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Determinants of Product Sophistication in Viet Nam: Findings from the Firm–Multi-Product Level Microdata Approach*

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Abstract: *Through capitalising data from the Viet Nam Enterprise Survey and applying the methods proposed by Hausmann, Hwang, and Rodrik (2007) and Eck and Huber (2016), this study investigates the determinants of product sophistication at the firm–multi-product level in Viet Nam – a developing economy – over 2010–2016. Regression results show that horizontal foreign direct investment (FDI) spillovers have a negative effect on the firm–multi-product sophistication of Viet Nam. On the vertical side, we find opposite influences on product sophistication, with a positive contribution of forward spillovers and a negative contribution of backward linkages. Estimated outcomes also indicate that the average amount of labour and revenue of firms has advantageous impacts on the product sophistication. This paper suggests that strengthening forward FDI linkages by facilitating the supply of intermediate inputs from multinational firms, coupled with improving governance capability, could help Viet Nam's domestic firms to produce more sophisticated goods.*

***Keywords*:** Firm-product level data; product sophistication; Viet Nam

***JEL Classification*:** F15; F23

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1. Introduction

While numerous studies have concentrated on trade openness (or trade liberalisation) and its causes and effects, recent works have often looked at the type of products exported by countries (Li, 2015). The reason is that a country's export basket matters for its growth. Economies that export more sophisticated goods tend to grow more rapidly (Hausmann, Hwang, and Rodrik, 2007; Minondo, 2010). Additionally, product sophistication is argued to play an important role in the stability of trade flows, especially those linked to global value chains amongst countries (Córcoles, Díaz-Mora, and Gandoy, 2014). Structural transformation is a development process that includes a shift in production from simple poor-country products to more complex rich-country goods (Hausmann and Klinger, 2006). This conclusion leads to a common but important question: what are the determinants of a country's export sophistication?

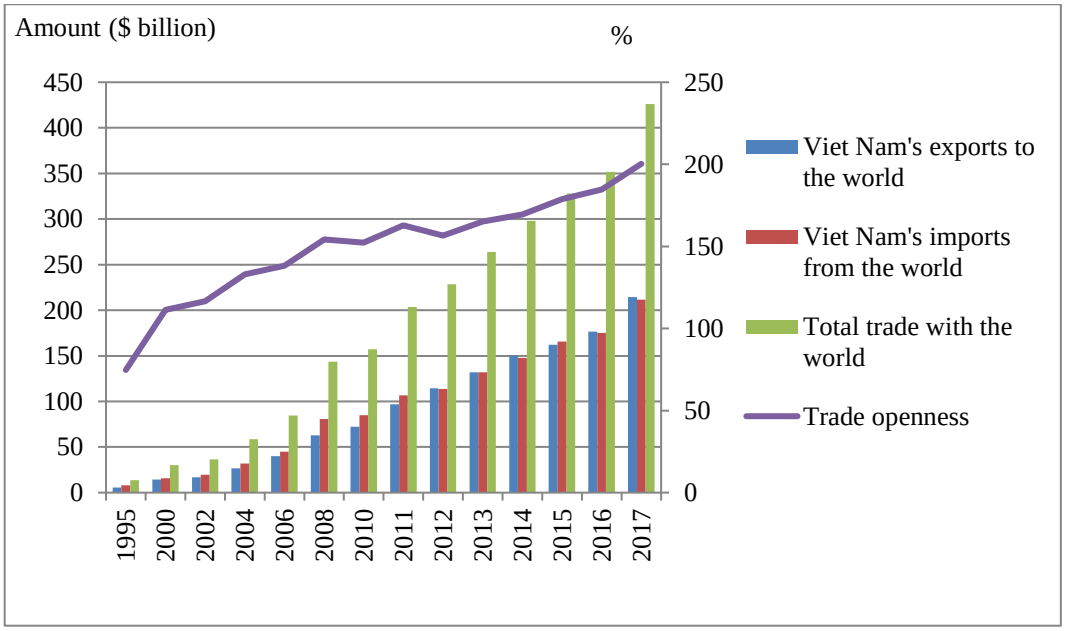
As a result of their rising importance in world trade and the global economy, particularly manufactured products, a large number of studies on export quality and its determinants have focused on China (Rodrik, 2006; Xu and Lu, 2007; Yao, 2009; Wang and Wei, 2010; Fu, 2011; Yu and Hu, 2015; Kruger, Steingress, and Thanabalasingam, 2017) or India (Franco and Sasidharan, 2010; Goldberg et al., 2010; Topalova and Khandelwal, 2011; Felipe, Kumar, and Abdon, 2013). Meanwhile, little attention has been paid to the transformation of the product structure of smaller developing economies such as Viet Nam.

