Urata, Shujiro; Baek, Youngmin

Working Paper

Technology transfer and firm competitiveness: The case of Indonesia

ADBI Working Paper, No. 1410

Provided in Cooperation with:
Asian Development Bank Institute (ADBI), Tokyo

Suggested Citation: Urata, Shujiro; Baek, Youngmin (2023) : Technology transfer and firm competitiveness: The case of Indonesia, ADBI Working Paper, No. 1410, Asian Development Bank Institute (ADBI), Tokyo, https://doi.org/10.56506/USNY3110

This Version is available at:
https://hdl.handle.net/10419/296802

ADBI Working Paper Series

TECHNOLOGY TRANSFER AND FIRM COMPETITIVENESS: THE CASE OF INDONESIA

Shujiro Urata and Youngmin Baek

No. 1410
August 2023

Asian Development Bank Institute

Shujiro Urata is a Visiting Fellow at the Asian Development Bank Institute and Professor Emeritus at Waseda University, Japan. Youngmin Baek is an Assistant Professor at Fukuyama University, Japan.

The Working Paper series is a continuation of the formerly named Discussion Paper series; the numbering of the papers continued without interruption or change. ADBI's working papers reflect initial ideas on a topic and are posted online for discussion. Some working papers may develop into other forms of publication.

The Asian Development Bank refers to "China" as the People's Republic of China.

Suggested citation:

Urata, S. and Y. Baek. 2023. Technology Transfer and Firm Competitiveness: The Case of Indonesia. ADBI Working Paper 1410. Tokyo: Asian Development Bank Institute. Available: https://doi.org/10.56506/USNY3110

Please contact the authors for information about this paper.

Email: surata@adbi.org

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

This paper examines the foreign direct investment (FDI) spillover effects from foreign to domestic firms in Indonesia and assesses the significance of geographical factors on FDI spillover. It uses firm-level data from the Indonesian Bureau of Public Statistics (BPS) covering the period from 2000 to 2009 and focuses on 16 manufacturing sectors. We find an absence of FDI spillover at the country level; however, we observe significant province-level forward FDI spillovers. These findings appear to indicate that intermediate goods supplied by foreign firms raise the productivity of domestic firms via learning, variety, and a quality effect. Our analysis reflects the importance of geographical proximity in realizing forward FDI spillovers. These findings show the importance of developing and improving transportation and telecommunication infrastructure to facilitate FDI spillovers by virtually reducing geographical distance between foreign and domestic firms.

Keywords: foreign direct investment, technology transfer, firm productivity

JEL Classification: D22, F21, O3

Contents

1. INTRODUCTION 1
2. LITERATURE REVIEW 1
3. PRESENCE OF FOREIGN FIRMS IN INDONESIA 3
4. METHODOLOGY AND DATA 6
5. ESTIMATION AND RESULTS 9
6. CONCLUSIONS 12
REFERENCES 13
APPENDIX 15

1. INTRODUCTION

Foreign direct investment (FDI) has been a key driver of economic growth and development, especially in developing countries. One of the potential benefits of FDI is the technology transfer from foreign firms to domestic firms. Technology transfer improves the productivity and competitiveness of domestic firms in developing countries, and this effect is commonly referred to as "FDI spillover."

FDI spillover can be realized in various ways, such as labor mobility, imitation, and business transactions. Workers who have acquired knowledge of technology by working for foreign firms may transfer this knowledge to the domestic context when hired by local firms. 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 occur where domestic and foreign firms operate in the same industry and are thus characterized as horizontal spillover. Domestic firms may also acquire technology through their business relations with foreign firms. The business relationships between domestic and foreign firms comprise backward and forward linkages. FDI spillover that occurs through a backward (forward) linkage is considered a backward (forward) spillover. Backward spillover occurs when domestic firms supply parts and semi-finished products to foreign firms, while forward spillover occurs when foreign firms provide parts and semi-finished products to domestic firms. Domestic firms acquire technology through channels such as the certification process and training courses within customer–supplier business relationships.

Meanwhile, the question of whether FDI spillovers in developing countries occur and, if so, what kinds of FDI spillovers occur continues to be debated, as the results of existing empirical studies have been inconsistent. This study conducts a comprehensive investigation of FDI spillover effects at Indonesia's country and region levels. Our findings indicate that while there is no country-level FDI spillover, regional-level FDI spillover is indeed present. This suggests that geographical factors such as geographical proximity are crucial in the FDI spillover dynamic in large developing countries such as Indonesia. These findings have important implications for policymakers in promoting FDI-led economic development.

The paper is organized as follows: Section 2 provides a literature review of selected studies and summarizes their main findings; Section 3 discusses the presence of foreign firms in Indonesia; Section 4 outlines the methodology and data used for the analysis; Section 5 presents and discusses the estimation results; Section 6 concludes the paper.

2. LITERATURE REVIEW

This section focuses on the contradictory results of earlier studies and provides an overview of selected studies investigating the FDI spillover effects in large countries. There are a large number of empirical studies that have examined the presence or absence of technology spillover through FDI. However, the results of those studies are mixed and inconsistent. Rojec and Knell (2018) claimed that the lack of evidence on FDI spillovers could be attributed to a number of reasons. For substantive reasons, the host country often lacks the prerequisites for FDI spillovers, such as absorptive capacity, leading to no (or even negative) spillovers. Several recent empirical studies focused on substantive reasons for these outcomes, highlighting either the absorptive capacity of the host country or that of the domestic firm (Aleksynska and Havrylchyk

2013; Demir and Hu 2016; Farole and Winkler 2012; Urata and Baek 2022). Furthermore, some studies have explored how the heterogeneity of investor countries or investor firms affects FDI spillover (Abraham, Konings, and Slootmaekers 2010; Castellani and Zanfei 2005; Marin and Bell 2004). According to the results of these studies, whether technology spillovers occur is determined by both the absorptive capacity of the host country and the heterogeneity of the investing countries. However, in regard to the substantive reasons for the presence of technology spillover, geographical factors concerning the scope of technology spillover should also be considered. This is particularly important for a geographically large country. For instance, when the same foreign firms invest in Singapore and Indonesia and the domestic firms in both countries have the same absorptive capacity, technology spillovers may take place in Singapore but not in Indonesia due to geographical factors. Labor mobility, imitation, and business transactions are the primary channels through which technology spillover from foreign to domestic firms is realized. Geographical factors such as the distance between foreign and domestic firms significantly impact these channels due to the high costs associated with long-distance moves and transactions.

