Journal of Social Economics Research
2025 Vol. 12, No. 1, pp. 67-80
ISSN(e): 2312-6264
ISSN(p): 2312-6329
DOI: 10.18488/35.v12i1.4163

The impact of foreign direct investment on total factor productivity: The case of Vietnam

Minh Ngo Ngoc
Industrial University of Hochiminh City, Vietnam.
Email: ngongocminh@iuh.edu.vn

Article History
Received: 23 December 2024
Revised: 10 March 2025
Accepted: 31 March 2025
Published: 15 April 2025

Keywords
FDI
Spillover effects
Supporting industry
TFP.

JEL Classification:
D00; D24; C23.

ABSTRACT

The purpose of this study is to evaluate the impact of spillover effects from foreign direct investment (FDI) on domestic supporting industry businesses in Vietnam. To this end, the paper uses the translog production function and addresses the endogeneity problem with the fixed effects method, followed by a random-effects model utilizing data from the enterprise survey conducted during the period of 2018-2022. The findings indicate that while intra-industry FDI enterprises have a negative impact, downstream FDI enterprises have a favorable impact. Domestic businesses with greater human resources will be better able to withstand downstream effects. Some policies that should be implemented in the near future include increasing the spillover effects from downstream FDI enterprises, reducing competitive pressure from FDI enterprises in the same industry, and promoting the role of human resources.

Contribution/Originality: This is the first study using the most updated data set to assess the spillover effects of FDI on the supporting industry in Vietnam. Not only that, the study also discusses the absorption capacity of FDI spillover effects of enterprises in this industry in Vietnam.

1. INTRODUCTION

Vietnam has drawn a significant amount of foreign direct investment following more than 30 years of economic reform. It has brought positive impacts to the Vietnamese economy in many aspects, such as increased exports, contributions to budget revenue, and job creation. However, the question arises as to whether FDI has brought about strong impacts, changed the structure of the domestic economy, and promoted domestic enterprises' participation in global value chains (GVCs). Supporting industries—producing intermediate inputs for export-oriented assembly businesses—are considered core industries of the economy, having a significant impact on the economy's involvement in GVCs. As a result, FDI's effects on domestic supporting industry businesses are vital in advancing the process of global economic integration.

Researching the impact of foreign direct investment (FDI) on total factor productivity (TFP) of domestic supporting industry enterprises (SI) in Vietnam is extremely necessary, especially in the context of the Vietnamese economy entering an era of development. SI plays an important role in the process of industrialization and modernization of the country, serving as a bridge between different industries. FDI is an important source of capital for the development of SI, bringing technology, management skills, and access to international markets. However, while FDI can bring benefits, it can also pose challenges for domestic SI enterprises. The study aims to objectively assess the impact of FDI, thereby proposing solutions to optimize benefits and minimize negative impacts. As Vietnam

deeply integrates into the world economy, researching the impact of FDI is essential to ensure the sustainable development of SI. The research content includes measuring TFP, analyzing the impact of FDI on TFP, identifying factors affecting the impact of FDI on TFP, and proposing solutions to optimize benefits from FDI and increase TFP of domestic supporting industry enterprises. Researching the impact of FDI on TFP of domestic supporting industry enterprises is an important task that contributes to the sustainable development of the Vietnamese economy.

Although there are many studies on the impact of foreign direct investment (FDI) on total factor productivity (TFP) in Vietnam (Arif-Ur-Rahman & Inaba, 2021; Han, Smith, & Wu, 2024; Huynh, Nguyen, Trieu, & Tran, 2021; Ni, Spatareanu, Manole, Otsuki, & Yamada, 2017; Thang, Pham, & Barnes, 2016) there are still many gaps that need to be exploited. Although there have been many studies on the impact of foreign direct investment (FDI) on total factor productivity (TFP) in Vietnam (Arif-Ur-Rahman & Inaba, 2021; Han, Smith, & Wu, 2024; Huynh, Nguyen, Trieu, & Tran, 2021; Ni, Spatareanu, Manole, Otsuki, & Yamada, 2017; Thang, Pham, & Barnes, 2016) there are still many gaps that need to be exploited. Specifically, the above studies only focus on studying the direct impact of FDI without deeply considering the spillover effects on domestic enterprises along the supply chain or in the same industry. Moreover, not all FDI flows have the same benefits, but there are still few studies that clearly analyze the differences between high-tech FDI and low-value-added FDI. Another important issue is the technology absorption capacity of Vietnamese enterprises – a decisive factor in the level of benefits from FDI – but it has not been fully studied.

To contribute to the literature, this research was the first to explore the spillover effects of FDI on a specific industry, the research subjects are domestic supporting industry enterprises. It is of great significance, especially in the context of Vietnam's increasing integration into the global economy through some new generation Free Trade Agreements.

To assess the spillover effects of FDI enterprises on domestic supporting industry enterprises, this paper focuses on evaluating the impact of FDI on the TFP of domestic supporting industry enterprises in Vietnam. The paper uses STATA 15.0 software to process the enterprise survey data over five years (2018-2022). The channels of FDI impact are intra-industry and downstream effects, and interaction variables are included in the model to examine the absorptive capacity of domestic enterprises. Besides FDI factors, the model also considers other influencing variables such as labor quality and capital intensity, domestic demand, institutional environment, and enterprise characteristics; these variables serve as control variables in the empirical model.

2. LITERATURE REVIEW

2.1. The Concept of Supporting Industries

The term "supporting industries" became popular in Vietnam around 2007 with the publication "Building Supporting Industries in Vietnam" edited by Ohno (2007). However, to date, there is no consensus on this concept. According to Quynh (2007) "Supporting industries are a group of industrial activities that provide intermediate inputs (including components, parts, and tools to produce these components and parts) for assembly and processing industries." According to Chau (2010), supporting industries are those that produce components, parts, and intermediate products, which serve as inputs and are assembled into final products. Meanwhile, Binh (2010) suggests that supporting industries encompass all activities involved in creating components and accessories that contribute to the formation of finished products for consumers.

