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Determinants of technology adaptation in the supply chains: The case of SMEs in the industrial zone in Vietnam

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A B S T R A C T

This article aims to analyze the different impacts that some factors may exert on the probability that an industrial zone-located firm adapts. Recently, industry policy in developing countries tends to spur both SMEs and the industrial zone in terms of adaptation, considering them as the main driver of innovation and growth. However, not all industrial zone-located firms adapt. Departing from an extensive sample of the Vietnam Technology and Competitiveness Survey in combination with the Vietnam Enterprise Survey in 2011-2013, we try to determine those factors that cause firms to become industrial zone-located adaptation SMEs (IA-SMEs, firms fewer than 250 employees, being located in the industrial zone and adapting existing technologies). The analysis results highlight the importance of direct linkages, technology transfer between FDI firms and industrial zone-located adaptation SMEs, economic obstacles, and the interactions between them that cause industrial zone-located adaptation SMEs to adapt in the supply chain (obtained through direct transfer of technology between linked firms).

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1. Introduction

Apart from the technology transfer arising from spillovers, firm firms can improve their technological capabilities through several other ways. Firms can invest in new and innovative R&D. Alternatively, firms can undertake a type of diffusion-based innovation, where the focus is on the adaptation of existing technologies, using knowledge and techniques already developed, but new to the firm itself. Although R&D is highly regarded as a major indicator of innovation and technological sophistication, innovative R&D projects are prone to failure, highly expensive, and also very intensive in terms of their physical and human capital requirements. Given that emerging economies tend to be located at a distance from the technological frontier, firms may see productivity improvements merely from investment in existing technology that improves their current operations. Basant and Fikkert (1996), for example, find that investments in existing technologies provide a better return for firms that innovative research, in the context of Indian firms. On top of that, in developing countries in recent decades, place-based policies are introduced to foster private economy. 'Industrial zone', 'special zones', and 'development zones', as in China and Vietnam, bring firms a basket of preferential policies to boost their performance and accelerate economic growth. Preferential policies are directed at expanding technological spillover effects. Following this phenomenon, Luo et al. (2015), Rahi et al. (2018a,b), Basheer et al. (2019), Walcott and Xiao (2000), Hu, Zheng, and Wang (2011) have recently focused their attention on technological spillover effects in the context of industrial zone development. However, so far, the evaluation of adaptation by firms within the industrial zone, in general, is almost silent. Until now, most micro-level studies of these issues are in the context of developed countries, especially the United States (e.g., Dunne (1994), Rose and Joskow (1988), Cohen and Levin (1989)). Detailed empirical studies on less developed countries at the firm level are scarce. One notable exception is Vishwasrao and Bosshardt (2001). Since less advanced

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countries differ in their institutions, technology, and endowments from advanced countries, we expect that the process of technology diffusion would also differ. Yet not much is known empirically about the factors affecting technology adaptation by firms in less advanced countries, specifically, the determinants that cause firms to become industrial zone-located adaptation SMEs (IA-SMEs are those SMEs and located in the industrial zone that adapt) remain unclear. While a broad range of literature has focused on the R&D of large firms, the necessities of adaptation by small firms, especially in the context of development of industrial zone have been neglected in the theoretical literature. Consequently, the main purpose of this article is to analyze the determinants that might cause small firms in the industrial zone to adapt and small firms in the industrial zone to decide against adapt as opposed to those that do. We claim that some incentives and obstacles may cause small firms to choose not to adapt. Our argument is in line with Carlsson et al. (2013) who state that ''the essence of entrepreneurship is being different because one has a different perception of the situation''. As a consequence, diverse strategies may appear when firms conceive differently the economic reality. If policymakers aim at providing support to the innovation activity of firms, they must take into account that this type of support might not be the best strategy for all firms. For the Vietnam Technology and Competitiveness Survey (TCS) in combination with the Vietnam Enterprise Survey (VEC) between 2011 and 2013, we analyze the determinants that explain the probability of a firm being an IA-SMEs. The analysis results highlight the importance of direct linkages, technology transfer between FDI firms and industrial zone-located adaptation SMEs, economic obstacles, and the interactions between them that cause industrial zone-located adaptation SMEs to adapt in the supply chain (obtained through direct transfer of technology between linked firms). These findings are consistent with the hypothesis that there are some key differences between groups of adaptation firms. We contribute to this literature by considering IA-SMEs as representing a rational strategy that firms may consider given their individual and sectoral characteristics. This may provide useful insights for obtaining a broader picture of the innovation activity of firms in a given industry. The structure of the article is as following. The next section presents a literature review, with particular emphasis on the incentives that small firms decide to invest in the industrial zone, and whether or not to adapt. Section 3 shows the data and method. Section 4 contains the results. Finally, we present our main conclusions in Section 5.

