JOURNAL OF ECONOMIC DEVELOPMENT
Volume 50, Number 3, September 2025

TECHNOLOGY SPILLOVER AND ABSORPTIVE CAPACITY OF FIRMS AND COUNTRIES*

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The paper examines the foreign direct investment (FDI) spillover effects in developing countries and investigates the importance of the absorptive capacity of a firm and a country in realizing and facilitating FDI spillover. It uses data obtained from the World Bank's Enterprise Surveys for 107 countries from 2007 to 2020. The study finds that firms in developing countries do not benefit from horizontal FDI but benefit from forward and backward vertical FDI. The study also finds that firms can benefit from horizontal, forward, and backward FDI by improving the absorptive capacity of firms and host countries. Based on these findings, several recommendations are presented to help firms benefit from FDI spillover.

Keywords: Foreign Direct Investment, Technology Transfer, Absorptive Capacity
JEL Classification: D22, F21, O3, R1

1. INTRODUCTION

Technology plays an important role in determining the competitiveness of a firm, as possession of advanced and efficient technology enables a firm to reduce production cost and increase productivity. Furthermore, possession of technology enables a firm to

* This study is part of the Asian Development Bank Institute (ADBI) project titled "Technology Transfer and Firm Competitiveness." This study uses micro-level questionnaire data from the World Bank's Enterprise Surveys. We would like to thank Shandre Thangavelu and other participants at ADBI Workshop for their helpful comments and discussions. Youngmin Baek acknowledges financial support from the JSPS under KAKENHI Grant Number JP22K13408. All remaining errors are ours.

develop new products, improving its competitiveness. Previous discussion of the importance of technology for a firm's competitiveness can be applied to a country where technological progress is key to achieving economic growth. Even with the same magnitude of factors of production - that is, labor and capital - technological progress leads to an expansion in production, or economic growth.

A firm may obtain technology internally as well as externally. A firm may obtain technology internally by developing new technology through research and development. A firm may also obtain technology externally through various channels, including purchasing licenses or patents, attending external seminars, hiring engineers, importing capital goods, doing business with foreign firms, and others. Firms obtain technology directly by purchasing licenses and patents, attending seminars, and hiring engineers, while technology is obtained indirectly by importing capital goods and doing business with foreign firms. Firms acquire technology through reverse engineering in the case of importing capital goods, and through their contact with foreign firms. Both types of technology acquisition are described as technology spillover. In this paper, we examine the latter type - that is, technology spillover through contact with foreign firms. In particular, we focus on technology spillover to domestic firms from foreign firms operating in developing countries, set up by foreign direct investment (FDI). As such, we use the expression "FDI spillover" in our study to describe technology spillover through foreign firms. In recent years, the attention of policymakers, business persons, and researchers to FDI spillover has increased, as the importance of FDI in transferring technology internationally is increasing with rapid expansion of FDI.

Technology spillover from foreign firms to domestic firms, or FDI spillover, is realized in various forms, including labor mobility, imitation, business transaction, etc[1]. Workers who have acquired technology by working for foreign firms may transfer technology to domestic firms when they are hired by them. Domestic firms may obtain technology by observing foreign firms' behavior, such as production methods and other business practices. These two types of spillover tend to take place where domestic and foreign firms operate in the same industry and are thus characterized as horizontal spillover (linkage). Domestic firms may acquire technology through their business relations with foreign firms. We can classify business relationships into two types, backward and forward linkages. FDI spillover through backward (forward) linkage is described as backward (forward) spillover. Backward spillover takes place when domestic firms supply parts and semi-finished products to foreign firms, while forward spillover occurs where foreign firms supply parts and semi-finished products to domestic firms. Within customer-supplier business relationships, domestic firms acquire technology through channels such as the certification process and training courses.

The objective of this paper is to analyze empirically the presence or absence of FDI spillover, and horizontal and vertical (backward and forward) spillovers. There have been many studies on this subject, but no consensus has been reached. We hope to make

[1] On the typology of technology spillover, see, for example, Lesher and Miroudot (2008).

new contributions to the literature. While many empirical studies have examined the issues for a particular country, our study considers 107 countries. Our study can therefore identify the characteristics of countries that have an impact on FDI spillover, enabling us to provide useful information for policymakers responsible for trade, industry, or technology policies.

The structure of our papers is as follows. Section 2 provides a brief literature review and summarizes the main findings of previous studies, as well as identifying unsolved issues. Section 3 presents the methodology and data used for the analysis, while section 4 presents and discusses the estimation results. Section 5 concludes the paper.

2. LITERATURE REVIEW

In this section, studies on technology spillover and the absorptive capacity of FDI spillover are reviewed to set the stage for our analysis. We first review studies on the FDI spillover effect and then turn to those focusing on the absorptive capacity in FDI spillover.

There are a large number of empirical studies that examined the presence or absence of technology spillover via FDI, FDI spillover. Their results are mixed. Table 1 shows the results of recent empirical studies using firm-level data since the early 2000s. In many studies, the effect of horizontal FDI spillover on firm's productivity was not statistically significant. (Javorcik, 2004; Blalock and Gertler, 2009; Wang, 2010; Farole and Winkler, 2012; Gorodnichenko et al., 2014; Newman et al., 2015; Dogan et al., 2017). Only a few studies found statistically significant results. The estimated coefficient of horizontal FDI was found positive and statistically significant for developed countries such as the UK (Haskel et al., 2007) and the US (Keller and Yeaple, 2009), while negative and statistically significant results were obtained for developing countries such as China (Lu et al., 2017). These results suggest that positive FDI spillover occurs but not everywhere (Keller, 2004). In developing countries, the presence of competitive foreign firms takes market away from domestic firms, reducing domestic firms' sales and production, while the presence of foreign firms tends to benefit domestic firms via technology spillover in developed countries. Rojec and Knell (2018) claimed that there are substantive and methodological reasons for the mixed results of empirical studies. The substantive reason is that the necessary preconditions for FDI spillovers are often missing in host countries. Concerning the methodological reason, the authors argue that the quality of the databases used by many studies is insufficient and many studies apply inappropriate econometric methods.

Turning to the results on vertical FDI spillover, the results on forward FDI spillover are mixed. Positive results are found in Wang (2010) and Lu et al. (2017), while negative results are found in Javorcik (2004), Newman et al. (2015) and Dogan et al. (2017). In contrast, the results for backward FDI spillover are generally positive

(Javorcik, 2004; Wang, 2010; Gorodnichenko et al., 2014; Newman et al., 2015; Lu et al., 2017) and statistically significant, except for Dogan et al. (2017). Summarizing the previous results, we can conclude that backward FDI spillover seems to take place, but no conclusive evidence has been found for horizontal and forward FDI spillovers.

