Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

Nguyen, Chi-Hai and Ngo, Quang-Thanh and Pham, My-Duyen and Nguyen, Anh-Tuan and Huynh, Ngoc-Chuong

1 March 2021

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

Chi-Hai Nguyen [1,2], Quang-Thanh Ngo [3, *], My-Duyen Pham [1,2], Anh-Tuan Nguyen[1,2], Ngoc-Chuong Huynh[1,2]

[1]*Faculty of Economics, University of Economics and Law, 71309 Ho Chi Minh City, Vietnam; hainc@uel.edu.vn (N.T.H.); duyenpm@uel.edu.vn (P.M.D); tuanna@uel.edu.vn (N.A.T); chuonghn@uel.edu.vn (H.N.C)*

[2]*University of Economics and Law, Vietnam National University Ho Chi Minh City (VNU-HCM), 71309 Ho Chi Minh City, Vietnam*

[3]*School of Government, University of Economics Ho Chi Minh City, 72407 Ho Chi Minh City, Vietnam*

[*]*Correspondence: thanhnq@ueh.edu.vn (N.Q.T.)*

Abstract: The current article examines the factors affecting economic linkages in the Southern Key Economic Zone of Vietnam, using a unique 5-year firm-level dataset with 5050 observations, using a unique 5-year firm-level dataset with 5050 observations, which is collected and merged from two data sources namely the Vietnam Technology and Competitiveness Survey and the Vietnam Annual Enterprise Survey in 2015-2019. Empirical results from estimating panel logit models based on different types of economic linkages such as (1) backward economic linkage with the domestic supplier, (2) backward economic linkage with a foreign supplier, (3) forward economic linkage with the domestic customer, and (4) forward economic linkage with a foreign customer reveal the importance of firm characteristics, technology transfer, and economic constraints that cause firms to conduct economic linkages across firm sizes and types of ownership. There is clear evidence for the determinants of economic linkages in manufacturing sectors by firm sizes, and by ownership in this analysis are concerned. To be specific, based on a regression analysis, employment, firm's experience, technology transfer, and economic constraints stand out as the major drivers of economic linkage of various forms. In addition, results reveal several patterns of economic linkages such as domestic technology embodied economic linkage, local supply-chain technology embodied economic linkage, international/global supply-chain technology embodied economic linkage, local market-explored economic linkage, local market privilege, and foreign market privilege. Moreover, it is evidence that investments in basic infrastructure, transport infrastructure, communication infrastructure, removal of financing constraints, increase the labor supply, improvement of working skills of laborers have favored the growth of economic linkages. Our results initiate policy implications in the context that, apart from the firm's and the industry sector's characteristics, economic obstacles and the nature of technology transfer significantly influence the firm's behaviors of conducting economic linkages in various firm sizes and types of ownership.

Author Correspondence: thanhnq@ueh.edu.vn

1. Introduction

There has been a long history of concerns on economic linkages in development strategy in developing countries (Hirschman, 1958; Lall, 1980). The key economic zone, in general, is considered as a crucial engine for economic growth (Aggarwal, 2006), especially in transition countries such as China, and Viet Nam (He, Pan, & Chen, 2016; Zeng, 2012). The terms 'key economic zone' can encompass the various type of economic vehicles such as special economic zones (including free zones, export processing zones, and special economic zones), industrial clusters, even though the key economic zone can have a broader context. Unlike special economic zone is a designated area within a country where firms gather together to participate in various economic activities promoted by a set of policy instruments not generally applicable to the rest of the country (W. Ge, 1999; Hazakis, 2014; Shakya, 2009; K.-y. Wong, 1987), a key economic zone is loosely defined as a region within a country boundary were having a more advanced economic and social conditions than other neighbouring regions and having many different administrative entitlements instead of a unified administration actor. Within the economic zone, the industrial cluster may often exist, which initiatives to promote economic development of region and the country as well (Porter, 1990b, 1998; World Bank, 2010).

Participating firms in key economic zones tend to be highly agglomerated and interdependent. One widely observed agglomeration phenomenon in development zones involves economic linkages of various forms, that is, clusters of vertically related firms. Theoretically, the more that related firms cluster together, the lower the cost of production, and the greater the market in which the firms can sell. Even though firms in the same cluster area may differ significantly in their relative factor intensities, there are still potential advantages to the proximity of buyers and sellers because cluster firms can attract more suppliers and customers than a single firm. Globalization and international economic integration have also increased the importance of economic linkages between a transnational corporation (TNC) and their subsidiaries with domestic firms (Giroud, 2007; Iguchi, 2008). TNC and TNC subsidiaries can maintain the backward economic linkages to domestic or local suppliers, who supply the materials of their supply chain (Giroud, 2007; Iguchi, 2008; Kiyota, Matsuura, Urata, & Wei, 2008). From this point, technology transfer the conduct of R&D, development of new products, search for resources in the host economy, and improved manufacturing processes can occur (Burgelman, 1983a, 1983b; D'Cruz, 1986; Pearce, 2001; Vernon, 1966; White & Poynter, 1984).

The recent emergence of global value chains (GVCs) in the last two decades is supportive of developing countries can specialize in particular tasks along the value chain rather than having to set up the whole traditional processes of production (Baldwin & Lopez-Gonzalez, 2015; Kaplinsky, 2013; Miroudot, Rouzet, & Spinelli, 2013; Timmer, Erumban, Los, Stehrer, & De Vries, 2014), especially in manufacturing activities (Costinot, Vogel, & Wang, 2013; Koopman, Wang, & Wei, 2014; Timmer et al., 2014). The objective of this paper is to determine the drivers and blockages to the process of economic linkages in one key economic zone in Vietnam, namely the Southern Key Economic Zone, using a unique 5-year firm-level dataset with 5050 observations, which is collected and merged from two data sources namely the Vietnam Technology and Competitiveness Survey and the Vietnam Annual Enterprise Survey in 2015-2019. Previous studies mostly focus on the determinants of backward local linkages between multinational companies and domestic suppliers in transition economies in Eastern European countries (Dries & Swinnen, 2004; Iguchi, 2008; Javorcik, 2004; Lorentzen, Møllgaard, & Rojec, 2003), Malaysia (Iguchi, 2008), Vietnam and Malaysia (Giroud, 2007),

Southeast Asia and China (Kiyota et al., 2008), developing country (Lall, 1980), Ireland (Görg & Ruane, 2001) or intra-industry economic linkages in Nigeria (Adewuyi & Oyejide, 2012). Our study contributions to the literature are threefold. First, it extends the empirical evidence by examining four types of economic linkages such as (1) backward economic linkage with the domestic supplier (BELDS), (2) backward economic linkage with a foreign supplier (BELFS), (3) forward economic linkage with the domestic customer (FELDC), and (4) forward economic linkage with a foreign customer (FELFC) and by using a uniquely generated firm-level panel dataset. In addition, the paper examines the associations between technology transfers and economic linkage, which are still a murky area in the study of industrial economics. By doing so, several patterns of economic linkages such as *domestic technology embodied economic linkage*, *local supply-chain technology embodied economic linkage*, *international/global supply-chain technology embodied economic linkage*, *local market-explored economic linkage*, *local market privilege*, and *foreign market privilege* are revealed. Furthermore, we take economic obstacles into the anticipating their effects, which come to be critical issues in the current context of worldwide pandemic. Last but not least, our paper contributes to the empirical evidence by providing heterogeneity of firms by labor size and ownership. This study is organized as follows; apart from this introduction section. Section 2 sets out the nature of economic linkages and the hypothesized drivers of these linkages. This is followed in Section 3 by a presentation of the data and methods. Section 4 presents the evidence of factors that affect the choices of economic linkages. Finally, the conclusion of this paper is presented in Section 5.

2. Vertical economic linkages factors and main hypotheses

Traditional roots of economic linkages of various forms can be traced back to the concept of agglomeration, which refers to the spatial concentration of people and economic activities, and the theory of development based on specialization in production (Marshall, 1890). Accordingly, Marshall (1890) stated that the geographical concentration of economic activities can have a snowball effect whereby new entrants tend to agglomerate to benefit from higher diversity and specialization in production processes. Recognizing technology linkages in the industrial sector as an important agglomeration factor, a growing number of economists have engaged in a variety of investigations seeking to document and substantiate the expected impacts, contributing to a wide range of academic disciplines and policy circles (Cella, 1986; Hazakis, 2014; Parr, 1999; Sonis, Hewings, & Guo, 2000). A great many researchers, attempting to account for the regional and national agglomeration of economic activities, have suggested that selected regions - especially those in which industries are linked in transaction-intensive networks - are capable of exerting powerful push effects on national or regional economic development (Fujita & Thisse, 1996; P. Krugman, Cooper, & Srinivasan, 1995; P. Krugman & Venables, 1996; P. R. Krugman, 1991). At the firm-level scale, many other scholars have accepted the notion that technology linkage benefits derived from the industrial cluster or zone occupancy lead to superior firm performance because of savings on transportation costs, shared infrastructure, increased availability of labor, forward and backward linkages, and/or knowledge and technology spillovers (Debaere, Lee, & Paik, 2009).

Current theory in economic geography acknowledges the importance of institutional factors in promoting localized growth and development. In many countries, including those in East Asia, governments have played a notably directive role in assigning investment to different localities and setting up

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

3

development zones and other local-development schemes, thereby shaping regional economic outcomes (Porter, 1990a). Empirical evidence from a set of studies of other countries also stresses the impact of governmental and organizational support for the promotion of the industrial zone. Other studies stress factors related to natural advantages (Y. Ge, 2009; He, Wei, & Pan, 2007), agglomeration economies and institutional changes (e.g., decentralization) associated with the economic transition (He et al., 2007; Yao, Chen, Smyth, & Zhang, 2018), economic globalization (Fujita & Hu, 2001; Y. Ge, 2009). A rarely-seen study on Vietnam by Vu, Pham, and Pham (2011), analyzing the role of Industrial Parks (IPs) in the Northern Key Economic Zone of Vietnam (NKEZ), find that IPs play a crucial role in mobilizing capital from domestic and international investors for investments in infrastructure enhancement, trade and production aimed at promoting the economic structure transition. However, there are a number of unstable factors preventing further development of the IPs and authors indicate that, among others, enhancing cooperation among firms and developing supporting industries are key concerns.

Economic linkages in general and in an economic zone, in particular, can take different forms by certain definitions. The two common types of linkages are vertical (or backward) and horizontal (forward) which was first established by Hirschman (1958), and then used in firm-level studies (Blomstrom & Kokko, 2001; Caves, 2007; Dunning, 1996; Lall, 1980; Rodriguez-Clare, 1996). By definition, it can happen between the business entity and its suppliers and its customers in the forms that we call the backward economic linkage and the forward economic linkage, respectively. Depending on the nature of activities, economic linkages can take the form of technology transfer, R&D cooperation and/or coordination, buying and/or selling materials and/or goods; or it can be an investment activity between the business entity and its business partners (Adewuyi & Oyejide, 2012; Belderbos, Capannelli, & Fukao, 2001; Giroud, 2007; Iguchi, 2008; Kiyota et al., 2008). Or even, the economic linkages can occur through information exchange, the provision of training, the upgrading of skills, and machinery lending (Giroud, 2007; Lall, 1980; P.-K. Wong, 1992).

Basing on several factors that drive linkages between firms (Adewuyi & Oyejide, 2012; Iguchi, 2008; Morris, Kaplinsky, & Kaplan, 2012), we analyze the impact of several drivers on economic linkages taken in various forms defined by the backward and forward spectrum among suppliers and customers in the manufacturing firms in an economic zone in Vietnam with a focus on the most dynamic one, the Southern Key Economic Zone. These drivers include factors such as: (1) firm-level characteristics, namely, employment level (Görg & Ruane, 2001), experience (Kiyota et al., 2008), (2) market concentration (Lall, 1980), (3) local demand agglomeration (Bresslein, Cieslik, & Matschke, 2019; Meliciani & Savona, 2015), (4) technology transfers (Giroud, 2007; Meliciani & Savona, 2015; Nooteboom, 1999), and (5) infrastructure and economic obstacles (Adewuyi & Oyejide, 2012; Iguchi, 2008).

Although there are some studies of determinants by which firms involve in the key economic or development zone, few studies look into the determinants of economic linkages, especially in key economic zones, at the firm-level scale. The empirical analysis in this article makes use of questionnaire data collected from the enterprise census in Vietnam, a transition economy. We quantitatively examine the determinants of economic linkages in the key economic zone, a rarely tested issue of research at the firm level, based on the regression results obtained from estimating a system of panel-data probit models. Second, various type of economic linkages has been considered with empirical situations in the context of a developing country. Third, by incorporating technology transfer to economic linkages, we can distinguish the nature of

economic linkages vs. technology linkages. Fourth, we take economic obstacles into anticipating their effects, which come to be critical issues in the current context of the worldwide pandemic. In short, our investigation includes policymakers very concerned with promoting regional and national economic growth, as well as firm managers eager to pursue sustainability of firm growth in key economic zones.

Although there are some studies of determinants by which firms involve in the key economic or development zone, few studies look into the determinants of economic linkages, especially in key economic zones, at the firm-level scale. The empirical analysis in this article makes use of questionnaire data collected from the enterprise census in Vietnam, a transition economy. We quantitatively examine the determinants of economic linkages in the key economic zone, a rarely tested issue of research at the firm level, based on the regression results obtained from estimating a system of panel-data probit models. Second, various type of economic linkages has been considered with empirical situations in the context of a developing country. Third, by incorporating technology transfer to economic linkages, we can distinguish the nature of economic linkages vs. technology linkages. Fourth, we take economic obstacles into anticipating their effects, which come to be critical issues in the current context of the worldwide pandemic. In short, our investigation includes policymakers very concerned with promoting regional and national economic growth, as well as firm managers eager to pursue sustainability of firm growth in key economic zones.

3. Data and methods

3.1. Data

The first main source of data comes from Vietnam Technology and Competitiveness Survey (TCS) in 2015-2019 by Central Institute for Economic Management (CIEM), General Statistics Office (GSO), and Development Economics Research Group (DERG) under the Faculty of Economics (DoE), University of Copenhagen (Denmark) jointly implemented. The dataset has been used widely in studies of Q.-T. Ngo, Doan, Tran, and Nguyen (2020), Q.-T. Ngo, Tran, Nguyen, and Nguyen (2020), Q. T. Ngo and Nguyen (2019), Q. T. Ngo and Tran (2020).

The second data source is the Vietnam Annual Enterprise Survey (VAES) which is conducted annually in 2015-2019 by General Statistical Office (GSO) of Vietnam. VAES collects information on firm characteristics and financial and accounting results, which are integrated with TCS to form the final dataset. In the current paper, we create a uniquely generated firm-level panel dataset of firms in five years, resulted in 5050 observations.

