International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 1545-1556 www.ijaem.net ISSN: 2395-5252

Role of Technology Transfer from Foreign Direct Investment for Productivity of Domestic Firms

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Submitted: 05-06-2022 Revised: 17-06-2022 Accepted: 20-06-2022

ABSTRACT
Foreign Direct Investment (FDI) became strategic pillar in developing countries for different aspects such as source of financing, technology transfer, productivity of domestic firms, and other economic aspects. It is highly expected that FDI spillovers improve productivity of domestic companies in host country through technology transfer. Specifically, in Ethiopia, manufacturing sector is given high priority while attracting FDI firms. This study was conducted to examine role of technology transfer from FDI for productivity of domestic manufacturing firms. We examined the role of FDI from aspects of direct linkages and indirect spillovers. Thus, we included samples of FDI and domestic firms in manufacturing sectors. In our analysis we included 101 FDI firms and 1,368 domestic firms. We evidenced that FDI has positive backward and forward spillovers on productivity of domestic manufacturing firms. It is evidenced that the positive productivity effect from backward spillover is due to backward linkage of the firms with FDI firms. But this effect is not related with technology transfer from the FDI firms. Comparatively, domestic firms that have supply chain linkage with FDI firms without technology transfer are more productive than firms with technology transfer. The result of study shows that the technology transfer from FDI firms has no role to improve productivity of domestic manufacturing firms in Ethiopia. Thus, this study reveals technology transfer from FDI does not result productivity gain for domestic firms.

Keywords: Domestic Manufacturing Firms,Foreign Direct Investment, Productivity, Technology Transfer

I. INTRODUCTION

Globalization provides poor countries with a once-in-a-lifetime opportunity to attain faster economic growth through trade and investment. Foreign direct investment (FDI) has become a critical component of global economic activity (Bodman & Le, 2018). Since the inflow of FDI comprises knowledge about new technologies and materials, industrial methods, or organizational management abilities, it is regarded one of the key conduits for technological diffusion across borders (Bodman & Le, 2018). FDI has increased its importance by transferring technologies and establishing marketing and procuring networks for efficient production and sales internationally (Swenson, 2019).FDI has become increasingly essential for both foreign investors and FDI recipients. According to Rutihinda (2017), FDI allows foreign investors to better utilize their assets and resources, while FDI recipients benefit from technology acquisition and participation in global production and commerce networks. FDI is important since it provides a substantial source of money as well as cutting-edge technology (Damooei & Tavakoli, 2016). It would be difficult to raise this capital through domestic savings, and even if it could, it would be impossible to import the essential technology from outside, as technology transfer to enterprises with no prior experience is difficult, hazardous, and costly (Sharma & Gani, 2014).

Technology transfer has been a key goal of FDI in recipient countries, particularly in developing ones. Technology transfers are made on a voluntary basis to multinational corporations' local suppliers in order to improve the products they deliver (Rodriguez-Clare, 2016). These new technologies are disseminated through training, technical assistance, and other information in order to increase the quality and quantity of items purchased by the multinational (OECD, 2017).Technology transfer via FDI has the effect of encouraging competitors in the domestic market to

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 1545-1556 www.ijaem.net ISSN: 2395-5252

upgrade their technology. Employees can learn the technology while working for the company, and some of them may use it to launch their own businesses. Multinationals frequently assist their local suppliers in obtaining raw materials and intermediate products, as well as in improving their facilities. However, in industries where technology is rapidly changing, the main gains given by multinationals are new products and manufacturing processes (Blomström & Kokko, 2018).

Although some researches have indicated that technology transfer through FDI has positive effects, other studies have demonstrated that technology transfer has detrimental consequences on local company productivity. It leads to the host country's reliance on technologies introduced by corporations and other industrialized countries, according to (Vissak & Roolaht, 2018). As a result, local enterprises' enthusiasm in developing new technology has waned. As a result of the substantial reliance on FDI enterprises, local firm productivity suffers. Desire of domestic firms to maintain a technological advantage may cause FDI firms to react negatively with domestic firms. Multinational corporations only transfer ineffective technologies to firms in host country that will not have importance for productivity of the domestic firms in host country. Under these conditions, the host country's reliance on foreign technologies will continue. Local enterprises' productivity may be harmed as a result of multinationals' negative reaction and improper technology offered. This discrepancy advises that more research be done to determine the impact of knowledge transfer through FDI on local company productivity (Vissak & Roolaht, 2018).