Decree 111/2015/QĐ-TTg dated November 3, 2015, on the development of supporting industries, defines supporting industries as "industries that produce raw materials, materials, components, and parts to supply the production of finished products." Decision 9028/QĐ-BCT 2014 on the Master Plan for Supporting Industry Development to 2020 with a vision to 2030 specifies three areas planned: (i) Components and parts; (ii) Supporting industries for textiles, garments, and footwear; (iii) Supporting industries for high-tech industries. The report of the Ministry of Industry and Trade on supporting industries, based on the 2018 sample survey of supporting industry

enterprises by the General Statistics Office, also focuses on similar industries, including automotive components, mechanics, electronics, textiles, garments, and footwear (Ministry of Industry and Trade, 2019).

It is evident that the concept of supporting industries lacks clear boundaries. Within research, this concept is increasingly specified across sectors and fields to ensure thorough consideration and alignment with practical contexts. In this study, we define supporting industries as those producing basic materials, components, parts, and semi-finished products supplied to industries within seven sub-sectors: (1) textile-footwear supporting industries; medium technology level: (2) plastic-rubber components, (3) metal-mechanical components; high technology level: (4) electronic components; (5) electrical components; (6) automotive and motorcycle components; (7) high-tech supporting industries.

2.2. Impact of FDI Enterprises on Domestic Supporting Industry Enterprises

For domestic supporting industry enterprises, linkages with FDI enterprises play an important role, especially for developing countries. This linkage not only brings a large demand for domestic supporting industry enterprises, but also contributes to improving the operational efficiency and technological level of domestic enterprises. Ohno (2007) pointed out that narrowing the gap in information and awareness between supporting industry enterprises and FDI assembly enterprises is one of the factors contributing to promoting the development of supporting industries.

Like other domestic enterprises in the economy, the spillover effects of FDI enterprises are divided into two groups: (i) horizontal spillovers, which are the effects from FDI enterprises in the same industry as domestic enterprises, and (ii) vertical spillovers, which are the effects from FDI enterprises that are suppliers or customers of domestic enterprises (Sari, Khalifah, & Suyanto, 2016).

The intra-industry impact is due to the learning process of domestic enterprises about the management methods and technology of FDI competitors in the industry. This impact also comes from the movement of labor from FDI enterprises - laborers who have improved their qualifications and skills after a period of working for FDI enterprises - to work for domestic enterprises. Some empirical studies show the positive impact of FDI enterprises on domestic enterprises, such as the case of Indonesian manufacturing enterprises (Sari et al., 2016) and Bangladeshi manufacturing and service enterprises (Arif-Ur-Rahman & Inaba, 2021). In addition to positive impacts, FDI enterprises can also cause negative impacts (Khalifah, Mohd Salleh, & Adam, 2015) such as squeezing domestic enterprises, attracting orders in the market, causing domestic enterprises - with less competitive capacity - to cut production, and affecting the production capacity and efficiency of these enterprises. Farole and Winkler (2015) found this negative impact in 78 low and middle-income countries. Kim (2015) provided evidence of this negative impact in Korea. Some studies in Vietnam also pointed out this negative impact (Huynh et al., 2021; Nguyen, Tran, Le, & Trieu, 2020; Ni et al., 2017; Thang et al., 2016). Besides, some studies show that the intra-industry FDI impact is insignificant (Khalifah et al., 2015; Wiboonchutikula, Phucharoen, & Pruektanakul, 2016).

Cross-sectoral FDI impacts include impacts from FDI enterprises as input suppliers (upstream impacts) and impacts from FDI enterprises as customers (downstream impacts). With production inputs being high-quality products and modern techniques from FDI suppliers, domestic enterprises must change and improve production processes, machinery, and equipment, thereby enhancing production capacity. FDI suppliers can also provide technical support to domestic enterprises so that inputs are used optimally. However, high input costs from FDI suppliers can also cause negative impacts on domestic enterprises. Sari et al. (2016) show this positive impact on Indonesian manufacturing enterprises, while Wiboonchutikula et al. (2016) indicate a negative impact on Thai manufacturing enterprises. Studies on Vietnam also show both negative (Nguyen et al., 2020; Thang et al., 2016) and positive (Duong & Hung, 2017) impacts.

FDI customers can also have positive or negative impacts. These FDI enterprises also provide technical support to ensure that the products of domestic enterprises meet their required standards.

These FDI enterprises are often multinational corporations, and with large orders, FDI enterprises create opportunities for domestic enterprises to promote economies of scale. Many empirical studies show the positive impacts of FDI customers on domestic enterprises, such as the cases of India (Fujimori & Sato, 2015) and Thailand (Wiboonchutikula et al., 2016).

Studies in Vietnam also show this positive impact (Duong & Hung, 2017; Newman, Rand, Talbot, & Tarp, 2015; Nguyen et al., 2020; Ni et al., 2017). However, in the case of FDI enterprises using imported inputs or from FDI enterprises that are competitors of domestic enterprises, it can create competitive pressure on domestic enterprises, narrowing the consumption market for domestic enterprises and hindering their development. Sari et al. (2016) demonstrated this negative impact on the productivity of Indonesian manufacturing enterprises.

There are studies evaluating the impact of FDI on industries related to supporting industries, but none evaluating the spillover effects of FDI on local supporting industry firms in Vietnam. Duong and Hung (2017) showed the positive impact of inter-industry FDI enterprises on garment enterprises from 2009 to 2013. Nguyen, Tran, Le, Trieu, and Huynh (2019) also showed the positive impacts of FDI customers on mechanical and electronic enterprises in the period 2007-2015. However, both studies did not find intra-industry impacts from FDI enterprises.