Using TSC, the paper explores some aspects of economic linkages, such as economic relations with suppliers, economic relationship with customers. In addition, obstacles in operation are also explored.

Firstly, regarding input and supplier relations, the questionnaire has the following questions:

- Source of raw materials or intermediates used to produce intermediate goods or final products for your enterprise (in percentage): (1) within the province, (2) from other provinces in the same region, (3) from other regions, (4) from ASEAN countries, (5) from countries outside ASEAN.

- Did or do your enterprise sign a long-term contract (from 36 months and above) with domestic or foreign suppliers of materials or intermediates? Answers: Yes/No (If domestic supplier, specify the number of suppliers).

- Did or do any of these contracting relationships with your domestic Vietnamese suppliers require any special investments

(for example, production or information technology, infrastructure, or staff training) from your enterprise? Answers: Yes/No.

- Do any of these relationships with domestic suppliers result in technology transfer from the supplier to your enterprise? Answers: Yes/No. If yes, is the technology transfer mainly: (1) intentional and part of the legal contract, (2) intentional, but not part of the legal contract, (3) unintentional.

- Do any of these relationships with foreign suppliers result in technology transfer from the supplier to your enterprise? Answers: Yes/No. If yes, is the technology transfer mainly: (1) intentional and part of the legal contract, (2) intentional, but not part of the legal contract, (3) unintentional. Secondly, with regards to output and customer/consumer relations, the questionnaire asks the following questions:

- Did or do any of these contracting relationships with your domestic customers in Vietnam require any special investments (for example, production or information technology, infrastructure, or staff training) from your enterprise? Answers: Yes/No.

- Did or do any of these contracting relationships with your domestic customers in Vietnam require any special investments (for example, production or information technology, infrastructure, or staff training) from your enterprise? Answers: Yes/No. If yes, is the technology transfer mainly: (1) intentional and part of the legal contract, (2) intentional, but not part of the legal contract, (3) unintentional.

- Did or do any of these contracting relationships with your international customers outside Vietnam require any special investments (for example, production or information technology, infrastructure, or staff training) from your enterprise? Answers: Yes/No.

- Do any of these relationships with international customers result in technology transfer from the customer to your enterprise? Answers: Yes/No. If yes, is the technology transfer mainly: (1) intentional and part of the legal contract, (2) intentional, but not part of the legal contract, (3) unintentional. With reference to obstacles in operation, the questionnaire asks: Does your enterprise face any constraints delaying or obstructing the enterprise's performance? 0= does not apply, 1=slightly important, 10= very important (Circle the most suitable answer). Answer: (1) Basic infrastructure (such as electricity, energy, land), (2) Transport infrastructure (such as roads, airports), (3) Communication infrastructure, (4) Financing constraints (such as credits, foreign capital), (5) Labor force (in terms of numbers), (6) Technological know-how (skilled labor), (7) Technologies (such as machinery, equipment), (8) Other (specified).

3.2. Methods

3.2.1. Model specification

To analyses the determinants of economic linkages, we, following McAleese and McDonald (1978) and O'farrell and O'Loughlin (1981), relate the choice of economic linkage in a firm i at time t to several independent variables,

$$y_{it} = \begin{cases} 1 \ if \ y_{it}^* = f(X_{it}\beta_1 + Z_{jt}\gamma_1 + u_{it}) > 0 \\ 0 \ otherwise \end{cases} \quad (1)$$

Where i, t, j denotes firm i in year t and at manufacturing sector j; y is a dummy variable that indicates that a firm decides to involve in economic linkages of one kind. Here, y^* is a latent dependent variable, X is a vector of the determinants of the firm's decision to involve in economic linkages, Z is industry-level characteristics, β_1 and γ_1 correspond to the vector of coefficients to be estimated and u_{it} is the error term which is assumed to consist of two components, viz., $u_{it} = \mu_i + \varepsilon_{it}$ with μ_i capturing a firm-specific permanent and unobservable effect, such as the influence of particular production technology or management technique, and ε_{it} being the remaining period-specific error term, assumed to be independent across firms and over time. The firm "it" will involve in economic linkage if y_{it}^* is positive. We use the three alternative economic linkage definitions, as presented above, as dependent variables.

In our empirical model, the dependent variable represents the firm's types of economic linkages and is measured by choosing a set of four different responses: (1) backward economic linkage with the domestic supplier (BELDS), (2) backward economic linkage with a foreign supplier (BELFS), (3) forward economic linkage with the domestic customer (FELDC), and (4) forward economic linkage with a foreign customer (FELFC). A firm can involve in more than one type of economic linkage. Thus, the error terms of economic-linkage choice functions may be correlated. This calls for the employment of a system of equations, which jointly estimate regression models. To be more specific, the following system of four simultaneous equations needs to be estimated:

$$\begin{aligned} y_{it1} &= \beta_{it11}X_{it} + Z_{jt}\gamma_{11} + \mu_{i1} + \varepsilon_{it1} \\ y_{it2} &= \beta_{it12}X_{it} + Z_{jt}\gamma_{12} + \mu_{i2} + \varepsilon_{it2} \\ y_{it3} &= \beta_{it13}X_{it} + Z_{jt}\gamma_{13} + \mu_{i3} + \varepsilon_{it3} \\ y_{it4} &= \beta_{it14}X_{it} + Z_{jt}\gamma_{14} + \mu_{i4} + \varepsilon_{it4} \end{aligned}$$

$$(2)$$

Since earlier studies suggest that longer-established firms have higher economic linkages, we would expect the variable of years in operation (ages) to be positively related to the existence of economic linkages. Firms may increase their economic linkages over time due to a "learning effect", i.e., firms learn about the quality and reliability of domestic suppliers or tighten the relationship with customers over time (McAleese & McDonald, 1978).

Table 1. Statistic description of dependent variables

Variable	Description	Obs.	Mean	Std. Dev.
Backward economic linkage with a domestic supplier	Having an economic linkage with domestic suppliers (Yes=1; 0 otherwise)	5,050	0.0216	0.1453
Backward economic linkage with a foreign supplier	Having an economic linkage with foreign suppliers (Yes=1; 0 otherwise)	5,050	0.0283	0.1659
Forward economic linkage with a domestic customer	Having an economic linkage with domestic customers (Yes=1; 0 otherwise)	5,050	0.7650	0.4241
Forward economic linkage with a foreign customer	Having an economic linkage with foreign customers (Yes=1; 0 otherwise)	5,050	0.7943	0.4043

Source: Authors' calculation from TCS and VES 2015-2019

In contrast with the earlier studies, we allow explicitly for the possibility of non-linear effects that this learning effect leads to a decreasing rate in the growth of linkages afterward, i.e.,

that the "maturity" effect levels off over time, by including the square of the maturity proxy variable (age) in the estimation. Also, as in (O'farrell & O'Loughlin, 1981), we include (the log of)

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

5

average employment as a proxy for firm size. We would expect this variable to be negatively related to the extent of a firm's linkages to the domestic market. As (O'farrell & O'Loughlin, 1981) point out, large firms might be expected to have lower linkages because economies of scale make them more self-sufficient than smaller firms. Furthermore, the recent trends towards global out-sourcing of activities and down-sizing of production in firms suggest that smaller firms may be more likely to have higher linkages than large firms, i.e., to source proportionally more inputs locally. Furthermore, the model includes the logarithm of total employment in the concerned industry, a proxy for the size of industry j. We include this

variable to control for aggregate demand in the specific manufacturing industry. To account for sector competition, we include the HHI index at time t, in the equation. We would expect that, as the competition concentrates, this would lead to a negative relationship between market competition and the extent of material and intermediate input linkages and output linkages in particular. To obtain the effect of economic and infrastructure constraints, we include variables reflecting the obstacles that firms are facing with. Firms are asked, "Does your enterprise face any constraints delaying or obstructing the enterprise's performance?"

Table 2. Statistic description of explanatory variables

Variable	Description	Obs.	Mean	Std. Dev.	Min	Max
Firm characteristics						
Size	Employment (in logarithm). Variable lagged one period	5,050	5.19	1.347	1.099	9.861
Year of operation	Years of operation (in logarithm)	5,050	2.697	.182	0	3.892
	Years of operation (in logarithm), squared	5,050	7.308	.901	0	15.146
Economic obstacles	Basic infrastructure	5,050	4.526	3.821	0	10
	Transport infrastructure	5,050	4.384	3.598	0	10
	Communication infrastructure	5,050	4.106	3.443	0	10
	Financing constraints	5,050	4.833	3.689	0	10
	Labor force	5,050	5.017	3.478	0	10
	Technological know-how	5,050	5.424	3.513	0	10
	Technologies	5,050	5.426	3.697	0	10
Sector characteristics						
Industry demand	Total sectoral employment (in logarithm)	5,050	36420	33960	128	99345
Market concentration	HHI by total gross revenues	5,050	432.5	423	122.7	5803

Source: Authors' calculation from TCS and VES 2015-2019

The obstacles can be (1) Basic infrastructure (electricity, energy, land), (2) Transport infrastructures (roads, airports), (3) Communication infrastructures, (4) Financing constraints (credits, foreign capital), (5) Labor force (in terms of numbers), (6) Technological know-how (skilled labor), (7) Technologies (machinery, equipment). Table 2 presents the statistical description of explanatory variables. In our empirical model, as described in Table 3, we also investigate the role of technology

transfer on the economic linkages by examining a set of four different technology transfers: (1) Technology backward linkage with a domestic supplier (TBLDS), (2) Technology backward linkage with a foreign supplier (TBLFS), (3) Technology forward linkage with a domestic customer (TFLDC)), and (4) Technology forward linkage with a foreign customer (TFLFC).

Table 3. Statistic description of technology transfers

Variable	Description	Obs.	Mean	Std. Dev.	Min	Max
Technology backward linkage with a domestic supplier	Having a technology relationship with domestic suppliers (Yes=1; 0 otherwise)	5,050	.0679	.2516	0	1
Technology backward linkage with a foreign supplier	Having technology relationship with foreign suppliers (Yes=1; 0 otherwise)	5,050	.0907	.2872	0	1
Technology forward linkage with a domestic customer	Having technology relationship with domestic customers (Yes=1; 0 otherwise)	5,050	.0477	.2132	0	1
Technology forward linkage with a foreign customer	Having technology relationship with foreign customers (Yes=1; 0 otherwise)	5,050	.0503	.2186	0	1

Source: Authors' calculation from TCS and VES 2015-2019

3.2.2. Estimation strategy

Our main objectives are to determine factors of deciding firms' choices of economic linkages. In addition, we also examine the influences of technology transfers on the economic linkages. Economic obstacles are further investigated in our model to clarify their effects on the economic linkages through their involvements with firm characteristics and in technology transfers. The estimation goes through three steps.

Step 1: Since our key research question is which factors drive firms' choices of economic linkages, we estimate four groups of the model as follows: Group 1 is the model with the dependent variable of "having economic linkages with domestic

customers" (ELDC), Group 2 "having economic linkages with foreign customers" (ELFC), Group 3 "having economic linkages with domestic suppliers" (ELDS), and Group 4 "having economic linkages with foreign suppliers" (ELFS). In each set of these four groups, we estimate five sets of models depending on the labor categories. Panel A takes workers from 10 and above (all sample), panel B workers from 10 to less than 100, panel C workers from 100 to less than 200, panel D workers from 200 to less than 300, and panel E workers from 300 and above. All models include firm and sector characteristics. Details of alternative models are in Table 4.

Table 4: Estimation strategy

Panel	ELDC	ELFC	ELDS	ELFS
A (all sample: 10 and above)	Yes	Yes	Yes	Yes
B (from 10 to less than 100)	Yes	Yes	Yes	Yes
C (from 100 to less than 200)	Yes	Yes	Yes	Yes
D (from 200 to less than 300)	Yes	Yes	Yes	Yes
E (from 300 and above)	Yes	Yes	Yes	Yes

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Source: Authors' designation.

Step 2: We are interested in the influences of technology transfers on choices of economic linkages to see whether the technology transfers underline the economic linkages.

Step 3: One of the further objectives of this study is to establish if certain drivers can interact to influence economic linkages. The first set of interactions is the ones between firm-characteristic variables and economic obstacles. The second set includes the interactions between economic obstacles and technology transfers. Hence, the system of equations (2) above is re-estimated to include the relevant interactions. Given the large number of drivers considered, the inclusion of interaction variables poses problems about degrees of freedom and multicollinearity. To address this problem, this study proceeds in four sub-steps. In the first step, bivariate correlations are estimated between each pair of the drivers, and only the significant pairs are selected for subsequent analysis. In the second step, interaction variables are created from the drivers in each of the significant pairs. Thereafter, an interaction variable is retained if it is significantly correlated with at least two of the five dependent variables. Lastly, all the retained interaction variables and the individual drivers are used as explanatory variables to each of the five dependent variables.

4. Empirical Results

As noted in Section 3.2.2, this analysis is undertaken both on the individual drivers and on the interaction between these drivers. We begin with a brief description of the overall patterns concerning the individual drivers and then follow this with econometric analysis to assess their significance.

4.1. Patterns of the individual drivers

Table 5 provides the characteristics of the manufacturing firms involved in four types of economic linkages. First of all, most economic linkages happen in terms of backward linkages with both domestic and foreign suppliers. A small faction of linkages belongs to domestic and foreign customers. Secondly, as is evident from Table 2, under the view of firms with economic linkage with domestic customers, basic infrastructure is the less important factor in terms of economic constraints. The second less important one is communication infrastructure. The third less important one is transport infrastructure. For firms with economic linkage with domestic customers, labor force, Financing constraints, technological know-how, and especially technologies are more significant that impede firms from forming economic linkages.

Under the view of firms with economic linkage with foreign customers, financing constraints, basic infrastructure, communication infrastructure, and transport infrastructure play a less important role in getting economic linkages. For those firms with economic linkage with domestic suppliers, technological know-how and technologies are considered important factors. For those firms with economic linkage with foreign suppliers, and the inadequate labor force is a significant constraint, apart from technological know-how and technologies. In general, the provision of the labor force and the availability of technologies in Vietnam are central issues in all types of economic linkages whereas the provision of basic infrastructure, communication infrastructure, and transport infrastructure is improving.