Table 1. Selected Previous Studies

Author	**Javorcik (2004)**	**Haskel et al. (2007)**	**Blalock and Gertler (2009)**	**Keller and Yeaple (2009)**	**Wang (2010)**
Countries, Year	Lithuania Manufacturing Firms 1996–2000	UK Manufacturing Firms 1973–1992	Indonesia Manufacturing Firms 1988–1996	US Manufacturing Firms 1987–1996	Canada Manufacturing Firms 1973–1997
Estimaton Method	Olley-Pakes 2 Stage Correction	DID	Fixed Effects	IV 2SLS	IV 2SLS First-Differencing
Dep.Var	Value-Added	ΔY, TFP	TFP	ΔTFP	TFP
Horizontal FDI	-	+**	+	+***	+
Forward FDI	-*				+***
Backward FDI	+**				+***
Author	**Farole and Winkler (2012)**	**Gorodnichenko et al. (2014)**	**Newman et al. (2015)**	**Dogan et al. (2017)**	**Lu et al. (2017)**
Countries, Year	78 Low and Middle-Income Countries Manufacturing Firms 2006–2010	17 Transition Market Economies 2002 and 2005	Viet Nam Manufacturing firms 2009–2012	Malaysia Manufacturing firms 2000–2004	PRC Manufacturing firms 1998–2007
Estimaton Method	IV 2SLS	First-Differencing	First-Differencing	First-Differencing	IV 2SLS
Dep.Var	Labor Productivity	Δsales	TFP	ΔTFP	TFP
Horizontal FDI	-	+	+	-	-***
Forward FDI		+	-***	-***	+***
Backward FDI		+*	+**	-*	+***

Source: Authors' compilation.

Note: + and – indicate the signs of estimated coefficients. '*', '**', and '***' indicate the statistical level of significance at 10, 5, and 1 percent, respectively.

Next, we review studies that examined the effect of absorptive capacity on FDI spillover. First, we review studies on domestic firms' absorptive capacity, and then the absorptive capacity of the host country. The most important factor for domestic firms to benefit from FDI spillover is the firm's technological capacity, which is reflected in high productivity. Glass and Saggi (1998) found that absorptive capacity for spillover is most affected by a firm's level of technological development. Nicolini and Resmini (2006);

Keller and Yeaple (2009); Farole and Winkler (2012); and Damijan et al. (2013) show that firms need relatively high productivity to benefit from FDI spillover. Human capital capacity is another important absorptive capacity on the part of domestic firms for benefiting from FDI spillover. Girma et al. (2009), Gorodnichenko et al. (2006), and Damijan et al. (2013) highlighted the importance of human capital in terms of absorption capacity for FDI spillover. Damijan et al. (2013) found that firms with highly educated employees benefit from FDI spillover. Some studies found that firms with export experience, which tends to reflect high productivity, benefited more from FDI spillover than those without export experience (Damijan and Knell, 2005; Girma et al., 2009; Castellani and Zanfei, 2007; Farole and Winkler, 2012). These findings support the importance of high technological capability and high productivity to benefit from FDI spillover.

From the late 1990s to the 2000s, a number of studies were conducted on the impact of FDI on economic growth using macro-level data. These studies examined the effects of the host country's economic environment on FDI spillover using the interaction term of the host country's absorptive capacity and FDI inflow. Some studies found the presence of prerequisites for the host country to benefit from FDI spillover. Important prerequisites include an adequate level of human capital, economic and political stability, liberalized markets, and a well-functioning infrastructure (Bengoa and Sanchez-Robles 2003). Borensztein et al. (1998) found that human capital is important to benefit from FDI spillover. FDI is a vehicle for obtaining new technologies, and training the labor force to work with new technologies is important. Alguacil et al. (2011) investigated the effects of the institutional environment on FDI spillover, using economic freedom as a proxy for institutions. They found that a stable institutional environment increases FDI spillover. A good institution based on fair and stable legal and political systems reduces uncertainty and insecurity, enabling firms to assimilate technology from FDI (Alguacil et al. 2011). Alfaro et al. (2004) and Durham (2004) examined the role of the financial market, finding that the need for external finance increases when domestic firms reorganize their structure, purchase new machines, and hire new managers and skilled labor to take advantage of new knowledge.

Only a few studies that examined FDI spillover using firm-level data considered the host country's absorptive capacity, because most of these studies examined just one country. One of few exceptions is Farole and Winkler (2012), which investigated the impact of national absorptive capacity on horizontal FDI spillover for 78 low and middle-income countries from 2006 to 2010. Most of the effects of the host country's absorptive capacity on FDI spillover were not statistically significant[2]. We extend the

[2] Among labor freedom, financial freedom, investment freedom, business freedom, education, expenditure on R&D, trade openness, sector concentration, and GDP per capita, only education was positive and statistically significant. Meanwhile, sector concentration and trade openness had a positive effect on horizontal FDI spillover in the model of firms with low productivity.

work of Farole and Winkler (2012) by increasing the number of sample countries[3] and analyzing forward and backward spillovers, which they did not examine.

3. METHODOLOGY AND DATA

In this section, we explain the methodology used to estimate the FDI spillover effects and how the absorptive capacity mediates those effects. As for absorptive capacity, we examine the effect of the heterogeneity of domestic firms and host countries on FDI spillovers and further analyze the effect of FDI spillovers of the geographical distance between domestic and foreign firms. The baseline specification to examine the FDI spillover effects is as follows.

$$\ln LP_{isct} = \alpha + \beta FDI_{sct} + \gamma Z_{isct} + \delta_s + \delta_c + \delta_t + \varepsilon_{isct}, \quad (1)$$

where $\ln LP_{isct}$ is labor productivity of firm i in sector s of country c in year t. FDI_{sct} denotes horizontal, forward, or backward FDI interchangeably, as explained below, in sector s of country c in year t. Z_{isct} is firm's characteristic that affects firm's productivity, such as firm size, running of training program, possession of quality certification, or adoption of foreign technologies[4]. δ_s, δ_c, and δ_t present sector, country, and year fixed effects, respectively.

To define three sector-level FDI linkages in country *c*, we refer to Javorcik (2004) as follows. First, horizontal FDI captures the extent of foreign presence in sector s at time t and is defined as the sales share of foreign firms in total sales in sector s. Horizontal FDI is used to examine the intra-industry spillover effects.

$$Horizontal_{st} = \frac{Sales^F_{st}}{Sales_{st}}. \quad (2)$$

Second, forward FDI is defined as the weighted share of foreign firms' presence in upstream sectors of sector s. α_{sk} is the ratio of intermediate goods purchased from sector k to the total intermediate goods purchased by sector *s*. In other words, forward FDI spillover considers the effect when domestic firms purchase intermediate goods from foreign firms.

$$Forward_{st} = \sum_{k \neq s} \alpha_{sk} Horizontal_{kt}. \quad (3)$$

Finally, backward FDI is defined as the weighted share of foreign firms' presence in

[3] A list of sample countries is presented in Appendix Table A1.