The supporting industry report of the Ministry of Industry and Trade also shows that the linkage between domestic supporting industry enterprises and FDI enterprises is still loose. Regarding linkages with downstream FDI enterprises, among the 48% of domestic supporting industry enterprises that have relationships with downstream FDI enterprises, only 5% have revenue entirely from FDI customers, of which the electronics industry has the highest rate of 22%, the textile and footwear industry has only 3%. Regarding linkages with upstream FDI enterprises, only 3% of domestic supporting industry enterprises have suppliers that are FDI enterprises, which shows that supporting industry enterprises have few connections with FDI suppliers. Regarding technical support from FDI enterprises for domestic supporting industry enterprises, only about 8% of domestic supporting industry enterprises in the survey sample received this support (Ministry of Industry and Trade, 2019).

Given Vietnam's growing involvement in both bilateral and international trade agreements and its growing appeal to foreign direct investment, it is necessary to assess the impact of FDI enterprises on domestic supporting industries. Since domestic supporting industry enterprises have few connections with upstream FDI enterprises, the study focuses on the intra-industry impact channel and the impact channel from downstream FDI enterprises.

Other research on domestic supporting industries showed a decline in technical efficiency (TE) of domestic supporting industry enterprises compared to FDI competitors in the period 2010-2018 (Thanh & Trang, 2020) thereby showing a decline in the competitiveness of domestic enterprises. Regarding the impact of FDI on domestic supporting industry enterprises, both FDI enterprises in the same industry and downstream FDI enterprises have a negative impact on TE (Trang & Thanh, 2021) while when assessing the impact on TFP, only FDI enterprises in the same industry have a negative impact, while downstream FDI has a positive impact (Trang & Thanh, 2022). This result shows the uneven efficiency of domestic supporting industry enterprises, so although downstream FDI enterprises have a positive impact, helping to improve the TFP of domestic supporting industry enterprises, they reduce the TE of domestic enterprises, showing the differentiation between the group with higher efficiency and the group with lower efficiency of domestic enterprises.

Papers on studying the impact of FDI on TFP in Vietnam have exhibited notable weaknesses. A significant limitation is the reliance on outdated data; for instance, some analyses utilize datasets from 2000 to 2005, which may not accurately reflect current economic conditions. Additionally, many studies focus predominantly on the direct effects of FDI, often overlooking the nuanced spillover impacts across different regions and industries. This narrow scope can lead to incomplete assessments of FDI's broader influence on TFP. Furthermore, there's a tendency to generalize findings without adequately considering regional disparities within Vietnam, despite evidence suggesting that FDI's impact on TFP varies significantly across different areas. Another critical gap is the insufficient examination of the absorptive capacity of local firms, which plays a crucial role in effectively leveraging FDI for

productivity gains. Lastly, the dynamic nature of Vietnam's investment climate, influenced by recent global trade shifts and policy changes, is often underrepresented in these analyses, leading to conclusions that may not align with the current economic landscape.

The novelty of this study is to consider the factors affecting intra-industry FDI and inter-industry FDI. Regarding the cross-industry FDI impact, since very few (about 3%) domestic supporting industry enterprises have FDI suppliers (Ministry of Industry and Trade, 2019) the study will only consider the downstream FDI impact without considering the upstream FDI impact. The enhanced absorption capacity of FDI spillover effects is also evaluated by taking into account the interaction variables between FDI and internal firm parameters like capital intensity and labor quality.

3. RESEARCH METHODS AND DATA

3.1. Production Function and TFP Estimation

Total factor productivity from the Cobb-Douglas production function was initiated by Solow in 1957 and developed into many different schools. Solow (1957) assumed that all enterprises are on the production frontier; TFP is the residual of the production process after calculating the contribution of input factors. With the parametric approach, the Cobb-Douglas production function of constant elasticity of substitution (CES) is a production function with a constant input elasticity coefficient.

Developing this production function, which allows the input elasticity coefficient to change, the transcendental logarithmic production function (translog function) was developed in 1967 (Kmenta, 1967). In the translog function, the input elasticity of substitution changes, resulting in a non-linear relationship between inputs and outputs. Studies estimating TFP growth from the translog function are also found in research such as Francis, Karalashvili, Maemir, and Meza (2020) and Le, Nguyen, and Do (2021).

Realizing that inputs such as capital investment and raw materials have endogeneity with TFP, economists continue to develop estimation methods to deal with the endogeneity problem. Van Beveren (2012) has summarized 4 main methods: (1) Fixed effects method; (2) Instrumental variable method (IV) and generalized method of moments (GMM); (3) Semi-parametric method of Olley and Pakes (1996) (abbreviated as OP); (4) Semi-parametric method of Levinsohn and Petrin (2003) (abbreviated as LP). However, to implement methods (2), (3), (4), it is necessary to have sufficient data. With the IV and GMM methods, it is necessary to have balanced panel data or some data fields for instrumental variables; OP needs data on investment capital; LP needs data on intermediate inputs.

Table 1 presents the variables used in model 1. Value added (VA) measures an enterprise's economic productivity, representing how much new value it generates. Higher VA means the firm is more productive and contributes more to the economy.

Fixed assets include physical assets such as machinery, buildings, and equipment that the enterprise owns. A higher Kit suggests that the firm has more capital investment to support production. Lit is a basic measure of employment within the enterprise. The average number of employees provides a more stable estimate than just looking at a single point in time. Instead of just counting workers, Hum measures their quality based on costs per worker (wages, training, etc.).

Taking the natural log (ln) smooths out variations and makes comparisons easier. Higher Hum suggests better-skilled workers or higher investment in human capital. Capital intensity (CI) measures how much capital is allocated per worker. A higher CI means the enterprise is more capital-intensive, relying more on machines, technology, and equipment rather than labor. The log transformation ensures values are comparable and reduces the impact of extreme values.

