districts which experience the event before 2006.

Table A.6: Changes in Domestic plants' productivity, following a foreign plant opening, Robustness to Specifications Addressing Transmission Bias

	Investment-Capital Interactions	Materials-Capital Interactions	Materials-Capital and Materials-Labor Interactions
	(1)	(2)	(3)
	Panel A: Research Design: Actual vs Planned		
Mean Shift	0.295***	0.100**	0.093**
	(0.085)	(0.046)	(0.044)
Observations	5,541	10,822	10,822
	Panel B: Research Design: Government Allocation		
Average change $\tau = 0 - 2$	0.124	0.168*	0.162**
	(0.139)	(0.086)	(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 Ackerberg 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.7: 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