Since the beginning of the so-called *Doi Moi* (renovation) program based on market principles in the mid-1980s,[**] Viet Nam has undertaken significant international and regional economic integration, as revealed through its participation in many bilateral and multilateral free trade agreements. The most notable of these are Viet Nam's participation in the Association of Southeast Asian Nations (ASEAN) since 1995, the signing of the Viet Nam–United States (US) Bilateral Trade

[**] Facing huge economic difficulties, Viet Nam undertook the *Doi Moi* (renovation) program in the mid-1980s with the aim of creating a socialist-oriented market economy. The ideology behind the reforms is that the state still holds the decisive role in the economy but the private sector plays a significant role in economic activities. Viet Nam has also opened its economy to foreign countries through trade and investment.

Agreement in 2000, and Viet Nam's accession to the World Trade Organization (WTO) in 2007.

Figure 1: Viet Nam's International Trade with the Rest of the World, 1995–2017



Source: Author's compilation from United Nations, Statistics Division, Trade Statistics, Comtrade Database. https://comtrade.un.org/data/; and World Bank, World Development Indicators, http://datatopics.worldbank.org/world-development-indicators/ (accessed on 28 October 2018).

Data from Figure 1 show that the total trade between Viet Nam and the rest of the world grew rapidly to $426 billion in 2017 from only $13 billion in 1995. This has resulted in a huge extension of the trade to gross domestic product ratio (trade openness) of Viet Nam, from 75% in 1995 to 152% in 2010 and 200% in 2017.

Viet Nam has also made significant achievements in improving its export basket by increasing the share of manufactured products that contain a higher level of sophistication. For example, the contribution of machinery and electronic products to Viet Nam's total export value to the global market reached 35.4% in 2015, up from 7.9% in 2000 and 14.1% in 2010. By contrast, the export share of products that often embrace a low degree of sophistication, such as fuels, dropped to 3.0% in 2015 from 26.4% in 2000 (Table 1). These successes raise the following question: what are the factors determining Viet Nam's product sophistication?

Table 1: Changing Patterns of Viet Nam's Export Products, 2000–2015

Product group	2000		2010		2015	
	Value ($ million)	Share (%)	Value ($ million)	Share (%)	Value ($ million)	Share (%)
Animal	1,583.0	10.93	4,260.8	5.90	5,201.1	3.21
Chemicals	111.8	0.77	1,234.4	1.71	2,592.5	1.60
Food products	193.6	1.34	2,078.9	2.88	4,746.8	2.93
Footwear	1,507.9	10.41	5,404.4	7.48	12,783.6	7.89
Fuels	3,824.8	26.41	7,979.7	11.05	4,996.6	3.08
Hides and skins	195.9	1.35	1,104.4	1.53	3,286.5	2.03
Machinery and electronics	1,151.2	7.95	10,221.2	14.15	57,413.1	35.44
Metals	126.9	0.88	2,791.5	3.86	5,713.5	3.53
Minerals	40.1	0.28	343.3	0.48	1,081.3	0.67
Miscellaneous	812.6	5.61	4,837.4	6.70	10,821.6	6.68
Plastic or rubber	294.5	2.03	4,306.7	5.96	5,189.9	3.20
Stone and glass	214.3	1.48	3,666.3	5.08	2,421.6	1.49
Textiles and clothing	2,095.4	14.47	13,303.7	18.42	27,270.1	16.83
Transportation	99.9	0.69	1,281.3	1.77	3,112.0	1.92
Vegetable	1,968.2	13.59	8,011.4	11.09	12,115.7	7.48
Wood	262.7	1.81	1,411.2	1.95	3,270.8	2.02
Total	**14,482.7**	**100.00**	**72,236.7**	**100.00**	**162,016.7**	**100.00**

Source: Author's compilation using World Bank, World Integrated Trade Solution (WITS). https://wits.worldbank.org/ (accessed 28 October 2018).

By employing firm–product level microdata for various years from the Vietnam Enterprise Survey (VES) published by the General Statistics Office (GSO) of Viet Nam, our study has the following objectives. Firstly, unlike other works that mostly calculate Viet Nam's product sophistication at the industry level (e.g. Thorbecke and Pai, 2015; Nguyen, 2016), our research aims at measuring the sophistication content of Vietnamese products directly at the firm level by employing the methods proposed by Hausmann, Hwang, and Rodrik (2007) as well as Eck and Huber (2016). Secondly and most interestingly, by applying the fixed effect model, we empirically investigate factors that determine Viet Nam's firm–multi-product sophistication from 2010 to 2016. In particular, we aim to test the impacts of foreign direct investment (FDI) spillover (horizontal and vertical spillovers); institutional quality (e.g. transparency and access to information); time taken; and firm

characteristics (e.g. number of workers, revenue, and capital–labour ratio) on Viet Nam's product sophistication during this period. Thirdly, based on empirical evidence, our study provides relevant policy implications for Viet Nam to ameliorate its product sophistication in the coming years.