[4] Size is total number of permanent employees in natural logarithms. For training programs, quality certification, and adaptation of foreign technologies, see AC_{isct} in Equation 5

downstream sectors of sector s. β_{sm} is the ratio of intermediate goods supplied by sector s to the total intermediate goods purchased by sector m. In other words, the backward FDI spillover concerns the effect when domestic firms supply intermediate goods to foreign firms.

$$Backward_{st} = \sum_{m \neq s} \beta_{sm} Horizontal_{mt}. \quad (4)$$

Both α_{sk} and β_{sm} are taken from Eora National Input-Output Tables. In addition, since forward and backward FDI are vertical FDI[5], intermediate goods purchased within the same sector are excluded from both forward and backward FDI.

We follow (Blalock and Gertler, 2009) as shown in Equations 5 and 6, to examine the effect of absorptive capability (AC) of domestic firms and host countries on FDI spillovers by introducing an interaction term of FDI with $AC_{isct\ or\ ct}$:

$$\ln LP_{isct} = \alpha + \beta_1 FDI_{sct} + \beta_2 FDI_{sct} * AC_{isct} + \delta_s + \delta_c + \delta_t + \varepsilon_{isct}, \quad (5)$$

where AC_{isct} is firm i's absorptive capacity in sector s of country c in year t and is obtained from the responses to the World Bank's Enterprise Surveys questionnaire as follows.

- plargefirm (part of a larger firm) = Is the establishment part of a larger firm? (a binary variable that takes unity if the answer is "Yes", zero otherwise)
- qualitycert (internationally recognized quality certification) = Does this establishment have an internationally recognized quality certification? (a binary variable that takes unity if the answer is "Yes", zero otherwise)
- foreigntech (foreign technology) = Does this establishment at present use technology licensed from a foreign-owned company, excluding office software? (a binary variable that takes unity if the answer is "Yes", zero otherwise)
- training (training programs) = Does this establishment have formal training programs for its permanent, full-time employees? (a binary variable that takes unity if the answer is "Yes", zero otherwise)
- gvc (firm's GVC participation) = GVC (global value chain) firm is defined as a firm which imports intermediate goods and exports output (a binary variable that takes unity if firm i is GVC firm, zero otherwise)

It is expected that "plargefirm" will facilitate FDI spillover as a firm belonging to a large firm is likely to obtain assistance such as technical and financial assistance, which may be used to absorb technology; and that "qualitycert," "foreigntech," and "training" will contribute to facilitating a firm to benefit from FDI spillover. Both "qualitycert" and "foreigntech" indicate a firm's high technical capability, although they reflect different capabilities: "qualitycert" shows a firm's capability in developing technology, while

[5] Note that forward and backward FDI here are defined based on the sector with foreign firms' presence.

"foreigntech" shows a firm's capability in using or adopting technology. Meanwhile, "training" indicates a firm's positive attitude toward absorbing technology, while "gvc" is likely to promote technology acquisition, as GVC provides opportunities to acquire technology through exporting and importing.

$$\ln LP_{isct} = \alpha + \beta_1 FDI_{sct} + \beta_2 FDI_{sct} * AC_{ct} + \delta_s + \delta_r + \delta_t + \varepsilon_{isct}, \quad (6)$$

In Equation 6, the effects of the characteristics of the host countries or region[6] on FDI spillover are investigated through the interaction term of FDI_{sct} with AC_{ct}. AC_{ct} represents characteristics of the host countries included for the following variables.

- agglom (agglomeration) = The proportion of the total number of manufacturing firms in a domestic region to the total number of manufacturing firms in a country. This measure is a proxy for locational advantages by agglomeration. This variable includes both domestic and foreign firms. (Data source: World Bank, Enterprise Surveys)
- tradeopen (trade openness) = Trade openness is the sum of exports and imports of goods and services measured as a share of gross domestic product. (Data source: World Bank, World Development Indicators)
- businessreg (business regulations) = This consists of six components (administrative requirements, bureaucracy costs, starting a business, extra payments/bribes/favoritism, licensing restrictions, and cost of tax compliance) obtained from the World Bank's Doing Business and the World Economic Forum's Global Competitiveness Report. This measure captures the overall business regulations. Countries with no business regulations earn a perfect 10, while ratings of countries with higher business regulations decline toward zero. (Data source: Fraser Institute's Economic Freedom Index using World Bank's Doing Business and World Economic Forum's Global Competitive Report)
- finanopen (financial openness) = Countries with the highest financial openness earn a perfect 10. In contrast, the ratings of the countries with lower financial openness decline toward zero. This measure is based on the Global Competitiveness Report of the World Economic Forum and indicates financial openness. (Data source: Fraser Institute's Economic Freedom Index using World Economic Forum's Global Competitive Report)
- education (school enrollment, tertiary) = Tertiary education is measured by the gross enrollment ratio for tertiary school and is a proxy for the quality of human capital. (Data source: World Development Indicators)
- ipr (International Property Right Index) = The IPRI measures physical property rights, intellectual property rights, and the legal and political environments[7] (Data

[6] Only the variable of "agglom" is regional characteristics: the rest of the variables are country-specific characteristics.

[7] The following elements are considered for the three components: legal and political environment (judicial independence, rule of law, political stability, control of corruption); physical property rights

source: Property Rights Alliance's The International Property Rights Index)

It is expected that "agglom" will promote FDI spillover, as it provides a firm with opportunities to acquire technology from other firms located in geographical proximity; "tradeopen" is expected to promote FDI spillover, as an open trade environment puts pressure on a firm to improve competitiveness by assimilating technology. Meanwhile, "businessreg" has a similar impact on FDI spillover to "tradeopen", as it ensures competition in the market. It is expected that "finanopen" will promote FDI spillover, as the availability of financial resources enables firms to purchase new machines and to hire engineers, which would facilitate technology spillover. It is likely that "education" will contribute to FDI spillover, because the availability of high-quality human resources facilitates a firm's technology acquisition; while "ipr" is expected to promote FDI spillover as it provides an environment where foreign firms may use technology actively without worrying about the misuse of their technology by other firms.

In estimating the FDI spillover effect, what is important is to address the endogeneity issue caused by reverse causality. Foreign firms tend to move to more productive, faster-growing, and profitable economies (Rodrik, 1999), and high-productivity sectors or firms may attract foreign firms to the same location, yielding a positive relationship between them even without spillovers taking place (Rojec and Knell, 2018). Therefore, to address the bias from reverse causality, equations 1, 5, and 6 are estimated using the instrumental variable (IV) method. We aggregate firms' responses to a question on senior management's time spent on dealing with regulations in the World Bank's Enterprise Survey at the sectoral level and use them as an instrument for our IV estimation. This industry-level instrument does not directly affect the firm's productivity but has a high correlation with the three types of FDI variables[8].