Table 5: Firm characteristics and economic linkages

	Economic linkage with domestic customers (Obs. = 109)		Economic linkage with foreign customers (Obs. = 143)		Economic linkage with domestic suppliers (Obs. = 3,863)		Economic linkage with foreign suppliers (Obs. = 4,011)	
Variable	Mean	Sd.	Mean	Sd.	Mean	Sd.	Mean	Sd.
Employment (ln)	5.736	1.24	5.438	1.351	4.965	1.238	5.448	1.307
Years of operation (ln)	2.759	.1954	2.69	.1764	2.7	.1927	2.703	.157
Basic infrastructure	4.468	3.584	4.769	3.819	4.483	3.839	4.497	3.786
Transport infrastructure	5.165	3.128	4.811	3.747	4.319	3.608	4.356	3.553
Communication infrastructure	4.835	3.262	4.441	3.504	4.028	3.445	4.163	3.405
Financing constraints	5.422	3.397	4.699	3.835	4.853	3.712	4.853	3.639
Labor force	5.376	3.033	5.462	3.58	4.899	3.48	5.096	3.434
Technological know-how	6.073	3.24	5.72	3.701	5.363	3.533	5.505	3.448
Technologies	6.523	3.404	5.538	3.767	5.446	3.713	5.476	3.653
Total sectoral employment	31907	29346	25847	23862	28712	29357	40546	35296
HHI by total gross revenues	422.2	424.7	537.8	451.2	451	446.8	428.3	410.9
TBLDS	.110	.314	.105	.308	.072	.259	.072	.259

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

7

TBLFS	.128	.336	.203	.404	.088	.284	.104	.305
TFLDC	.064	.246	.077	.267	.062	.242	.043	.203
TFLFC	.101	.303	.070	.256	.044	.204	.063	.244

Note: (1) TBLDS: Technology backward linkage with domestic supplier, (2) TBLFS: Technology backward linkage with a foreign supplier, (3) TFLDC: Technology forward linkage with the domestic customer, and (4) TFLFC: Technology forward linkage with a foreign customer. Source: Authors' calculation from TCS and VES 2015-2019

Thirdly, with respect to technology transfers, similar to economic linkages, most technology transfers happen in terms of backward linkages with both domestic and foreign suppliers. In addition, firms involved in a kind of economic linkages are associated with various types of technology transfers. Moreover, technology transfers are less likely to happen with the same types of customers or suppliers. For example, firms having economic linkage with domestic customers are less likely to have technology forward linkage with the domestic customer; firms having economic linkage with foreign customers are less likely to have technology forward linkage with a foreign customer. In the contrast, firms obtaining economic linkage with domestic suppliers tend to have more technology backward linkage with a domestic supplier; Likewise, firms obtaining economic linkage with foreign suppliers tend to have more technology backward linkage with a foreign supplier;

4.2. Causality in the drivers of economic linkages

4.2.1. Individual drivers

In the regression analysis, four areas of economic linkage are considered and each is represented by one of the columns in Table 6, using Stata command *gsem* (Huber, 2013). The first is the backward economic linkage with a domestic supplier.

The next three areas of economic linkage considered are the backward economic linkage with a foreign supplier, the forward economic linkage with the domestic customer, and the forward economic linkage with a foreign customer.

We find that firms are less likely to obtain economic linkages with domestic customers, with foreign customers, and with foreign suppliers when it expands its size (in terms of employment). However, the adverse association occurs in the case of linkages with domestic suppliers. In addition, a non-linear relationship happens with linkages with foreign suppliers: at the first stage of development, firms are more dependent on foreign suppliers, and later on, the dependency is less. This has been found in Kiyota et al. (2008). We find that the linear positive association with domestic suppliers is observed throughout the sample. Firms are also more tightened on foreign suppliers rather than domestic ones in the pace of upward growth. Moreover, under the sectoral demand of input factor inputs, firms try to meet up the challenges of stiff competition in inputs by engaging in economic linkages with foreign suppliers. With respect to market concentration, firms facing a less competitive market tend to reduce economic linkages with domestic customers and domestic suppliers and move to cooperation with foreign customers and suppliers.

Table 6: Determinants of economic linkage choices (Marginal effects), 2015-2019

VARIABLES	(1) Linkages with domestic customers	(2) Linkages with foreign customers	(3) Linkages with domestic suppliers	(4) Linkages with foreign suppliers
Employment (ln)	0.009***	0.008***	-0.046***	0.108***
	(0.002)	(0.002)	(0.004)	(0.004)
Years of operation (ln)	-0.004	0.038	0.082***	0.669***
	(0.083)	(0.039)	(0.028)	(0.180)
Years of operation (ln), squared	0.008	-0.011		-0.124***
	(0.015)	(0.008)		(0.035)
Basic infrastructure	-0.003***	-0.0002	-0.003	-0.003
	(0.001)	(0.001)	(0.002)	(0.002)
Transport infrastructure	0.002**	0.001	-0.003	-0.009***
	(0.001)	(0.001)	(0.003)	(0.003)
Communication infrastructure	0.001	2.62×10^{-5}	-0.006**	0.012***
	(0.001)	(0.001)	(0.003)	(0.003)
Financing constraints	0.001	-0.002**	0.007***	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Labor force	-0.002*	0.002	-0.005**	-0.001
	(0.001)	(0.001)	(0.002)	(0.003)
Technological know-how	-2.38×10^{-5}	0.0002		0.004
	(0.001)	(0.001)		(0.003)
Technologies	0.002***	-0.0004	0.007***	0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Total sectoral employment (ln)	-2.67×10^{-7}***	-4.46×10^{-7}***	-3.42×10^{-6}***	1.86×10^{-6}***
	(7.45×10^{-8})	(8.87×10^{-8})	(1.45×10^{-7})	(2.12×10^{-7})
HHI by total gross revenues	-9.11×10^{-6}	5.69×10^{-6}	-2.62×10^{-5}**	1.34×10^{-5}
	(6.11×10^{-6})	(4.70×10^{-6})	(1.25×10^{-6})	(1.27×10^{-5})
Observations	5,050	5,050	5,050	5,050

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

Regarding economic obstacles, basic infrastructure is only constrained on economic linkages with domestic customers, whereas transport infrastructure may stipulate linkages with domestic customers, but not for economic linkages with foreign

suppliers. The results also show that communication infrastructure aids economic linkages with foreign suppliers, but it appears as a barrier to economic linkages with domestic suppliers. Regarding financial constraints, it is probable that

they tighten more the economic linkages with international customers, but less with domestic suppliers, where payment can usually be settled easier upon business customs. Labor shortage may narrow down economic linkages with domestic customers and with domestic suppliers. Constraints on technologies may be supportive to firms to seek economic linkages with domestic customers and with domestic suppliers, instead.

4.2.2. Technology transfers

Table 8 presents the effects of technology transfers on economic linkages. We find that activities such as technology backward linkage with a domestic supplier is supportive to the

economic linkages with domestic suppliers (*domestic technology embodied economic linkage*), technology backward linkage with a foreign supplier stipulates linkages with foreign customers (*international supply-chain technology embodied economic linkage*), technology forward linkage with a foreign customer enhances economic linkages with domestic customers (*local market-explored economic linkage*). However, we also find that activities such as 'Technology forward linkage with the domestic customer' are not supportive to the linkages with foreign suppliers (*local market privilege*), and 'Technology forward linkage with a foreign customer' is not positively associated with the linkages with domestic suppliers (*foreign market privilege*)

Table 8: Technology transfers and economic linkage choices (Marginal effects), 2015-2019

VARIABLES	(1) Linkages with domestic customers	(2) Linkages with foreign customers	(3) Linkages with domestic suppliers	(4) Linkages with foreign suppliers
Employment (ln)	0.009***	0.007***	-0.045***	0.106***
	(0.002)	(0.002)	(0.004)	(0.004)
Years of operation (ln)	-0.004	0.041	-0.779***	0.661***
	(0.088)	(0.041)	(0.293)	(0.179)
Years of operation (ln), squared	0.007	-0.011	0.172***	-0.123***
	(0.015)	(0.009)	(0.056)	(0.035)
Basic infrastructure	-0.003***	-6.76×10^5	-0.003	-0.003
	(0.001)	(0.001)	(0.002)	(0.002)
Transport infrastructure	0.002**	0.001	-0.003	-0.009***
	(0.001)	(0.001)	(0.003)	(0.003)
Communication infrastructure	0.001	0.0002	-0.005**	0.013***
	(0.001)	(0.001)	(0.003)	(0.003)
Financing constraints	0.0004	-0.002*	0.007***	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Labor force	-0.002**	0.002	-0.005*	-0.002
	(0.001)	(0.001)	(0.003)	(0.003)
Technological know-how	5.87×10^5	0.0003	-0.002	0.004
	(0.001)	(0.001)	(0.003)	(0.003)
Technologies	0.002***	-0.001	0.008***	0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Total sectoral employment (ln)	-2.65×10^7	-4.38×10^{7}***	-3.38×10^6***	1.88×10^6***
	(2.51×10^7)	(9.04×10^8)	(1.45×10^7)	(2.12×10^7)
HHI by total gross revenues	-9.11×10^6	5.89×10^6	-2.45×10^5*	1.50×10^5
	(6.13×10^6)	(4.72×10^6)	(1.25×10^5)	(1.27×10^5)
TBLDS	0.009	-0.009	0.063**	0.004
	(0.007)	(0.001)	(0.026)	(0.026)
TBLFS	-0.002	0.029***	-0.029	0.131***
	(0.006)	(0.008)	(0.021)	(0.025)
TFLDC	-0.004	0.008		-0.086***
	(0.009)	(0.010)		(0.024)
TFLFC	0.013*	0.0002	-0.059**	
	(0.007)	(0.010)	(0.023)	
Observations	5,050	5,050	5,050	5,050

Note: (1) TBLDS: Technology backward linkage with domestic supplier, (2) TBLFS: Technology backward linkage with a foreign supplier, (3) TFLDC: Technology forward linkage with the domestic customer, and (4) TFLFC: Technology forward linkage with a foreign customer. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

4.2.3. Interactions of drivers

Economic obstacles and firm characteristics

Table 10 presents the results of the regression estimates showing the interactive drivers between economic obstacles and firm characteristics in determining the economic linkage in the Vietnamese manufacturing sector. An overview of the table shows that the results for the individual drivers are similar to those documented in Table 5 above. In the following part, only the interaction drivers will be interpreted in this discussion.

Firstly, large firms faced with any constraint in basic infrastructure are more likely to be involved in economic linkages with domestic customers. However, those firms are less engaged with economic linkages with domestic suppliers since this may result in higher costs. Secondly, large firms faced with any constraint in the number of laborers are more likely to be involved in economic linkages with foreign customers, and with economic linkages with domestic suppliers. Thirdly, lacking skilled labor (technology know-how) is more likely to push large firms to get in touch with foreign suppliers.

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

9

Table 10: Economic linkage choices: Economic obstacles and firm characteristics (Marginal effects), 2015-2019

VARIABLES	(1) Linkages with domestic customers	(2) Linkages with foreign customers	(3) Linkages with domestic suppliers	(4) Linkages with foreign suppliers
Employment (ln)	0.004	0.0004	-0.058***	0.072***
	(0.003)	(0.004)	(0.008)	(0.008)
Years of operation (ln)	0.007	0.028	0.084***	0.675***
	(0.093)	(0.037)	(0.028)	(0.178)
Years of operation (ln), squared	0.005	-0.009		-0.125***
	(0.016)	(0.008)		(0.035)
Basic infrastructure	-0.008***	0.001	0.011	-0.014*
	(0.003)	(0.003)	(0.008)	(0.008)
Transport infrastructure	0.002**	0.001	-0.003	-0.010***
	(0.001)	(0.001)	(0.003)	(0.003)
Communication infrastructure	0.001	5.96×10^5	-0.006**	0.012***
	(0.001)	(0.001)	(0.003)	(0.003)
Financing constraints	0.001	-0.002*	0.007***	-0.001
	(0.001)	(0.001)	(0.002)	(0.002)
Labor force	-0.003	-0.012***	-0.032***	0.006
	(0.003)	(0.004)	(0.008)	(0.010)
Technological know-how	0.001	0.006		-0.027***
	(0.003)	(0.004)		(0.010)
Technologies	0.002***	-0.001	0.007***	0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Total sectoral employment (ln)	-2.59×10^{-7}***	-4.81×10^{-7}***	-3.42×10^{-6}***	1.88×10^{-6}***
	(7.42×10^{-8})	(9.51×10^{-8})	(1.45×10^{-7})	(2.12×10^{-7})
HHI by total gross revenues	-8.65×10^{-6}	5.12×10^{-6}	-2.63×10^{5}**	1.49×10^{5}
	(6.02×10^{-6})	(4.69×10^{-6})	(1.25×10^{5})	(1.28×10^{5})
Employment (ln) * Basic infrastructure	0.001** (0.0004)	-0.0001 (0.001)	-0.003* (0.001)	0.002 (0.002)
Employment (ln) * Labor force	0.0002	0.003***	0.005***	-0.002
	(0.0005)	(0.001)	(0.001)	(0.002)
Employment (ln) * Technological know-how	-0.0002	-0.001	-0.001	0.007***
	(0.001)	(0.001)	(0.001)	(0.002)
Observations	5,050	5,050	5,050	5,050

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

Economic obstacles and technology transfers

Table 11 presents the results of the regression estimation showing the interactive drivers between economic obstacles and technology transfers in determining the economic linkage in the Vietnamese manufacturing sector. Firstly, firms having technology backward linkage with a domestic supplier and lacking labor force may less likely take part in economic linkages with domestic customers. Secondly, with reference to firms having technology forward linkage with the domestic customer, they tend to involve more into economic linkages with domestic customers and with foreign suppliers if facing constraint on transport infrastructure, and less into linkages with domestic customers if facing obstacle in communication infrastructure. In addition, firms lacking labor force may switch to economic linkages with foreign suppliers. In relation to the technology forward linkage with a foreign customer, firms without abundant technologies tend to separate from economic linkages with domestic customers and with foreign customers. In addition, firms facing constraints in communication infrastructure may establish economic linkages with foreign customers, but not with domestic suppliers. Moreover, firms with financial constraints may stay away from the economic linkage with foreign customers. However, firms with constraints in the labor force may tighten their economic linkage with foreign customers.