Table 1: Selected Previous Studies

Author	Country	Year	FDI Spillover Level	Dep. Var (level)	HFDI	FFDI	BFDI
Ponomareva (2000)	Russian Federation	1993–1997	Country	Output (firm)	+		
Feinberg and Majumdar (2001)	India	1980–1994	Country	Output (firm)	n.s.		
Hu and Jefferson (2002)	PRC	1995–1999	Country	Value added (firm)	n.s./–		
Liu (2002)	PRC	1993–1998	Special economic zone	Value added (firm)	n.s.		
Sabirianova, Svejnar, and Terrell (2005)	Russian Federation	1993–2000	Country	Output (firm)	–		
Buckley, Clegg, and Wang (2007)	PRC	1995	Country	Labor productivity (industry)	+		
Blalock and Gertler (2009)	Indonesia	1988–1996	Region	Output (firm)	+		
Keller and Yeaple (2009)	US	1987–1996	Country	ΔTFP (firm)	+		
Takii (2009)	Indonesia	1990–1995	Region	Value added (firm)	+		
Ito et al. (2010)	PRC	2000–2007	Region	TFP (industry)	n.s.	+	+
Wang (2010)	Canada	1973–1997	Country	TFP (industry)	n.s.	+	+
Xu and Sheng (2012)	PRC	2000, 2003	Country and region	TFP (firm)	+	–	–
Fujimori and Sato (2015)	India	1995–2004	Country	TFP (industry)	n.s.		–
Lu, Tao, and Zhu (2017)	PRC	1998–2007	Country	TFP (firm)	–	+	+

Note: “n.s.” stands for “not significant.”

Source: Authors’ compilation.

Table 1 shows the results of firm-level studies that have examined FDI spillovers in large countries such as Canada, the People’s Republic of China (PRC), India, Indonesia, the Russian Federation, and the United States. In developed countries, such as Canada and the United States, FDI has been found to have a statistically significant and positive impact on firm productivity (Keller and Yeaple 2009; Wang 2010). Conversely, in the PRC, the effects of FDI on firm productivity are mixed, with most studies showing no significant impacts (Buckley, Clegg, and Wang 2007; Hu and Jefferson 2002; Ito et al. 2012; Liu 2002; Lu, Tao, and Zhu 2017; Xu and Sheng 2012). Likewise, the evidence suggests that FDI spillover in India has no statistically significant effect (Feinberg and Majumdar 2001; Fujimori and Sato 2015). Meanwhile, in the Russian Federation, FDI spillover is statistically significant but shows mixed results (Ponomareva 2000; Sabirianova, Svejnar, and Terrell 2005). Finally, in Indonesia, FDI positively impacts firms’ value added but has no significant impact on total factor productivity. These studies focused on FDI spillover at the country level and found that FDI spillover occurs only in developed countries with relatively well-developed transportation and communication infrastructure, even among large

countries. These results suggest that FDI spillover in large countries with less developed transportation and communication infrastructure is limited to areas in close proximity. FDI spillover at the country level requires infrastructure improvements to lower labor mobility costs and facilitate transactions between foreign and domestic firms. To empirically test these hypotheses, we use firm-level data from Indonesia and investigate the extent of FDI spillover at the country and region levels.

3. PRESENCE OF FOREIGN FIRMS IN INDONESIA

This section provides an overview of foreign firms operating in Indonesia. Table 2 shows the share of foreign firms' output in the total output of each sector from 2000 to 2009[1]. Foreign firms' share of total production across all sectors in Indonesia experienced a substantial rise from 34.6% in 2000 to 42% in 2009. The presence of foreign firms is particularly prominent in the machinery sectors, including general machinery, electronic and optical machinery, electrical machinery, motor vehicles, and other transport equipment. In addition to the machinery sector, the chemical sector has a high share of foreign firms' output, accounting for 72.6% of the sector's total output in 2009. The machinery and chemical sectors are key sectors in East Asia's global value chains (GVCs). The increasing output of foreign firms in these two sectors indicates that Indonesia's participation in GVCs is also rising. The share of foreign firms in the coke and refined petroleum sectors used to be high, with over 50% in 2000 and reaching a peak of 70.8% in 2002; however, it has since declined steadily, dropping to just 7.2% in 2009.

Table 2: Presence of Foreign Firms by Sector
(%)

Sector	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Food	18.6	15.4	13.7	25.9	24.3	26.4	25.6	23.9	26.3	25.5
Apparel	30.1	30.2	30.2	28.9	28.3	27.1	33.5	28.0	35.5	38.7
Wood	8.9	12.5	12.9	18.9	9.4	9.0	18.0	16.2	16.8	23.7
Paper	31.9	28.7	46.7	11.6	19.5	15.1	27.7	23.3	22.1	21.7
Coke and refined petroleum	54.9	55.8	70.8	44.5	53.4	9.1	2.6	7.9	10.0	7.2
Chemicals	55.5	47.5	40.2	37.9	30.9	35.1	44.9	46.5	68.6	72.6
Rubber and plastic	27.7	32.9	31.6	35.1	30.5	36.7	31.6	26.0	31.2	30.3
Minerals	38.3	30.7	31.3	34.6	35.2	33.6	42.1	37.7	38.2	35.2
Basic metals	16.9	18.1	13.2	16.7	13.3	17.2	15.1	12.8	18.9	24.8
Fabricated metals	67.7	38.7	22.6	39.2	38.0	39.0	36.5	41.5	53.6	43.2
General machinery	62.2	80.5	58.0	63.5	71.9	54.2	54.5	61.4	67.4	62.1
Electronic and optical machinery	83.1	80.4	58.1	60.6	46.7	71.3	84.1	91.7	87.1	84.9
Electrical machinery	76.8	38.2	49.5	48.7	51.1	56.4	48.2	48.3	61.5	61.0
Motor vehicles	82.8	67.8	64.8	69.0	82.7	56.6	76.8	64.5	75.5	73.4
Other transport equipment	26.7	42.2	78.8	45.6	80.5	80.7	68.8	73.0	81.8	79.2
Manufacturing n.e.c.	31.6	24.1	23.3	28.1	29.6	31.5	28.1	33.0	43.6	40.3
Total	34.6	30.9	30.0	30.4	32.6	31.3	35.2	32.6	40.2	42.0

Source: Authors' compilation, using Statistik Industri.