We use a cross-section dataset of 18 manufacturing sectors[9] in 107 countries from 2007 to 2020 for estimating horizontal FDI spillover effects. For the estimation of forward and backward spillover effects, we use a cross-sectional dataset of seven sectors in 89 countries from 2007 to 2015, adopting the sector classification of Eora National Input-Output Tables[10], since it is necessary to connect Enterprise Surveys with Eora National Input-Output Tables. All domestic currency units obtained from the World Bank's Enterprise Surveys are converted to USD using the official exchange rate and then deflated to the 2015 baseline year by GDP deflator for the US.

(protection of physical property rights, registering property, ease of access to loans); intellectual property rights (protection of intellectual property rights, patent protection, copyright piracy).

[8] All interaction terms of absorptive capacity are also instrumented by their interaction terms with the aggregated time-spent regulations at the sectoral level.

[9] For the list of sample sectors, see Appendix Table 2.

[10] For the basic statistics, see Appendix Tables 3 and 4.

4. ESTIMATION RESULTS

We estimated Equations 1, 5, and 6 by the ordinary least squares (OLS) and IV methods using the data covering 18 sectors[11] and 107 developing countries from 2007 to 2020[12]. Table 2 shows the baseline results using OLS[13]. Columns 1, 3, and 5 are intended to investigate the factors determining labor productivity by including foreign firms as sample firms. The estimated coefficients of foreign firms are all positive and statistically significant, indicating that foreign firms' productivity is higher than that of domestic firms. This finding provides a rationale for us to investigate FDI spillover. The results of estimation using only the data on domestic firms are shown in columns 2, 4, and 6. The estimated coefficient on horizontal FDI is negative and statistically significant, while the coefficients of forward and backward FDI are statistically insignificant. Other variables have a positive effect on labor productivity, as expected.

The results estimated by the IV method are presented in Table 3. The estimated coefficient on horizontal FDI, which was negative and statistically significant in the OLS estimation, is positive but not statistically significant. In contrast, forward and backward FDI, which were not statistically significant in the OLS estimation, are positive and statistically significant. These results are consistent with our expectations and with Wang (2010), which examined the case of Canadian manufacturing firms.

In the case of the samples limited to Asia in Table 4, the coefficient of horizontal FDI is negative and statistically significant. This result, which is the same as Lu et al. (2017), which examined the case of Chinese manufacturing firms, probably reflects that horizontal FDI's competition effect that reduces value-added is greater than the spillover effects on domestic firms in the same sector in Asia. This, in turn, indicates foreign firms' significantly greater competitiveness compared with domestic firms. The coefficient of forward FDI is not statistically significant in Asia, while the effect of backward FDI spillover is significantly positive and much greater compared to the case for the world shown in Table 3. A finding that backward FDI spillover is particularly notable in Asia may indicate that there are many foreign firms engaged in assembling final products, and so domestic firms selling their parts and components to foreign firms acquire technology via business transactions. This may imply the importance of developing domestic parts and components producers, because they may be able to benefit from obtaining technology from foreign firms, particularly in Asia.

[11] Since Eora National Input-Output tables are used for estimating forward and backward FDI spillover, 7 sectors are used according to the sector classification of Eora National Input-Output Tables.

[12] For the same reason as footnote 11, 89 developing countries from 2007 to 2015 are used for estimating forward and backward FDI spillover.

[13] We focus on the results of IV methods for the FDI spillover effect to address the endogeneity from reverse causality.

Table 2. Baseline Results by OLS, World

	(1)	(2)	(3)	(4)	(5)	(6)
	Horizontal FDI		Forward FDI		Backward FDI	
FDI	-0.156	-0.314***	-0.121	-0.131	0.039	0.084
	(0.097)	(0.098)	(0.196)	(0.195)	(0.190)	(0.205)
lnsize	0.054***	0.065***	0.059***	0.076***	0.059***	0.075***
	(0.012)	(0.012)	(0.017)	(0.017)	(0.017)	(0.017)
training	0.213***	0.208***	0.230***	0.220***	0.230***	0.220***
	(0.019)	(0.020)	(0.026)	(0.027)	(0.026)	(0.027)
qualitycert	0.340***	0.299***	0.382***	0.334***	0.382***	0.334***
	(0.023)	(0.023)	(0.030)	(0.031)	(0.030)	(0.031)
foreigntech	0.199***	0.186***	0.243***	0.234***	0.242***	0.233***
	(0.029)	(0.028)	(0.039)	(0.037)	(0.039)	(0.037)
foreign firm	0.320***		0.303***		0.304***	
	(0.034)		(0.050)		(0.050)	
Observations	51,966	45,686	35,564	31,102	35,564	31,102
# of sectors	18	18	7	7	7	7
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.396	0.400	0.493	0.496	0.493	0.496

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, country-sector clustered standard error is used.

Table 3. IV Results, World

	(1)	(2)	(3)	(4)	(5)	(6)
	Horizontal FDI		Forward FDI		Backward FDI	
FDI	3.601	5.611	3.668***	4.174***	0.901**	0.688*
	(2.273)	(3.757)	(0.744)	(1.016)	(0.351)	(0.399)
lnsize	0.024	0.051***	0.058***	0.074***	0.058***	0.074***
	(0.019)	(0.012)	(0.007)	(0.007)	(0.007)	(0.007)
training	0.216***	0.200***	0.230***	0.220***	0.228***	0.219***
	(0.018)	(0.021)	(0.019)	(0.020)	(0.019)	(0.019)
qualitycert	0.360***	0.320***	0.385***	0.343***	0.380***	0.334***
	(0.022)	(0.026)	(0.021)	(0.021)	(0.020)	(0.021)
foreigntech	0.208***	0.200***	0.212***	0.198***	0.239***	0.230***
	(0.024)	(0.030)	(0.026)	(0.029)	(0.025)	(0.027)
foreign firm	-0.108		0.315***		0.313***	
	(0.261)		(0.032)		(0.032)	
Observations	51,925	45,656	35,564	31,102	35,564	31,102
# of sectors	18	18	7	7	7	7
Underidentification test	9.381	5.242	373.738	202.627	1180.778	884.317
Weak identification test	19.234	10.303	756.68	424.938	2747.026	2305.764
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, robust standard error is used. In underidentification and weak identification tests, we report Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic, respectively.