Table 1. Main variables in the models.

Variables	Symbol	Definition/Calculation
The value added of enterprise i in year t	VA_{it}	The VA uses the income method and calculates it in millions of VND.
The assets of enterprise i in year t	K_{it}	K uses the fixed assets of the enterprise, and the calculations are in millions of VND.
The number of employees of enterprise i, at time point in year t	L_{it}	L measures the average number of employees at the beginning and end of the year for the enterprise.
Labor quality	Hum	Hum is represented by the natural logarithm of the average cost per worker of the enterprise.
Capital intensity	CI	CI is determined by the natural logarithm of the average asset value per worker of the enterprise.

Therefore, to estimate TFP in this study, we use the translog production function and handle the endogeneity problem with the fixed effects method.

The general log-linear production function is as follows.

$$LnVA_{it} = \beta_0 + \beta_1 lnK_{it} + \beta_2 lnL_{it} + v_i + \varepsilon_{it} \quad (1)$$

The translog production function has the form.

$$Ln\,VA_{it} = \beta_0 + \beta_1 lnK_{it} + \beta_2 lnL_{it} + \beta_3 (lnK_{it})^2 + \beta_4 (lnL_{it})^2 + \beta_5 (lnK_{it})(lnL_{it}) + v_i + \varepsilon_{it} \quad (2)$$

In which,

v_i are the observable residuals of firm i's characteristics over time (fixed effects). ε_{it} are the unobservable residuals, which are assumed to be normally distributed.

The F-test is used to determine whether the translog production function is superior to the log-linear function.

From the selected production function, TFP growth is determined as follows:

$$\widehat{LnTFP} = \widehat{\beta_0} + \widehat{\vartheta_i} + \widehat{\varepsilon_{it}} \quad (3)$$

3.2. Model of Factors Affecting TFP

With the endogenous growth approach, developed in the 1980s by representatives such as Lucas Jr (1988) and Romer (1994), total factor productivity is no longer an exogenous factor as in the Solow model, but is determined by factors such as human capital, technology level, institutional environment, etc. The model of factors affecting TFP has the following form.

$$LnTFP_{it} = \delta_0 + \delta Z_{it} + u_i + \omega_{it} \quad (4)$$

Where Zit is a vector of factors affecting TFP (lnTFP), including the spillover effects of FDI enterprises. Specifically, Zit includes the following factors:

*Internal factors of the enterprise:

- Labor quality (lnHum) is represented by the natural log of the average cost per worker of the enterprise.
- Capital intensity (lnCI) is determined by the natural log of the average asset value per worker of the enterprise.

*FDI factors and interaction variables:

- The impact of intra-industry FDI enterprises (HFSpill) is determined by the following formula.

$$HFSpill_{jt} = \frac{\sum_{i \in j} FSh_{it} + L_{it}}{\sum_{i \in j} L_{it}}$$

Where, FSh_{it} is the foreign capital ratio of enterprise i, at time t; j is one of the seven sub-sectors.

- Interaction variable between the impact of intra-industry FDI and 2 internal factors of the enterprise.

$$HFSpill_{hum} = HFSpill_{jt} * lnHum_{it}$$

$$HFSpill_{CI} = HFSpill_{jt} * lnCI_{it}$$

- The impact of downstream FDI enterprises indicates the impact of FDI enterprises in industries using inputs as products of supporting industrial enterprises - FDI backward effect (BFSpill) - measured by the spillover effect of these downstream FDI enterprises, determined by the formula:

$$BFSpill_{jt} = \sum_{k} b_{kl} * HSpill_{jt}$$

$BFSpill_{jt}$ is the spillover effect of FDI enterprises on the supporting industry sub-sector j. Downstream FDI enterprises use inputs as products of supporting industry enterprises in industry j. bkl is the coefficient indicating that when industry k increases by 1 unit of product, industry l needs to increase by how many units of product. This coefficient is calculated from the inter-industry balance sheet Input-Output Table (IOT).

$$BSpill\_ratio_{jt} = \frac{\sum_k b_{kl} * L_{jt}}{\sum_{i \in j} L_{jt}}$$

- Interaction variable between the impact of downstream FDI and 2 internal factors (human resource quality and capital intensity)

$$BFSpill_{hum} = BFSpill_{jt} * lnHum_{it}$$

$$BFSpill\_CI = BFSpill_{jt} * lnCI_{it}$$

Other factors:

- Domestic demand for industry j (BSpill_ratio) shows the impact of all downstream enterprises using inputs as products of industry j, measured by the following formula:

$$BSpill\_ratio_{jt} = \frac{\sum_k b_{kl} * L_{jt}}{\sum_{i \in j} L_{jt}}$$

- Institutional environment, represented by two components of the Provincial Competitiveness Index (PCI). These are the "informal costs" component and the "competition environment" component.

Business characteristics:

- The Region variable is a dummy variable, taking 6 values from 1 to 6, representing 6 geographical regions: 1: Red River Delta; 2: Northern Midlands and Mountains; 3: North Central and Central Coast; 4: Central Highlands; 5: Southeast; 6: Mekong Delta.
- The enterprise size variable (SIZE) is also a dummy variable, taking values from 1 to 4, corresponding to the enterprise sizes: 1 - micro; 2 - small; 3 - medium; and 4 - large.
- The industry (sub-industry) of the enterprise (supind) is a dummy variable with values from 61 to 67, corresponding to 7 sub-industries of the supporting industry: 61 - textile and garment - footwear supporting industry; 62 - plastic - rubber components; 63 - mechanical and metal components; 64 - electronic components; 65 - electrical components; 66 - automotive and motorbike components; 67 - high-tech supporting industry. Observations are calculated in enterprise money (value added, assets) adjusted by the deflator to obtain real values at the time of 2010.