[1] Due to data availability, we chose the years 2000 and 2009 for our analysis, using the data from annual industrial surveys (Statistik Industri) conducted by the Indonesian Bureau of Public Statistics (BPS). The latest survey data from the BPS cover the years from 2000 to 2015, but for TFP calculations, we can only analyze the years from 2000 to 2009, excluding 2006 due to missing values of capital stock. For our analysis, we used firm-level unbalanced data for the period 2000–2009.

Table 3: Presence of Foreign Firms by Province-Sector in 2000

(%)

	Food	Apparel	Wood	Paper	Coke and refined Petroleum	Chemicals	Rubber and Plastic	Minerals	Basic Metals
Aceh	26.5	0.0	17.7	0.0		55.7	0.0	99.7	
North Sumatra	35.5	0.0	0.0	17.6	100.0	42.6	26.4	0.0	0.0
West Sumatra	69.5	0.0	87.8		0.0	0.0	0.0	99.9	
Riau and Riau Islands	0.0	72.4	3.6	88.4		84.0	41.8	87.4	62.7
Jambi	16.9	0.0	0.0				19.2	0.0	
South Sumatra and Bangka Belitung	13.6	0.0	2.6			0.0	43.4	0.1	
Bengkulu	0.8		0.0				0.0		
Lampung	9.3	0.0	0.0			0.0	0.0	0.0	0.0
Banten									
Jakarta	24.2	38.5	0.0	6.4		52.0	0.9	51.9	0.2
West Java	33.1	32.1	24.7	16.6	72.7	69.8	36.0	38.2	4.1
Central Java	6.2	14.8	4.4	0.0		0.3	19.1	0.4	60.5
Yogyakarta S. R.	0.0	12.9	0.3	0.0		0.0	0.0	3.2	
East Java	10.7	35.0	16.0	1.2	0.0	32.3	8.3	45.2	58.2
Bali	58.9	16.7	3.0	0.0	0.0	0.0	0.0	0.0	
West Nusa Tenggara	0.0	0.0	0.0					0.0	
East Nusa Tenggara	0.0		0.0	0.0		0.0		0.0	
West Kalimantan	29.4	0.0	0.5	0.0		0.0	14.3	0.0	
Central Kalimantan	83.1		53.7				0.0	0.0	
South Kalimantan	2.9		9.9			0.0	13.5	0.0	
East Kalimantan and North Kalimantan	20.3		1.5	0.0		0.0	0.0	0.0	
North Sulawesi and Gorontalo	10.7	0.0	0.0			0.0		0.0	
Central Sulawesi	0.0		21.4	0.0		0.0		0.0	
South Sulawesi and West Sulawesi	11.2	0.0	8.3	0.0		20.3	31.5	0.0	100.0
Southeast Sulawesi	11.0	0.0	0.0	0.0		0.0		0.0	0.0
Maluku and North Maluku	39.1		0.0	0.0	100.0	0.0		0.0	
Papua									
Total	18.6	30.1	8.9	31.9	54.9	55.5	27.7	38.3	16.9

	Fabricated Metals	General Machinery	Electronic and Optical Machinery	Electrical Machinery	Motor Vehicles	Other Transport	Manufacturing n.e.c.	Total
Aceh	0.0						0.0	36.9
North Sumatra	0.0	0.0	0.0	0.0	0.0	0.0	6.4	26.6
West Sumatra					0.0	0.0	0.0	68.9
Riau and Riau Islands	97.6		94.1	100.0		75.1	0.0	80.0
Jambi						0.0	0.0	9.7
South Sumatra and Bangka Belitung	0.0	0.0				0.0	0.0	20.1
Bengkulu					0.0			0.6
Lampung	0.0				0.0		0.0	8.5
Banten								
Jakarta	57.6	48.6	74.3	34.9	85.3	58.7	53.3	44.8
West Java	77.0	75.4	72.4	65.7	89.9	1.9	46.4	39.1
Central Java	10.5	62.3			0.0	0.0	14.3	11.1
Yogyakarta S. R.	0.0	0.0		100.0			12.6	17.0
East Java	38.8	49.6	6.6	47.6	4.5	0.2	14.7	19.0
Bali	0.0						32.5	32.4
West Nusa Tenggara							0.0	0.0
East Nusa Tenggara							0.0	0.0
West Kalimantan	0.0					0.0	0.0	9.9
Central Kalimantan								55.3
South Kalimantan	0.0					0.0	0.0	9.0
East Kalimantan and North Kalimantan						0.0	0.0	3.7
North Sulawesi and Gorontalo							0.0	9.4
Central Sulawesi							92.5	5.9
South Sulawesi and West Sulawesi	0.0			0.0		0.0	67.7	8.5
Southeast Sulawesi						0.0		2.7
Maluku and North Maluku	0.0					0.0	0.0	27.0
Papua								
Total	67.7	62.2	83.1	76.8	82.8	26.7	31.6	34.6

Source: Authors' compilation, using Statistik Industri.

Table 4: Presence of Foreign Firms by Province-Sector in 2009

(%)