In line with this gap, although various studies were conducted to identify the effect of FDI on economic growth, there are no empirical studies conducted in Ethiopia to identify the role of FDI for productivity of local companies through technology transfer except (Yared, Daniel, & Gulelat, 2014). This study was conducted only in Metal and Engineering industry and it has followed descriptive method and failed to include econometric estimation in assessing the impact. Technology transfer is highly practiced in manufacturing industries as manufacturing industries use capital intensive production and requires skilled labor to utilize machineries used in the production process (Vissak & Roolaht, 2018). Local industries' technological capability to absorb, alter, and develop a given technology is very weak, and the working environment between foreign and domestic businesses is very uncooperative, and national technology policies are very weak to benefit from FDI(Yared, Daniel, & Gulelat, 2014). This finding contrasts to the majority of previous studies. Thus, it is important to further identify role of technology transfer through FDI for productivity of local manufacturing companies in Ethiopia. Therefore, this study was conducted with aim of identifying role of technology transfer from FDI companies for productivity of domestic manufacturing firms in Ethiopia.

II. METHOD

Our analysis uses five-year panel data surveyed from 2016 to 2020 by Ethiopian Statistical Authority (ESA)about manufacturing firms in Ethiopia. The data includes about domestic and FDI firms currently operating in Ethiopia in different regions. We specifically used 1,469 observations of manufacturing firms that include 1,368 observation of domestic firms and 101 observations of foreign owned firms that data on relevant variables are not missing. Our data from CSA mainly includes about information on supply chain linkages, technology transfers, and other topics for manufacturing enterprises. The FDI companies were included to compute indicators of indirect spillovers for the local manufacturing companies and they are not included in productivity estimations.

Additional survey was conducted for information missed in data of CSA and this data was collected by using questionnaire. The survey instruments were emailed to the companies and the companies that do not respond are contacted by mail, by phone or through face-to-face visits. The information on firm activities gathered through additional survey were matched with data from CSA. The data collected through questionnaire is mainly about outputs sold to FDI companies and inputs purchased from FDI companies in Ethiopia. it is intended to measure direct linkage between local and FDI companies. In addition, the companies were asked about existence of contracting relationship with the FDI companies about technology transfers.

The first step in our analysis requires that we estimate productivity for each firm in our sample. Estimating a production function and using the estimated parameters to back out a firm-specific measure of productivity is the standard approach.The inputs must be computed independently of the firm's efficiency level when using OLS to estimate the production function. In most cases, this is an unrealistic assumption. It is quite likely that unobserved productivity shocks are linked to companies' input choices. When a firm bases its variable input decisions on productivity

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 1545-1556 www.ijaem.net ISSN: 2395-5252

shocks that the firm observes but not the econometrician, the OLS estimates of the coefficients on these inputs in the production function are bias.

Firms with higher productivity, for example, may elect to hire more workers, resulting in an upward bias in the labor coefficient if productivity is not taken into account. Higher productivity enterprises may use less labor inputs per unit of capital, resulting in a downward bias in OLS estimations of the labor coefficient. This is in line with the premise that as businesses get more productive, they become more capital intensive. Where there is simultaneity, the capital coefficient will likewise be biased. The bias could be in either direction in both circumstances. Semi-parametric techniques, which impart some structure to a firm's underlying decision-making process, have become a common solution to solve these challenges. The most commonly applied approaches include (Olley & Pakes, 1996) (OP), (Levinsohn & Petrin, 2003) and (Ackerberg, Caves, & Frazer, 2006) (ACF). These approaches account for endogeneity between variable inputs and unobserved productivity by using a set of assumptions about firm behavior in regard to how productivity changes over time and the timing of input selections. The model is estimated using the one-step GMM estimator (Wooldridge, 2009), which is more efficient than the traditional two-step technique.

We analyzed the effect of FDI on productivity of domestic manufacturing firms in two stages; in the first stage we estimated the production function and productivity and; in the second stage we analyzed effect of FDI on estimated productivity. In the first stage, we assume a Cobb–Douglas production function written in the following form for the purpose of empirical estimation of production function.

$$y_{it} = \beta_{1l} l_{it} + \beta_k k_{it} + \omega_{it} + e_{it} \quad (1)$$

Where yit is the log of value added, lit is the log of the labor input, kit is the log of the capital input, ωit is unobserved productivity, and eit is an unanticipated shock or random error term.