This paper is structured as follows. Section 2 provides a literature review of the empirical works on product sophistication, particularly export goods from countries including Viet Nam. Section 3 analyses the FDI spillover channels and their impacts on product sophistication, while section 4 elaborates the methodology and data sources. Section 5 summaries the data statistics and section 6 discusses the empirical results. Finally, section 7 discusses the policy implications.

2. Literature Review

Several previous studies have shown that the level of sophistication of a country's products, especially export products, matters for its economic growth and capacity to improve income. Kwan (2002) was amongst the first scholars to build a product sophistication index and detected that countries with higher incomes export higher value-added products. Lall, Weiss, and Zhang (2006) proposed a similar measure of export productivity, the normalised sophistication index, for 97 countries and 237 products at the 3-digit level (second revision of the Standard International Trade Classification (SITC)) and for 766 products at the 4-digit level in 1990 and 2000. They found a positive nexus between export sophistication and the per capita income of the countries that export the product.

By developing a new measure of export sophistication called EXPY and using cross-country panel regression, Hausmann, Hwang, and Rodrik (2007) discovered that a country with a higher level of sophistication of export baskets grows faster. Numerous studies have employed the work of Hausmann, Hwang, and Rodrik (2007) to investigate the export sophistication of countries (Schott, Fuest, and O'Rourke, 2008; Usui, 2011; Sutton and Trefler, 2011; Jarreau and Poncet, 2012; Bayudan-Dacuycuy and Lim, 2017; Memiş and Özay, 2018).

Much research has surveyed the determinants of export sophistication or the relationship between this variable and other factors. Xu and Lu (2007); Xu (2010); Yao (2009); and Swenson and Chen (2014) showed that FDI is an important factor

driving China's export sophistication. Meanwhile, Fang, Gu, and Li (2015) found that financial development is a key contributor to upgrading Chinese export sophistication.

Using a larger sample, Martincus and Gallo (2009) revealed that better institutions are correlated with a higher export share of products that have more complex production processes and diversified intermediate input linkages across sectors. Likewise, Costinot (2009) concluded that better quality institutions and higher levels of human capital are complementary sources of comparative advantage in more complex industries. Iwamoto and Nabeshima (2012), by utilising the dynamic panel data model based on the generalised method of moments (GMM) for 175 countries from 1980 to 2007, showed that the 5-year lagged FDI inflow correlates positively with both export diversification and sophistication, and FDI stock makes a positive contribution to export sophistication. Similarly, Weldemicael (2012), using cross-country panel data, detected that FDI has a positive effect on export sophistication in which the effect is greater for economies with low institutional quality; by contrast, remoteness from major markets has a strong negative effect on export quality.

Relying on a cross-country panel data set for 1992–2006, Zhu and Fu (2013) investigated the determinants of export upgrading in 65 countries. They found that the export sophistication of countries has positive links with capital deepening, engagement in knowledge creation, transfers via investment in education and research and development, and FDI and imports. On the other hand, using time series cross-sectional data for 61 countries, Li (2015) argued that a synergetic relationship between the state and society contributes positively to the degree of export sophistication. By employing instrumental variables techniques and a data set for 1981–2000, Lin, Weldemicael, and Wang (2017) indicated that within-country variations in export sophistication led to income growth in sub-Saharan Africa. Employing a panel data set of 115 countries from 1970 to 2010, Can and Gozgor (2018) empirically investigated the effects of export product diversification on overall export quality. They found that export quality has only been rising with a higher variation in export values amongst existing exports in low- and lower-middle-income countries. Meanwhile, export quality has been increasing with

both a higher variation in export values amongst existing exports and new products exported in upper-middle and high-income countries. Based on a large panel data set of 101 countries for 2001–2014, Kočenda and Poghosyan (2018) discovered that per capita income and the size of the economy exhibit significant and positive impacts on export sophistication, while weak institutional quality reveals a negative effect.

Many studies have paid great attention to the effects of FDI at the micro level on the productivity of domestic firms or their export performance. For instance, Aitken, Hanson, and Harrison (1997) studied the export behaviour of domestic firms in Mexico and found that the proximity of multinational firms raises the probability for domestic firms to access export markets. However, Bernard and Jensen (2004) found no evidence of export spillovers on a panel of United States manufacturing firms. Wang and Wei (2010) examined the impacts of foreign equity and processing activities on export sophistication at the city level. Xu and Lu (2009) also looked at the effect of foreign firms on China's export sophistication across industries. Eck and Huber (2016) compiled an extensive firm–product-level data set of Indian manufacturing firms to explore different channels through which spillovers from multinationals to local Indian firms foster the manufacturing of complex products. Empirical evidence showed that spillovers via supplier linkages strongly enhance the production of sophisticated products in India.