	Food	Apparel	Wood	Paper	Coke and Refined Petroleum	Chemicals	Rubber and Plastic	Minerals	Basic Metals
Aceh	18.0	12.2	0.0	0.0		0.0		0.0	
North Sumatra	25.4	0.0	4.9	45.5	0.0	25.9	30.1	28.7	62.7
West Sumatra	47.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Riau and Riau Islands	27.9	78.6	0.0	55.3	0.0	20.5	41.0	45.3	57.6
Jambi	30.5	0.0	0.0	0.0			30.0	0.0	
South Sumatra and Bangka Belitung	15.7	0.0	24.0	94.9		0.0	33.8	5.9	16.0
Bengkulu	0.7	0.0		0.0			0.0	0.0	
Lampung	19.5	0.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0
Banten	38.7	46.2	40.9	9.9	46.2	56.6	21.9	20.0	6.0
Jakarta	20.5	56.9	0.0	28.3	0.0	52.0	19.4	30.3	23.4
West Java	12.9	37.6	22.1	16.0	14.2	88.1	56.5	33.5	16.2
Central Java	10.4	30.6	13.5	0.1	0.0	16.2	15.6	69.6	10.3
Yogyakarta S. R.	72.1	28.6	0.0	0.0	0.0	0.0	0.0	0.0	
East Java	25.1	29.4	29.4	1.2	0.0	23.7	17.8	55.4	73.3
Bali	13.9	32.3	43.6	7.7	0.0	0.0	0.0	7.0	
West Nusa Tenggara	0.0	0.0	0.0	0.0				0.0	
East Nusa Tenggara	57.7	0.0		0.0		0.0		0.0	
West Kalimantan	12.6	0.0	0.0	0.0	0.0	0.0	10.1	0.0	0.0
Central Kalimantan	52.5		31.9	0.0	0.0		0.0	0.0	
South Kalimantan	83.9	0.0	25.2	0.0		86.6	39.7	99.6	
East Kalimantan and North Kalimantan	51.3	0.0	47.2	0.0	0.0	62.5	0.0	0.0	0.0
North Sulawesi and Gorontalo	38.7	0.0	1.6	0.0	0.0	22.9		0.0	
Central Sulawesi	39.1		2.7	0.0				0.0	
South Sulawesi and West Sulawesi	39.4	0.0	0.7	30.5		0.0	0.0	0.0	100.0
Southeast Sulawesi	13.6	0.0	0.0	0.0				0.0	0.0
Maluku and North Maluku	0.0		0.0	0.0		0.0	0.0		
Papua	17.2		12.2	0.0	100.0			0.0	
Total	25.5	38.7	23.7	21.7	7.2	72.6	30.3	35.2	24.8

	Fabricated Metals	General Machinery	Electronic and Optical Machinery	Electrical Machinery	Motor Vehicles	Other Transport	Manufacturing n.e.c.	Total
Aceh						0.0	0.0	17.8
North Sumatra	9.5	77.2	0.0	0.0	0.0	0.0	64.2	29.6
West Sumatra	0.0				0.0	0.0	0.0	20.1
Riau and Riau Islands	91.4	98.0	74.1	99.2	100.0	36.0	83.4	45.7
Jambi						0.0	0.0	28.9
South Sumatra and Bangka Belitung	0.0					0.0	0.0	24.2
Bengkulu	0.0						0.0	0.4
Lampung	0.0	0.0			0.0	0.0	0.0	16.7
Banten	58.1	69.6	71.6	23.9	36.6	36.5	26.1	33.6
Jakarta	12.5	17.9	0.0	16.7	80.9	98.9	46.1	60.9
West Java	46.4	70.3	93.8	85.6	71.7	65.2	57.9	61.8
Central Java	8.7	36.0	35.0	0.0	0.0	0.0	28.2	17.1
Yogyakarta S. R.	0.0	0.0	0.0	100.0	0.0		55.3	43.5
East Java	11.0	29.3	38.3	49.2	27.6	23.0	17.6	24.9
Bali	71.1						50.3	27.6
West Nusa Tenggara						0.0	0.0	0.0
East Nusa Tenggara							0.0	47.1
West Kalimantan	0.0						0.0	10.6
Central Kalimantan								44.9
South Kalimantan	0.0				0.0	0.0	0.0	74.1
East Kalimantan and North Kalimantan	0.0					5.8	0.0	49.8
North Sulawesi and Gorontalo						3.8	2.0	36.5
Central Sulawesi							25.8	33.6
South Sulawesi and West Sulawesi	0.0			0.0		0.0	76.1	30.0
Southeast Sulawesi	0.0					0.0	0.0	1.3
Maluku and North Maluku						0.0	0.0	0.0
Papua						0.0	0.0	16.1
Total	43.2	62.1	84.9	61.0	73.4	79.2	40.3	42.0

Source: Authors' compilation, using Statistik Industri.

Tables 3 and 4 show the share of foreign firms in total output in each sector by province for 2000 and 2009, respectively, which enables us to understand the distribution of foreign firms' presence in Indonesia. In 2000, foreign firms had a particularly strong presence in Riau and the Riau Islands, where they accounted for over 80% of the region's output in the paper (88.4%), chemical (84%), minerals (87.4%), fabricated metals (97.6%), electronic and optical machinery (94.1%), and electrical machinery (100%) sectors, as shown in Table 3. Another region with a substantial foreign presence was West Sumatra, where foreign firms contributed to 68.9% of the region's output, primarily in the raw material processing sectors, such as minerals (99.9%) and wood (87.8%). This was followed by Central Kalimantan, with a 55.3% foreign output share due to the high foreign presence in the food sector (83.1%). The metropolitan areas of Jakarta and West Java are characterized by a wide range of sectors where foreign firms play a significant role, contributing to approximately 40% of output in both regions. Notably, the machinery sectors have a substantial foreign presence in these regions. A comparison between foreign output shares in 2000 and 2009 reveals a decrease in West Sumatra, Riau, and the Riau Islands, while the regions surrounding Jakarta experienced an increase. In particular, Banten province stands out with a remarkable rise in foreign output shares across all sectors, especially in electronic and optical machinery, which exhibits the highest foreign output share (71.6%). Foreign firm output in the food sector experienced substantial growth in Indonesia's eastern regions of East Nusa Tenggara, South Kalimantan, East Kalimantan, North Kalimantan, North Sulawesi and Gorontalo, Central Sulawesi, South Sulawesi, and West Sulawesi. Furthermore, in South Kalimantan, the foreign output share in the chemical and mineral sectors increased significantly by 86.6% and 99.6%, respectively. To summarize, the period from 2000 to 2009 witnessed substantial growth in the share of foreign firms in output in most regions of Indonesia. Specifically, the metropolitan area experienced a surge in the machinery sector, while rural areas observed a significant increase in the food sector.