The production function is estimated by instrumental variables estimation with the instruments of kit and iit. After computing consistent estimators for βl and βk, we predicted productivity as;

$$\hat{\omega}_{it} = y_{it} - \hat{\beta} l_{it} - \hat{\beta}_k k_{it} \quad (2)$$

Our main focus is to examine the role of technology transfer from FDI on productivity of domestic firms. In addition, we tried to identify FDI spillovers are associated with this direct linkage. Based on Javorcik (2004) we consider three measures for FDI spillovers; horizontal, forward and backward spillovers. We captured FDI spillovers based on proportion of revenue accounted for FDI firms. We computed the horizontal spillovers by the proportion of total revenue accounted for FDI firms in the sector; forward spillovers by the proportion of total revenue in upstream sectors accounted for by FDI firms; and backward spillover as the proportion of total revenue in downstream sectors accounted for by foreign-owned firms.

Our main interest is to identify the role of FDI on firm level productivity. But the challenge is existence of many potential confounding factors that affect FDI flow into a sector and productivity of the firm. Therefore, in the second stage model, we include time varying firms specific and fixed effect control variables. Time-varying firm specific control variables are age of the firm, import of intermediate inputs and export of output; and fixed effect control variables are sector, time, and region fixed effects. Our model is specified as;

$$\omega_{ijrt} = \alpha + \gamma_1 H_{jt} + \gamma_2 F_{jt} + \gamma_3 B_{jt} + \delta Z_{ijt} + \varphi D_{jrt} + e_{ijrt} \quad (3)$$

Where ωijpt is productivity of firm i in sector j in region r in time t; Hjt, Fjt, and Bjt are the horizontal, forward and backward indirect spillover measures; Zjt is a matrix of time-varying firm specific control variables; Djrt are dummies for sector, region and time; and eijpt is a statistical noise term.

We add direct linkage between domestic and FDI firms to the empirical literatures about FDI spillovers. Out dataset contains proportion of output sold to FDI firms and proportion of inputs purchased from FDI firms. We used model suggested by (Newman et al. 2015) but we argue that the level of strength of direct linkage varies based on amount of input purchased from and the output sold to FDI firm. Newman et al. (2015) has used whether the domestic firms have direct linkage with FDI firms as a customer or supplier. Instead, we measured the direct linkage by using proportion of input of the domestic firm from FDI firm and proption of output of the domestic firm sold to FDI firm. The baseline emperical model we used to estimate direct linkage is presented as follows.

$$\omega_{it} = \alpha + \gamma_1 O_{it} + \gamma_2 I_{it} + \delta Z_{it} + \varphi D_{jt} + e_{it} \quad (4)$$

Where; O_{ijt} is proportion of output of domestic firm i at period t sold to FDI firms and I_{ijt} is proportion of input of domestic firm purchased from FDI firm.

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Volume 4, Issue 6 June 2022, pp: 1545-1556 www.ijaem.net ISSN: 2395-5252

Further, we disaggregate the direct linkage with technology transfer relationship. We have data about contractual agreement for transfer of technology. Thus, the direct linkage through technology transfer is estimated as follows;

$$\omega_{it} = \alpha + \gamma_1 OTt_{it} + \gamma_2 OTn_{it} + \gamma_3 ITt_{it} + \gamma_4 ITn_{it} + \delta Z_{it} + \varphi D_{jt} + e_{it} \quad (5)$$

Where; OTt_{it} is output sold to FDI firm receives technology transfer; OTt_{it} is output sold to FDI firm does not receive technology transfer; ITt_{it} is input purchased from FDI firm receives technology transfer; ITn_{it} is input purchased from FDI firm receives technology transfer.

We examine the productivity effect of indirect spillovers due to presence of direct linkage with interaction of indirect spillovers and direct linkages. The estimation model is presented in equation (6) below.

$$\omega_{ijrt} = \alpha + \gamma_1 H_{jt} + \gamma_2 F_{jt} + \gamma_3 B_{jt} + \gamma_1 O_{it} + \gamma_2 I_{it} + \lambda_1 F_{jt} \times O_{it} + \lambda_2 B_{jt} \times I_{it} + \delta Z_{ijt} + \varphi D_{jrt} + e_{ijrt} \quad (6)$$

Finally, we examine the productivity effect of indirect spillovers due to presence of direct linkage with technology transfer.

$$\omega_{ijrt} = \alpha + \gamma_1 H_{jt} + \gamma_2 F_{jt} + \gamma_3 B_{jt} + \phi_1 OTt_{it} + \phi_2 OTn_{it} + \phi_3 ITt_{it} + \phi_4 ITn_{it} + \psi_1 F_{jt} \times OTt_{it} + \psi_2 F_{jt} \times OTn_{it} + \psi_3 B_{jt} \times ITt_{it} + \psi_4 B_{jt} \times ITn_{it} + \delta Z_{ijt} + \varphi D_{jrt} + e_{ijrt} \quad (7)$$

III. RESULTS

We provide descriptive analysis for output and employment contribution of FDI firms, Direct Linkages including technology transfer, and indirect spillovers. The effect of technology transfer via FDI on productivity of domestic firms is empirically estimated based on econometric procedures.