Many works on Viet Nam's economic reforms have attempted to explore the impacts of trade liberalisation on development, poverty reduction, employment, and so on (Hill, 2000; Kien and Heo, 2009; McCaig, 2011; Fukase, 2013; Nguyen, 2015; Ha and Tran, 2017), while very little research has looked at export sophistication and its determinants. The most striking work is perhaps Nguyen (2016). Following the method proposed by Hausmann, Hwang, and Rodrik (2007), Nguyen (2016) indicated that Viet Nam's export structure was similar to that of Indonesia and the Philippines before becoming much more similar to that of Thailand after Viet Nam's accession to the WTO. Other findings from this research are that tariff reductions have a positive influence on the sophistication level of Viet Nam's industrial exports, while WTO membership does not have any additional impacts on quality upgrading of the Vietnamese export sector. Having said that, however, Nguyen (2016) only employed an export product database at the industry level and did not capitalise

firm–product level microdata to investigate Viet Nam's export sophistication and its determinants. Furthermore, this study did not consider the impact on Viet Nam's product sophistication of other factors such as FDI, institutional quality, education level, and research and development. In other words, understanding of the effects of firm characteristics on Viet Nam's product sophistication remains limited.

In short, recent literature has increasingly paid attention to product sophistication, particularly the export sector and its determinants. Nevertheless, studies that empirically examine product sophistication and its determinants are lacking, particularly at the firm level, in smaller developing economies such as Viet Nam. Thus, our study tries to partially fill this gap by investigating Viet Nam's product sophistication and its determinants at the firm–multi-product level, by using a range of algorithms and firm-level microdata from the VES for a 7-year period spanning 2010 to 2016.

3. Transmission Channels of FDI Spillovers on Firms' Product Sophistication

FDI could have direct and indirect effects on countries' product sophistication. The direct effect is that foreign and domestic firms in a joint venture are likely to produce and sell sophisticated products to international markets.

The second effect our study tries to investigate is indirect – revealed through the spillover impacts of FDI on domestic firms' level of innovation. Indirect spillover effects are divided into horizontal and vertical spillovers. Horizontal spillovers measure how foreign investment in the same industry enhances the productivity and sophistication level of domestic firms. Examples of positive horizontal spillovers are learning-by-observation and worker turnover. Local firms learn how to produce a more sophisticated product by simply observing or copying the production techniques of foreign companies in the same industry. Meanwhile, workers who have been employed by foreign companies can transfer their acquired knowledge when shifting to a local firm (Eck and Huber, 2016). In other words, enhanced labour mobility between foreign and local firms could create positive spillover effects on the improvement of domestic firms' production capability in the same industry. However, such an effect may be limited, since foreign firms have a motivation to prevent

technology leakage to local competitors. This can be achieved via formal protection of their intellectual property, trade secrecy, paying higher wages to prevent labour turnover, or locating in countries or industries where domestic firms have limited imitative capacities to begin with (Javorcik, 2004). The presence of foreign firms could also trigger a negative competition effect on local firms, however, which may restrain local firms from manufacturing higher complicated products.

Meanwhile, vertical spillovers (or inter-industry spillovers) measure the extent of positive externalities to domestic suppliers or customers from the presence of foreign enterprises. Vertical spillovers could take place under forward and backward linkages. In the forward linkage channel, domestic firms could produce more sophisticated products when foreign firms located in the domestic market supply intermediate inputs using new technologies or processes. It is worth noting that the magnitude of the effect of positive forward spillovers depends on the availability of sophisticated inputs before the entry of multinational downstream firms (Javorcik, 2008). If sophisticated inputs are accessible via imports and the technological gap between local and foreign firms is too large, the forward spillovers are limited in size (Javorcik, 2008; Carluccio and Fally, 2013).

On the other hand, backward linkages occur when foreign firms make contracts with domestic suppliers of intermediate inputs and directly transfer knowledge and technologies to enhance the production capability of their local supplier (Harrison and Rodríguez-Clare, 2010; Iwamoto and Nabeshima, 2012; Weldemicael, 2012). This may also take place through higher requirements for product quality and on-time delivery introduced by multinational enterprises (MNEs) which provide incentives to domestic suppliers to upgrade their production management or technology; or through multinational entry increasing demand for intermediate products, which allows local suppliers to reap the benefits of scale economies (Javorcik, 2004). It should be noted that the effect of the backward spillover channel relies on the degree to which MNEs source locally. When inputs are predominantly acquired from abroad, positive backward spillovers are limited in size (Javorcik, 2008; Eck and Huber, 2016).