4. METHODOLOGY AND DATA

In this section, we outline the methodology and data employed to estimate the sector- and province-level FDI spillover effects in Indonesia. As described in Section 2, the transportation and communication infrastructure in developing countries is less developed than that in developed countries, hindering technology spillovers from foreign to domestic firms. In addition, in Indonesia, weaker technology spillovers than in other countries could be attributed to the country's extensive land area and numerous islands[2]. Hence, this study examines the impact of geographic distance between domestic and foreign firms on FDI spillovers at the province level. This approach is adopted to examine the possibility that the inconsistent or statistically insignificant outcomes reported in earlier country-level studies may have resulted from the influence of these geographical factors. The specification for examining FDI spillover effects at the province level is as follows:

$$lnTFP_{ispt} = \alpha + \beta FDI_{spt} + \gamma Z_{ispt} + \delta_s + \delta_p + \delta_t + \varepsilon_{ispt}, \quad (1)$$

[2] Indonesia is the 14th-largest country by area in the world, with an area of 1,904,569 square kilometers and approximately 17,000 islands.

where subscripts *i*, *s*, *p*, and *t* denote firm, sector, province[3], and year, respectively. $lnTFP_{ispt}$ is the total factor productivity[4] of domestic firm *i* in sector *s* of province *p* in year *t*. FDI_{spt}, which is used interchangeably to denote horizontal, forward, or backward FDI, is defined and explained in Equations 2, 3, and 4. Z_{ispt} is a firm's characteristics that affect the productivity, such as firm size (Size), the ratio of skilled labor (Skilled Labor), and import/export status (Import and Export Dummies).

In estimating the FDI spillover effect, addressing the potential selection problem is essential. Foreign firms tend to be located in 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 (Rojec and Knell 2018). To deal with this potential selection problem, we apply a simple approach of using one-year lagged values on the right-hand side and province-sector and year-fixed effects.

To define three sector- and province-level FDI linkages, we refer to Javorcik (2004) as follows[5]. First, horizontal FDI captures the extent of the foreign presence in sector *s* in province *p* at time *t* and is defined as the output share of foreign firms in total output in sector *s* in province *p*. Horizontal FDI is used to examine the intrasector spillover effects in province *p*.

$$Horizontal_{spt} = \frac{Sales^{F}_{spt}}{Sales_{spt}} \tag{2}$$

Second, forward FDI is defined as the weighted share of foreign firms' presence in upstream sectors of sector *s* in province *p*. α_{sk} is the ratio of intermediate goods purchased from sector *k* to the total intermediate goods purchased by sector *s*[6]. In other words, forward FDI spillover considers the effect when domestic firms purchase intermediate goods from foreign firms.

$$Forward_{spt} = \sum_{k \neq s} \alpha_{sk} Horizontal_{kpt} \tag{3}$$

Finally, backward FDI is defined as the weighted share of foreign firms' presence in downstream sectors of sector *s* in province *p*. β_{sm} is the ratio of intermediate goods supplied by sector *s* to the total intermediate goods purchased by sector *m*. In other words, backward FDI spillover concerns the effect when domestic firms supply intermediate goods to foreign firms.

$$Backward_{spt} = \sum_{m \neq s} \beta_{sm} Horizontal_{mpt} \tag{4}$$

---

[3] Since some older provinces were divided into several provinces by political reforms after the 1997−98 economic and political crisis, we use 27 aggregated provinces in our study, as shown in Table 3.

[4] TFP was calculated using Wooldridge's (2009) method.

[5] Note that forward and backward FDI here are defined based on the sector with a foreign presence, and the discussions for the calculation of these FDI linkages are adopted from Urata and Baek (2022).

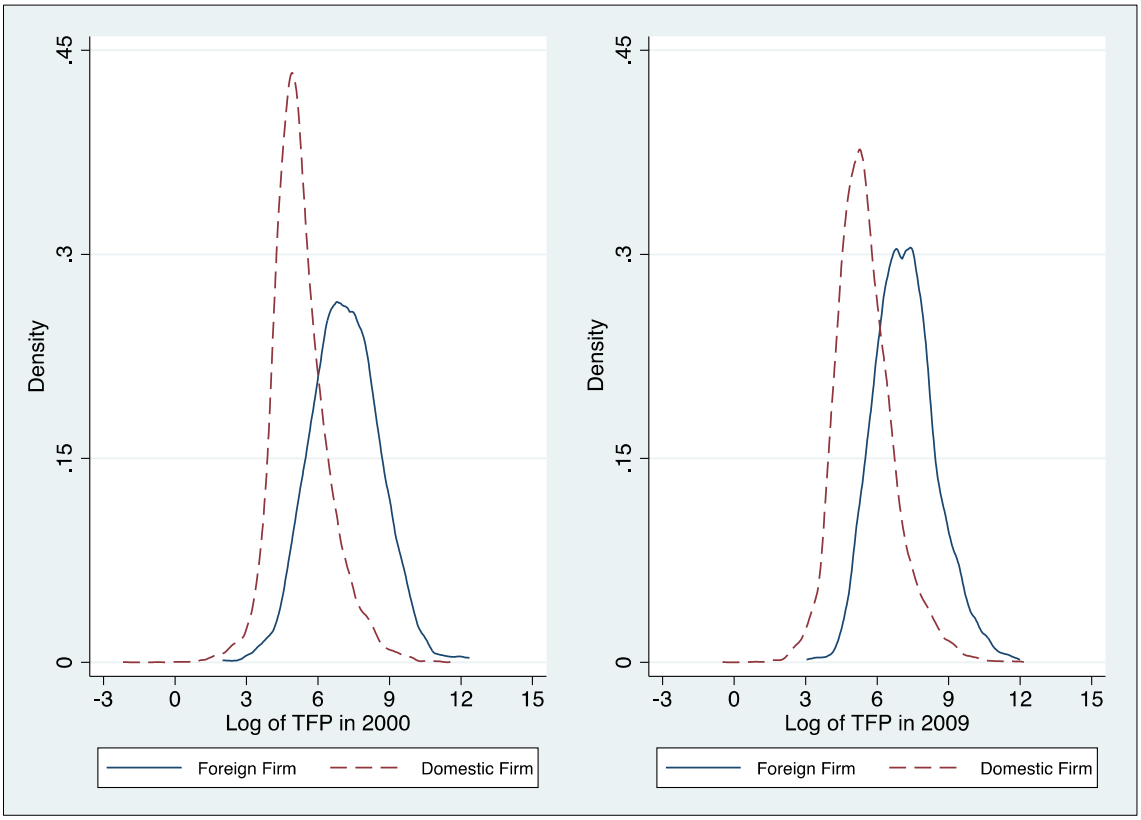
[6] Since input–output tables at the province and sector levels are not available, we computed forward and backward coefficients (α_{sk} and β_{sm} in Equations 3 and 4, respectively) using country- and sector-level input–output tables, assuming that the transactional relationships between sectors in the province are the same as those in the country.