3.1. Output and Employment Contribution

We summarized output and employment contribution of FDI and domestic firms manufacturing industries in Ethiopia. We compared domestic and FDI firms from perspective of output and employment contribution. We presented the output contribution of the FDI firms by disaggregating to sectors. The result of descriptive statistics about employment and output contribution and list of top ten sectors that FDI firms have highest output contribution in Table 1.

Table 1: Contribution of FDI firms

Descriptions	Proportion
Proportion of FDI Firms	0.07
Employment contribution	0.16
Output contribution	0.28
Sector*: Output	
Other general-purpose machinery	.82
Glass and glass products	.63
Malt liquors and malt	.61
Soft drinks & production of mineral waters	.50
Tanning and dressing of leather, luggage and handbags	.50
Food products n.e.c.	.48
Basic iron and steel	.40
Cement, lime and plaster	.39
Soap and detergents cleaning and polishing, perfumes and toilet p	.37
Production, processing and preserving of meat, fruit and vegetables	.35

Note: * Top ten sectors with highest output contribution of FDI Firms

We computed that in manufacturing sectors in Ethiopia, 93% of firms are domestic and only 7% are foreign owned firms. Employment is important consideration while attracting FDI firms to the country.It was shown that 16% of the employment and 28% of output contribution by FDI firms. However, the contribution of FDI firms vary from sector to sector. Highest contribution of FDI is observed in general purpose machinery manufacturing sector where FDI firms supply 82% of the outputs. This means domestic firms produce only 18%. Manufacturing of glass and glass products is also dominated by FDI firms. In addition, in malt liquors and malt industry 61% of outputs comes from foreign owned firms.

3.2 Linkage and Spillovers

In addition to improving supply and employment, FDI attraction to the country mainly targets on improving productivity of domestic firms

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Volume 4, Issue 6 June 2022, pp: 1545-1556 www.ijaem.net ISSN: 2395-5252

through technology transfer. The FDI firms have obligations to make direct linkage with domestic firms in their supply chain. Therefore, it is important to assess the level of direct linkage through technology transfer from FDI firms to domestic firms and its effect on productivity of domestic firms. further, it is important to assess compliance to FDI policy in Ethiopia in regards to making direct linkage between the domestic and MNCs.

Domestic firms make direct linkage with FDI firms with contractual agreement to receive technology transfer or without technology transfer. The FDI firms make contractual agreement for technology transfer with strategic partner domestic firms. As FDI firms have few strategic partner domestic firms, large number of domestic firms have no direct linkage with FDI firms through technology transfer. Although contractual agreement for technology transfer from FDI firms to domestic firms do not indicate that the technology transfer agreement was made based on the level of relationship in supply chain, we argue that amount of input received from FDI firms and output supplied to FDI firms are importantfactorswhile identifying effect of the technology transfer. As a result, we believe that it is important to analyze proportion of input received and output supplied to FDI by disaggregating with technology transfer. As an indicator of direct linkage, proportion of input from/output to FDI companies are disaggregated to input from/output to FDI companies with technology transfer and without technology transfer. Therefore, we used level of linkage that was proxied by proportion of input from FDI firms and outputs to FDI firms while examining the role of technology transfer. Before conducting empirical estimation, we summarized direct linkage and indirect spillover of FDI manufacturing firms with domestic manufacturing firms. In Table 2, we present descriptive statistics to summarize indirect spillovers and direct linkagesand, further, we disaggregate direct linkage to linkage with technology transfer and without technology transfer.