2. Theoretical background

2.1. The motivation to invest in the industrial zone

The theoretical background of establishing the industrial zone has a long historical root form the theory of industrialization and development in the third world. The industrial zone can be characterized by specific features: (1) It is a geographical concentration of firms; (2) It offers benefits based on physical location within the zone in terms of infrastructure and procedures of administration from the central and local governments. The industrial zone can be distinguished from a special economic zone in the following aspects (Zeng 2012): (1) The Industrial zone does not have single management or administration, (2) It does have a separate customs area (duty-free benefits) (Aubert et al., 2010).

2.3 The motivation to become an adaptation SMEs

While there is a common understanding of the importance of innovation to survive, little attention has been devoted to SMEs that decide to adapt their technologies. Theoretical background for adaptation of existing technologies can be traced from the disadvantages of investment in R&D, and technology adoption (technology purchase). With respect to R&D, under both of Schumpeter's hypotheses of "creative destruction" and "creative accumulation", firms face such disadvantages in investing in R&D such as firms may find more difficulties in comparison with incumbents since they will not be able to take advantage of economies of scale and scope and complementarities with other competencies needed to commercialize their innovations. In that sense, much-concentrated industries, industries with large sunk costs, and in the late stages of the life cycle do not favor the appearance of small innovative entrants (Acs & Audretsch, 1987; Utterback, 1994; Malerba, 2004). More recently, a set of models rooted in the distance-to-frontier theoretical tradition have appeared. The ''Schumpeterian effect'' remarks that competition decreases the monopoly rents of prospective innovative firms, thus reducing their incentive to engage in R&D activities (Scherer, 1967; Geroski, 1990; Nickell, 1996). In addition, Schneider and Veugelers (2010) point out several characteristics that may cause small young firms not to innovate: lack of financial resources (asymmetric information is very accurate among young small firms, so small innovators are more likely to be financially constrained both internally and externally, see Segarra, García-Quevedo, and Teruel (2013); Schneider and Veugelers (2010), lack of human resources (incumbents may attract highly-skilled human resources), lack of absorptive capacity (incumbents may invest in internal R&D which increases their absorptive capacity, while small young firms may have more difficulties in attracting more skilled workers and as a consequence may have more difficulties in dealing with complexity) (Cohen and Levinthal 1990) and lack of the appropriation of benefits from innovation appropriation requires complementary strategies to patents, such as trademarks, secrecy, lead time and complexity, all of which might require a critical scale that SMEs may lack (Teece (1986); Cassiman and Veugelers (2002), the licensing possibilities (Gans & Stern, 1999), the strength of intellectual property protection (Anton & Yao 1994), the stage in the industry life cycle (Klepper 1996), the effectiveness of the market for ideas, the control over complementary assets, the association with venture capital, the likelihood of cooperation between entrants and incumbents, among others (Gans, Hsu, and Stern 2000).

3. Data and method

3.1. Data

The data are from the TCS which gathered detailed information on supply chain linkages, and technology transfers for a nationally representative sample of over 4000 Vietnamese manufacturing enterprises in three years: 2011-2013. The TCS sample is a subset of manufacturing firms covered by the Vietnam Enterprise Census (VEC) administered annually by the General Statistics Office of Vietnam. The VEC includes information on firm activities and financial accounts. The exploration of the two combined datasets allows us to investigate in detail the relationship between firm characteristics, financial structure, and performances and technology adaptation at the firm level. With regard to technology adaptation, the questionnaire asks the question: "Does your enterprise modify ("adapt") already existing (production or process) technologies?". These activities are those are related to the modification of already existing technologies that are new to the enterprise and/or to the country. Table 1 shows the distribution of our sample of SMEs. Our database has over 4,300 observations in a three-year panel. The percentage of IA-SMEs represents around 1.3% of our sample at the beginning of the study period, while this value reduces to around 1.1% at the end of the period. With respect to INA-SMEs, the starting value is around 9.45%, and at the end of our period, it is equal to 13.23%.