In addition, since forward and backward FDIs are vertical, intermediate goods purchased within the same sector are excluded from both forward and backward FDI.

Our main data set comprises the annual industrial surveys (Statistik Industri) conducted by the Indonesian Bureau of Public Statistics (BPS). The data set includes all manufacturing establishments employing at least 20 workers every year. The data set used in our estimation covers 16 manufacturing sectors[7] from 2000 to 2009, with the exception of 2006[8]. Forward and backward coefficients used to measure vertical FDI are taken from the OECD Inter-Country Input-Output Tables and combined with our Statistik Industri data. All nominal values, including variables required for productivity computation, are deflated by the sectoral wholesale price index using 2000 as the reference base year.

Before discussing the estimation results, we compare foreign and domestic firms' productivity. We find that foreign firms' productivity was higher than that of domestic firms in both 2000 and 2009 (Figure 1). This indicates that technology spillovers can occur through various channels, from foreign firms with higher productivity to domestic firms with relatively lower productivity in Indonesia.

Figure 1: Distribution of Productivity in 2009



Note: Our comparison of TFP in 2000 and 2009 is due to our estimates using TFP covering the period from 2000 to 2009, excluding 2006.

Source: Authors' compilation, using Statistik Industri.

[7] For more details about sector classification, see Appendix Table 1.

[8] We have excluded the year 2006 due to the unavailability of capital stock required for the computation of TFP.

5. ESTIMATION AND RESULTS

In this section, we report the results of estimation based on Equation (1) using the country-level and province-level data. We then conduct an analysis by estimating production function as a robustness check.

Table 5 shows the results of country-level estimation[9]. All types of FDI coefficients—horizontal, forward, and backward—are not statistically significant across all columns. This finding is consistent with Blalock and Gertler (2009), who found that country-level FDI spillover does not occur in Indonesia. The control variables, namely Size, Skilled Labor, and Import, have a positive effect on productivity, as expected[10], while Export has no effect on productivity.

Table 6 presents the estimation results at the province level. While the coefficients of horizontal and backward FDIs are estimated to be insignificant, forward FDI has a significantly positive coefficient. This finding is contrary to the results of earlier studies that have examined FDI spillovers in developing countries. Several earlier studies analyzing FDI spillovers in developing countries have reported either statistically insignificant or negative coefficients for horizontal and forward FDI, with only the coefficient for backward FDI being positive and statistically significant (Javorcik 2004; Gorodnichenko, Svejnar, and Terrell 2014; Newman et al. 2015; Urata and Baek 2022). The findings from our study indicate that the more domestic firms purchase intermediate goods such as parts and components from foreign firms located in close geographical proximity, the greater the spillover effect. This finding appears to reflect the presence of a productivity-enhancing effect of intermediate goods of higher quality and greater variety that are supplied by foreign firms. In addition, domestic firms may acquire advanced technology and management know-how by procuring intermediate goods from foreign firms. It is often the case that foreign firms supplying parts and components provide purchasing domestic firms with training and teach them how to use parts and components effectively. Such activities are conducted easily and effectively if foreign and domestic firms are located in geographical proximity. Our finding is consistent with Amiti and Konings (2007), who found that a reduction in tariffs on inputs increases the productivity of firms, particularly that of firms importing inputs, in their analysis of Indonesian manufacturing firms for the 1991–2001 period. The estimated results for the control variables are basically the same as those obtained in the country-level study.

We present the estimation results of a Cobb-Douglas production function in Tables 7 and 8 as a robustness check for TFP measurement issue arising from unbalanced panel data. In this production function model, the dependent variable is value added, and the independent variables include three inputs, i.e., number of employees (Labor), capital stock (Capital), and material costs (Material), as well as three FDI variables representing horizontal, forward, and backward FDI, and the control variables used in Equation 1. We obtained similarly robust results, showing no FDI spillover at the country level in Table 7, and significant forward FDI spillover at the province level in Table 8.

[9] For country-level estimation, we modify Equation 1 by subtracting subscript *p*. This adjustment allows us to utilize FDI-related variables at the country-sector level rather than at the province-sector level.

[10] For the basic statistics and definitions of variables, see Appendix Table 2.

Table 5: Estimation Results at Country Level

	(I)	(II)	(III)	(IV)
Dep. Variable	**Log of Total Factor Productivity**			
HFDI	–0.196	–0.202	–0.206	–0.201
	[0.212]	[0.213]	[0.212]	[0.212]
FFDI	0.065	0.08	0.077	0.079
	[0.196]	[0.204]	[0.205]	[0.204]
BFDI	0.314	0.331	0.341	0.335
	[0.194]	[0.198]	[0.197]	[0.200]
Size	0.554***	0.546***	0.531***	0.541***
	[0.045]	[0.044]	[0.043]	[0.049]
Skilled Labor		0.009***	0.009***	0.009***
		[0.001]	[0.001]	[0.001]
Import			0.199***	
			[0.048]	
Export				0.048
				[0.046]
Number of obs.	78,921	78,921	78,921	78,921
Adjusted R-sq.	0.418	0.429	0.431	0.429

Note: Each model is estimated using the OLS method and includes province-sector and year-fixed effects. All explanatory variables are lagged by one year. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively. In parentheses is the standard error clustered by sectors.

Table 6: Estimation Results at Province Level

	(I)	(II)	(III)	(IV)
Dep. Variable	**Log of Total Factor Productivity**			
HFDI	–0.045	–0.041	–0.039	–0.042
	[0.084]	[0.087]	[0.086]	[0.087]
FFDI	0.144**	0.136**	0.135*	0.137**
	[0.063]	[0.064]	[0.063]	[0.064]
BFDI	–0.076	–0.083	–0.081	–0.083
	[0.055]	[0.055]	[0.056]	[0.055]
Size	0.554***	0.546***	0.531***	0.541***
	[0.046]	[0.044]	[0.043]	[0.049]
Skilled Labor		0.009***	0.009***	0.009***
		[0.001]	[0.001]	[0.001]
Import			0.198***	
			[0.049]	
Export				0.048
				[0.045]
Number of obs.	78,921	78,921	78,921	78,921
Adjusted R-sq.	0.418	0.428	0.431	0.429

Note: Each model is estimated using the OLS method and includes province-sector and year-fixed effects. All explanatory variables are lagged by one year. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively. In parentheses is the standard error clustered by sectors.