3.3. Data

The study uses data from the General Statistics Office's Enterprise Census from 2019 to 2023 to examine the impact of internal factors, characteristic factors, and coordinates with the 2020 IO Table to examine the impact of variables related to FDI enterprises and domestic aggregate demand. Uses PCI data from 2018 to 2022 to examine the impact of the institutional environment on enterprise TFP.

4. MODEL RESULTS

4.1. Supporting Industry Codes

From the list of VSIC 2007 and VSIC 2022 industry codes, the supporting industry codes are determined as follows: textile-garment-leather-footwear supporting industry includes codes such as 131, 132, 15110; plastic-rubber components include 221, 222; metal mechanical components include 251, 25910, 25920, 25930, 25999; electronic components include 261; electrical components include 271, 272, 273, 274, 279; automobile-motorcycle components include 281, 292, 293, 30990; High-tech supporting industries include 20131, 20132, 203, 26510, 266, 267, 268, 32501.

4.2. Descriptive Statistics

After cleaning the data, the research sample consists of 60,812 observations of domestic supporting industry enterprises over 5 years, of which 11,560 observations were in 2018; 15,981 observations were in 2019; 5,967 observations were in 2020; 12,161 observations were in 2021; and 15,143 observations were in 2022.

The majority of domestic supporting industry enterprises in the survey sample are located in the Red River Delta (40%) and the Southeast (40%). 95% are micro and small enterprises. About 60% of the companies are in the mechanical and metal components sub-sector, followed by plastic-rubber components and textile-leather-footwear.

Table 2 presents descriptive statistics for key variables in the model over the years 2018–2022. The descriptive statistics include the Mean (M) and Standard Deviation (SD) for each variable. LnCI represents the logarithm of capital investment. LnHum measures human capital based on education levels. HFSpill captures knowledge or technology spillover from foreign firms operating in the same industry. BFSpill represents spillover effects from foreign firms to their local suppliers. Bspill_ratio is the ratio of backward spillover to another metric. Informal reflects the extent of informal economic activities. Competition indicates the level of competition in the market.

Capital investment (LnCI) peaked in 2019 but fluctuated afterward. Human capital (LnHum) steadily increased but stabilized in later years. Foreign spillovers (HFSpill & BFSpill) remained relatively stable, though backward spillovers (BFSpill) dipped in 2020. Backward spillover ratio declined, suggesting reduced dependency on foreign spillovers. Informality in the economy increased, which might indicate regulatory challenges or a growing informal sector. Competition levels increased steadily, indicating a more competitive business environment.

Table 2. Descriptive statistics for some key variables in the model (4).

Variables	Mean (M) and Standard deviation (SD)	Year				
		2018	2019	2020	2021	2022
LnCI	M	4.05	4.59	4.07	4.02	4.05
	SD	1.05	1.24	1.54	1.51	1.42
LnHum	M	3.68	3.86	3.92	3.91	3.87
	SD	0.53	0.55	0.61	0.56	0.58
HFSpill	M	0.43	0.45	0.46	0.44	0.41
	SD	0.15	0.14	0.14	0.15	0.16
BFSpill	M	0.33	0.32	0.28	0.33	0.34
	SD	0.12	0.15	0.14	0.12	0.12
Bspill_ratio	M	2.15	2.13	1.88	1.86	1.68
	SD	1.11	1.21	1.35	1.17	1.11
Informal	M	4.92	4.77	5.11	5.15	5.71
	SD	0.57	0.62	0.57	0.71	0.48
Competition	M	4.33	4.43	4.37	4.56	5.47
	SD	0.75	0.57	0.59	0.68	0.74

4.3. Selecting the Production Function and Estimating TFP

Using the F-test to confirm the selection of the translog production function and running model (2). Use robust standard error estimates to handle heteroscedasticity. LnTFP is determined by Equation 3.

4.4. Results of the Model of Factors Affecting TFP (LnTFP)

In Equation 4, Z_{it} is a vector of factors affecting LnTFP, including some enterprise-specific variables, which are variables that do not change over time. Therefore, the study uses panel data regression with the stochastic estimation method for model (4). Robust standard error estimates are used to handle heteroscedasticity.

To examine the spillover effects of FDI more closely, interaction variables are included in the model. The study runs 4 models. Model 1 does not include any interaction variables. Model 2 includes interaction variables between FDI spillover variables and the quality of human resources of enterprises. Model 3 includes interaction variables between FDI spillover variables and the capital intensity of enterprises. Model 4 includes both types of interaction variables above. The results of the 4 models are as follows:

The results of running the 4 models show that there are not many changes in the coefficients of the variables, showing the stability of the model.

Table 3 presents the results of four different models analyzing the impact of foreign direct investment (FDI) on total factor productivity (TFP) of domestic supporting industry enterprises. The coefficient of LnHum is consistently positive and highly significant across all models (ranging from 0.81 to 0.85, significant at 1%). This indicates that an increase in human capital strongly enhances TFP in domestic supporting industries. LnCI shows a small but negative coefficient, which is statistically significant at different levels across models (-0.01 to -0.03). This suggests that excessive capital intensity may have a slight adverse impact on productivity. HFSpill (horizontal spillovers) has a negative impact on TFP, although its significance varies across models. BFSpill (backward spillovers) has a strong positive effect on TFP, with coefficients ranging from 2.68 to 3.29, significant at 5% or 10% levels. These results suggest that while horizontal spillovers from FDI firms may not benefit domestic firms, backward linkages (supply chain relationships) contribute positively to TFP. The interaction between horizontal spillovers and human capital is positive but not statistically significant. The interaction between backward spillovers and human capital is positive and significant, indicating that human capital enhances the benefits of backward spillovers. These interactions show small and insignificant effects, suggesting that capital intensity does not strongly moderate the impact of spillovers.