Table 1
Distribution of SMEs, 2011-2013

Year	IA-SMEs: N, (%)	INA-SMEs: N, (%)	NI-SMEs: N, (%)	Full SMEs: N, (%)
2011	56 (1.28)	413 (9.45)	3,902 (89.27)	4,371 (100.00)
2012	46 (1.05)	517 (11.75)	3,836 (87.20)	4,399 (100.00)
2013	48 (1.05)	603 (13.23)	3,906 (93.77)	4,557 (100.00)
Total	150 (1.13)	1,533 (11.50)	13,327 (87.37)	13,327 (100.0)

Note: IA-SMEs: Industrial Zone-located Adaptation SMEs. INA-SMEs: Industrial Zone-located Non-Adaptation SMEs. NI-SMEs: Industrial Zone-unlocated SMEs. N: number of observations. Source: Author's calculation from TCS and VEC.

Table 2 shows the main characteristics of our four groups of firms: IA-SMEs, INA-SMEs, and NI-SMEs. We observe differences among IA-SMEs, INA-SMEs, and their counterparts. Regarding firm characteristics, first, IA-SMEs, and INA-SMEs have the higher size of capital (both total assets and equity in absolute terms) than NI-SMEs, while the mean size of NI-SMEs in terms of labor has the lowest value regardless of whether we consider the number of employees or volumes of total assets and equity. Second, with respect to the sale volumes, IA-SMEs have higher in absolute terms than both INA-SMEs and other firms. Third, with respect to the age, IA-SMEs is older than both INA-SMEs and NI-SMEs. Fourth, in terms of exports, IA-SMEs is less international than both INA-SMEs, and NI-SMEs. However, in terms of imports, IA-SMEs is more tradable than both INA-SMEs, and NI-SMEs

Table 2
Descriptive analysis, SMEs

Descriptive statistic	IA-SMEs	INA-SMEs	NI-SMEs	Average
Sales (mill. VND)	114163.3	94812.57	40090.18	47218.59
Employees (persons)	93.04	82.38	55.41	58.93
Age (years)	10.33	9.9	10.1	10.08
Assets (mill. VND)	84074.02	76534.95	31412.93	37196.02
Equity (mill. VND)	27965.99	28416.01	10648.58	12887.27
Firm exports (%)	0.82	0.85	0.85	0.85
Firm import (%)	0.91	0.9	0.86	0.87

Note: Mean and standard deviation in brackets. Source: Author's calculation from TCS and VEC.

Regarding constraints delaying the firm's performance, as shown in Fig. 2, firstly, IA-SMEs state that they suffer more the constraints in basic infrastructure, transport infrastructure, financing, labor force, technological know-how, technologies than both INA-SMEs and NI-SMEs. Secondly, larger percentages of INA-SMEs state that they suffer the constraints less in basic infrastructure, transport infrastructure, technological know-how, technologies than both IA-SMEs and NI-SMEs.

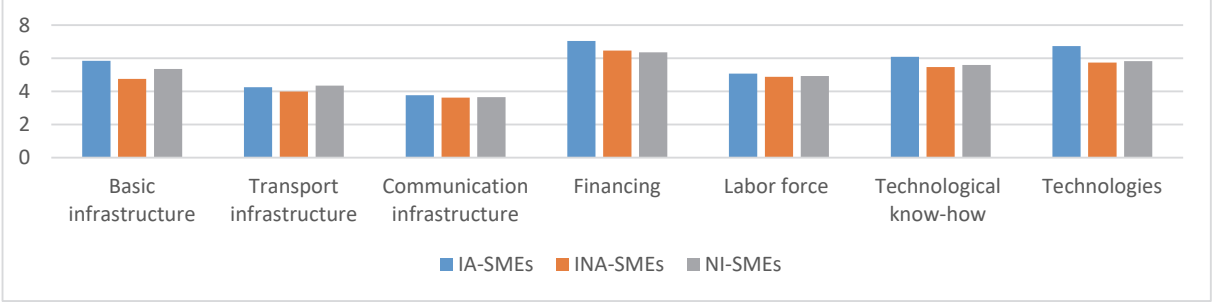

Fig. 2. Constraints on SMEs' economic performance; average points over 2011–2013. Note: Seven types of constraints: (1) basic infrastructure (electricity, energy, land), (2) transport infrastructure (roads, airports), (3) communication infrastructure, (4) financing (credits, foreign capital), (5) labor force (number of laborers), (6) technological know-how (skilled labor), and (7) technologies (machinery, equipment). The level of constraints is measured as average points of each constraint (range from 0 to 10). Source: Authors' calculation from TCS.