Table 7: Estimation Results at Country Level by Cobb–Douglas Production Function

	(I)	(II)	(III)	(IV)
Dep. Variable		**Log of Value Added**		
Labor	0.539***	0.545***	0.543***	0.546***
	[0.013]	[0.012]	[0.012]	[0.012]
Capital	0.112***	0.104***	0.103***	0.105***
	[0.018]	[0.016]	[0.016]	[0.017]
Material	0.376***	0.374***	0.373***	0.374***
	[0.020]	[0.020]	[0.020]	[0.021]
HFDI	–0.116	–0.121	–0.122	–0.123
	[0.139]	[0.141]	[0.142]	[0.142]
FFDI	0.07	0.078	0.077	0.079
	[0.148]	[0.154]	[0.154]	[0.154]
BFDI	0.25	0.269	0.274	0.263
	[0.190]	[0.194]	[0.194]	[0.196]
Size	0.091***	0.093***	0.091***	0.098***
	[0.013]	[0.011]	[0.011]	[0.013]
Skilled Labor		0.006***	0.006***	0.006***
		[0.000]	[0.000]	[0.000]
Import			0.077***	
			[0.017]	
Export				–0.064
				[0.067]
Number of obs.	76,063	76,063	76,063	76,063
Adjusted R-sq.	0.823	0.825	0.825	0.825

Note: Each model is estimated using the OLS method and includes province-sector and year-fixed effects. All explanatory variables except three inputs (Labor, Capital, and Material) are lagged by one year. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively. In parentheses is the standard error clustered by sectors.

Table 8: Estimation Results at Province Level by Cobb–Douglas Production Function

	(I)	(II)	(III)	(IV)
Dep. Variable		**Log of Value Added**		
Labor	0.539***	0.545***	0.543***	0.546***
	[0.013]	[0.012]	[0.012]	[0.012]
Capital	0.112***	0.104***	0.104***	0.105***
	[0.018]	[0.016]	[0.016]	[0.017]
Material	0.376***	0.374***	0.373***	0.374***
	[0.020]	[0.020]	[0.020]	[0.021]
HFDI	–0.012	–0.012	–0.012	–0.011
	[0.062]	[0.065]	[0.064]	[0.065]
FFDI	0.106**	0.101**	0.101**	0.101**
	[0.039]	[0.040]	[0.040]	[0.041]
BFDI	–0.017	–0.022	–0.021	–0.022
	[0.016]	[0.016]	[0.016]	[0.016]
Size	0.091***	0.093***	0.091***	0.097***
	[0.014]	[0.011]	[0.011]	[0.014]
Skilled Labor		0.006***	0.006***	0.006***
		[0.000]	[0.000]	[0.000]
Import			0.076***	
			[0.018]	
Export				–0.065
				[0.066]
Number of obs.	76,063	76,063	76,063	76,063
Adjusted R-sq.	0.823	0.825	0.825	0.825

Note: Each model is estimated using the OLS method and includes province-sector and year-fixed effects. All explanatory variables except three inputs (Labor, Capital, and Material) are lagged by one year. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively. In parentheses is the standard error clustered by sectors.

6. CONCLUSIONS

This paper aimed to examine the FDI spillover effects from foreign to domestic firms in Indonesia and assess the significance of geographical factors for FDI spillover. It used firm-level data obtained from the Indonesian BPS, covering the period from 2000 to 2009 and focusing on 16 manufacturing sectors. Our findings indicate the absence of FDI spillover at the country level. However, we do observe significant forward FDI spillover at the province level. These findings indicate that in a large and archipelagic country such as Indonesia, FDI spillover is realized at the local level but not at the national level. Additionally, FDI spillover is likely to occur in the form of forward spillover, i.e., domestic firms procuring intermediate goods from foreign firms. This forward spillover may reflect the presence of quality, variety, and the learning effect.

We provide the following recommendations for domestic firms and governments based on our findings. By being located in close proximity to foreign firms, domestic firms can not only procure high-quality intermediate goods with a wide variety from foreign firms but they can also promote efficient use of intermediate goods and improve labor skills through active customer–supplier business relationships with foreign firms. With regard to recommendations for the government, our study highlights the importance of developing infrastructure facilities, such as transportation and telecommunication networks, to promote the diffusion of FDI spillover beyond the region and across the country. The presence of well-developed and well-functioning infrastructure could contribute to economic growth and development, particularly in areas with limited access to such infrastructure.

REFERENCES

Abraham, F., J. Konings, and V. Slootmaekers. 2010. Evidence of Firm Heterogeneity: FDI Spillovers in the Chinese Manufacturing Sector. *Economics of Transition* 18(1): 143–182.

Aleksynska, M., and O. Havrylchyk. 2013. FDI from the South: The Role of Institutional Distance and Natural Resources. *European Journal of Political Economy* 29: 38–53.

Amiti, M., and J. Konings. 2007. Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia. *American Economic Review* 97 (5): 1611–1638.

Blalock, G., and P. J. Gertler. 2009. How Firm Capabilities Affect Who Benefits from Foreign Technology. *Journal of Development Economics* 90(2): 192–199.

Buckley, P. J., J. Clegg, and C. Wang. 2007. Is the Relationship between Inward FDI and Spillover Effects Linear? An Empirical Examination of the Case of China. *Journal of International Business Studies* 38: 447–59.

Castellani, D., and A. Zanfei. 2007. Multinational Firms and Productivity Spillovers: The Role of Firms' Heterogeneity. *Progress in International Business Research*, 1: 33–60.

Demir, F., and C. Hu. 2016. Institutional Differences and Direction of Bilateral FDI Flows: Are South–South Flows any Different than the Rest? *The World Economy* 39(12): 2000–2024.