Table 4. IV Results, Asia

	(1)	(2)	(3)	(4)	(5)	(6)
	Horizontal FDI		Forward FDI		Backward FDI	
FDI	-1.322*	-1.939**	0.910	0.248	1.716***	1.896***
	(0.728)	(0.824)	(0.755)	(1.052)	(0.500)	(0.610)
lnsize	0.038***	0.050***	0.032***	0.054***	0.033***	0.051***
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
training	0.196***	0.199***	0.226***	0.224***	0.221***	0.224***
	(0.022)	(0.023)	(0.024)	(0.025)	(0.024)	(0.024)
qualitycert	0.355***	0.305***	0.407***	0.356***	0.407***	0.361***
	(0.024)	(0.025)	(0.026)	(0.026)	(0.026)	(0.026)
foreigntech	0.199***	0.196***	0.283***	0.263***	0.273***	0.249***
	(0.029)	(0.031)	(0.034)	(0.035)	(0.034)	(0.035)
foreign firm	0.413***		0.278***		0.315***	
	(0.092)		(0.054)		(0.054)	
Observations	24,208	21,890	19,429	17,510	19,429	17,510
# of sectors	18	18	7	7	7	7
Underidentification test	58.277	53.34	276.131	148.914	1153.185	750.783
Weak identification test	124.159	102.248	530.318	274.048	1337.547	1007.217
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, robust standard error is used. In underidentification and weak identification tests, we report Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic, respectively.

Tables 5 and 6 show the effects of firm-level absorptive capacity on FDI spillover[14]. The coefficients of all the interaction terms are positive and statistically significant, except GVC (column 5) in the case of world. These results indicate that a firm that belongs to a large firm, has internationally recognized quality certification, uses foreign technology, has training programs, and participates in GVC can benefit from FDI spillover. In the case of forward and backward FDI, the positive spillover is reinforced for a firm with absorptive capacity. These findings are consistent with earlier findings on the importance of a firm's absorptive capability for promoting FDI spillover. For the case of firms in Asia (Table 6), although the coefficient of FDI is negative in the cases of horizontal and forward FDI (columns 1 through 10), the sum of the coefficients of FDI and each interaction term are positive. These results indicate that the presence of high absorptive capacity leads to positive FDI spillover, because the positive impact of absorptive capacity overwhelms the negative effect of FDI.

[14] In Tables 5-7 in the first column, hfdi, ffdi, and bfdi indicate horizontal, forward, and backward FDI, respectively.

Table 5. Absorptive Capacity at Firm Level, World

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Horizontal FDI					Forward FDI					Backward FDI				
FDI	1.794	10.290	8.518	11.440	9.767	7.049***	6.571***	5.275***	3.998***	4.689***	1.916***	1.073***	1.323***	0.399	0.587
	(1.402)	(7.229)	(5.223)	(7.261)	(6.648)	(0.978)	(0.915)	(0.908)	(0.996)	(0.973)	(0.400)	(0.391)	(0.386)	(0.408)	(0.414)
hfdi/ffdi/bfdi × plargefirm	0.992***					1.186***					1.302***				
	(0.125)					(0.154)					(0.149)				
hfdi/ffdi/bfdi × qualitycert		1.360***					2.139***					2.221***			
		(0.258)					(0.124)					(0.123)			
hfdi/ffdi/bfdi × foreigntech			1.054***					1.211***					1.675***		
			(0.190)					(0.152)					(0.166)		
hfdi/ffdi/bfdi × training				0.894***					1.371***					1.619***	
				(0.290)					(0.095)					(0.103)	
hfdi/ffdi/bfdi × gvc					0.534					1.584***					1.737***
					(0.446)					(0.125)					(0.132)
Observations	47,499	48,074	47,054	48,613	42,092	32,034	33,005	32,049	33,299	27,222	32,034	33,005	32,049	33,299	27,222
# of sectors	18	18	18	18	18	7	7	7	7	7	7	7	7	7	7
Underidentification test	23.722	3.109	4.479	3.638	3.428	246.064	273.87	271.966	214.08	223.513	838.428	891.776	931.383	870.97	825.736
Weak identification test	21.724	3.051	4.422	3.628	3.038	265.573	297.588	292.635	221.905	201.495	1114.14	1170.4	1253.14	1150.24	954.047
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, robust standard error is used. In underidentification and weak identification tests, we report Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic, respectively.

Table 5. Absorptive Capacity at Firm Level, World

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Horizontal FDI					Forward FDI					Backward FDI				
FDI	1.794	10.290	8.518	11.440	9.767	7.049***	6.571***	5.275***	3.998***	4.689***	1.916***	1.073***	1.323***	0.399	0.587
	(1.402)	(7.229)	(5.223)	(7.261)	(6.648)	(0.978)	(0.915)	(0.908)	(0.996)	(0.973)	(0.400)	(0.391)	(0.386)	(0.408)	(0.414)
hfdi/ffdi/bfdi × plargefirm	0.992***					1.186***					1.302***				
	(0.125)					(0.154)					(0.149)				
hfdi/ffdi/bfdi × qualitycert		1.360***					2.139***					2.221***			
		(0.258)					(0.124)					(0.123)			
hfdi/ffdi/bfdi × foreigntech			1.054***					1.211***					1.675***		
			(0.190)					(0.152)					(0.166)		
hfdi/ffdi/bfdi × training				0.894***					1.371***					1.619***	
				(0.290)					(0.095)					(0.103)	
hfdi/ffdi/bfdi × gvc					0.534					1.584***					1.737***
					(0.446)					(0.125)					(0.132)
Observations	47,499	48,074	47,054	48,613	42,092	32,034	33,005	32,049	33,299	27,222	32,034	33,005	32,049	33,299	27,222
# of sectors	18	18	18	18	18	7	7	7	7	7	7	7	7	7	7
Underidentification test	23.722	3.109	4.479	3.638	3.428	246.064	273.87	271.966	214.08	223.513	838.428	891.776	931.383	870.97	825.736
Weak identification test	21.724	3.051	4.422	3.628	3.038	265.573	297.588	292.635	221.905	201.495	1114.14	1170.4	1253.14	1150.24	954.047
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, robust standard error is used. In underidentification and weak identification tests, we report Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic, respectively.

A comparison of the interaction terms in the case of the world and Asia reveals that the magnitudes of all the coefficients are larger in the case of Asia. This observation highlights the importance of firms' characteristics in determining the impacts of FDI spillover particularly for firms in Asia, leading to a policy recommendation to improve firms' capability of assimilating technology from foreign firms.