IA-SMEs report fewer competitors at the provincial level than both INA-SMEs and NI-SMEs, as shown in Fig. 3. However, IA-SMEs report more competitors at the national and international levels than both INA-SMEs and NI-SMEs do.

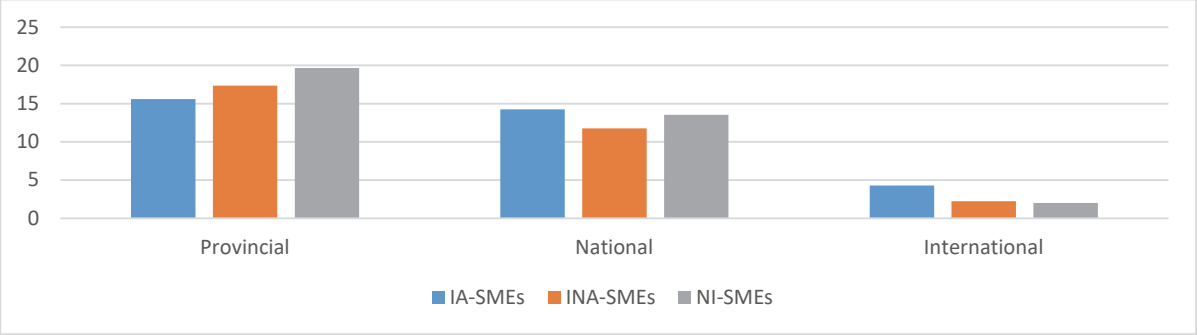

Fig. 3. An average number of competitors by SMEs, 2011–2013. Source: Authors' calculation from TCS.

Furthermore, larger percentages of IA-SMEs state that they face competition in the main field of activity than both INA-SMEs and NI-SMEs do, as shown in Figure 4. It is noted that a larger percentage of INA-SMEs status is "price taker" firms than IA-SMEs do, while we observe a higher percentage of "significant autonomy in setting prices" for some INA-SMEs.

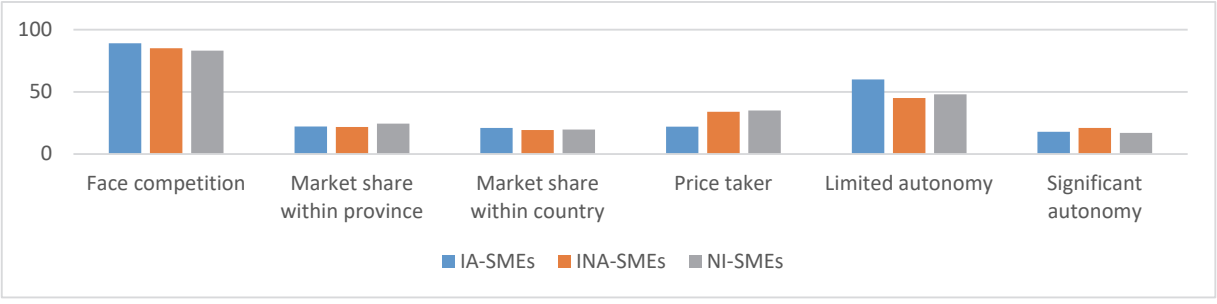

Fig. 4. Competition and firms' market power by SMEs; average percentage over 2011–2013. Source: Authors' calculation from TCS

To summarize, we find that IA-SMEs, INA-SMEs and NI-SMEs differ substantially in terms of size of labor, age, physical capital intensity, sales volumes (growth ability), and openness to international trade. These attributes capture a firm's choice to conduct technology adaptation. Second, IA-SMEs, INA-SMEs and NI-SMEs face different constraints on their economic performance. Third, IA-SMEs, INA-SMEs and NI-SMEs face a different level of competition.