Farole, T., and D. E. Winkler. 2012. Foreign Firm Characteristics, Absorptive Capacity and the Institutional Framework: The Role of Mediating Factors for FDI Spillovers in Low-and Middle-income Countries. World Bank Policy Research Working Paper No. 6265.

Feinberg, S. E., and S. K. Majumdar. 2001. Technology Spillovers from Foreign Direct Investment in the Indian Pharmaceutical Industry. *Journal of International Business Studies* 32: 421–437.

Fujimori, A., and T. Sato. 2015. Productivity and Technology Diffusion in India: The Spillover Effects from Foreign Direct Investment. *Journal of Policy Modeling* 37(4): 630–651.

Gorodnichenko, Y., J. Svejnar, and K. Terrell. 2014. When Does FDI Have Positive Spillovers? Evidence from 17 Transition Market Economies. *Journal of Comparative Economics* 42(4): 954–969.

Hu, A. G., and G. H. Jefferson. 2002. FDI Impact and Spillover: Evidence from China's Electronic and Textile Industries. *The World Economy* 25(8): 1063–1076.

Ito, B., N. Yashiro, Z. Xu, X. Chen, and R. Wakasugi. 2012. How do Chinese Industries Benefit from FDI Spillovers? *China Economic Review* 23(2): 342–356.

Javorcik, B. S. 2004. Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages. *American Economic Review* 94(3): 605–627.

Keller, W., and S. R. Yeaple. 2009. Multinational Enterprises, International Trade, and Productivity Growth: Firm-level Evidence from the United States. *The Review of Economics and Statistics* 91(4): 821–831.

Liu, Z. 2002. Foreign Direct Investment and Technology Spillover: Evidence from China. *Journal of Comparative Economics* 30(3): 579–602.

Lu, Y., Z. Tao, and L. Zhu. 2017. Identifying FDI Spillovers. *Journal of International Economics* 107: 75–90.

Marin, A., and M. Bell. 2004. Technology Spillovers from Foreign Direct Investment (FDI): An Exploration of the Active Role of MNC Subsidiaries in the Case of Argentina in the 1990s. SEWPS – SPRU Electronic Working Paper Series, Paper No. 118.

Newman, C., J. Rand, T. Talbot, and F. Tarp. 2015. Technology Transfers, Foreign Investment and Productivity Spillovers. *European Economic Review* 76: 168–187.

Ponomareva, N. 2000. Are There Positive or Negative Spillovers from Foreign Owned to Domestic Firms? Working Paper BSP/00/042. Moscow: New Economic School.

Rodrik, D. 1999. The New Global Economy and Developing Countries: Making Openness Work. Policy Essay No. 24. Overseas Development Council, Washington, DC.

Rojec, M., and M. Knell. 2018. Why Is There a Lack of Evidence on Knowledge Spillovers from Foreign Direct Investment? *Journal of Economic Surveys* 32(3): 579–612.

Sabirianova, K., J. Svejnar, and K. Terrell. 2005. Distance to the Efficiency Frontier and Foreign Direct Investment Spillovers. *Journal of the European Economic Association* 3: 576–586.

Takii, S. 2009. Multinationals, Technology Upgrading, and Wages in Urban and Rural Indonesia. *Review of Development Economics* 13(1): 151–163.

Urata, S., and Y. Baek. 2022. Technology Spillover and Absorptive Capacity of Firms and Countries. ADBI Working Paper 1323.

Wang, Y. 2010. FDI and Productivity Growth: The Role of Inter–Industry Linkages. *Canadian Journal of Economics* 43(4): 1243–1272.

Wooldridge, J. M. 2009. On Estimating Firm-level Production Functions Using Proxy Variables to Control for Unobservables. *Economics Letters* 104(3): 112–114.

Xu, X., and Y. Sheng. 2012. Are FDI Spillovers Regional? Firm-level Evidence from China. *Journal of Asian Economics* 23(3): 244–258.

APPENDIX

Appendix Table 1: Description of Sample Sectors

No	Sector Name	Indonesian Statistik Industri ISIC rev3, 2 digit	OECD ICIO, ISIC rev4, 2 digit
1	Food	15	10T12
		16	10T12
2	Apparel	17	13T15
3	Wood	18	13T15
		19	13T15
		20	16
4	Paper	21	17T18
		22	17T18
5	Coke and refined petroleum	23	19
6	Chemicals	24	20
		24	21
7	Rubber and plastic	25	22
8	Minerals	26	23
9	Basic metals	27	24
10	Fabricated metals	28	25
11	General machinery	29	28
12	Electronic and optical machinery	30	26
		32	26
		33	26
13	Electrical machinery	31	27
14	Motor vehicles	34	29
15	Other transport equipment	35	30
16	Manufacturing n.e.c.	36	31T33

Source: Authors' compilation.

Appendix Table 2: Basic Statistics

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
Log of TFP	TFP was calculated by Wooldridge's (2009)'s method	78,921	5.528	1.251	–4.112	12.953
HFDI (Country level)	Horizontal FDI	78,921	0.291	0.113	0.026	0.917
FFDI (Country level)	Forward FDI	78,921	0.378	0.110	0.160	0.619
BFDI (Country level)	Backward FDI	78,921	0.416	0.101	0.162	0.789
HFDI (Province level)	Horizontal FDI	78,921	0.235	0.170	0.000	1.000
FFDI (Province level)	Forward FDI	78,921	0.237	0.202	0.000	0.802
BFDI (Province level)	Backward FDI	78,921	0.269	0.202	0.000	0.954
Log of Size	Number of employees	78,921	4.052	1.101	2.996	10.596
Skilled Labor (%)	Ratio of nonproduction workers to all workers	78,921	14.581	14.916	0	100
Import	Import dummy	78,921	0.116	0.320	0	1
Export	Export dummy	78,921	0.148	0.355	0	1

Note: For FDI-related variables, we have 128 FDI observations at country level (16 sectors × 8 years) and 1,798 FDI observations at province level (27 provinces × 16 sectors × 8 year = 1,658 (provinces with no firms in a specific sector)). In the estimation, these observations are assigned to the corresponding firms, and thus the number of observations for the FDI-related variables is given as 78,921, that is, the number of sample firms.

Source: Authors' compilation.