Table 7 shows the results of estimation of the impact of country-specific absorptive capacity on three types of FDI spillover: horizontal, forward, and backward. All of the estimated coefficients are positive and statistically significant except three: education, in the cases of forward and backward FDI, and ipr in forward FDI, all of which are statistically insignificant. These findings are consistent with our expectation and indicate the importance of agglomeration, a free and open business environment, an open financial market, and a well-protected intellectual property rights environment for the promotion and acceleration of FDI spillovers. The finding of the importance of agglomeration highlights the generation of external economies by agglomeration, which justifies government support for the construction of industrial clusters and estates. The finding on a free and open business environment indicates the importance of competition in obtaining FDI spillover, while the finding on open financial market indicates the importance of financial resources in promoting FDI spillover. The finding on intellectual property right (IPR) protection confirms the importance of providing an environment where IPR is fully protected in order for a foreign firm to use technology actively without worrying about the misuse of its technology. The unexpected result for education may be attributable to the notion that it is not a high level of education but technical training that is effective in assimilating technology. This observation is consistent with an earlier finding that training programs provided by firms promote technology spillover.

We examined how the geographical distance between foreign and domestic firms affects FDI spillover using the regional (location) information included in the World Bank's Enterprise Surveys. We estimated Equation 1 using region-sector level FDI (FDI_{srt}) instead of country-sector level FDI (FDI_{sct}). In other words, we measure FDI_{srt} by the extent of foreign presence in sector *s*, in region *r*, at time *t*, defined as the sales share of foreign firms in total sales in sector *s* in region *r*. As for the calculation of vertical FDI variables at region-sector level, since regional input-output tables are not available, we calculated vertical FDI with forward and backward coefficients (α_{sk} and β_{sm} in equations 3 and 4, respectively) taken from Eora national input-output tables, assuming that the transactional relationships between sectors in the region are the same as those in the country. Table 8 shows the estimated results. We expect the coefficient of each FDI to be greater than those in Table 3 based on the assumption that the shorter the geographical distance between foreign firms and domestic firms, the greater the FDI spillover. The coefficient of horizontal FDI is negative due to the greater competition effects between foreign firms and domestic firms at region level compared to country level. The coefficient on forward FDI is negative but not significant, while the coefficient on backward FDI is positive and statistically significant as expected. A

comparison of the results in Table 8 and Table 3 appears to indicate that geographical proximity at region level is not so important in vertical FDI spillover. This is because forward FDI spillover, observed at country level in Table 3, is not observed here. Backward FDI spillover is observed in Table 8 but the magnitude is significantly smaller compared to the result in Table 3. These findings seem to indicate that it is business relationship that is important in FDI spillover, and geographical proximity at region level is not so important.

Table 7. Absorptive Capacity at Country Level

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
			Horizontal FDI			
FDI	2.626***	5.492***	10.140***	12.240***	0.103	9.540**
	(0.826)	(0.973)	(3.214)	(2.738)	(0.683)	(4.273)
hfdi/ffdi/bfdi × agglom	0.019***					
	(0.002)					
hfdi/ffdi/bfdi × tradeopen		0.012***				
		(0.003)				
hfdi/ffdi/bfdi × businesreg			1.009***			
			(0.144)			
hfdi/ffdi/bfdi × finanopen				0.295***		
				(0.055)		
hfdi/ffdi/bfdi × education					0.065***	
					(0.009)	
hfdi/ffdi/bfdi × ipr						0.970***
						(0.212)
Observations	41,090	48,730	41,322	41,218	33,821	45,421
# of sectors	18	18	18	18	18	18
Underidentification test	71.769	93.207	28.988	29.634	57.553	20.757
Weak identification test	64.209	72.831	22.852	24.415	50.189	15.711
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
			Forward FDI			
FDI	0.227	-0.001	5.902***	2.477***	-0.484	13.780***
	(0.383)	(0.596)	(1.137)	(0.653)	(0.546)	(2.073)
hfdi/ffdi/bfdi × agglom	0.030***					
	(0.003)					
hfdi/ffdi/bfdi × tradeopen		0.028***				
		(0.002)				
hfdi/ffdi/bfdi × businesreg			0.488***			
			(0.092)			
hfdi/ffdi/bfdi × finanopen				0.334***		
				(0.028)		
hfdi/ffdi/bfdi × education					0.007	
					(0.008)	
hfdi/ffdi/bfdi × ipr						-0.313
						(0.214)
Observations	29,089	33,609	33,403	33,338	25,550	31,939
# of sectors	7	7	7	7	7	7
Underidentification test	593.137	549.692	368.62	590.812	473.328	217.306
Weak identification test	573.784	309.416	211.314	319.228	210.265	94.099

Table 7. Absorptive Capacity at Country Level (cont')

	(13)	(14)	(15)	(16)	(17)	(18)
	Backward FDI					
FDI	1.913***	3.261***	0.153	6.105***	3.611***	-0.751
	(0.459)	(0.466)	(0.787)	(0.452)	(0.608)	(0.832)
hfdi/ffdi/bfdi × agglom	0.027***					
	(0.003)					
hfdi/ffdi/bfdi × tradeopen		0.036***				
		(0.003)				
hfdi/ffdi/bfdi × businesreg			0.926***			
			(0.084)			
hfdi/ffdi/bfdi × finanopen				0.424***		
				(0.042)		
hfdi/ffdi/bfdi × education					-0.004	
					(0.012)	
hfdi/ffdi/bfdi × ipr						1.476***
						(0.107)
Observations	29,089	33,609	33,403	33,338	25,550	31,939
# of sectors	7	7	7	7	7	7
Underidentification test	524.257	659.642	517.683	606.561	746.895	421.147
Weak identification test	860.78	911.371	756.083	788.957	1056.37	633.514

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, robust standard error is used. In underidentification and weak identification tests, we report Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic, respectively. In all specifications, we control for subregion, sector and year fixed effects.

Table 8. IV results (Domestic FDI spillover)

	(1)	(2)	(3)	(4)	(5)	(6)
	Horizontal FDI		Forward FDI		Backward FDI	
FDI	-2.375**	-2.212*	-0.199	-0.291	0.602***	0.534**
	(1.118)	(1.240)	(0.260)	(0.305)	(0.229)	(0.268)
lnsize	0.079***	0.078***	0.042***	0.057***	0.042***	0.059***
	(0.015)	(0.009)	(0.008)	(0.009)	(0.007)	(0.008)
training	0.214***	0.224***	0.240***	0.237***	0.248***	0.246***
	(0.019)	(0.021)	(0.023)	(0.024)	(0.020)	(0.020)
qualitycert	0.366***	0.320***	0.389***	0.345***	0.394***	0.352***
	(0.020)	(0.020)	(0.024)	(0.025)	(0.021)	(0.022)
foreigntech	0.211***	0.196***	0.217***	0.243***	0.232***	0.255***
	(0.024)	(0.025)	(0.030)	(0.033)	(0.026)	(0.029)
foreign firm	0.926***		0.264***		0.265***	
	(0.297)		(0.037)		(0.033)	
Observations	43,168	37,780	22,636	19,748	30,589	26,641
# of sectors	18	18	7	7	7	7
Underidentification test	34.412	30.507	1255.464	957.094	975.469	756.831
Weak identification test	40.24	31.978	5015.014	4084.582	8000.719	6661.216
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is labor productivity. ***, **, and * indicate 1 %, 5 %, and 10 % significance, respectively. In the parenthesis, robust standard error is used. In underidentification and weak identification tests, we report Kleibergen-Paap rk LM statistic and Cragg-Donald Wald F statistic, respectively.