4. Methodology and Data Sources

4.1. Methodology

4.1.1. Export Sophistication

Basically, the PRODY index developed by Hausmann, Hwang, and Rodrik (2007) is a basis on which to determine the sophistication of a product. The level of sophistication of product *k* is calculated as follows:

$$PRODY_k = \sum_i \frac{(\frac{x_{ik}}{X_i})}{\sum_i (\frac{x_{ik}}{X_i})} Y_i \qquad (1)$$

where Y_i denotes the income per capita and x_{ik} represents the export volume of product *k* of country *i*, and X_i is the total value of country *i*'s exports. Hence, PRODY is a weighted average of the income level of the countries exporting product *k*, with the weights being the share of this product in each country's total exports.

Then, Hausmann, Hwang, and Rodrik (2007) proposed a measure of the sophistication level associated with the export basket of country *i* as follows:

$$EXPY_i = \sum_k \frac{x_{ik}}{X_k} PRODY_k \qquad (2)$$

EXPY is computed as the average level of sophistication of country *i*'s export bundle. It measures 'the degree of specialization of a country in high-PRODY goods, or the similarity of a given export basket with that of the most developed countries' (Jarreau and Poncet, 2012: 8).

At the firm level, Eck and Huber (2016) construct the variable EXS, which measures the average level of product sophistication per firm. It is weighted by the share of each product in the total sales of the firm. The product sophistication index of firm *i* is then calculated as follows:

$$EXS_{it} = \sum_k \frac{Sales_{ikt}}{\sum_k^K Sales_{ikt}} PRODY_{kt}, k = 1, \dots K \quad (3)$$

In this study, we capitalise on this approach to detect the economic prevalence of sophistication of Vietnamese firms. Thus, a higher value EXS shows that a firm makes products with a higher sophistication level, or more sophisticated goods occupy a greater share of the firm's sales.

4.1.2. FDI Spillovers

Following the approach of Smarzynska Javorcik (2004), horizontal spillovers are determined as follows:

$$Hori_{jt} = \frac{\sum_{i,j\epsilon j} FS_{it} * Y_{it}}{\sum_{i,j\epsilon} Y_{it}} \quad (4)$$

where, $Hori_{jt}$ is the horizontal spillover of industry j; FS_{it} presents the percentage of foreign equity in firm i at time t; and Y_{it} indicates the total sales of the firm. Hori is a proxy of the spillover coming from the intensity degree of foreign investment in domestic enterprises.

Note that backward and forward spillovers on the vertical side are defined by following function:

$$Back_{jt} = \sum_{k,k\neq j} a_{jk} * Hori_{kt} \quad (5)$$

and

$$Forw_{jt} = \sum_{m,m\neq j} b_{jm} \frac{\sum_{i,i\epsilon m} FS_{it} * (Y_{it} - X_{it})}{\sum_{i,i\epsilon m}(Y_{it} - X_{it})} \quad (6)$$

where, $Back_{jt}$ and $Forw_{jt}$ are backward and forward spillovers from FDI, respectively; X_{it} denotes the exports of firms; and a_{ik} and b_{jm} are the share of outputs of industry j supplied to industry k and the share of inputs that industry j consumes from industry m.

4.1.3. Econometric Model

To investigate the determinants of the product sophistication of Vietnamese firms, we rely on the empirical work of Hausmann, Hwang, and Rodrik (2007) as well as Eck and Huber (2016). Empirically, product sophistication relates significantly to FDI, institutional quality, remoteness from major markets, and human capital (Hausmann, Hwang, and Rodrik, 2007; Kočenda and Poghosyan, 2018; Wang and Wei, 2010; Weldemicael, 2012). At the firm level, spillover from FDI and firm characteristics are found to play an important role in determining product sophistication (Eck and Huber, 2016). Using the fixed effect approach, the econometric specification of the product sophistication of a firm is defined as the

following equation:

$$EXS_{ijt} = a_0 + a_1 FDI_{jt} + a_2 IQ_{st} + a_3 EFI_{ijt} + \mu_t + \mu_i + e_{ijt} \quad (7)$$

where *i, j, s,* and *t* denote the firm, product, province, and time, respectively; μ_t and μ_i are controlled variables for time and firm fixed effects, respectively; and e_{ijt} is the error term. Dependent variables include the product sophistication (EXS) of firms.