Chi-Hai Nguyen, Quang-Thanh Ngo, My-Duyen Pham, Anh-Tuan Nguyen, Ngoc-Chuong Huynh

Table 11: Economic linkage choices: Economic obstacles and technology transfers (Marginal effects), 2015-2019

VARIABLES	(1) Linkages with domestic customers	(2) Linkages with foreign customers	(3) Linkages with domestic suppliers	(4) Linkages with foreign suppliers
Employment (ln)	0.009***	0.007***	-0.045***	0.106***
	(0.002)	(0.002)	(0.004)	(0.004)
Years of operation (ln)	-0.009	0.042	-0.790***	0.669***
	(0.082)	(0.04)	(0.292)	(0.181)
Years of operation (ln), squared	0.009	-0.011	0.174***	-0.125***
	(0.014)	(0.008)	(0.056)	(0.035)
Basic infrastructure	-0.003***	-5.08×10^5	-0.003	-0.003
	(0.001)	(0.001)	(0.002)	(0.002)
Transport infrastructure	0.001	0.001	-0.003	-0.011***
	(0.001)	(0.001)	(0.003)	(0.003)
Communication infrastructure	0.002**	0.0002	-0.004	0.013***
	(0.001)	(0.001)	(0.003)	(0.003)
Financing constraints	0.0004	-0.001	0.007***	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Labor force	-0.001	0.001	-0.005*	-0.0004
	(0.001)	(0.001)	(0.003)	(0.003)
Technological know-how	0.0003	-0.0002	-0.002	0.004*
	(0.001)	(0.001)	(0.003)	(0.003)
Technologies	0.003***	7.38×10^5	0.008***	0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Total sectoral employment (ln)	-2.60×10^7***	-4.35×10^7***	-3.37×10^6***	1.88×10^6***
	(7.51×10^8)	(9.10×10^8)	(1.45×10^7)	(2.12×10^7)
HHI by total gross revenues	-9.11×10^6 (6.12×10^6)	4.79×10^6 (4.76×10^6)	-2.44×10^5* (1.25×10^5)	1.56×10^5 (1.28×10^5)
TBLDS	0.034***	-0.007	0.064**	0.005
	(0.011)	(0.010)	(0.026)	(0.026)
TBLFS	-0.001	0.030***	-0.029	0.134***
	(0.007)	(0.008)	(0.021)	(0.025)
TFLDC	-0.009	0.010		-0.095**
	(0.011)	(0.010)		(0.044)
TFLFC	0.043***	-0.0005	0.0004	
	(0.011)	(0.018)	(0.037)	
TBLDS * Labor force	-0.004*** (0.002)			
TFLDC * Transport infrastructure	0.007** (0.003)			0.022*** (0.007)
TFLDC * Communication infrastructure	-0.008** (0.003)			
TFLDC * Labor force				-0.019*** (0.007)
TFLFC * Technologies	-0.006*** (0.002)	-0.013*** (0.004)		
TFLFC * Communication infrastructure		0.007** (0.003)	-0.012** (0.006)	
TFLFC * Financial constraint		-0.010*** (0.003)		
TFLFC * Labor force		0.014*** (0.005)		
Observations	5,050	5,050	5,050	5,050

Note: (1) TBLDS: Technology backward linkage with domestic supplier, (2) TBLFS: Technology backward linkage with a foreign supplier, (3) TFLDC: Technology forward linkage with the domestic customer, and (4) TFLFC: Technology forward linkage with a foreign customer. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

4.3. Ownership: domestic vs. foreign-owned firms

4.3.1. Individual drivers

Table 12 presents the determinants of economic linkage choices by distinguishing domestic vs. FDI firms, using Stata command *gsem* (Huber, 2013): column (1), (2), (3), and (4) are the backward economic linkage with domestic supplier, the backward economic linkage with a foreign supplier, the forward economic linkage with the domestic customer, and the forward economic linkage with a foreign customer, respectively. Table 12 shows that domestic firms are less likely to obtain economic linkages with domestic customers, with foreign customers, and with foreign suppliers when it expands its size (in terms of employment). A similar pattern is found with FDI firms, with the exception that the adverse association occurs in the case of linkages with domestic suppliers. We also find a non-linear relationship happens for those FDI firms with linkages with foreign suppliers and this is in line with Kiyota et al. (2008). With regard to economic obstacles, basic infrastructure, in addition to economic linkages with domestic customers, is constrained on economic linkages with domestic suppliers by FDI firms, whereas transport infrastructure may not stipulate

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

11

linkages with domestic suppliers for the case of domestic firms, and economic linkages with foreign suppliers for the case of FDI firms. The results also show that communication infrastructure aids economic linkages with foreign suppliers for the case of FDI firms, but it appears as a barrier to economic linkages with domestic suppliers as for domestic firms. Regarding financial constraints, domestic firms more look at the economic linkages with domestic customers, whereas FDI firms put advantages on the economic linkages with foreign suppliers. Labor shortage may narrow down economic linkages by domestic firms with both domestic and foreign customers, whereas FDI firms may face similar problems in economic linkages with domestic and with foreign suppliers. Constraints on technologies may be supportive to domestic firms to seek economic linkages with foreign customers and with domestic suppliers, instead. FDI firms may overcome the constraints on technologies by increasing the cooperation with both domestic customers and suppliers.

Table 12: Determinants of economic linkage choices (Marginal effects) by ownership, 2015-2019

	Domestic firms				FDI firms			
VARIABLES	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	0.016***	0.007***	0.003	0.140***	0.008***	0.007***	-0.052***	0.082***
	(0.004)	(0.002)	(0.007)	(0.010)	(0.002)	(0.003)	(0.005)	(0.005)
Years of operation (ln)	0.123	2.73×10^6	-0.076**	0.288	-0.048	0.086	0.163***	0.781***
	(0.163)	(0.021)	(0.037)	(0.217)	(0.045)	(0.135)	(0.042)	(0.245)
Years of operation (ln), squared	-0.015	-0.002		-0.026	0.017*	-0.022		-0.154***
	(0.026)	(0.006)		(0.046)	(0.009)	(0.026)		(0.047)
Basic infrastructure	-0.003**	0.002*	0.007**	0.003	-0.003***	-0.001	-0.008***	-0.003
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)	(0.003)	(0.002)
Transport infrastructure	0.004***	0.0003	-0.008**	-0.008	0.002	0.002	0.0004	-0.009***
	(0.001)	(0.001)	(0.004)	(0.005)	(0.001)	(0.001)	(0.003)	(0.003)
Communication infrastructure	0.002	-0.0002	-0.009**	0.002	0.001	-0.0003	-0.002	0.010***
	(0.002)	(0.001)	(0.004)	(0.005)	(0.001)	(0.002)	(0.003)	(0.003)
Financing constraints	0.002**	-0.001	0.004	-6.14×10^5	0.0002	-0.002	0.003	0.006***
	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.001)	(0.003)	(0.002)
Labor force	-0.002**	-0.002**	-0.001	0.006	-0.001	0.004***	-0.008**	-0.004*
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.002)	(0.003)	(0.002)
Technological know-how	0.003*	0.001		0.005	-0.001	-0.0001		0.003
	(0.002)	(0.001)		(0.006)	(0.001)	(0.002)		(0.002)
Technologies	-0.0004	0.002**	0.007**	0.003	0.003***	-0.002*	0.009***	-0.001
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)	(0.003)	(0.002)
Total sectoral employment (ln)	-4.11×10^8	-1.91×10^7	$-2.48 \times 10^{6***}$	$2.96 \times 10^{6***}$	$-4.16 \times 10^{7***}$	$-5.45 \times 10^{7***}$	$-3.77 \times 10^{6***}$	$1.24 \times 10^{6***}$
	(1.36×10^7)	(2.73×10^7)	(2.12×10^7)	(3.93×10^7)	(1.02×10^7)	(1.19×10^7)	(1.83×10^7)	(2.29×10^7)
HHI by total gross revenues	7.86×10^6	$1.20 \times 10^{5*}$	$9.07 \times 10^{5***}$	-5.48×10^5	$-1.51 \times 10^{5*}$	1.30×10^6	$-2.41 \times 10^{5*}$	-8.94×10^7
	(7.78×10^6)	(6.33×10^6)	(3.00×10^5)	(3.40×10^5)	(8.08×10^6)	(6.31×10^6)	(1.46×10^5)	(1.17×10^5)
Observations	1,506	1,506	1,506	1,506	3,544	3,544	3,544	3,544

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

4.3.2. Technology transfers

Table 13 presents the effects of technology transfers on economic linkages by two groups of ownership. We find that activities such as technology backward linkage with a domestic supplier is supportive to the economic linkages with domestic customers by FDI firms (*local supply-chain technology embodied economic linkage*), whereas technology backward linkage with domestic supplier limits the economic linkages with both domestic and foreign customers by domestic firms. This may be explained by the different market preferences and segmentations. Activities such as technology backward linkage with a foreign supplier stipulate linkage with foreign customers and with foreign suppliers by both domestic and FDI firms (*global supply-chain technology embodied economic linkage*), technology backward linkage with a foreign supplier manipulates linkages with foreign customers and with foreign suppliers by FDI firms. We find evidence to strengthen the proposition that technology forward linkage with a domestic customer enhances economic linkages with domestic customers by domestic firms (*local supply-chain technology embodied economic linkage*). However, we also find that activities such as 'Technology forward linkage with the domestic customer' are not supportive to the linkages with foreign suppliers by FDI firm (*local market privilege*), and 'Technology forward linkage with a foreign customer' is not positively associated with the linkages with domestic suppliers by domestic firms (*foreign market privilege*).

Chi-Hai Nguyen, Quang-Thanh Ngo, My-Duyen Pham, Anh-Tuan Nguyen, Ngoc-Chuong Huynh

Table 13: Technology transfers and economic linkage choices by ownership (Marginal effects), 2015-2019

VARIABLES	Domestic firms				FDI firms			
	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	0.015***	0.006***	0.005	0.138***	0.008***	0.006**	-0.052***	0.081***
	(0.004)	(0.002)	(0.007)	(0.010)	(0.002)	(0.003)	(0.005)	(0.005)
Years of operation (ln)	0.072	0.004	-0.555	0.298	-0.052	0.083	-0.870**	0.754***
	(0.158)	(0.024)	(0.467)	(0.220)	(0.042)	(0.077)	(0.423)	(0.237)
Years of operation (ln), squared	-0.006	-0.004	0.089	-0.029	0.017*	-0.021	0.204**	-0.149***
	(0.025)	(0.007)	(0.084)	(0.047)	(0.009)	(0.016)	(0.081)	(0.046)
Basic infrastructure	-0.003**	0.002**	0.007**	0.002	-0.003***	-0.0004	-0.008***	-0.002
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)	(0.003)	(0.002)
Transport infrastructure	0.003***	-5.71×10^5	-0.008**	-0.007	0.002	0.001	0.001	-0.009***
	(0.001)	(0.001)	(0.004)	(0.005)	(0.001)	(0.001)	(0.003)	(0.003)
Communication infrastructure	0.002	0.0004	-0.009**	0.003	0.001	-0.0002	-0.001	0.010***
	(0.001)	(0.001)	(0.004)	(0.005)	(0.001)	(0.002)	(0.003)	(0.003)
Financing constraints	0.002**	-0.001	0.004	-0.001	9.97×10^5	-0.002	0.004	0.006***
	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.001)	(0.003)	(0.002)
Labor force	-0.003**	-0.003***	-0.005	0.005	-0.001	0.004***	-0.005*	-0.004*
	(0.001)	(0.001)	(0.003)	(0.006)	(0.001)	(0.002)	(0.003)	(0.003)
Technological know-how	0.004**	0.001	0.007*	0.005	-0.001	4.70×10^5	-0.007*	0.003
	(0.001)	(0.001)	(0.004)	(0.006)	(0.001)	(0.002)	(0.003)	(0.002)
Technologies	-0.001	0.001**	0.004	0.003	0.003***	-0.002*	0.011***	-0.001
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)	(0.003)	(0.002)
Total sectoral employment (ln)	-6.51×10^8	$-1.86 \times 10^{7**}$	$-2.40 \times 10^{6***}$	$2.96 \times 10^{6***}$	$-4.18 \times 10^{7***}$	$-5.37 \times 10^{7***}$	$-3.72 \times 10^{6***}$	$1.26 \times 10^{6***}$
	(2.08×10^7)	(9.31×10^8)	(2.13×10^7)	(3.95×10^7)	(1.03×10^7)	(1.22×10^7)	(1.84×10^7)	(2.28×10^7)
HHI by total gross revenues	5.22×10^6	9.13×10^6	0.0001***	-5.40×10^5	$-1.52 \times 10^{5*}$	2.24×10^6	-2.39×10^5	3.71×10^7
	(7.20×10^6)	(5.61×10^6)	(3.27×10^5)	(3.39×10^5)	(8.15×10^6)	(6.29×10^6)	(1.46×10^5)	(1.17×10^5)
TBLDS	-0.026*	-0.029**	0.063	0.042	0.020**	-0.002	0.042	-0.010
	(0.013)	(0.012)	(0.041)	(0.052)	(0.008)	(0.013)	(0.033)	(0.026)
TBLFS	0.005	0.028***	-0.023	0.122**	-0.007	0.026**	-0.016	0.085***
	(0.011)	(0.009)	(0.033)	(0.057)	(0.007)	(0.011)	(0.027)	(0.024)
TFLDC	0.027***	0.009		-0.063	-0.022	0.013		-0.040*
	(0.010)	(0.009)		(0.049)	(0.014)	(0.014)		(0.023)
TFLFC	0.018*	0.002	-0.115***		0.012	-0.001	-0.047	
	(0.009)	(0.009)	(0.034)		(0.009)	(0.014)	(0.029)	
Observations	1,506	1,506	1,506	1,506	3,544	3,544	3,544	3,544

Note: (1) TBLDS: Technology backward linkage with domestic supplier, (2) TBLFS: Technology backward linkage with a foreign supplier, (3) TFLDC: Technology forward linkage with the domestic customer, and (4) TFLFC: Technology forward linkage with a foreign customer.

ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

4.3.3. Interactions of drivers

Economic obstacles and firm characteristics

Table 14 presents the results of the regression estimation by two groups of ownership, showing the interactive drivers between economic obstacles and firm characteristics in determining the economic linkage in the Vietnamese manufacturing sector. With respect to domestic firms, firstly, large firms faced with any constraint in communication infrastructure, in technologies are more likely to be involved in economic linkages with domestic customers by domestic firms. However, those firms facing constraints in communication infrastructure, in transportation infrastructure are less engaged with economic linkages with foreign customers by domestic firms since this may result in higher costs. In addition, large firms faced with any constraint in communication infrastructure, technology know-how, and basic infrastructure are more likely to be involved in economic linkages with foreign suppliers by domestic firms. A financial constraint can lead large firms less involve in economic linkages with domestic customers, and with foreign suppliers. Moreover, firms with more experience with constraint in technology know-how may be eager to take part in the economic linkages with foreign suppliers. In regard to FDI firms, firstly, large firms faced with any constraint in the number of laborers are more likely to be involved in economic linkages with foreign customers, and with domestic and foreign suppliers. In addition, firms with more experience with inadequate transport infrastructure are more likely to get in touch with both domestic and foreign customers.