Table 2: Direct Linkages and Indirect Spillovers

Variable		Number of Firms		Proportion of Input/output	
		Count	Percent	Mean	Std. Dev
Backward Linkage					
FDI Suppliers	No	164	11.99		
	Yes	1,204	88.01	.67	.39
technology transfer	Without	769	56.21	.44	.45
	With	435	31.80	.23	.39
Forward Linkage					
FDI customers	No	516	37.72		
	Yes	852	62.28	.17	.25
technology transfer	Without	518	37.87	.10	.21
	With	334	24.42	.07	.19
Spillovers					
Horizontal				.14	.14
Forward				.18	.12
Backward				.66	.21

Our analysis shows that, on overall, FDI firms are supplying inputs to 88% of domestic firms. This indicates majority of manufacturing FDI firms in Ethiopia are that supply domestic firms with intermediate inputs. But from these domestic firms, only 31.8% receive technology transfer from the FDI firms. In addition, 62.28% of the local firms have FDI firms as customer. However, the technology transfer agreement exists with only 24.42% of the domestic firms. Regarding the technology transfer, the linkage between FDI firms and domestic firms is at low level. Based on this, we suggest FDI firms in Ethiopia are forward linked with domestic firms.

We measured direct linkage by using proportion of output and input to and from FDI companies directly sold and purchased from FDI companies. The direct linkage is presented interaction with contract for technology transfer and without technology transfer. On average, 17% of output from local manufacturing companies is sold FDI companies without contractual agreement to transfer technology but 7% of outputs are sold to FDI companies that have contractual agreement for technology transfer. Linkage is higher with input

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Volume 4, Issue 6 June 2022, pp: 1545-1556 www.ijaem.net ISSN: 2395-5252

supply; where 67% of inputs for domestic firms supplied by foreign owned companies. However, similar to forward linkage with FDI firms, technology transfer is practiced in few domestic firms where only 23% of inputs are supplied by FDI companies with technology transfer. From the perspective of the number of the companies, 88% of the local companies are supplied inputs from FDI companies. Further, it is observed that 31.7% of the companies have agreement for technology transfer.

As presented in Table 2, summary result on horizontal spillovers indicates 14% of the revenue share is by FDI companies within a sector. On the other hand, for vertical spillovers, 18% of the outputs are sold to FDI companies through forward linkages and 66% of the inputs are purchased from FDI companies through backward linkages. This indicates FDI inflow to Ethiopia targets manufacturing of inputs for companies in other sectors. There is foreign dominance in input markets in the country.

3.3 Production Function and Productivity Estimation

Descriptive statistics and econometric estimation of variables used in production function estimation are presented in Table 3. The output variable included in our production function is value added output. Capital is the value of assets at the beginning of the year and labor is the total number of workers employed at the end of the year. In the empirical approach, we estimated the firm-level productivity for only local companies. Validity of the instruments is confirmed by weak identification, under identification and the first stage F-tests. Overidentification is tested by using higher order terms of the instruments. Production function is estimated by using GMM and OLS models.

Table 3: Production function Estimates

Variables	Descriptive Statistics		Estimation	
	Mean	**Std. Dev**	**GMM**	**OLS**
Output	59.358	246.61		
Labor	92.952	257.88	0.413***	0.371***
			(0.0508)	(0.0458)
Capital	29.926	255.32	0.208***	0.281***
			(0.0578)	(0.0533)
Investment	4.382	27.34	0.315***	0.260***
			(0.0584)	(0.0573)
Constant			7.380***	7.161***
			(0.201)	(0.189)
Observations			1,368	1,368

Note. Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Under the estimations, coefficient of capital is lower when the estimation is conducted by using GMM than OLS. This suggests the capital choice of the firms is positively correlated with productivity and estimating production function by using OLS will lead to an upward bias in the capital coefficient. In addition, in the OLS estimation coefficient on labor is smaller when compared to the GMM estimation that suggests labor and productivity are positively correlated causing upward bias in the labor coefficient if OLS is used to estimate production function. On the other hand, GMM estimates higher coefficient for labor suggesting that labor and productivity are negatively related. This is similar with hypothesis that smaller units of labor are employed per unit of output at more productive firms. On overall, OLS estimates coefficient of labor in opposite direction to estimation through GMM. This is similar Ackerberg et al. (2006) that states, in the first stage, multicollinearity hampers estimation of coefficient of labor. Overall, OLS leads to an underestimation of productivity due to lower returns to scale when a production function is estimated by using OLS instead of GMM. Therefore, for the second stage, we computed productivity estimates by using GMM.

By assuming that firms within a sector use similar technology, we computed an average productivity from the production function estimated. It is evidenced that the most productive sector is pharmaceuticals, medicinal chemicals and botanical products. On the other hand, Cordage, rope, twine and netting is the least productive sector. Table 4 presents average productivity for each sector.