3.2. Method

We apply a panel probit model to examine how firms decide to conduct a technology adaptation. We are particularly interested in FDI linkages and technology transfers. This is achieved through the estimation of Eq. (1):

$$y_{1it} = \begin{cases} 1 \ if \ y^*_{1it} = f\begin{pmatrix} X_{1it}\beta_1 + Z_{1it}\delta_1 + \gamma_{11}FDIDomSup_{1it} + \gamma_{12}FDIDomCus_{1it} + \\ +\gamma_{13}FDIDomSupTech_{1it} + \gamma_{14}FDIDonCusTech_{1it} + u_{1it} \end{pmatrix} > 0 \\ 0 \ otherwise \end{cases} \quad (1)$$

where y_{1it} is a dummy variable, which indicates that a firm i decides t to adapt in time t. Here, y^*_{1it} is a latent dependent variable, X_{1it} are the determinants of the firm's decision to to adapt, Z_{1it} is a matrix of time-varying firm-specific control variables, β_1, δ_1, γ_{11}, γ_{12}, γ_{13}, γ_{14} corresponds to the vector of coefficients to be estimated, and u_{1it} is the error term which follows N(0, σ^2_1). A firm "it" will adapt if y^*_{1it} is positive. Equation (1) will depend on the following set of explanatory variables *(X_{1it}): Size* (sales lagged one period), *Age* (years of operation), *ShareExp* (export share in sales), *FDIDomSup* (firm having relationship with FDI domestic suppliers), *FDIDomCus* (firm having relationship with FDI domestic customers), *FDIDomSupTech* (Technological transfer with FDI domestic suppliers), *FDIDonCusTech* (Technological transfer with FDI domestic customers), *BInfrasT* (difficulties in terms of basic infrastructure such as electricity, energy, land), *TranInfrasT* (difficulties in terms of transport infrastructure such as roads, airports), *ComInfrasT* (difficulties in terms of communication infrastructure), *FinT* (difficulties in terms of financial constraints such as credits, foreign capital), *LabornbT* (difficulties in terms of the number of the labor force), *KnowhowT* (difficulties in terms of technological know-how, namely skilled labor), and *TechT* (difficulties in terms of technologies such as machinery, equipment), *MarketShareP* (market share at province level), *MarketShareC* (market share at country level), *ComP* (competition at province level), and *ComC* (competition at country level) (Table 2).

Table 2
Variables in the model of adaptation choice

Variable	Description	Mean	SD
Dependent variable			
Adapt	Firm conducting a technology adaptation (Yes=1; No=0)	0.09	0.29
Explanatory variable			
Size	ln(sales), lagged one period	10.15	1.57
Age	ln(age), lagged one period	2.22	0.39
ShareExp	Export share in sales (%)	13.77	30.28
FDI linkage			
FDIDomSup	Relationship with FDI domestic suppliers (Yes=1; No=0)	0.07	0.26
FDIDonCus	Relationship with FDI domestic customers (Yes=1; No=0)	0.17	0.38
FDI Technology transfer			
FDIDomSupTech	Technological transfer with FDI domestic suppliers (Yes=1; No=0)	0.02	0.14
FDIDonCusTech	Technological transfer with FDI domestic customers (Yes=1; No=0)	0.03	0.17
Constraints: Level of difficulties			
BInfrasT	Basic infrastructure	4.85	3.70
TranInfrasT	Transport infrastructure	4.02	3.36
ComInfrasT	Communication infrastructure	3.63	3.23
FinT	Financial constraints	6.52	3.35
LabornbT	Number of labor force	4.90	3.34
KnowhowT	Technology know-how	5.52	3.26
TechT	Technologies	5.83	3.46
Market share			
MarketShareP	the province level (%)	24.11	28.50
MarketShareC	the country level (%)	19.67	26.20
MarketShareP2	the province level (%), squared	1393.36	2567.69
MarketShareC2	the country level (%), squared	1073.21	2301.05
Competition: Number of competitors			
ComP	the province level	19.35	64.03
ComC	the country level	13.33	54.13
ComP2	the province level, squared	4474.49	66089.64
ComC2	the country level, squared	3107.12	36856.38

Note: Level of difficulties that delay or obstruct the realization of technology in terms of (0 = does not apply, 1 = slightly important, 10 = very important). Panel A: 13,327 obs. Panel B: 1,683 obs. Source: Author's calculation from TCS and VEC