The independent variables of the model are divided into three groups (see Appendices B1 and B2 for detailed definitions):

(i) FDI_{jt} presents a set of spillover impacts from FDI;

(ii) EFI_{ijt} denotes the vector of firm characteristics: number of workers, revenue, and the capital–labour ratio;

(iii) IQ_{st} stands for institutional quality variables, which measure the economic governance of a province where firm *i* is located; and

(iii) μ_t and μ_i denote the time and firm fixed effects.

4.2. Data Sources

Data used for the models are compiled from the following sources:

a. Aggregated and disaggregated data on country exports are retrieved from the World Bank's World Integrated Trade Solution (WITS) database (World Bank, various years).

b. Firm level data are collected from the VES database (GSO, various years).

The VES covers major information (e.g. firm characteristics, annual sales, production costs, capacity, land, finance, labour, trade, and infrastructure) on all enterprises operating during 2000–2017 in Viet Nam. In this study, we compile an unbalanced panel data set of 46,731 observations of multi-product firms across the 7-year period spanning 2010–2016.

The product classification of the VES uses the definition of the Vietnam Standard Industrial Classification (VSIC) and the system of Vietnamese products, so it does not link directly to international standard trade classification systems (e.g. the Harmonized System (HS), SITC, Broad Economic Categories (BEC), and International Standard Industrial Classification (ISIC)). Therefore, we will reclassify trade data and firm-level data to generate unique industry-firm data for the study.

The VSIC 2007 was developed on the basis of the fourth revision of the ISIC (Rev. 4) and the ASEAN Common Industrial Classification (ACIC). The product classification of the VES uses the definition of the system of Vietnamese Classification of product by activity (VCPA) 5-digit product-level code, which is related to economic activities as defined by the VSIC 2007. The VCPA has a hierarchical structure with seven levels. Five levels (from 1-digit to 5-digit codes) of the VCPA are the same as those of the VSIC 2007.

According to the GSO, the VSIC 2007 includes five levels (Table 2):

(i) Level 1 (including 21 sections coded by capital letters from A to U) is kept the same as the ISIC Rev. 4 sections.

(ii) Level 2 (including 88 divisions coded by 2 digits) is kept the same as the ISIC Rev. 4 sections.

(iii) Level 3 (including 242 groups coded by 3 digits) is kept the same as the ACIC, which is conducted on the basis of level 4 of the ISIC Rev. 4.

(iv) Level 4 (including 437 classes coded by 4 digits) is developed in more detail than the ISIC Rev. 4.

(v) Level 5 (including 642 subclasses coded by 5 digits) is developed in more detail than the ISIC Rev. 4.

Table 2: Comparison of Quantity Between VSIC 2007, ACIC, and ISIC Rev. 4

Level	VSIC 2007	ACIC	ISIC Rev. 4
1. Section (level 1)	21	21	21
2. Divisions (level 2)	88	88	88
3. Groups (level 3)	242	242	238
4. Classes (level 4)	437		420
5. Subclasses (level 5)	642		

ACIC = ASEAN Common Industrial Classification, ISIC Rev. 4 = International Standard Industrial Classification Revision 4, VSIC 2007 = Vietnam Standard Industrial Classification 2007.
Source: Tran (2008).

Trade data for this study, retrieved from the World Bank's WITS database, are classified by the ISIC Rev. 3. The VSIC 1993 was developed based on the ISIC Rev. 3. Hence, we use the correspondence table between the VSIC 2007 and VSIC 1993 to convert the VSIC 2007 to the corresponding ISIC Rev. 3 categories. This allowed us to create a correspondence table between the trade data codes and the

product/industry codes of firm-level data and generate our own unique industry-firm data for this research. The GSO provided the concordance tables between the VSIC 1993 and VSIC 2007.

c. Data of backward and forward spillover effects are derived from the input–output table of Viet Nam published by the GSO.[††]

d. We capitalise on the correspondence table between 164 industries in the 2012 input–output table and the 4-digit industries at the ISIC Rev. 4 provided by the GSO to link the matrix of industry-specific supply and consumption share data to firm data constructed from the VES.

Institutional quality variables are collected from the Provincial Competitiveness Index (PCI) database (Vietnam Chamber of Commerce and Industry, various years).

The PCI comprises an annual business survey, assessment, and ranking of the quality of economic governance by the provincial authorities in creating a favourable business environment for private sector development in Viet Nam (Tuyen et al., 2016). It comprises (i) market entry costs for business start-ups; (ii) access to land and security for business premises; (iii) a transparent business environment and equitable business information; (iv) informal charges; (v) time requirements for bureaucratic procedures and inspections; (vi) restrictions on the marginalisation of private activity due to policy biases toward state-owned or foreign-owned businesses; (vii) proactive, creative provincial leadership in problem solving for businesses; (viii) business support services; (ix) labour training policies and regulations; and (x) fair and effective legal procedures for dispute resolution. We aim at investigating how changes in local governance have impacts on firm-level product sophistication and labour productivity. To attain that target, we employ regressions with the overall PCI and some individual PCI modules. The individual PCI used in our model includes market, informal cost, transparency, and time cost (see details in Appendix B2).