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

13

Table 14: Economic linkage choices: Economic obstacles and firm characteristics by ownership (Marginal effects), 2015-2019

VARIABLES	Domestic firms				FDI firms			
	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	-0.003	0.005	-0.003	0.118***	0.006*	-0.005	-0.065***	0.060***
	(0.005)	(0.004)	(0.008)	(0.021)	(0.003)	(0.004)	(0.009)	(0.007)
Years of operation (ln)	0.159	0.004	-0.075**	0.288	-0.056	0.138	0.201***	0.759***
	(0.289)	(0.022)	(0.037)	(0.219)	(0.095)	(0.123)	(0.064)	(0.237)
Years of operation (ln), squared	-0.022	-0.003		-0.07	0.012	-0.039		-0.149***
	(0.047)	(0.005)		(0.050)	(0.019)	(0.027)		(0.046)
Basic infrastructure	-0.002**	0.002**	0.006**	-0.043**	-0.003***	-0.0002	-0.007**	-0.002
	(0.001)	(0.001)	(0.003)	(0.019)	(0.001)	(0.001)	(0.003)	(0.002)
Transport infrastructure	0.004***	0.008**	-0.008**	-0.008*	-0.018*	-0.026*	0.023	-0.004
	(0.001)	(0.004)	(0.004)	(0.005)	(0.010)	(0.015)	(0.029)	(0.021)
Communication infrastructure	-0.011**	0.007	-0.010***	-0.045**	0.0006	-0.0004	-0.001	0.010***
	(0.005)	(0.004)	(0.004)	(0.022)	(0.001)	(0.002)	(0.003)	(0.003)
Financing constraints	0.007***	-0.001		0.045**	0.0003	-0.001		0.006***
	(0.002)	(0.001)		(0.019)	(0.001)	(0.001)		(0.002)
Labor force	-0.002	-0.003**	-0.001	0.007	-0.004	-0.008**	-0.021**	-0.026***
	(0.001)	(0.001)	(0.003)	(0.005)	(0.003)	(0.004)	(0.009)	(0.007)
Technological know-how	0.002	-0.011***		-0.158***	-0.001	-0.0001		0.003
	(0.002)	(0.004)		(0.056)	(0.001)	(0.002)		(0.002)
Technologies	-0.011**	0.002**	0.006**	0.063**	0.003***	-0.002*	0.009***	-0.001
	(0.005)	(0.001)	(0.003)	(0.025)	(0.001)	(0.001)	(0.003)	(0.002)
Total sectoral employment (ln)	-3.50×10^8	$-2.37 \times 10^{7**}$	$-2.47 \times 10^{6***}$	$3.02 \times 10^{6***}$	$-4.24 \times 10^{7***}$	$-5.88 \times 10^{7***}$	$-3.77 \times 10^{6***}$	$1.21 \times 10^{6***}$
	(9.46×10^8)	(9.58×10^8)	(2.12×10^7)	(3.90×10^7)	(1.01×10^7)	(1.19×10^7)	(1.84×10^7)	(2.28×10^7)
HHI by total gross revenues	8.89×10^6	1.26×10^5**	$9.39 \times 10^{5***}$	$-5.73 \times 10^{5*}$	$-1.58 \times 10^{5*}$	3.50×10^7	-2.28×10^5	-1.18×10^6
	(7.80×10^6)	(6.34×10^6)	(3.04×10^5)	(3.41×10^5)	(8.12×10^6)	(6.37×10^6)	(1.47×10^5)	(1.18×10^5)
Employment (ln) * Communication infrastructure	0.002*** (0.001)	-0.001* (0.001)		0.010** (0.005)				
Employment (ln) * Financial constraints	-0.001* (0.0004)		0.001** (0.0005)	-0.009** (0.004)				
Employment (ln) * Technologies	0.002** (0.001)			-0.013** (0.005)				
Employment (ln) * Technology know-how		0.002*** (0.001)		0.011** (0.005)				
Employment (ln) * Basic infrastructure				0.009** (0.004)				
Ages (ln) * Technology know-how				0.042** (0.019)				
Employment (ln) * Transport infrastructure		-0.001** (0.0007)						
Employment (ln) * Labor					0.0004	0.002***	0.003*	0.005***
					(0.0005)	(0.001)	(0.001)	(0.001)
Ages (ln) * Transport infrastructure					0.007**	0.010*	-0.009	-0.002
					(0.004)	(0.006)	(0.011)	(0.008)
Observations	1,506	1,506	1,506	1,506	3,544	3,544	3,544	3,544

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation.

Economic obstacles and technology transfers

Table 15 presents the results of the regression estimations by two groups of ownership showing the interactive drivers between economic obstacles and technology transfers in determining the economic linkage in the Vietnamese manufacturing sector. In regard to domestic firms, firstly, firms having technology backward linkage with a domestic supplier and lacking technologies may less likely take part in economic linkages with foreign customers, and with domestic suppliers.

Secondly, with reference to firms having technology forward linkage with the foreign suppliers, they tend to involve less in economic linkages with foreign customers if facing constraint on the labor force. However, firms having technology forward linkage with the foreign suppliers and facing constraint in technology know-how tend to involve more into economic linkages with foreign customers and with domestic suppliers. Thirdly, firms having technology forward linkage with the

domestic customers and facing constraints in communication infrastructure are likely to take part in the economic linkage with foreign customers. However, firms will go away from this type of economic linkages if they face constraints in technologies.

With respect to FDI firms, those having technology forward linkage with the domestic customers and facing constraint in technologies are likely to take part into the economic linkage with foreign suppliers, but less into the economic linkage with domestic customers if constrained by technology know-how. Secondly, in relation to the technology forward linkage with a foreign customer, firms without abundant labor force tend to focus more on economic linkages with domestic suppliers and with foreign suppliers. In addition, firms facing constraint in technology know-how may be less intensive to establish economic linkages with domestic suppliers. Moreover, firms with constraints in technologies may stay away from the economic linkage with domestic and foreign suppliers. Besides, firms with constraints in financial issues may less tighten their economic linkage with foreign suppliers. Furthermore, firms facing transport constraints may switch to economic linkages with foreign suppliers.

Table 15: Economic linkage choices: Economic obstacles and technology transfers by ownership (Marginal effects), 2015-2019

	Domestic firms				FDI firms			
VARIABLES	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	0.015***	0.006**	0.002	0.138***	0.007***	0.006**	-0.052***	0.080***
	(0.004)	(0.002)	(0.007)	(0.010)	(0.002)	(0.003)	(0.005)	(0.005)
Years of operation (ln)	0.096	0.019	-0.636	0.312	-0.056	0.073	-0.870**	0.765***
	(0.165)	(0.022)	(0.494)	(0.229)	(0.040)	(0.073)	(0.423)	(0.241)
Years of operation (ln), squared	-0.010	-0.007	0.102	-0.032	0.018**	-0.019	0.204**	-0.151***
	(0.026)	(0.006)	(0.089)	(0.048)	(0.008)	(0.015)	(0.081)	(0.046)
Basic infrastructure	-0.002**	0.001	0.006**	0.002	-0.003***	-0.0003	-0.008***	-0.002
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)	(0.003)	(0.002)
Transport infrastructure	0.003***	-5.79×10^5	-0.008**	-0.008	0.002	0.001	0.001	-0.010***
	(0.001)	(0.001)	(0.004)	(0.005)	(0.001)	(0.002)	(0.003)	(0.003)
Communication infrastructure	0.002	-0.0002	-0.009**	0.002	0.001	0.0003	-0.001	0.010***
	(0.001)	(0.001)	(0.004)	(0.005)	(0.001)	(0.002)	(0.003)	(0.003)
Financing constraints	0.002**	-0.0004	0.004	-0.001	3.16×10^6	-0.001	0.004	0.006***
	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.001)	(0.003)	(0.002)
Labor force	-0.002**	-0.002*	-0.006*	0.005	-0.002	0.003**	-0.005*	-0.004*
	(0.001)	(0.001)	(0.003)	(0.006)	(0.001)	(0.002)	(0.003)	(0.003)
Technological know-how	0.004**	0.001	0.010***	0.005	-0.001	-0.0005	-0.007*	0.003
	(0.001)	(0.001)	(0.004)	(0.006)	(0.001)	(0.002)	(0.003)	(0.002)
Technologies	-0.001	0.002***	0.003	0.003	0.004***	-0.002	0.011***	-0.002
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)	(0.003)	(0.002)
Total sectoral employment (ln)	-5.00×10^8	$-2.03 \times 10^{7**}$	$-2.31 \times 10^{6***}$	$2.97 \times 10^{6***}$	$-3.99 \times 10^{7***}$	$-5.41 \times 10^{7***}$	$-3.72 \times 10^{6***}$	$1.26 \times 10^{6***}$
	(1.01×10^7)	(9.32×10^8)	(2.13×10^7)	(3.95×10^7)	(1.03×10^7)	(1.21×10^7)	(1.84×10^7)	(2.28×10^7)
HHI by total gross revenues	6.26×10^6	7.71×10^6	0.0001***	-5.55×10^5	$-1.57 \times 10^{5*}$	8.64×10^7	-2.39×10^5	4.86×10^7
	(7.23×10^6)	(4.84×10^6)	(3.32×10^5)	(3.40×10^5)	(8.42×10^6)	(6.29×10^6)	(1.46×10^5)	(1.17×10^5)
TBLDS	-0.024*	0.007	0.359***	0.041	0.022***	-0.001	0.042	-0.007
	(0.013)	(0.010)	(0.124)	(0.052)	(0.008)	(0.013)	(0.033)	(0.027)
TBLFS	0.005	0.017*	-0.173***	0.120**	-0.007	0.027***	-0.016	0.088***
	(0.011)	(0.010)	(0.051)	(0.056)	(0.007)	(0.010)	(0.027)	(0.024)
TFLDC	0.026***	0.028**		-0.061	0.001	0.016		-0.110***
	(0.010)	(0.011)		(0.049)	(0.018)	(0.014)		(0.039)
TFLFC	0.019**	-0.003	-0.112***		0.029*	-0.019	-0.047	
	(0.010)	(0.008)	(0.035)		(0.016)	(0.029)	(0.029)	
TBLDS * Technologies		-0.010***	-0.042***					
		(0.003)	(0.016)					
TBLFS * Labor		-0.009***						
		(0.003)						
TBLFS * Technology know-how		0.008***	0.026***					
		(0.003)	(0.008)					
TFLDC * Communication infrastructure		0.009**						
		(0.004)						
TFLDC * Technologies		-0.013***						0.012**
		(0.004)						(0.005)

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

15

TFLDC * Technology know-how					-0.005* (0.003)			
TFLFC * Labor							0.017*** (0.005)	0.013** (0.007)
TFLFC * Technology know-how							-0.012*** (0.004)	
TFLFC * Technologies							-0.010*** (0.003)	-0.012*** (0.004)
TFLFC * Transport infrastructure								0.010* (0.005)
TFLFC * Financial constraints								-0.012*** (0.004)
Observations	1,506	1,506	1,506	1,506	3,544	3,544	3,544	3,544

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

4.4. Firm heterogeneity and the drivers of economic linkages

4.4.1. Individual drivers

Table 16 reveals the heterogeneity of drivers of economic linkages across various firm sizes. Panel A takes workers from 10 and above (all sample), panel B workers from 10 to less than 100 (small firms), panel C workers from 100 to less than 200 (lower-medium firms), panel D workers from 200 to less than 300 (upper-medium firms), and panel E workers from 300 and above (large firms). In general, the results on firms' employment in four samples are consistent with the ones in the full sample.

Table 16 shows that small firms are less likely to obtain economic linkages with domestic customers, and with foreign suppliers when it expands its size (in terms of employment). This is a confirmation of what we obtain from the full sample. We also find a non-linear relationship happens for those small firms with linkages with foreign suppliers and this is in line with Kiyota et al. (2008). With regard to economic obstacles, basic infrastructure, in addition to economic linkages with foreign suppliers, is constrained on economic linkages with domestic customers by small firms, whereas transport infrastructure may not stipulate linkages with foreign suppliers. The results also show that communication infrastructure aids economic linkages with foreign suppliers as for domestic firms. Labor shortage may narrow down economic linkages by small firms with domestic customers, whereas constraints on technologies may hide the economic linkages with foreign customers. In regard to lower-medium firms, Table 16 shows that lower-medium firms are less likely to obtain economic linkages with foreign suppliers when it expands its size (in terms of employment). We also find, as for small firms, a non-linear relationship happens for those lower-medium firms with linkages with foreign suppliers and this is in line with Kiyota et al. (2008). With regard to economic obstacles, basic infrastructure is constrained on economic linkages with domestic customers by lower-medium firms, whereas transport infrastructure may stipulate linkages with domestic customers for the case of lower-medium firms. The results also show that communication infrastructure aids economic linkages with foreign suppliers for the case of lower-medium firms, but it appears as a barrier to economic linkages with domestic suppliers. Labor shortage may narrow down

economic linkages by lower-medium firms with domestic customers. Constraints on technology know-how may be supportive to lower-medium firms to seek economic linkages with foreign customers and with foreign suppliers, instead.

Regarding upper-medium firms, Table 16 shows that upper-medium firms follow a U-shaped relationship for those upper-medium firms with linkages with foreign suppliers. With regard to economic obstacles, basic infrastructure limits the economic linkages with domestic customers by upper-medium firms, but not the economic linkages with foreign customers. Transport infrastructure may not stipulate linkages with foreign suppliers for the case of the economic linkages with firms but can enhance economic linkages with domestic customers for the case of the economic linkages with firms. The results also show that communication infrastructure aids economic linkages with foreign customers, and with foreign suppliers for the case of the economic linkages with firms, but it appears as a barrier to economic linkages with domestic suppliers. Regarding financial constraints, upper-medium firms more look at the economic linkages with domestic customers and domestic suppliers. Constraints on technology know-how may be supportive to upper-medium firms to seek economic linkages with foreign suppliers, instead. The upper-medium firms may overcome the constraints on technologies by increasing the cooperation with domestic customers, but not with foreign customers. With respect to large firms, Table 16 shows that large firms are less likely to obtain economic linkages with foreign customers, and with foreign suppliers when it expands its size (in terms of employment), but not with domestic suppliers. We also find a non-linear relationship happens for those large firms with linkages with domestic suppliers and this is in line with Kiyota et al. (2008). Regarding economic obstacles, basic infrastructure is constrained on economic linkages with domestic suppliers by large firms. Regarding financial constraints, large firms are less likely to look at the economic linkages with domestic customers, whereas FDI firms put advantages on the economic linkages with foreign customers. Labor shortage may enhance economic linkages by large firms with foreign customers. Constraints on technologies may be supportive to large firms to seek economic linkages with foreign customers and with domestic suppliers, instead.