We further examine the extent to which the economic constraints used in Eq. (1) are related to direct linkage between foreign and domestic firms and technology transfers as well. To test this, we examine the impact of the interaction between economic constraints and being directly linked with foreign firms and technology transfers along the supply chain. The models we estimate are given in Eq. (2).

$$y_{1it} = \begin{cases} 1 \;\; if \; y_{1it}^{*} = f \left(\begin{array}{c} X_{1it}\beta_1 + Z_{1it}\delta_1 + \gamma_{11} FDIDomSup_{1it} + \gamma_{12} FDIDomCus_{1it} + \\ + \gamma_{13} FDIDomSupTech_{1it} + \gamma_{14} FDIDonCusTech_{1it} + \\ + \lambda_{11} Z_{1it}.FDIDomSup_{1it} + \lambda_{12} Z_{1it}.FDIDomCus_{1it} + \\ + \lambda_{13} Z_{1it}.FDIDomSupTech_{1it} + \lambda_{14} Z_{1it}.FDIDonCusTech_{1it} + \\ + u_{1it} \end{array} \right) > 0 \\ 0 \;\; otherwise \end{cases} \tag{2}$$

4. Results

The overall aim of our analysis is to determine the extent to which a decision of technology adaptation by firms is related to firm-level factors and in particular, economic constraints, FDI linkages, and FDI technology transfer, considering both direct and indirect effects.

Table 4
Constraints, FDI linkage and technology transfer: total effects (marginal effect), 2011-2013

VARIABLES	Adaptation	VARIABLES	Adaptation
Sales lagged one period (ln)	0.0547***	Competitors (province), squared	-5.18e-07
Age (Ln form)	0.177**	Competitors (nation), squared	-8.55e-07
Export share in sales (%)	-0.00142	Basic infrastructure	0.0571***
Having FDI domestic customers	0.127	Transport infrastructure	-0.00454
FDI domestic customers with technological transfer	0.481***	Communication infrastructure	-0.0229**
Having FDI domestic suppliers	0.273**	Financial constraints	0.000505
FDI domestic suppliers with technological transfer	0.783***	Number of labor force	-0.0213**
Market share (province)	0.000503	Technology know-how	0.000108
Market share (country)	0.000303	Technologies	0.0261**
Market share (province), squared	-1.02e-05	Observations	13,303
Market share (country), squared	2.19e-05	Number of firms	4,582
Competitors (province)	0.00116	Log Likelihood	-2864
Competitors (nation)	0.00140	Rho	0.594
		Likelihood-ratio test of rho=0	504.6

Note: Each model is estimated using random effects. * p < 0.10, ** * p < 0.05, *** p < 0.01. Source: Authors' estimation from VEC-TCS.

We begin by estimating the basic specification for economic constraints, FDI linkages, and FDI technology transfer given in Eq. (1). The results are presented in Table 4. We find that a firm with FDI domestic customers resulted in the technological transfer is more likely to conduct technology adaptation. However, we find no significant effect on the firm that only has a linkage with FDI domestic customers. A firm with FDI domestic suppliers resulted in technology transfer is more likely to implement technology adaptation. With respect to firm characteristics, first of all, firm size shows significant positive coefficients, which is in line with the studies of Vishwasrao and Bosshardt (2001), Scherer (1965), Kamien and Schwartz (1975), Katz and Shapiro (1987), Loury (1979), Fudenberg and Tirole (1985), Lim and Trakulmaykee (2018) and Chang and Robin (2006). We also find significantly positive influence of firm age. The significantly positive impact has been found on the barriers of basic infrastructure, technologies on the probability of conducting technology adaptation. However, the significantly negative impact has been found on the barriers of communication infrastructure, labor force on the probability of conducting technology adaptation. We then continue to look at the indirect effects by estimating the interaction specification for economic constraints, FDI linkages, and FDI technology transfer given in Eq. (2). The results are presented in Table 5. Among firms with FDI domestic customers resulted in technological transfer, the significantly negative impact has been found on the barriers of financing on the probability of carrying out technology adaptation.