Informality has a consistently positive and significant coefficient (0.05, significant at 1%), implying that informal practices contribute to higher TFP. Competition has a slightly negative effect but is mostly insignificant. Various industry dummies (62.Supind to 67.Supind) show different effects on TFP, with some industries experiencing negative impacts and others positive. Regional effects are mostly insignificant, except for Regions 5 and 6, which positively influence TFP. Larger firm sizes (Size 2, 3, and 4) have a strong and positive impact on TFP, significant at 1%. This suggests that larger firms benefit more from FDI spillovers compared to smaller ones. The inclusion of interaction variables in Models 3 and 4 enhances explanatory power. Model 4 is identified as the most suitable, as it accounts for interaction effects and improves the significance of key variables. This analysis highlights that human capital and firm size are key determinants of TFP in domestic supporting industries. While backward spillovers from FDI positively contribute to productivity, horizontal spillovers show a negative or insignificant impact. The results emphasize the necessity of interactive variables in the model, validating Model 4 as the best fit for explaining the relationship between FDI and TFP.

The results show that FDI enterprises bring both negative and positive impacts to domestic supporting industry enterprises. Compared with all previous studies on the impact of FDI on the Vietnamese economy, this paper finds that downstream FDI enterprises (BFSpill) have positive impacts, helping to improve enterprise productivity, while FDI enterprises in the same industry (HFSpill) have negative impacts. All four models have consistent results on the impact of FDI with a significance level of over 5%. The interaction variables help clarify the spillover effects of FDI. Enterprises with higher human resources quality increase the ability to absorb spillover effects from downstream FDI enterprises, but do not help reduce the negative impacts from the impact of FDI enterprises in the same industry.

Table 3. Results of four models assessing the impact of FDI on TFP of domestic supporting industry enterprises.

Dependent variable: Ln (TFP)	Model 1	Model 2	Model 3	Model 4
Independent variables	**Coefficients**			
LnHum	0.85***	0.81***	0.84***	0.81***
	(0.01)	(0.03)	(0.01)	(0.05)
LnCI	-0.01***	-0.01***	-0.03*	-0.03*
	(0.01)	(0.01)	(0.01)	(0.01)
HFSpill	-0.22*	-0.36	-0.37**	-0.47*
	(0.14)	(0.24)	(0.16)	(0.25)
BFSpill	3.21**	2.77**	3.29**	2.68*
	(1.35)	(1.43)	(1.39)	(1.41)
Bspill_ratio	-0.16***	-0.16***	-0.17***	-0.17***
	(0.01)	(0.01)	(0.01)	(0.02)
HFSpill_hum		0.05		0.05
		(0.05)		(0.06)
BFSpill_hum		0.14**		0.15*
		(0.06)		(0.06)
HFSpill_CI			0.04	0.04
			(0.02)	(0.03)
BFSpill_CI			0.03	0.02
			(0.03)	(0.03)
Informal	0.05***	0.05***	0.05***	0.05***
	(0.00)	(0.00)	(0.00)	(0.00)
Competition	-0.01	-0.01	-0.01*	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)
62.Supind	-0.26***	-0.23***	-0.25***	-0.25***
	(0.06)	(0.06)	(0.07)	(0.07)
63.Supind	-0.67**	-0.69**	-0.67**	-0.68**
	(0.33)	(0.33)	(0.33)	(0.32)
64.Supind	0.41***	0.42***	0.42***	0.42***
	(0.13)	(0.13)	(0.14)	(0.14)
65.Supind	-0.07	-0.11	-0.08	-0.10
	0.05***	0.05***	0.05***	0.05***
66.Supind	0.41*	0.41*	0.41	0.41*
	(0.24)	(0.24)	(0.24)	(0.24)
67.Supind	0.43	0.43	0.43	0.43
	(0.44)	(0.44)	(0.44)	(0.44)
2.Region	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
3.Region	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
4.Region	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)
5.Region	0.05***	0.05***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
6.Region	0.11***	0.11***	0.11***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)
2. Size	0.11***	0.11***	0.11***	0.10***
	(0.00)	(0.00)	(0.00)	(0.00)
3. Size	0.34***	0.34***	0.34***	0.34***
	(0.01)	(0.01)	(0.01)	(0.01)
4. Size	0.47***	0.47***	0.47***	0.47***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	-0.13	0.08	-0.03	0.17
	(0.26)	(0.33)	(0.28)	(0.33)

Note: Standard errors are in parentheses; ***, **, * indicate statistical significance at the 1%, 5%, 10% levels. The inclusion of interactive variables in the model has made some variables statistically significant (HFSpill variable, BFSpill_hum variable), showing the necessity of including interactive variables in the model. Therefore, model 4 is the most suitable model among the 4 models.

This one differs from the results of the studies of Binh (2010) and supports Huynh et al. (2021). The interaction variable with capital intensity is not statistically significant, thereby showing that the capacity of enterprises to equip machinery and equipment is not sufficient to support enterprises in absorbing spillover effects from FDI enterprises.

In addition to FDI variables, the impact results of other variables show more clearly the factors affecting TFP of domestic supporting industry enterprises. Labor quality (lnHum) has a positive impact, while capital intensity (lnCI) has a negative impact. Domestic demand (BSpill_ratio) also has a negative impact on the productivity of domestic supporting industry enterprises. One of the distinctive contributions of this study is to figure out that informal costs help enterprises operate more productively. Regarding the enterprise characteristics of the sub-sector, enterprises in the electronic components (64) and automobile and motorbike components (66) sub-sectors have higher TFP, while rubber, plastic (62), and mechanical (63) enterprises have lower TFP. Enterprises in the Southeast (5th Region) and the Mekong Delta (6th Region) operate more productively than enterprises in the Red River Delta. In terms of enterprise size, micro-enterprises have the lowest productivity.