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Table 4: Average productivity

Sectors	Mean
Production, processing and preserving of meat, fruit and vegetables	6.98
Vegetable and animal oils and fats	7.60
Dairy product	7.48
Grain mill products	8.28
Prepared animal feeds	7.70
Bakery products	7.36
Sugar and sugar confectionery	8.07
Macaroni and spaghetti	7.11
Food products n.e.c.	7.60
Malt liquors and malt	7.69
Soft drinks & production of mineral waters	7.34
Spinning, weaving and finishing of textiles	6.96
Cordage, rope, twine and netting	6.61
Wearing apparel except fur apparel	6.77
Tanning and dressing of leather, luggage and handbags	6.69
Footwear	7.04
Wood and of products of wood and cork, except furniture	7.01
Paper and paper products	7.20
Paints, varnishes and mastics	7.96
Pharmaceuticals, medicinal chemicals and botanical products	8.91
Soap and detergents cleaning and polishing, perfumes and toilet p	7.35
Chemical products n.e.c.	7.36
Plastic products	7.12
Glass and glass products	8.45
Cement, lime and plaster	7.47
Articles of concrete, cement and plaster	6.91
Basic iron and steel	8.18
Structural metal products, tanks, reservoirs and containers of me	7.13
Other general purpose machinery	7.26
Parts and accessories for motor vehicles and their engines	8.66
Furniture; manufacturing n.e.c.	7.25

3.4 Technology Transfer and Productivity

We mainly conducted this analysis to examine the role of FDI through technology transfer on productivity of domestic manufacturing firms. For this purpose, we examined the effect of technology transfer in interaction with indirect and direct effects. We begin our analysis by indirect spillovers based on equation (3) and the result is presented in Table 5 in column 1.

Table 5: Direct and Indirect of Effects and their Interactions

VARIABLES	(1)	(2)	(3)
Indirect Spillovers			
Horizontal	-0.0046		-0.0049
	(0.0042)		(0.00420)
Forward	0.0660***		0.0265
	(0.0149)		(0.0244)
Backward	0.0301***		0.0419***
	(0.0082)		(0.0091)
Direct Linkages			
Backward		0.361**	1.902***
		(0.179)	(0.511)
Forward		0.394	-0.700
		(0.271)	(0.553)

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Spillover interactions	
Forward	0.0506**
	(0.0207)
Backward	-0.0252***
	(0.0078)

Note. Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

The horizontal spillover has no impact on productivity (β = -0.0046). We partially evidenced that competition from foreign owned firms negatively affects productivity of domestic firms. But forward spillover has positive impact on productivity (β = 0.066, p < 0.01). The coefficient of indirect spillover through forward spillover shows that a one percentage increase of the proportion of supply of output to FDI firms in upstream sectors, on average, increase productivity of firms in a sector by 0.066 units. The impact of backward spillover is positive and significant on productivity (β = 0.0301, p <0.01). Further, the coefficient of backward spillover indicates one percentage increase of percentage of inputs supplied to a sector by foreign owned firms, on average, leads to 0.03 percentage units increase of productivity of the local firms.

To unravel the indirect effect, we analyze the direct effect from FDI firms to productivity of the domestic firms based on the firm level indicators. We estimated this effect based on model provided in equation (4) and the result is presented in Table 5 in column 2. Backward linkage with FDI firms has significant positive effect on productivity of local firms in the sector (β = 0.361). The coefficient of this linkage indicates that one percentage point increase in proportion of input of the local firm supplied by FDI firm causes 0.36 units increase in the level of productivity of the local firms. But impact of forward linkage is not significant (β = 0.394).

We extend impacts from indirect spillovers and direct linkage to consider the impacts through interaction between direct link along the supply chain and indirect spillovers. This is intended to examine effects of direct linkages on traditional spillovers. We estimate this based on equation (5) and the results are presented at column 3 in Table 5. We find strong effects from interaction terms in both cases. The effect of forward interaction is positive (β = 0.0506, p < 0.05) but the effect of backward interaction is negative (β = 0.0252, p < 0.01) on productivity of the domestic firms.The negative effects from horizontal spillovers might be due adverse effect from FDI firms due to crowding effect and competition within the industry.

Further, we disaggregate the direct linkage based on the contractual agreement for technology transfer i.e. whether the domestic firms have agreement for technology transfer or not. We present the result of our analysis in column 1 of Table 6.