Table 16: Determinants of economic linkage choices (Marginal effects) by firm sizes, 2015-2019

Variable	Panel B				Panel C				Panel D				Panel E			
	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	0.012***	-0.004	-1.15×10^5	0.190***	0.001	0.020	-0.057	0.082*	-0.009	0.026	0.046	0.058	0.006	0.013***	-0.078***	0.054***
	(0.004)	(0.005)	(2.14×10^5)	(0.018)	(0.012)	(0.020)	(0.043)	(0.046)	(0.029)	(0.039)	(0.097)	(0.092)	(0.005)	(0.004)	(0.013)	(0.008)
Years of operation (ln)	0.062	0.472	0.011	1.314***	0.041	0.029	0.059	1.004**	1.056	-0.771**	0.106	-4.414**	-0.114	0.818	0.311***	0.202
	(0.146)	(0.334)	(0.010)	(0.345)	(0.042)	(0.208)	(0.043)	(0.433)	(1.517)	(0.370)	(0.100)	(1.775)	(0.255)	(0.676)	(0.074)	(0.395)
Years of operation (ln), squared	-0.011	-0.10		-0.274***	-0.010	2.17×10^5		-0.162*	-0.163	0.128*		0.847**	0.028	-0.140		-0.035
	(0.027)	(0.064)		(0.070)	(0.009)	(0.042)		(0.089)	(0.261)	(0.071)		(0.338)	(0.043)	(0.117)		(0.071)
Basic infrastructure	-0.002**	0.002	0.001	-0.009*	-0.005***	-0.002	-0.003	-0.005	-0.006**	0.003**	-0.001	0.002	0.0003	-0.001	-0.008**	0.002
	(0.001)	(0.001)	(0.001)	(0.005)	(0.002)	(0.002)	(0.004)	(0.006)	(0.003)	(0.001)	(0.007)	(0.006)	(0.002)	(0.001)	(0.004)	(0.002)
Transport infrastructure	0.0002	0.0004	-3.87×10^9	-0.015***	0.003*	0.002	0.001	-0.002	0.008***	-0.0003	0.001	-0.021***	0.002	-3.53×10^5	-0.007	-0.004
	(0.001)	(0.002)	(6.55×10^8)	(0.006)	(0.002)	(0.003)	(0.005)	(0.008)	(0.003)	(0.002)	(0.008)	(0.007)	(0.002)	(0.001)	(0.005)	(0.003)
Communication infrastructure	0.002	-0.001	-9.95×10^8	0.014**	0.002	0.003	-0.012***	0.018***	-0.003	0.005*	-0.022***	0.024***	0.002	-0.001	0.002	0.001
	(0.001)	(0.002)	(0.0002)	(0.006)	(0.001)	(0.003)	(0.004)	(0.006)	(0.003)	(0.003)	(0.008)	(0.008)	(0.002)	(0.002)	(0.006)	(0.003)
Financing constraints	8.79×10^5	-0.001	0.001	-0.0004	-0.001	-0.003	0.0004	-0.007	0.005*	0.002	0.016**	-0.001	-0.0004	-0.003*	0.005	0.0002
	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.002)	(0.004)	(0.005)	(0.003)	(0.002)	(0.007)	(0.006)	(0.002)	(0.002)	(0.004)	(0.002)
Labor force	-0.002**	-0.002	-1.38×10^7	0.0002	0.002*	0.003	0.010	-0.005	-0.0004	0.002	-0.005	-0.002	-0.002	0.005***	-0.002	0.001
	(0.001)	(0.002)	(1.35×10^6)	(0.006)	(0.001)	(0.002)	(0.005)	(0.006)	(0.002)	(0.004)	(0.009)	(0.007)	(0.002)	(0.002)	(0.005)	(0.003)
Technological know-how	-0.0003	0.001		-0.004	-0.001	0.005**		0.012*	-0.003	-0.006		0.017***	0.002	-0.003		0.002
	(0.001)	(0.001)		(0.006)	(0.001)	(0.002)		(0.006)	(0.002)	(0.004)		(0.005)	(0.002)	(0.002)		(0.002)
Technologies	0.002	-0.002*	-1.82×10^8	0.006	0.001	-0.002	0.002	0.004	0.004**	-0.004**	0.006	-0.003	0.001	0.003*	0.012***	0.001
	(0.002)	(0.001)	(6.46×10^6)	(0.005)	(0.001)	(0.002)	(0.004)	(0.005)	(0.002)	(0.002)	(0.007)	(0.005)	(0.002)	(0.002)	(0.004)	(0.002)
Total sectoral employment (ln)	-5.30×10^7*	3.16×10^9	-0	3.18×10^6***	-2.13×10^7	-9.70×10^7***	-1.96×10^6***	1.18×10^6***	6.22×10^8	-8.64×10^7***	-4.37×10^6***	1.17×10^6***	-4.01×10^7***	-3.96×10^7***	-5.22×10^6***	1.28×10^6***
	(2.79×10^7)	(1.67×10^7)	(1.92×10^8)	(6.05×10^7)	(4.09×10^7)	(2.97×10^7)	(2.86×10^7)	(4.26×10^7)	(4.21×10^7)	(2.50×10^7)	(3.85×10^7)	(4.25×10^7)	(1.36×10^7)	(1.38×10^7)	(2.64×10^7)	(2.10×10^7)
HHI by total gross revenues	-4.71×10^6	1.57×10^5***	1.35×10^6	-2.03×10^5	-6.43×10^6	-4.81×10^5**	7.41×10^5**	3.38×10^5	1.43×10^5	-4.91×10^5**	-3.85×10^5	1.58×10^5	-3.01×10^5**	2.72×10^5***	-0.0001***	3.74×10^5***
	(5.94×10^6)	(5.75×10^6)	(3.59×10^6)	(2.45×10^5)	(6.75×10^6)	(2.18×10^5)	(3.05×10^5)	(3.84×10^5)	(1.49×10^5)	(2.17×10^5)	(4.63×10^5)	(3.48×10^5)	(1.39×10^5)	(9.78×10^6)	(3.04×10^5)	(1.21×10^5)
Observations	1,715	1,715	1,715	1,715	1,097	1,097	1,097	1,097	593	593	593	593	1,645	1,645	1,645	1,645

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

4.4.2. Technology transfers

Table 17 presents the effects of technology transfers on economic linkages by firm sizes. With respect to small firms, firstly, we find that activities such as technology backward linkage with a domestic supplier is supportive to the economic linkages with domestic customers and with domestic suppliers by small firms (*supply-chain technology embodied economic linkage*). However, technology backward linkage with domestic suppliers limits the economic linkages with foreign suppliers by small firms (*local market privilege*). In addition, activities such as technology backward linkage with a foreign supplier stipulate linkage with foreign customers and with foreign suppliers by small firms (*global supply-chain technology embodied economic linkage*), but not with linkages with domestic suppliers by small firms. We also find evidence that technology forward linkage with a domestic customer is not supportive to economic linkages with foreign suppliers by small firms. Regarding lower-medium firms, we find that activities such as technology backward linkage with a domestic supplier is supportive to the economic linkages with domestic customers by lower-medium firms (*supply-chain technology embodied economic linkage*). Activities such as technology backward linkage with a foreign supplier stipulate linkage with foreign customers and with foreign suppliers by lower-medium firms (*global supply-chain technology embodied economic linkage*).

In relation to upper-medium firms, we find that activities such as technology backward linkage with a domestic supplier is supportive to the economic linkages with foreign suppliers by upper-medium firms (*supply-chain technology embodied economic linkage*). In addition, technology backward linkage with domestic suppliers enhances the economic linkages with both foreign customers and suppliers by upper-medium firms. We find that technology forward linkage with a domestic customer does not support economic linkages with foreign customers by upper-medium firms (*local market privilege*). In addition, we also find that activities such as 'Technology forward linkage with a foreign customer' are not positively associated with the linkages with domestic suppliers by upper-medium (*foreign market privilege*).

In regard to large firms, we find that activities such as technology backward linkage with a domestic supplier is supportive to the economic linkages with domestic suppliers by upper-medium firms (*local technology embodied economic linkage*), but not to the economic linkages with foreign customers by upper-medium firms.

4.4.3. Interactions of drivers

Economic obstacles and firm characteristics

Table 18 presents the results of the regression estimation by firm sizes (Panel B and Panel E), showing the interactive drivers between economic obstacles and firm characteristics in determining the economic linkage in the Vietnamese manufacturing sector. With respect to economic obstacles, firstly, lower-medium and larger firms faced by any constraint in labor, in technological know-how are less likely to be involved in economic linkages with foreign suppliers. However, low-medium firms facing constraints in technological know-how are more engaged with economic linkages with foreign suppliers. In addition, -lower-medium firms faced by any constraint in communication infrastructure, and in technologies are more likely to be involved in economic linkages with foreign customers. Basic infrastructure can lead large firms less involve in economic linkages with foreign suppliers.

Table 19 presents the results of the regression estimations by three groups of firms by sizes (Panels B, D, and F), showing the interactive drivers between economic obstacles and technology transfers in determining the economic linkage in the Vietnamese manufacturing sector. First, large firms having technology backward linkage with a domestic supplier and in inadequate basic infrastructure may more likely take part in economic linkages with foreign customers. Second, with reference to firms having technology forward linkage with the foreign suppliers, they tend to involve less in economic linkages with foreign customers if facing constraint on basic infrastructure and having a lower-medium size, and less if facing constraint on technologies and having a large size. However, large firms having technology forward linkage with the foreign suppliers and facing constraints in communication tend to involve more economic linkages with foreign suppliers. Thirdly, lower-medium firms having technology forward linkage with the domestic customers and facing constraints in transport infrastructure are likely to take part in the economic linkage with foreign suppliers. In addition, those having technology forward linkage with the domestic customers and facing constraint in communication are less likely to take part in the economic linkage with foreign suppliers when they are both medium and large sizes, but more into the economic linkage with foreign customers if they are large size. Moreover, those having technology forward linkage with the domestic customers and facing constraint in labor are less likely to take part in the economic linkage with foreign suppliers when they are lower-medium size. Besides, large firms having technology forward linkage with the domestic customers and facing constraints in finance are less likely to take part in the economic linkage with both domestic and foreign customers, but not with foreign suppliers. Last but not least, large firms having technology forward linkage with the domestic customers and facing constraints in technological know-how are less likely to take part in the economic linkage with domestic customers.

Fourth, in relation to the technology forward linkage with a foreign customer, upper-medium firms without constraints in basic infrastructure, communication, and technological know-how tend to be less interested in economic linkages with domestic customers, but more when facing problems with transport infrastructure and financial constraints.

Table 17: Technology transfers and economic linkage choices by firm sizes (Marginal effects), 2015-2019

VARIABLES	Panel B				Panel C				Panel D				Panel E			
	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	0.022***	-0.002	-0.052***	0.189***	0.003	0.013	-0.055	0.078*	-0.019	0.026	0.060	0.066	0.006	0.013***	-0.078***	0.053***
	(0.007)	(0.005)	(0.015)	(0.018)	(0.011)	(0.024)	(0.042)	(0.045)	(0.022)	(0.042)	(0.096)	(0.084)	(0.005)	(0.004)	(0.013)	(0.009)
Years of operation (ln)	0.239	0.409	-0.391*	1.260***	0.025	0.048*	-0.147	0.995**	1.189	-1.073***	-1.667	-4.241**	-0.129	0.887	-1.716	0.230
	(0.314)	(0.310)	(0.201)	(0.329)	(0.034)	(0.028)	(0.188)	(0.429)	(1.393)	(0.392)	(1.290)	(1.773)	(0.252)	(0.739)	(1.136)	(0.427)
Years of operation (ln), squared	-0.038	-0.088	0.078*	-0.265***	-0.007	-0.005	0.045	-0.162*	-0.185	0.186**	0.338	0.816**	0.031	-0.152	0.370*	-0.040
	(0.055)	(0.059)	(0.045)	(0.067)	(0.009)	(0.006)	(0.044)	(0.088)	(0.239)	(0.074)	(0.245)	(0.336)	(0.043)	(0.129)	(0.205)	(0.077)
Basic infrastructure	-0.003***	0.003**	-0.0003	-0.008	-0.006***	-0.002	-0.002	-0.007	-0.006***	0.004**	-0.002	0.003	0.0002	-0.001	-0.009**	0.002
	(0.001)	(0.001)	(0.003)	(0.005)	(0.002)	(0.002)	(0.004)	(0.006)	(0.003)	(0.002)	(0.007)	(0.006)	(0.002)	(0.002)	(0.004)	(0.002)
Transport infrastructure	0.0003	-0.0002	0.002	-0.016***	0.003*	0.002	0.001	-0.001	0.008***	7.35×10^5	0.003	-0.020***	0.001	-8.14×10^6	-0.006	-0.004
	(0.001)	(0.002)	(0.004)	(0.006)	(0.001)	(0.003)	(0.005)	(0.007)	(0.003)	(0.002)	(0.008)	(0.007)	(0.002)	(0.001)	(0.005)	(0.003)
Communication infrastructure	0.002	-0.001	-0.005	0.015***	0.002	0.003	-0.012***	0.018***	-0.003	0.005**	-0.022***	0.023***	0.002	-0.0004	0.002	0.002
	(0.001)	(0.002)	(0.004)	(0.006)	(0.001)	(0.003)	(0.004)	(0.006)	(0.003)	(0.002)	(0.008)	(0.008)	(0.002)	(0.002)	(0.006)	(0.003)
Financing constraints	0.0003	-0.0002	0.011***	-0.002	-0.001	-0.003	0.001	-0.007	0.004*	0.002	0.017**	-0.002	-0.001	-0.003*	0.005	-0.0002
	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.002)	(0.004)	(0.005)	(0.002)	(0.002)	(0.007)	(0.006)	(0.002)	(0.002)	(0.004)	(0.002)
Labor force	-0.003**	-0.002	-0.015***	0.001	0.002*	0.003	0.005	-0.006	2.77×10^6	0.001	-0.004	-0.002	-0.002	0.005***	-0.001	0.0003
	(0.001)	(0.002)	(0.004)	(0.005)	(0.001)	(0.002)	(0.005)	(0.006)	(0.002)	(0.004)	(0.010)	(0.008)	(0.002)	(0.002)	(0.005)	(0.003)
Technological know-how	-0.0001	0.001	-0.003	-0.005	-0.001	0.005**	0.003	0.013*	-0.003	-0.006	-0.0003	0.017***	0.002	-0.003	-0.004	0.002
	(0.001)	(0.001)	(0.004)	(0.006)	(0.001)	(0.002)	(0.005)	(0.007)	(0.002)	(0.004)	(0.010)	(0.006)	(0.002)	(0.002)	(0.005)	(0.002)
Technologies	0.002*	-0.002**	0.004	0.007	0.001	-0.002	0.0005	0.003	0.005**	-0.004**	0.008	-0.002	0.001	0.003*	0.013***	0.001
	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.002)	(0.004)	(0.005)	(0.002)	(0.002)	(0.008)	(0.005)	(0.002)	(0.002)	(0.005)	(0.002)
Total sectoral employment (ln)	-7.79×10^7***	4.18×10^8	-2.28×10^6***	3.19×10^6***	-2.26×10^7*	-9.19×10^7***	1.99×10^6***	1.27×10^6***	8.67×10^8	-9.62×10^7***	-4.14×10^6***	1.23×10^6***	-4.07×10^7***	-4.16×10^7***	-5.16×10^6***	1.27×10^6***
	(2.87×10^7)	(1.19×10^7)	(2.94×10^7)	(6.03×10^7)	(1.36×10^7)	(2.85×10^7)	(2.79×10^7)	(4.26×10^7)	(2.40×10^7)	(2.96×10^7)	(3.88×10^7)	(4.18×10^7)	(1.38×10^7)	(1.49×10^7)	(2.63×10^7)	(2.17×10^7)
HHI by total gross revenues	-7.11×10^6	1.69×10^5***	-3.94×10^6	-1.66×10^5	-5.73×10^6	-5.11×10^5**	7.42×10^5**	3.76×10^5	1.42×10^5	-5.06×10^5**	-3.09×10^5	2.29×10^5	-3.02×10^5**	2.59×10^5**	-0.0001***	3.74×10^5***
	(8.73×10^6)	(5.84×10^6)	(1.74×10^5)	(2.43×10^5)	(6.80×10^6)	(2.37×10^5)	(3.09×10^5)	(3.85×10^5)	(1.40×10^5)	(2.10×10^5)	(4.63×10^5)	(3.53×10^5)	(1.40×10^5)	(1.01×10^5)	(3.04×10^5)	(1.22×10^5)
TBLDS	0.013*	-0.009	0.167***	-0.100*	0.020***	0.010	-0.074	0.052	0.028	0.016	-0.057	1.063***	-0.003	-0.037**	0.096**	0.048