5. CONCLUSION AND POLICY IMPLICATIONS

The study effectively addresses the research gap, not only assessing the direct impact of FDI but also considering the technology spillover effect and productivity improvement at domestic enterprises in the supporting industry. These findings provide practical evidence for the development of policies to attract and effectively utilize FDI in this sector.

The results of this study indicate that downstream FDI enterprises bring positive spillover effects, helping to improve the TFP productivity of domestic supporting industry enterprises. This result is quite consistent with many other studies on the impact of downstream FDI enterprises on domestic enterprises, such as the case of manufacturing and processing enterprises (Huynh et al., 2021) and service enterprises (Arif-Ur-Rahman & Inaba, 2021). However, FDI enterprises that are competitors of domestic supporting industry enterprises cause negative impacts. These FDI enterprises with increasingly higher technical efficiency than domestic enterprises (Thanh & Trang, 2020) have created competitive pressure on domestic enterprises, attracting orders from the market, reducing development opportunities and reducing the productivity of domestic enterprises. Some studies on the impact of FDI enterprises on other domestic enterprises also have similar results such as Huynh et al. (2021) and Ni et al. (2017).

The participation of interaction variables in the model contributes to affirming the role of human resources in increasing the ability to absorb spillover effects from downstream FDI enterprises. Human resource quality is also a factor that increases TFP productivity of domestic supporting industry enterprises. Meanwhile, capital intensity indicates the level of capital equipment of enterprises, which is a factor that reduces the productivity of supporting industry enterprises and, therefore, does not increase the ability to absorb FDI spillover effects. This shows that the human resource factor still plays an important role for domestic supporting industry enterprises. Machinery investment is a particularly important factor for supporting industry enterprises, but research results show that domestic supporting industry enterprises invest in ineffective machinery, leading to a decrease in enterprise productivity. In fact, nearly 90% of domestic supporting industry enterprises are still using manual and semi-automatic machinery (Ministry of Industry and Trade, 2019) so increasing investment in machinery will not increase the efficiency of the enterprise. Some enterprises invest in foreign machinery, but the human resources are not capable of operating and maintaining the machinery effectively, which is also a reason for ineffective investment in machinery (Tung & Oyama, 2018).

Domestic market demand plays an important role in the development of domestic supporting industry enterprises. However, the results show that increased domestic demand reduces the productivity of enterprises. In practice, many domestic enterprises import components and equipment to serve production, so not only does it not create demand for domestic supporting industry enterprises but also increases competitive pressure on domestic supporting industry enterprises.

Among the seven supporting industry sub-sectors, electronics and auto-motorcycle components enterprises have higher TFP productivity. With more and more FDI projects in the electronics and auto-motorcycle components sector, the positive spillover of high-end FDI enterprises in this sector has contributed to increasing the productivity of domestic enterprises, thereby showing that domestic supporting industry enterprises in these two sub-sectors are currently making good use of FDI capital. In addition, these two sub-sectors belong to high-tech industries and have higher TFP productivity, which will contribute to improving the technology level of domestic supporting industries. Although the majority of domestic supporting industry enterprises are located in the Red River Delta and the Southeast region, associated with two major economic centers, Hanoi and Ho Chi Minh City, the results show that enterprises in the South have higher productivity than those in the North. This may indicate that the southern business investment environment is more favorable than the northern environment. The study makes several policy recommendations based on empirical findings, including.

First, to increase the spillover effects from downstream FDI enterprises, business connection policies need to be further promoted, so that domestic supporting industry enterprises can easily access FDI enterprises and receive support and spillover from FDI enterprises.

Second, to reduce competitive pressure from FDI enterprises in the same industry, it is necessary to review preferential policies for FDI enterprises, helping domestic supporting industry enterprises have a more equal playing field, contributing to reducing the pressure of FDI enterprises on supporting industry enterprises.

Third, policies on improving the capacity of domestic supporting industry enterprises are necessary. It is essential to continue promoting the role of human resources through training programs that enhance skills and qualifications for workers. Investment in machinery and equipment plays an important role for supporting industrial enterprises, especially when current enterprises use outdated machinery, which hinders their development. However, investing in modern machinery requires a significant amount of capital, which poses a major challenge for most supporting industrial enterprises, particularly small and medium-sized enterprises. Therefore, in-depth research is needed to comprehensively address this problem according to the roadmap and appropriate priority criteria.

Funding: This study received no specific financial support.
Institutional Review Board Statement: The Ethical Committee of the Industrial University of Hochiminh City, Vietnam has granted approval for this study on 1 September 2024.
Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: Minh Ngo Ngoc can provide the supporting data of this study upon a reasonable request.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

REFERENCES

Arif-Ur-Rahman, M., & Inaba, K. (2021). Foreign direct investment and productivity spillovers: A firm-level analysis of Bangladesh in comparison with Vietnam. *Journal of Economic Structures, 10*(1), 17.

Binh, T. T. (2010). *Developing supporting industries in the consumer electronics industry in Vietnam.* Ph.D Disertation, National Economics University.

Chau, H. V. (2010). *Policy on supporting industry development to 2020 in Vietnam.* Hanoi: Information and Communication Publishing House.

Duong, V., & Hung, L. (2017). FDI spillOvers, absorptive capacity and domestic firms' technical efficiency in Vietnamese wearing apparel industry'. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 65*(3), 1075-1084. https://doi.org/10.11118/actaun201765031075

Farole, T., & Winkler, D. (2015). The role of foreign firm characteristics, absorptive capacity and the institutional framework for FDI spillovers. *Journal of Banking and Financial Economics, 1*(3), 77-112.

Francis, D. C., Karalashvili, N., Maemir, H., & Meza, J. R. (2020). *Measuring total factor productivity using the enterprise survey*. Policy Research Working Paper, World Bank Group.