Table 6: Technology transfer and productivity

VARIABLES	(1)	(2)
Indirect Spillovers		
Horizontal		-0.442
		(0.416)
Forward		6.121***
		(1.597)
Backward		2.992***
		(0.816)
Technology Transfer and Linkages		
Backward Linkage without technology transfer	0.491***	
	(0.187)	
Backward linkage with technology transfer	0.173	
	(0.205)	
Forward Linkage without technology transfer	0.380	
	(0.276)	

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Forward linkage with technology transfer	0.449	
	(0.276)	
Technology Transfer with Linkages and Spillovers		
Backward without technology transfer		0.404**
		(0.196)
Backward with technology transfer		-0.198
		(0.276)
Forward without technology transfer		0.148
		(0.869)
Forward with technology transfer		0.975
		(0.822)

Note. Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

The coefficient of backward linkage without technology transfer is positive and significant ($\beta = 0.49$, $p < 0.01$) that indicates one percentage unit increase in proportion of input from foreign owned firms cause 0.49 percentage increase on productivity of the local firms. This effect might be due to other horizonal spillovers. Coefficient of backward linkage with technology is positive, however, it is not significant ($\beta = 0.173$).Forward linkage whether with technology transfer or without technology transfer has no impact on productivity. We partially support positive productivity effect of forward linkage with technology transfer ($\beta = 0.449$).

In column 2 of Table 6, we included interaction of indirect spillover with direct linkage and technology transfer. The effect of indirect spillovers with backward linkage without technology transfer is positive and significant ($\beta = 0.404$). The coefficient of interaction of backward linkage with spillovers is interpreted as one percentage unit increase of proportion of input from FDI firms results on 0.404 percentage increase on productivity of local firms that have not technology transfer from the FDI firms. But backward interaction with technology is not significant ($\beta = -0.198$). On the other hand, forward interactions are not significant in both case (with technology transfer and without technology transfer).

IV. DISCUSSION

FDI in Ethiopia has important contribution on employment and supply of goods. Although only 6.88% manufacturing are foreign owned firms, they have role of 15.75% contribution to employment and 28% of output contribution within the manufacturing sectors. When compared with domestic firms, FDI firms have good contribution for employment and supply of manufactured goods in the country. Other contribution of the FDI firms is supply of input for the domestic firms that can be consumed by importing. The domestic firms use 67% of their inputs from foreign owned firms that operate in Ethiopia. This is good source for domestic firms where foreign currency became challenge to import inputs. Further, there is no adverse effect of competition on domestic firms from FDI firms. This may be due to FDI firms are highly encouraged to export for two reasons; protecting domestic firms and trade balance. Despite the employment and supply role, FDI inflow to Ethiopia mainly focuses on building capacity of domestic firms for sustainable development in the country. Technology transfer from the FDI firms to domestic firms is the core focus for capacity building through improved productivity. But only 37.4% of domestic firms have direct linkage with FDI firms through technology transfer.

We find no evidence that there is horizontal spillover or externalities to local manufacturing firms from FDI companies in Ethiopia. This is consistent with Javorcik (2004) that states foreign owned firms protect their technology and know-how and prevent it from leaking to competitors. From the perspective of forward spillovers, we identified strong positive backward spillovers on local downstream manufacturing firms from the upstream FDI firms. This is consistent with findings of other empirical studies (Javorcik, 2004; Blalock and Gertler, 2008; Kugler, 2006). Similar to finding about the effect of backward spillovers from FDI firms on productivity, we find strong positive forward spillovers on productivity of upstream local firms from downstream foreign owned firms. Although these findings are consistent with other studies, it is not easy to suggest practical implication on the work. Literatures suggested that positive forward

spillover effect from downstream foreign owned firms on productivity of upstream local companies will be due direct knowledge and/or technology transfers along the supply chain, or indirect spillovers through efficiency improvements by increased competition among domestic input suppliers competing for foreign customers or scale economies due to a greater demand for domestically produced inputs. The positive backward spillover effect will be due to positive indirect externalities such as domestic firms can copy new and more advanced technologies.

We find a positive and strong effect of linkage from FDI firm in backward sectors and the productivity of the upstream domestic firms. This is consistent to effect of indirect spillovers. Different evidences are provided about productivity spillovers for domestic firms from backward linkages with downward stream FDI firms. But little evidences are provided about this linkage in developing countries, including Ethiopia. Our result suggests backward linkage with downstream FDI firms is source of productivity of local manufacturing companies in Ethiopia. this is condition only for local companies that are directly linked with FDI companies in supply chain. On the other hand, we do not find evidence about the effect of forward linkage with FDI firms. Productivity of firms that are not supplied by foreign firms decreasing and, in contrast, productivity of the local firms that are supplied by foreign firms is increasing. This suggests that indirect spillovers and direct linkages of local firms with foreign owned firms are important source of productivity of the local firms. The positive productivity impact from forward spillover is increased due to direct linkage. The positive productive effect from backward linkage is reversed because of indirect spillover from the downward stream FDI firms.