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

19

	(0.006)	(0.016)	(0.052)	(0.058)	(0.007)	(0.022)	(0.047)	(0.070)	(0.023)	(0.023)	(0.078)	(0.082)	(0.016)	(0.018)	(0.046)	(0.031)
TBLFS	-0.004	0.029**	-0.074*	0.234***	0.008	0.035*	0.003	0.173***	0.010	0.042***	0.079	0.135**	-0.012	0.022	-0.050	0.008
	(0.006)	(0.013)	(0.040)	(0.057)	(0.005)	(0.019)	(0.045)	(0.066)	(0.017)	(0.016)	(0.054)	(0.057)	(0.014)	(0.014)	(0.038)	(0.021)
TFLDC		0.016		-0.140***		0.0123		-0.038		-0.094**		-0.125*		0.021		-0.037
		(0.012)		(0.052)		(0.022)		(0.051)		(0.038)		(0.075)		(0.020)		(0.030)
TFLFC			-0.061				-0.035				-0.207***				-0.002	
			(0.041)				(0.045)				(0.058)				(0.041)	
Observations	1,715	1,715	1,715	1,715	1,097	1,097	1,097	1,097	593	593	593	593	1,645	1,645	1,645	1,645

Note: (1) TBLDS: Technology backward linkage with domestic supplier, (2) TBLFS: Technology backward linkage with a foreign supplier, (3) TFLDC: Technology forward linkage with the domestic customer, and (4) TFLFC: Technology forward linkage with a foreign customer.

ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' estimation

Table 18: Economic linkage choices: Economic obstacles and firm characteristics by firm sizes (Marginal effects), 2015-2019

	Panel B				Panel E			
VARIABLES	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	0.023***	-0.022***	-0.054***	0.106***	0.007	-0.005	-0.078***	0.057***
	(0.007)	(0.007)	(0.015)	(0.033)	(0.008)	(0.007)	(0.013)	(0.012)
Years of operation (ln)	0.217	0.426	-0.028	1.314***	-0.131	0.991	0.308***	0.218
	(0.293)	(0.287)	(0.035)	(0.358)	(0.239)	(0.801)	(0.073)	(0.416)
Years of operation (ln), squared	-0.034	-0.092*		-0.277***	0.020	-0.169		-0.038
	(0.051)	(0.055)		(0.072)	(0.040)	(0.140)		(0.075)
Basic infrastructure	-0.003***	0.002	0.001	-0.007	0.024*	-0.0002	-0.009**	-0.052***
	(0.001)	(0.001)	(0.003)	(0.005)	(0.013)	(0.001)	(0.004)	(0.018)
Transport infrastructure	0.0002	0.0003	0.001	-0.016***	0.035**	-0.0003	-0.007	0.049***
	(0.001)	(0.002)	(0.004)	(0.006)	(0.018)	(0.001)	(0.005)	(0.016)
Communication infrastructure	0.002	-0.001	-0.005	0.014**	-0.093***	-0.029***	0.003	0.001
	(0.001)	(0.002)	(0.004)	(0.006)	(0.024)	(0.009)	(0.006)	(0.003)
Financing constraints	0.0002	-0.0004	0.010***	0.0002	-0.0002	-0.003*	0.005	3.85×10^{6}
	(0.0008)	(0.001)	(0.003)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)
Labor force	-0.003**	-0.002	-0.015***	0.076**	-0.002	0.005***	-0.002	0.001
	(0.001)	(0.002)	(0.003)	(0.036)	(0.002)	(0.002)	(0.005)	(0.003)
Technological know-how	-0.0003	0.001		-0.138***	0.002	-0.003		0.002
	(0.001)	(0.001)		(0.035)	(0.002)	(0.002)		(0.002)
Technologies	0.002*	-0.020***	0.003	0.006	0.001	0.004**	0.012***	0.001
	(0.001)	(0.006)	(0.003)	(0.005)	(0.002)	(0.002)	(0.004)	(0.003)
Total sectoral employment (ln)	-7.83×10^{7}***	6.49×10^{9}	-2.24×10^{6}***	3.21×10^{6}***	-4.00×10^{7}***	-3.79×10^{7}***	-5.22×10^{6}***	1.33×10^{6}***
	(2.83×10^{7})	(9.97×10^{8})	(2.94×10^{7})	(5.96×10^{7})	(1.31×10^{7})	(1.36×10^{7})	(2.64×10^{7})	(2.15×10^{7})

HHI by total gross revenues	-7.38×10^6	$1.64 \times 10^{5***}$	-6.01×10^6	-1.64×10^5	$-2.76 \times 10^{5**}$	$2.69 \times 10^{5***}$	$-0.0001***$	$3.87 \times 10^{5***}$
	(8.70×10^6)	(5.74×10^6)	(1.73×10^5)	(2.49×10^5)	(1.33×10^5)	(9.69×10^6)	(3.05×10^5)	(1.21×10^5)
Employment (ln) * Labor				$-0.020**$ (0.001)				
Employment (ln) * Technology know-how				$0.035***$ (0.009)				$-0.008***$ (0.003)
Employment (ln) * Technologies		$0.005***$ (0.002)						
Employment (ln) * Basic infrastructure								$0.009***$ (0.003)
Employment (ln) * Communication infrastructure						$0.004***$ (0.001)		
Observations	1,715	1,715	1,715	1,715	1,645	1,645	1,645	1,645

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Panels C, D: Interactions are not significant. Source: Authors' estimation.

Economic obstacles and technology transfers

Table 19: Economic linkage choices: Economic obstacles and technology transfers by firm size (Marginal effects), 2015-2019

	Panel B				Panel D				Panel E			
VARIABLES	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS	ELDC	ELFC	ELDS	ELFS
Employment (ln)	$0.022***$	-0.001	$-0.052***$	$0.187***$	-0.017	0.024	0.060	0.064	0.005	$0.015***$	$-0.078***$	$0.056***$
	(0.007)	(0.005)	(0.015)	(0.018)	(0.024)	(0.042)	(0.096)	(0.087)	(0.006)	(0.004)	(0.013)	(0.009)
Years of operation (ln)	0.239	0.413	$-0.391*$	$1.246***$	$3.227***$	$-1.051**$	-1.667	$-4.199**$	-0.231	0.853	-1.716	0.226
	(0.314)	(0.318)	(0.201)	(0.323)	(0.998)	(0.408)	(1.290)	(1.711)	(0.244)	(0.728)	(1.136)	(0.378)
Years of operation (ln), squared	-0.038	-0.088	$0.078*$	$-0.263***$	$-0.540***$	$0.182**$	0.338	$0.809**$	0.050	-0.147	$0.370*$	-0.041
	(0.055)	(0.061)	(0.045)	(0.066)	(0.172)	(0.077)	(0.245)	(0.326)	(0.041)	(0.127)	(0.205)	(0.068)
Basic infrastructure	$-0.003***$	$0.003**$	-0.0003	-0.007	$-0.005**$	$0.003**$	-0.002	0.002	0.0002	-0.001	$-0.009**$	0.001
	(0.001)	(0.001)	(0.003)	(0.005)	(0.002)	(0.002)	(0.007)	(0.006)	(0.002)	(0.002)	(0.004)	(0.002)
Transport infrastructure	0.0003	-0.0003	0.002	$-0.022***$	$0.005***$	-2.11×10^5	0.003	$-0.021***$	0.001	-0.0003	-0.006	-0.004
	(0.001)	(0.001)	(0.004)	(0.006)	(0.002)	(0.002)	(0.008)	(0.007)	(0.002)	(0.001)	(0.005)	(0.003)
Communication infrastructure	0.002	-0.0005	-0.005	$0.018***$	-0.0007	$0.005**$	$-0.022***$	$0.023***$	0.002	-0.0007	0.002	0.001
	(0.001)	(0.002)	(0.004)	(0.006)	(0.002)	(0.002)	(0.008)	(0.008)	(0.002)	(0.002)	(0.006)	(0.003)
Financing constraints	0.0003	-0.0004	$0.011***$	-0.002	0.002	0.002	$0.017**$	-0.0003	-0.0003	$-0.003*$	0.005	-0.001
	(0.001)	(0.001)	(0.003)	(0.004)	(0.002)	(0.002)	(0.007)	(0.005)	(0.002)	(0.002)	(0.004)	(0.002)
Labor force	$-0.003**$	-0.002	$-0.02***$	0.005	-9.88×10^6	0.001	-0.004	-0.003	-0.003	$0.005***$	-0.0008	0.001
	(0.001)	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)	(0.009)	(0.008)	(0.002)	(0.002)	(0.005)	(0.002)
Technological know-how	-0.0002	0.001	-0.003	-0.004	-0.0003	-0.006	-0.0003	$0.017***$	0.003	-0.003	-0.004	0.002
	(0.001)	(0.001)	(0.004)	(0.006)	(0.002)	(0.004)	(0.010)	(0.006)	(0.002)	(0.002)	(0.005)	(0.002)
Technologies	$0.002*$	$-0.002**$	0.004	0.005	$0.004**$	$-0.004**$	0.008	-0.003	0.003	$0.003*$	$0.013***$	0.001
	(0.001)	(0.001)	(0.003)	(0.005)	(0.002)	(0.002)	(0.008)	(0.005)	(0.002)	(0.002)	(0.005)	(0.002)
Total sectoral employment (ln)	$-7.82 \times 10^{7***}$	2.06×10^8	$-2.28 \times 10^{6***}$	$3.19 \times 10^{6***}$	1.54×10^7	$-9.98 \times 10^{7***}$	$-4.14 \times 10^{6***}$	$1.21 \times 10^{6***}$	$-3.86 \times 10^{7***}$	$-5.05 \times 10^{7***}$	$-5.16 \times 10^{6***}$	$1.24 \times 10^{6***}$

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

21

	(2.88×10^7)	(1.10×10^7)	(2.94×10^7)	(5.95×10^7)	(2.31×10^7)	(2.75×10^7)	(3.88×10^7)	(4.20×10^7)	(1.41×10^7)	(1.42×10^7)	(2.63×10^7)	(2.17×10^7)
HHI by total gross revenues	-7.09×10^6	1.67×10^5***	-3.94×10^6	-1.25×10^5	2.14×10^5	-5.08×10^5**	-3.09×10^5	2.26×10^5	-3.23×10^5**	2.26×10^5**	-0.0001***	3.57×10^5***
	(8.68×10^6)	(5.69×10^6)	(1.74×10^5)	(2.42×10^5)	(1.36×10^5)	(2.08×10^5)	(4.63×10^5)	(3.56×10^5)	(1.46×10^5)	(9.90×10^6)	(3.04×10^5)	(1.22×10^5)
TBLDS	0.013*	-0.010	0.167***	-0.087	-0.101***	0.015	-0.057		-0.001	-0.259***	0.096**	0.038
	(0.007)	(0.018)	(0.052)	(0.058)	(0.038)	(0.021)	(0.078)		(0.017)	(0.079)	(0.046)	(0.031)
TBLDS * Basic infrastructure										0.029***		
										(0.008)		
TBLFS	-0.004	0.053***	-0.074*	0.225***		0.041***	0.079	0.163***	0.043	0.021	-0.050	-0.053**
	(0.006)	(0.016)	(0.040)	(0.057)		(0.016)	(0.054)	(0.058)	(0.028)	(0.014)	(0.038)	(0.026)
TBLFS * Basic infrastructure		-0.018**										
		(0.009)										
TBLFS * Technologies									-0.014***			
									(0.005)			
TBLFS * Communication infrastructure												0.026***
												(0.007)
TFLDC		0.014		-0.115	0.063***	-0.095**		-0.073	0.073*			-0.077**
		(0.012)		(0.093)	(0.023)	(0.039)		(0.065)	(0.038)			(0.036)
TFLDC * Transport infrastructure				0.197***								
				(0.054)								
TFLDC * Communication infrastructure				-0.156***							0.021**	-0.019**
				(0.054)							(0.010)	(0.009)
TFLDC * Labor				-0.044**								
				(0.019)								
TFLDC * Finance constraints									-0.006*	-0.018*		0.028***
									(0.004)	(0.010)		(0.011)
TFLDC * Technology know-how									-0.009**			
									(0.005)			
TFLFC			-0.061			0.011	-0.207***		0.054***	-0.004	-0.002	
			(0.041)			(0.022)	(0.058)		(0.015)	(0.017)	(0.041)	
TFLFC * Basic infrastructure					-0.203***							
					(0.056)							
TFLFC * Transport infrastructure					0.623***							
					(0.177)							
TFLFC * Communication infrastructure					-0.615***							
					(0.178)							
TFLFC * Financial constraints					0.217***							
					(0.060)							
TFLFC * Technology know-how					-0.242***							
					(0.068)							
Observations	1,715	1,715	1,715	1,715	593	593	593	593	1,645	1,645	1,645	1,645

Note: (1) TBLDS: Technology backward linkage with domestic supplier, (2) TBLFS: Technology backward linkage with a foreign supplier, (3) TFLDC: Technology forward linkage with the domestic customer, and (4) TFLFC: Technology forward linkage with a foreign customer.

Note: ELDC: Having economic linkages with domestic customers; ELFC: Having economic linkages with foreign customers; ELDS: Having economic linkages with domestic suppliers; ELFS: Having economic linkages with foreign suppliers. Standard errors in parentheses. Panel C: Interactions are not significant. Source: Authors' estimation.