5. CONCLUSIONS

The paper has attempted to identify the FDI spillover effects in developing countries and to investigate the importance of the absorptive capacity of a firm and a country in realizing and facilitating FDI spillover. It used data obtained from the World Bank's Enterprise Surveys for 107 countries from 2007 to 2020.

We found that firms in developing countries do not benefit from horizontal FDI but benefit from forward and backward FDI. In other words, there are no horizontal FDI spillover effects, but there are vertical spillover effects in developing countries. As regards horizontal FDI, competition for domestic firms from foreign firms in the same sector could increase domestic firms' productivity by forcing them to improve their production technology to survive in the market. This is a case of positive spillover. Domestic firms may experience a decline in productivity, or negative spillover, if competitive foreign firms force them to reduce production. Our finding on horizontal FDI showed that neither of these two opposing effects overwhelms the other, indicating no FDI spillover.

Based on our findings, we offer the following recommendations for domestic firms and governments. For firms, research and development activities need to be promoted so that firms may acquire an internationally recognized quality certificate. Firms are also advised to run training programs to improve workers' skills, and they are advised to participate in GVCs. These activities will promote FDI spillover by improving the firm's capacity to absorb foreign technology.

Turning to the recommendation to the government, establishing and maintaining open trade and financial regimes and ensuring a competitive business environment are very important. To achieve these objectives, governments are advised to participate in international rules/agreements such as free trade agreements (FTAs), which will exert external competitive pressure on domestic firms from imports and ensure the availability of foreign financial resources. Protection of IPR is highly recommended by complying with international rules such as the World Trade Organization Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), the World Intellectual Property Organization (WIPO), and FTAs with IPR chapters. Developing clusters is also recommended -for example, by constructing industrial zones.

In order to realize these recommendations, governments, and particularly political leaders, have to recognize the importance of assimilating foreign technology to promote economic development and growth. Political leaders and policymakers with that recognition need to persuade the general public, with assistance from international organizations such as the Asian Development Bank and the World Bank, to gain support for needed policies by presenting successful cases, which can be found in many East Asian developing countries.

APPENDIX

Table A1. Sample Countries and Number of Sample Firms

No	country name	included in	# of firms	No	country name	included in	# of firms
1	Afghanistan	HFDI, FFDI, BFDI	46	26	Egypt	HFDI, FFDI, BFDI	2,549
2	Angola	HFDI, FFDI, BFDI	115	27	Ethiopia	HFDI, FFDI, BFDI	496
3	Albania	HFDI, FFDI, BFDI	294	28	Gabon	HFDI, FFDI, BFDI	21
4	Argentina	HFDI, FFDI, BFDI	1,161	29	Ghana	HFDI, FFDI, BFDI	496
5	Armenia	HFDI, FFDI, BFDI	345	30	Guatemala	HFDI, FFDI, BFDI	325
6	Azerbaijan	HFDI, FFDI, BFDI	182	31	Honduras	HFDI, FFDI, BFDI	155
7	Burundi	HFDI, FFDI, BFDI	54	32	Croatia	HFDI, FFDI, BFDI	306
8	Burkina Faso	HFDI, FFDI, BFDI	66	33	Indonesia	HFDI, FFDI, BFDI	1,927
9	Bangladesh	HFDI, FFDI, BFDI	1,044	34	India	HFDI, FFDI, BFDI	6,747
10	Bulgaria	HFDI, FFDI, BFDI	500	35	Iraq	HFDI, FFDI, BFDI	430
11	Bosnia and Herzegovina	HFDI, FFDI, BFDI	265	36	Jamaica	HFDI, FFDI, BFDI	60
12	Belarus	HFDI, FFDI, BFDI	434	37	Jordan	HFDI, FFDI, BFDI	322
13	Brazil	HFDI, FFDI, BFDI	1,008	38	Kazakhstan	HFDI, FFDI, BFDI	912
14	Bhutan	HFDI, FFDI, BFDI	61	39	Kyrgyzstan	HFDI, FFDI, BFDI	255
15	Botswana	HFDI, FFDI, BFDI	68	40	Lao PDR	HFDI, FFDI, BFDI	292
16	Chile	HFDI, FFDI, BFDI	603	41	Lebanon	HFDI, FFDI, BFDI	420
17	People's Republic of China	HFDI, FFDI, BFDI	1,635	42	Liberia	HFDI, FFDI, BFDI	80
18	Côte d'Ivoire	HFDI, FFDI, BFDI	191	43	Sri Lanka	HFDI, FFDI, BFDI	321
19	Cameroon	HFDI, FFDI, BFDI	141	44	Lesotho	HFDI, FFDI, BFDI	107
20	DRC	HFDI, FFDI, BFDI	233	45	Lithuania	HFDI, FFDI, BFDI	136
21	Colombia	HFDI, FFDI, BFDI	1,071	46	Latvia	HFDI, FFDI, BFDI	132
22	Costa Rica	HFDI, FFDI, BFDI	217	47	Morocco	HFDI, FFDI, BFDI	473
23	Djibouti	HFDI, FFDI, BFDI	53	48	Republic of Moldova	HFDI, FFDI, BFDI	301
24	Dominican Republic	HFDI, FFDI, BFDI	160	49	Madagascar	HFDI, FFDI, BFDI	116
25	Ecuador	HFDI, FFDI, BFDI	167	50	Mexico	HFDI, FFDI, BFDI	908

Table A1. Sample Countries and Number of Sample Firms (cont')