Table 5

Constraints and FDI linkage and technology transfer: Indirect effects (marginal effect), 2011-2013

VARIABLES	Adaptation
Sales lagged one period (ln)	0.0545***
Age (Ln form)	0.178**
Export share in sales (%)	-0.00144
Having FDI domestic customers	0.0694
FDI domestic customers with technological transfer	0.973**
Having FDI domestic suppliers	-0.446
FDI domestic suppliers with technological transfer	1.302**
Market share (province)	0.000342
Market share (country)	0.000783
Market share (province), squared	-9.30e-06
Market share (country), squared	1.67e-05
Competitors (province)	0.00117
Competitors (nation)	0.00127
Competitors (province), squared	-5.18e-07
Competitors (nation), squared	-6.39e-07
Basic infrastructure	0.0609***
Transport infrastructure	-0.0125
Communication infrastructure	-0.0221*
Financial constraints	-0.00310
Number of labor force	-0.0150
Technology know-how	-0.00424
Technologies	0.0258**
Interactions with FDI domestic customers	
Basic infrastructure	-0.0192
Transport infrastructure	0.00985
Communication infrastructure	0.0319
Financial constraints	0.0426
Number of labor force	-0.0516
Technology know-how	0.0211
Technologies	-0.0238
Interactions with FDI domestic customers resulted in technological transfer (vertical R&D spillovers through backward linkages)	
Basic infrastructure	-0.0306
Transport infrastructure	0.107
Communication infrastructure	-0.0978
Financial constraints	-0.195***
Number of labor force	0.108
Technology know-how	0.0204
Technologies	0.0199
Interactions with FDI domestic suppliers	
Basic infrastructure	-0.00715
Transport infrastructure	0.0492
Communication infrastructure	-0.0265
Financial constraints	0.0390
Number of labor force	-0.0169
Technology know-how	0.0177
Technologies	0.0584
Interactions with FDI domestic suppliers resulted in technological transfer (vertical R&D spillovers through forwarding linkages)	
Basic infrastructure	-0.00269
Transport infrastructure	0.0795
Communication infrastructure	-0.109
Financial constraints	-0.0358
Number of labor force	0.00187
Technology know-how	-0.0167
Technologies	-0.0187
Observations	13,303
Number of firms	4,582
Log Likelihood	-2849
Rho	0.598
Likelihood-ratio test of rho=0	504.4

Note: Models are estimated using random effectsand are provided on request. * p < 0.10, ** * p < 0.05, *** p < 0.01. Source: Authors' estimation from VEC-TCS

5. Conclusions

SMEs' innovation is crucial to increase the long-term productivity. Industrial zone is considered as a pillar to spur the development of technology and industrial sector. However, the question of what factors affect adaptation decision of a firm in the industrial zone in a world of interdependencies has attracted a series of papers. On top of that, given the close relation between FDI and technology spillovers, it is surprising that no one has yet analyzed the influence of FDI linkages and technology transfer in the context of SMEs; hence, the paper aims to fill this gap. The purpose of this article is to analyze the impacts of FDI linkages and technology transfer, which might cause industrial zone-located adaptation SMEs to adapt. We claim that there are conditions and incentives that may cause such industrial zone-located adaptation SMEs to adapt. Supported by the Vietnam Technology and Competitiveness Survey in combination with the Vietnam Enterprise Survey in 2011-2013, we establish a dataset consisted of over 4300 Vietnamese SMEs in the period 2011–2013 and conduct estimations of panel probit models. The analysis results highlight the importance of direct linkages, technology transfer between FDI firms and industrial zone-located adaptation SMEs, economic obstacles, and the interactions between them that cause industrial zone-located adaptation SMEs to adapt in the supply chain (obtained through direct transfer of technology between linked firms). Specifically, our results indicate that firm size shows positive effects in adaptation. The significantly positive impact has been found on the barriers of basic infrastructure on the probability of conducting technology adaptation. However, the significantly negative impact has been found on the barriers of communication infrastructure, labor force on the probability of conducting technology adaptation. We then continue to look at the indirect effects by estimating the interaction specification for economic constraints, FDI linkages, and FDI technology transfer. The results are presented in Table 5. Among firms with FDI domestic customers resulted in technological transfer, the significantly negative impact has been found on the barriers of financing on the probability of carrying out technology adaptation. While policies aiming to promote SMEs' innovation obtain a consensus, it is less understandable why firms decid e to undertake adaptation. Apart from the firm's characteristics, FDI supply-chain linkages, and technology transfer influence the firm's adaptation behavior. Therefore, concerning policies must be aware that incentives along supply-chain may better reach the innovation outcomes for SMEs. Important equally, policy-makers must consider a broader range of economic and financial constraints that may influence innovation behavior.

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