[††] The GSO published an input–output table in 2016, but we use the 2012 input–output table because of limited access.

5. Statistical Summary

We provide summary statistics on the key characteristics of firms, FDI spillover, and EXS (each year) in Viet Nam over a 7-year period from 2010 to 2016 for all industry as well as specific industries for multi-product firms (see Appendix A, Tables A1 and A2 for details). In terms of all industry, the average number of labourers per firm fluctuated significantly from 2010 to 2016. The mean value of a firm's sale increased considerably over the years. Meanwhile, the average revenue per firm also varied from 2010 to 2013 before increasing dramatically – reaching nearly D670 billion (about $30 million) in 2016. On the other hand, the capital per worker expanded to D1.1 billion in 2016 from D0.6 billion in 2010. During this period, the EXS value fluctuated slightly, reaching nearly $20,000 in 2016.

The FDI spillover in the domestic sector mainly took place in a horizontal form, with the share increasing from 31.6% to 40.1% over 2010–2016. The share of the vertical forward spillover was slightly higher than that of the backward spillover.

As for specific industries, the average number of labourers per firm reached the highest number in the tobacco industry, followed by textiles and the apparel industry, while the lowest number was found in wood, paper, and basic metals. In 2016, the tobacco and coke and refined petroleum industries had the highest value of capital per worker, while the capital–labour ratio in the textile and apparel industry was the lowest. The coke and refined petroleum industry also had the highest value in terms of average revenue per firm, followed by tobacco, and the machinery, computer, electrical, and electronic industries. Conversely, the average revenue per firm was lowest in the wood, paper, and other manufacturing industries. On the other hand, the value of EXS per firm attained the highest value in industries producing tobacco, and machinery, computer, electrical, and electronic products, but the lowest in the textile and apparel industry.

Regarding FDI spillover, we find that the horizontal linkage was strongest in the machinery, computer, electrical, and electronic industry, followed by other manufacturing and other transport equipment industries. On the contrary, this effect remained weakest in the coke and refined petroleum industry and the mining and quarrying industry. On the vertical side, the backward linkage was most evident in the other transport equipment industry, the textile and apparel industry, as well as the

machinery, computer, electrical, and electronic industry, while this effect was lowest in the food and beverage and tobacco industries. In terms of forward linkage, the effect was highest in the basic metals and wood and paper industries, but weakest in the tobacco and other manufacturing industries.

All in all, the data show that the tobacco industry had the highest average value in terms of sales, average number of labourers per firm, capital–labour ratio, and EXS, while FDI spillovers were often high in industry with significant foreign equity, particularly the machinery, electronic, and electrical industry.

6. Results and Discussion

In this section, we discuss the results of different model specifications in terms of product sophistication, including a data set for a sample of all firms and domestic firms in the manufacturing sector at the aggregate level, and multi-product firms. The estimation results are illustrated in Table 3.

The changes in the product sophistication index may reflect sharing reallocation across products for multi-product firms but do not reveal that of single-product firms. Thus, to capture the product-structured differences of firms, we operate estimation of models by multi-product firms only. We also provide an estimation of models with all firms and domestic firms separately. To test whether forward spillovers depend on the scale of firms, we take the *lrevenue* (log of total sales) variable to control for firm size. The results are presented in Table 3.

The estimated results are almost the same for the domestic firm only and all firms cases, and there is little difference from the viewpoint of coefficient magnitude regarding the estimation of multi-product firms between total firms and domestic firms. In contrast, the impacts of subcomponents of institutional quality variables designated by the PCI are quite similar in terms of magnitude across all samples. In other words, the PCI in general or each sublevel tended to impact equivalently on the firms regardless of the type of firm. Most governments have launched policies favouring domestic firms over foreign firms. However, these results could imply that Vietnamese administrative activities at the national and provincial levels have taken quite efficient steps in terms of implementing national policy to ensure fair market competition for not only local enterprises but also foreign firms.