5. Conclusion and implications

Economic linkages are crucial to develop the manufacturing sector, the industrial cluster, the development of the key economic zone, and to spur long-term productivity. However, the question of what factors affect various types of economic linkages recently emerge. On top of that, given the important role of the key economic zone, it is surprising that no one has yet to examine the determinants of economic linkages in the context of the key economic zone; hence, the paper aims to fill this gap. The purpose of this article is to investigate the determinants of economic linkages across firm sizes, and ownership in the Southern Key Economic Zone of Vietnam, using firm-level data. Supported by the Vietnam Technology and Competitiveness Survey in combination with the Vietnam Enterprise Survey in 2015-2019, we establish a dataset consisted of 5050 Vietnamese firms and conduct estimations of panel probit models. It has explored the key drivers in affecting the existence of economic linkages, namely firm-level characteristics (namely, employment level, experience), market concentration, local demand agglomeration, technology transfers, and infrastructure and economic obstacles that cause firms to conduct economic linkages in the supply chain in SKEZ of Vietnam.

There is clear evidence for the determinants of economic linkages in manufacturing sectors by firm sizes, and by ownership in this analysis are concerned. To be specific, based on a regression analysis, employment, firm's experience, technology transfer, and economic constraints stand out as the major drivers of economic linkage of various forms. In addition, results show that there are several patterns of economic linkages such as *domestic technology embodied economic linkage*, *local supply-chain technology embodied economic linkage*, *international/global supply-chain technology embodied economic linkage*, *local market-explored economic linkage*, *local market privilege*, and *foreign market privilege*. Moreover, it is evidence that investments in basic infrastructure, transport infrastructure, communication infrastructure, removal of financing constraints, increase the labor supply, improvement of working skills of laborers have favored the growth of economic linkages.

Regression results come to policy implications. Policies with regard to the market imperfections including removing market entrance barrier, fair competition, market information symmetric improvement, and with respect to infrastructure for development, such as the adequate provision of various types of infrastructures, labor regulation, and business registration are strongly recommended. On top of that, policies on technology-endured economic linkages are important for sustained economic development.

References

Adewuyi, A. O., & Oyejide, T. A. (2012). Determinants of backward linkages of oil and gas industry in the Nigerian economy. *Resources Policy, 37*(4), 452-460. doi:https://doi.org/10.1016/j.resourpol.2012.06.007

Aggarwal, A. (2006). Special economic zones: revisiting the policy debate. *Economic and Political Weekly*, 4533-4536.

Baldwin, R., & Lopez-Gonzalez, J. (2015). Supply-chain trade: A portrait of global patterns and several testable hypotheses. *The World Economy, 38*(11), 1682-1721. doi:https://doi.org/10.1111/twec.12189

Belderbos, R., Capannelli, G., & Fukao, K. (2001). Backward vertical linkages of foreign manufacturing affiliates: Evidence from Japanese multinationals. *World development, 29*(1), 189-208. doi:https://doi.org/10.1016/S0305-750X(00)00086-3

Blomstrom, M., & Kokko, A. (2001). Foreign direct investment and spillovers of technology. *International journal of technology management, 22*(5-6), 435-454. doi:https://doi.org/10.1504/IJTM.2001.002972

Bresslein, M., Cieslik, A., & Matschke, X. (2019). Vertical industry linkages and the location of foreign direct investment in Poland. *Eastern European Economics, 57*(6), 457-483. doi:https://doi.org/10.1080/00128775.2019.1575756

Burgelman, R. A. (1983a). A model of the interaction of strategic behavior, corporate context, and the concept of strategy. *Academy of management Review, 8*(1), 61-70. doi:https://doi.org/10.5465/amr.1983.4287661

Burgelman, R. A. (1983b). A process model of internal corporate venturing in the diversified major firm. *Administrative science quarterly*, 223-244. doi:https://doi.org/10.2307/2392619

Caves, R. E. (2007). *Multinational Enterprise and Economic Analysis* (3 ed.). Cambridge: Cambridge University Press.

Cella, G. (1986). The Input-output Measurement of Interindustry Linkages. *OXFORD BULLETIN OF ECONOMICS AND STATISTICS, 48*(4), Page(s) 379 To 384. doi:https://www.sid.ir/en/journal/ViewPaper.aspx?ID=292630

Costinot, A., Vogel, J., & Wang, S. (2013). An elementary theory of global supply chains. *Review of Economic studies, 80*(1), 109-144. doi:https://doi.org/10.1093/restud/rds023

D'Cruz, J. R. (1986). Strategic management of subsidiaries. *Managing the Multinational Subsidiary: response to environment change and the host nation R and D policies. London: Croom Helm*.

Debaere, P., Lee, J. H., & Paik, M. (2009). Clustering together abroad: South Korean multinationals in China. Retrieved from https://voxeu.org/article/clustering-together-abroad-south-korean-multinationals-china

Dries, L., & Swinnen, J. F. (2004). Foreign direct investment, vertical integration, and local suppliers: Evidence from the Polish dairy sector. *World development, 32*(9), 1525-1544. doi:https://doi.org/10.1016/j.worlddev.2004.05.004

Dunning, J. H. (1996). The geographical sources of the competitiveness of firms: some results of a new survey: University of Reading, Department of Economics Reading.

Fujita, M., & Hu, D. (2001). Regional disparity in China 1985–1994: The effects of globalization and economic liberalization. *The annals of regional science, 35*(1), 3-37. doi:https://doi.org/10.1007/s001680000020

Fujita, M., & Thisse, J.-F. (1996). Agglomeration and Market Interaction. *Advances in Economics and Econometrics*, 302.

Economic linkages, technology transfers, and firm heterogeneity: The case of manufacturing firms in the Southern Key Economic Zone of Vietnam

23

Ge, W. (1999). Special economic zones and the opening of the Chinese economy: Some lessons for economic liberalization. *World development, 27*(7), 1267-1285. doi:https://doi.org/10.1016/S0305-750X(99)00056-X

Ge, Y. (2009). Globalization and industry agglomeration in China. *World development, 37*(3), 550-559. doi:https://doi.org/10.1016/j.worlddev.2008.07.005

Giroud, A. (2007). MNEs vertical linkages: The experience of Vietnam after Malaysia. *International Business Review, 16*(2), 159-176. doi:https://doi.org/10.1016/j.ibusrev.2006.11.003

Görg, H., & Ruane, F. (2001). Multinational companies and linkages: Panel-data evidence for the Irish electronics sector. *International Journal of the Economics of Business, 8*(1), 1-18. doi:https://doi.org/10.1080/13571510151075215

Hazakis, K. J. (2014). The rationale of special economic zones (SEZs): An I nstitutional approach. *Regional Science Policy & Practice, 6*(1), 85-101. doi:https://doi.org/10.1111/rsp3.12030

He, C., Pan, F., & Chen, T. (2016). Research progress of industrial geography in China. *Journal of Geographical Sciences, 26*(8), 1057-1066. doi:https://doi.org/10.1007/s11442-016-1315-y

He, C., Wei, Y. D., & Pan, F. (2007). Geographical concentration of manufacturing industries in China: The importance of spatial and industrial scales. *Eurasian Geography and Economics, 48*(5), 603-625. doi:https://doi.org/10.2747/1538-7216.48.5.603

Hirschman, A. (1958). *The Strategy of Economic Development*. New Haven: Yale University Press.

Huber, C. (2013). *Generalized structural equation modeling using stata*. Paper presented at the Italian Stata Users Group Meeting, November.

Iguchi, C. (2008). Determinants of backward linkages: The case of TNC subsidiaries in Malaysia. *Asian Business & Management, 7*(1), 53-73. doi:https://doi.org/10.1057/palgrave.abm.9200244

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.

Kaplinsky, R. (2013). Global value chains: where they came from, where they are going and why this is important. *Innovation, Knowledge, Development Working Papers, 68*, 1-28.

Kiyota, K., Matsuura, T., Urata, S., & Wei, Y. (2008). Reconsidering the backward vertical linkages of foreign affiliates: Evidence from Japanese multinationals. *World development, 36*(8), 1398-1414. doi:https://doi.org/10.1016/j.worlddev.2007.08.006

Koopman, R., Wang, Z., & Wei, S.-J. (2014). Tracing value-added and double counting in gross exports. *American economic review, 104*(2), 459-494. doi:https://doi.org/10.1257/aer.104.2.459

Krugman, P., Cooper, R. N., & Srinivasan, T. (1995). Growing world trade: causes and consequences. *Brookings papers on economic activity, 1995*(1), 327-377. doi:https://doi.org/10.2307/2534577

Krugman, P., & Venables, A. J. (1996). Integration, specialization, and adjustment. *European economic review, 40*(3-5), 959-967. doi:https://doi.org/10.1016/0014-2921(95)00104-2

Krugman, P. R. (1991). *Geography and trade*: MIT press.

Lall, S. (1980). Vertical inter-firm linkages in LDCs: an empirical study. *OXFORD BULLETIN OF ECONOMICS AND STATISTICS, 42*(3), 203-226. doi:https://doi.org/10.1111/j.1468-0084.1980.mp42003002.x

Lorentzen, J., Møllgaard, P., & Rojec, M. (2003). Host-country absorption of technology: Evidence from automotive supply networks in Eastern Europe. *Industry and Innovation, 10*(4), 415-432. doi:https://doi.org/10.1080/1366271032000163658

Marshall, A. (1890). Principles of economics Macmillan. *London (8th ed. Published in 1920)*.

McAleese, D., & McDonald, D. (1978). Employment growth and the development of linkages in foreign-owned and domestic manufacturing enterprises. *OXFORD BULLETIN OF ECONOMICS AND STATISTICS, 40*(4), 321-339. doi:https://doi.org/10.1111/j.1468-0084.1978.mp40004003.x

Meliciani, V., & Savona, M. (2015). The determinants of regional specialisation in business services: agglomeration economies, vertical linkages and innovation. *Journal of Economic Geography, 15*(2), 387-416. doi:https://doi.org/10.1093/jeg/lbt038

Miroudot, S., Rouzet, D., & Spinelli, F. (2013). Trade policy implications of global value chains: Case studies. 56. doi:https://doi.org/10.1787/18166873

Morris, M., Kaplinsky, R., & Kaplan, D. (2012). "One thing leads to another"—Commodities, linkages and industrial development. *Resources Policy, 37*(4), 408-416. doi:https://doi.org/10.1016/j.resourpol.2012.06.008

Ngo, Q.-T., Doan, N.-P., Tran, T. T.-H., & Nguyen, T.-D. (2020). Technology Adoption Strategies in the Supply Chain: The case of Vietnamese Young Small and Medium-sized Enterprises. *Journal of Open Innovation: Technology, Market, and Complexity, 6*(2), 37.

Ngo, Q.-T., Tran, Q.-V., Nguyen, T.-D., & Nguyen, T.-T. (2020). How Heterogeneous Are the Determinants of Total Factor Productivity in Manufacturing Sectors? Panel-Data Evidence from Vietnam. *Economies, 8*(3), 57. doi:https://doi.org/10.3390/economies8030057

Ngo, Q. T., & Nguyen, C. T. (2019). Do export transitions differently affect firm productivity? Evidence across Vietnamese manufacturing sectors. *Post-Communist Economies*, 1-27.

Ngo, Q. T., & Tran, Q. V. (2020). Firm heterogeneity and total factor productivity: New panel-data evidence from Vietnamese manufacturing firms. *Management Science Letters, 10*(7), 1505-1512.

Nooteboom, B. (1999). Innovation and inter-firm linkages: new implications for policy. *Research policy, 28*(8), 793-805. doi:https://doi.org/10.1016/S0048-7333(99)00022-0

O'farrell, P., & O'Loughlin, B. (1981). New industry input linkages in Ireland: an econometric analysis. *Environment and Planning A, 13*(3), 285-308.

Parr, J. B. (1999). Growth-pole strategies in regional economic planning: A retrospective view: Part 1. Origins and advocacy. *Urban studies, 36*(7), 1195-1215. doi:https://doi.org/10.1080%2F0042098993187

Pearce, R. (2001). Multinationals and industrialisation: the bases of 'inward investment' policy. *International Journal of the Economics of Business, 8*(1), 51-73. doi:https://doi.org/10.1080/13571510151075279

Porter, M. E. (1990a). The competitive advantage of nations. *Harvard business review, 68*(2), 73-93.

Porter, M. E. (1990b). The Competitive Advantage of Nations: With a New Introduction [Tekst]. In: NY: The Free Press.

Porter, M. E. (1998). *Clusters and the new economics of competition* (Vol. 76): Harvard Business Review Boston.

Rodriguez-Clare, A. (1996). Multinationals, linkages, and economic development. *The American Economic Review, 86*(4), 852-873. Retrieved from https://www.jstor.org/stable/2118308

Shakya, M. (2009). Clusters for competitiveness: A practical guide and policy implications for developing cluster initiatives. *Available at SSRN 1392479*, 95. doi:https://dx.doi.org/10.2139/ssrn.1392479

Sonis, M., Hewings, J., & Guo, J. (2000). A new image of classical key sector analysis: minimum information decomposition of the Leontief inverse. *Economic Systems Research, 12*(3), 401-423. doi:https://doi.org/10.1080/09535310050120952

Timmer, M. P., Erumban, A. A., Los, B., Stehrer, R., & De Vries, G. J. (2014). Slicing up global value chains. *Journal of economic perspectives, 28*(2), 99-118. doi:https://doi.org/10.1257/jep.28.2.99

Vernon, R. (1966). International Investment and International Trade in the Product Cycle. *The Quarterly Journal of Economics, 80*(2), 190-207.

Vu, H. T., Pham, L., & Pham, L. N. (2011). Strategies to Promote Sustainable Development of Industrial Parks in Vietnam's Northern Key Economic Zone. *Huntsville, Texas, USA*, 31.

White, R. E., & Poynter, T. A. (1984). Strategies for foreign-owned subsidiaries in Canada. *Business quarterly, 49*(2), 59-69.

Wong, K.-y. (1987). China's special economic zone experiment: an appraisal. *Geografiska Annaler: Series B, Human Geography, 69*(1), 27-40. doi:https://doi.org/10.1080/04353684.1987.11879532

Wong, P.-K. (1992). Technological development through subcontracting linkages: evidence from Singapore. *Scandinavian International Business Review, 1*(3), 28-40.

World Bank. (2010). *Innovation Policy: a guide for developing countries*: World Bank Publications.

Yao, Y., Chen, G., Smyth, R., & Zhang, L. (2018). Host-location financial development and foreign direct investment: City-level evidence from China. *Available at SSRN 3120148*, 29. doi:https://dx.doi.org/10.2139/ssrn.3120148

Zeng, D. Z. (2012). China's special economic zones and industrial clusters: the engines for growth. *Journal of International Commerce, Economics and Policy, 3*(03), 1250016. doi:https://doi.org/10.1142/S1793993312500160