No	country name	included in	# of firms	No	country name	included in	# of firms
51	North Macedonia	HFDI, FFDI, BFDI	298	80	Tanzania	HFDI, FFDI, BFDI	217
52	Mali	HFDI, FFDI, BFDI	442	81	Uganda	HFDI, FFDI, BFDI	218
53	Myanmar	HFDI, FFDI, BFDI	601	82	Ukraine	HFDI, FFDI, BFDI	1,658
54	Montenegro	HFDI, FFDI, BFDI	90	83	Uruguay	HFDI, FFDI, BFDI	310
55	Mongolia	HFDI, FFDI, BFDI	319	84	Uzbekistan	HFDI, FFDI, BFDI	769
56	Mozambique	HFDI, FFDI, BFDI	489	85	Venezuela	HFDI, FFDI, BFDI	50
57	Mauritania	HFDI, FFDI, BFDI	35	86	Viet Nam	HFDI, FFDI, BFDI	1,257
58	Malawi	HFDI, FFDI, BFDI	94	87	Yemen	HFDI, FFDI, BFDI	165
59	Malaysia	HFDI, FFDI, BFDI	481	88	South Africa	HFDI, FFDI, BFDI	817
60	Namibia	HFDI, FFDI, BFDI	54	89	Zambia	HFDI, FFDI, BFDI	634
61	Nigeria	HFDI, FFDI, BFDI	646	90	Benin	Only HFDI	58
62	Nicaragua	HFDI, FFDI, BFDI	165	91	Bolivia	Only HFDI	156
63	Nepal	HFDI, FFDI, BFDI	213	92	Georgia	Only HFDI	309
64	Pakistan	HFDI, FFDI, BFDI	453	93	Guinea	Only HFDI	15
65	Panama	HFDI, FFDI, BFDI	59	94	Gambia	Only HFDI	62
66	Peru	HFDI, FFDI, BFDI	1,076	95	Kenya	Only HFDI	679
67	Philippines	HFDI, FFDI, BFDI	1,482	96	Cambodia	Only HFDI	108
68	Papua New Guinea	HFDI, FFDI, BFDI	22	97	Mauritius	Only HFDI	120
69	Poland	HFDI, FFDI, BFDI	708	98	Niger	Only HFDI	26
70	Romania	HFDI, FFDI, BFDI	720	99	Paraguay	Only HFDI	159
71	Russian Federation	HFDI, FFDI, BFDI	2,305	100	Rwanda	Only HFDI	101
72	Senegal	HFDI, FFDI, BFDI	347	101	Solomon Islands	Only HFDI	34
73	Sierra Leone	HFDI, FFDI, BFDI	60	102	Suriname	Only HFDI	42
74	El Salvador	HFDI, FFDI, BFDI	357	103	Eswatini	Only HFDI	52
75	Serbia	HFDI, FFDI, BFDI	286	104	Chad	Only HFDI	55
76	South Sudan	HFDI, FFDI, BFDI	57	105	Togo	Only HFDI	36
77	Tajikistan	HFDI, FFDI, BFDI	238	106	Thailand	Only HFDI	584
78	Tunisia	HFDI, FFDI, BFDI	482	107	Timor-Leste	Only HFDI	18
79	Turkey	HFDI, FFDI, BFDI	2,277				

Table A2. Sample Sectors

Enterprise Surveys		Eora National Input-Output Tables	
No	Sector Name	No	Sector Name
1	Food	1	Food and Beverages
2	Tobacco		
3	Textiles	2	Textiles and Wearing Apparel
4	Garments		
5	Leather		
6	Wood	3	Wood and Paper
7	Paper		
8	Publishing, Printing, and Recorded Media		
9	Refined Petroleum Products	4	Petroleum, Chemical and Non-Metallic Mineral Products
10	Chemicals		
11	Plastic and Rubber		
12	Non Metallic Mineral Products		
13	Basic Metals	5	Metal Products
14	Fabricated Metal Products		
15	Machinery and Equipment	6	Electrical and Machinery
16	Electronics		
17	Precision Instruments		
18	Transport Machines	7	Transport Equipment

Note: As we mentioned in section 3, 18 sector classification of Enterprise Surveys is for horizontal FDI, and 7 sector classification of Eora National Input-Output Tables is for forward and backward FDI.

Table A3. Basic Statistics for Horizontal FDI Spillover

Variable	Obs	Mean	Std. Dev.	Min	Max
lnLP	51,966	5.302	1.893	-9.102	20.071
hfdi	51,966	0.260	0.277	0	1
lnsize	51,966	3.603	1.434	0	11.067
training	51,966	0.370	0.483	0	1
qualitycert	51,966	0.301	0.459	0	1
foreigntech	51,966	0.158	0.364	0	1
foreign firm	51,966	0.121	0.326	0	1
hfdi × plargefirm	47,499	0.030	0.119	0	0.999
hfdi × qualitycert	48,074	0.055	0.153	0	0.999
hfdi × foreigntech	47,054	0.032	0.126	0	0.999
hfdi × training	48,613	0.082	0.185	0	0.999
hfdi × gvc	42,092	0.055	0.160	0	0.999
hfdi × agglom	41,090	7.098	12.198	0	99.613
hfdi × tradeopen	48,730	15.491	20.594	0	157.664
hfdi × businessreg	41,322	1.413	1.589	0	8.042
hfdi × finanopen	41,218	1.066	1.565	0	9.987
hfdi × education	33,821	8.646	11.280	0	84.063
hfdi × ipr	45,421	1.133	1.243	0	6.591

Source: Authors' compilation.

Table A4. Basic Statistics for Horizontal FDI Spillover

Variable	Obs	Mean	Std. Dev.	Min	Max
lnLP	35,564	5.351	2.022	-9.102	20.071
ffdi	35,564	0.241	0.193	0	0.988
bfdi	35,564	0.209	0.167	0	0.878
lnsize	35,564	3.614	1.438	0	11.067
training	35,564	0.383	0.486	0	1
qualitycert	35,564	0.318	0.466	0	1
foreigntech	35,564	0.157	0.364	0	1
foreign firm	35,564	0.125	0.331	0	1
ffdi × plargefirm	32,034	0.029	0.093	0	0.907
ffdi × qualitycert	33,005	0.053	0.117	0	0.880
ffdi × foreigntech	32,049	0.031	0.102	0	0.906
ffdi × training	33,299	0.079	0.145	0	0.907
ffdi × gvc	27,222	0.050	0.126	0	0.880
ffdi × agglom	29,089	6.692	9.692	0	78.161
ffdi × tradeopen	33,609	14.400	14.518	0	91.821
ffdi × businessreg	33,403	1.371	1.110	0	6.772
ffdi × finanopen	33,338	0.954	1.174	0	7.744
ffdi × education	25,550	7.441	8.231	0	50.886
ffdi × ipr	31,939	1.101	0.858	0	4.571
bfdi × plargefirm	32,034	0.028	0.090	0	0.833
bfdi × qualitycert	33,005	0.047	0.108	0	0.833
bfdi × foreigntech	32,049	0.027	0.089	0	0.826
bfdi × training	33,299	0.069	0.131	0	0.873
bfdi × gvc	27,222	0.042	0.108	0	0.833
bfdi × agglom	29,089	5.842	8.544	0	77.864
bfdi × tradeopen	33,609	13.131	15.239	0	129.796
bfdi × businessreg	33,403	1.186	0.971	0	5.268
bfdi × finanopen	33,338	0.825	0.982	0	6.531
bfdi × education	25,550	6.615	7.600	0	62.157
bfdi × ipr	31,939	0.951	0.753	0	4.318

Source: Authors' compilation.

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Received May 13, 2025, Accepted September 17, 2025.