Fujimori, A., & Sato, T. (2015). Productivity and technology diffusion in India: The spillover effects from foreign direct investment. *Journal of Policy Modeling*, *37*(4), 630-651. https://doi.org/10.1016/j.jpolmod.2015.04.002

Han, Y., Smith, R. B., & Wu, L. (2024). The impacts of foreign direct investment on total factor productivity: An empirical study of agricultural enterprises. *China Agricultural Economic Review*, *16*(1), 20-37. https://doi.org/10.1108/caer-02-2023-0035

Huynh, H. T., Nguyen, P. V., Trieu, H. D., & Tran, K. T. (2021). Productivity spillover from FDI to domestic firms across six regions in Vietnam. *Emerging Markets Finance and Trade*, *57*(1), 59-75. https://doi.org/10.1080/1540496x.2018.1562892

Khalifah, N. A., Mohd Salleh, S., & Adam, R. (2015). FDI productivity spillovers and the technology gap in M alaysia's electrical and electronic industries. *Asian-Pacific Economic Literature*, *29*(1), 142-160. https://doi.org/10.1111/apel.12094

Kim, M. (2015). Productivity spillovers from FDI and the role of domestic firm's absorptive capacity in South Korean manufacturing industries. *Empirical Economics*, *48*, 807-827. https://doi.org/10.1007/s00181-014-0804-z

Kmenta, J. (1967). On estimation of the CES production function. *International Economic Review*, *8*(2), 180-189. https://doi.org/10.2307/2525600

Le, Q. C., Nguyen, T. P. T., & Do, T. N. (2021). State ownership, quality of sub-national governance, and total factor productivity of firms in Vietnam. *Post-Communist Economies*, *33*(1), 133-146. https://doi.org/10.1080/14631377.2020.1793608

Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, *70*(2), 317-341. https://doi.org/10.1111/1467-937x.00246

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42. https://doi.org/10.1016/0304-3932(88)90168-7

Ministry of Industry and Trade. (2019). *Supporting industry report*. Hanoi: Ministry of Industry and Trade.

Newman, C., Rand, J., Talbot, T., & Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review*, *76*, 168-187. https://doi.org/10.1016/j.euroecorev.2015.02.005

Nguyen, P. V., Tran, K. T., Le, H. C. P., Trieu, H. D. X., & Huynh, H. T. N. (2019). Technology spillovers in the electronics and mechanical industries: The roles of ownership structure and wage and training costs in Vietnam. *Journal for Global Business Advancement*, *12*(2), 212-231.

Nguyen, P. V., Tran, K. T., Le, N. T. T., & Trieu, H. D. X. (2020). Examining FDI spillover effects on productivity growth: Firm-level evidence from Vietnam. *Journal of Economic Development*, *45*(1), 97-121.

Ni, B., Spatareanu, M., Manole, V., Otsuki, T., & Yamada, H. (2017). The origin of FDI and domestic firms' productivity—Evidence from Vietnam. *Journal of Asian Economics*, *52*, 56-76. https://doi.org/10.1016/j.asieco.2017.08.004

Ohno, K. (2007). *Building supporting industries in Vietnam*. Tokyo, Japan: Vietnam Development Forum.

Olley, S., & Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*, *64*(6), 1263–1297.

Quynh, N. T. (2007). Supporting industry: Overview of concept and development, in K. Ohno, Building Supporting Industry in Vietnam. In (pp. 29-51). Tokyo, Japan: Vietnam Development Forum.

Romer, P. M. (1994). The origins of endogenous growth. *Journal of Economic Perspectives*, *8*(1), 3-22. https://doi.org/10.1257/jep.8.1.3

Sari, D. W., Khalifah, N. A., & Suyanto, S. (2016). The spillover effects of foreign direct investment on the firms' productivity performances. *Journal of Productivity Analysis*, *46*, 199-233. https://doi.org/10.1007/s11123-016-0484-0

Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics*, *39*(3), 312-320. https://doi.org/10.2307/1926047

Thang, T. T., Pham, T. S. H., & Barnes, B. R. (2016). Spatial spillover effects from foreign direct investment in Vietnam. *The Journal of Development Studies*, *52*(10), 1431-1445. https://doi.org/10.1080/00220388.2016.1166205

Thanh, T. T., & Trang, N. Q. (2020). *Technical efficiency of supporting industry firms in Vietnam: Domestic versus foreign invested firms.* Paper presented at the The 3rd International Conference on Contemporary Issues in Economics, Management and Business (CIEMB) (pp. 1409-1422), Hanoi: Finance Publishing House.

Trang, N. Q., & Thanh, T. T. (2021). *Determinants of Technical Efficiency of domestic supporting industry firms in Vietnam.* Paper presented at the The 4rd International Conference on Contemporary Issues in Economics, Management and Business (CIEMB), (pp. 600-616), Hanoi: National Economic University Publishing House.

Trang, N. Q., & Thanh, T. T. (2022). *Determinants of total factor productivity of domestic supporting industry firms in Vietnam.* Paper presented at the 15th Neu-KKU International Conference Socio-Economic and Environmental Issues in Development, (pp. 155-166), Hanoi.

Tung, N. V., & Oyama, T. (2018). Investigating the supporting industry in the manufacturing sector in Vietnam–role, development and future strategies. *Review Public Administration Management*, *6*(1), 1-10. https://doi.org/10.4172/2315-7844.1000242

Van Beveren, I. (2012). Total factor productivity estimation: A practical review. *Journal of Economic Surveys*, *26*(1), 98-128. https://doi.org/10.1111/j.1467-6419.2010.00631.x

Wiboonchutikula, P., Phucharoen, C., & Pruektanakul, N. (2016). Spillover effects of foreign direct investment on domestic manufacturing firms in Thailand. *The Singapore Economic Review*, *61*(02), 1640028. https://doi.org/10.1142/s0217590816400282