The positive effect on productivity of domestic firms from supply of inputs is not linked with technology transfer from the FDI firms. In contrary, there is strong positive productivity effect from direct linkage without technology transfers. Therefore, the positive effect from direct linkage may other factors irrespective to technology transfer agreement. For example, Girma et al. (2008) stated that positive productivity effect from direct linkage will be due to better technology used by foreign firms, higher quality of inputs or inputs are provided with support services. At domestic firms in Ethiopia, our findings suggest that the direct effect on productivity of the local firms from linkage with FDI firms is not due deliberate technology transfers. Instead, local firms without technology transfer have higher productivity than the firms with technology transfer. This suggests addition of technology transfer on directly linked local firms with FDI firms is not important. It is not evidenced that the direct linkage with technology transfer is associated with indirect spillover from the foreign firms. Instead, strong positive productivity is evidenced in firms that have no technology transfer. Our finding evidenced that negative impact of backward linkage with indirect spillover on productivity is due to technology transfer accompanied with direct linkages. Therefore, our finding suggests that technology transferred from downstream FDI firms contradicts with indirect spillovers from FDI firms. On the other hand, the strong positive productivity impact from forward interactions is not accompanied by technology transfer. But local firms with technology transfer have higher productivity impact from firms without technology transfer. This finding is consistent to Newman et al (2015).

The main theoretical puzzle we addressed is how technology transfer from FDI firms affects productivity of domestic firms. This study provides theoretical contribution to literatures of FDI and technology transfer.

First, we contribute to finance and economics researches by examining whether domestic firms accept technology of FDI firms or develop their own technology based on situations in their production philosophy. Our first contribution lies on incorporation of technology transfer to domestic firms from FDI firms with indirect spillovers and direct linkages at firm level. Previous researches have mainly focused effect of FDI on country level or sector level. Based on our finding, we shed light on productivity effect of technology transfer at firm level by considering the direct linkages at the firm level and indirect spillovers on the sector level. This framework provides how advantages of FDI from spillovers and linkages can be utilized through technology transfer to improve productivity at firm level.

Second, we contribute to the theoretical literature by taking some initial steps toward understanding of effect of technology transfers from FDI by disentangling direct linkages from indirect spillover. We include interaction of direct linkage with indirect spillovers.

Third, we mainly focused on measurement of direct linkage. Previous studies about incorporated direct linkage by measuring whether domestic firms are directly linked or not with FDI firms. But we argue that the direct linkage with be measured with intensity of linkage, i.e. proportion of inputs from FDI firm and proportion of output to

FDI firm. Technology transfer conditionally varies based on the level of the direct linkage, its importance is low at firms that use low proportion of inputs from FDI firms and at firms that supply small proportion of their output to FDI firms. Further, we indicate that if all firms are directly linked with FDI firms through backward or forward linkages, it is not possible to examine direct linkage unless it is examined based on intensity approach.

Our findings have significant relevance to managers of domestic firms that operate at manufacturing sectors where FDI firms exist. This study insight managers of domestic firms to make linkage with FDI firms by supplying their outputs to FDI firms and use inputs from FDI firms. We identified that indirect backward and forward spillovers improve productivity. Increasing FDI firms to a sector improve productivity of domestic firms in the sector. Domestic firms that purchase inputs from FDI firms strongly improve their productivity. We recommend managers of the domestic firms to increase proportion of input supplied by FDI firms in order to improve their productivity.

Technology transfer from FDI firms has no important role to domestic firms to improve their productivity. But productivity of the domestic firms is improved because of other direct linkages with FDI firms in the supply chain. To exploit advantage of positive productivity, it is not important to make contractual relationship for technology transfer that the domestic firms without technology transfer earn higher advantage than firms with technology transfer. Specially, domestic firms that are supplied inputs from FDI firms are not required receive technology transfer from FDI firms. Therefore, the main managerial implication of this study is that managers of the domestic firms have to strengthen their linkage with FDI firms without technology transfers.

V. ACKNOWLEDGMENTS

This study was supported by heads of strategy management department at FDI firms and domestic firms. We would like to thank them for their positive response, guidance and collaborations during data collection process. In addition, we would like to thank, Wubishet Gebrewold, for his support in data collection and constructive suggestions during the data analysis. Finally, we would like to thank Shonte Abebe Negeri for his constructive comments.

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