Table 3: Product Sophistication Models

	(1)	(2)	(3)	(4)
	All firms	**All firms**	**Domestic firms**	**Domestic firms**
Variable	***l_exs***	***l_exs***	***l_exs***	***l_exs***
horizontal	-0.00148***	-0.00150***	-0.00156***	-0.00160***
	(0.000174)	(0.000170)	(0.000205)	(0.000200)
backward	-0.00301***	-0.00257***	-0.00327***	-0.00274***
	(0.000686)	(0.000681)	(0.000823)	(0.000820)
forward	0.00237***	0.00242***	0.00272***	0.00271***
	(0.000362)	(0.000358)	(0.000432)	(0.000426)
labourer	0.0262***	0.0252***	0.0250***	0.0242***
	(0.00554)	(0.00554)	(0.00630)	(0.00630)
lrevenue	-0.00455	-0.00223	0.000242	0.00167
	(0.00344)	(0.00339)	(0.00394)	(0.00388)
lcapperw	0.00148	0.00982*	-8.14e-05	0.00734
	(0.00606)	(0.00583)	(0.00695)	(0.00672)
market	0.0156***		0.0144***	
	(0.00236)		(0.00272)	
informalcost	0.00453**		0.00609**	
	(0.00215)		(0.00261)	
transparence	0.0194***		0.0204***	
	(0.00460)		(0.00535)	
timecost	0.00855***		0.0107***	
	(0.00297)		(0.00342)	
pci2016		0.00235***		0.00188**
		(0.000772)		(0.000913)
Constant	9.413***	9.482***	9.368***	9.503***
	(0.0808)	(0.0823)	(0.0923)	(0.0947)
Observations	46,731	46,731	38,222	38,222
R-squares	0.011	0.008	0.012	0.008
Number of firms	21,967	21,967	19,186	19,186

informalcost = informal cost, lcapperw = log of capital per worker, l_exs = log of EXS, lrevenue = log of revenue (total sales), p = probability, pci2016 = Provincial Competitiveness Index 2016, R-squares = residual sum of squares, timecost = time cost.
Notes:
1. Standard errors in parentheses.
2. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors' estimation.

Empirical results also provide us with evidence for the above-mentioned issues in which the coefficients of all subcomponents of PCI are statistically significant and produce positive signs for both the total firms and domestic firms. In general, our findings regarding the positive impact of institutional quality in the sophistication of products are in line with many existing studies such as Levchenko (2007), Krishna and Levchenko (2009), Martincus and Gallo (2009), Costinot (2009), Weldemicael (2012), and Kočenda and Poghosyan (2018).

The estimated results indicate that horizontal spillovers have significantly negative impacts on product sophistication in all models; and the coefficients of this factor across all samples are found to be similar in terms of magnitude. The results imply that the presence of FDI in an industry does not benefit each firm in that industry in Viet Nam. This is likely because FDI inflows to Viet Nam have mostly focused on low- and medium-technology industry as well as labour-intensive sectors, and as a result, horizontal spillover effects academically weaken. The estimated results in our paper are similar to those of Huber (2017), as they suggest that firms do not benefit from the presence of FDI in their own industry in terms of product sophistication.

For vertical spillover effects, the signs of significant coefficients of forward and backward spillovers are different for all models. This indicates that the linkage between the domestic sector and FDI sector is unclear. The measures of FDI backward linkages are found to be statistically significant and negatively related to the product sophistication of firms. This result advocates the pessimistic view of the effect of FDI on industrial development in a host country. Arguably, FDI improves the technology of a local industry and creates linkages between the host industry and its suppliers and buyers. However, FDI is likely to create adverse effects on domestic firms if they become these firms' competition. Lin and Saggi (2003: 3) stated that:

> The net effect that the MNC has on the degree of backward linkages in the local economy as well as on the profitability of the local supplier of the intermediate depends on the technological asymmetry between the MNC and the local firm. When the MNC's technological advantage over the local firm is only moderate, entry by the MNC increases the degree of backward linkage in the local economy and improves the profitability of the local supplier. However, when the MNC's advantage over the local firm is large, its entry can have adverse effect on the degree of backward linkage and on the profitability of the local supplier.

Our finding regarding backward effects on product sophistication in the paper is contrary to Huber (2017), but it indicates a large technological gap between multinational companies (MNCs) and local firms in Viet Nam.

Interestingly, the coefficients for forward linkages on product sophistication are positive and highly significant across all samples, but produce different degrees regarding the level of effect. It is worth emphasising that the linkages between the forward spillover effect and product sophistication are strong with samples of multi-product firms for all firms as well as domestic firms. This result suggests that Viet Nam's domestic firms, to some extent, are able to produce more sophisticated products when foreign companies locate intermediate inputs with new technological content in the domestic market supply. Once again, this outcome is different from the academic point of view and some empirical studies such as Rodríguez-Clare (1996) and Huber (2017). Nevertheless, the result seems to be consistent in Viet Nam's case whereby foreign firms providing intermediate inputs that fit well with the demand of domestic firms in the context that Viet Nam is lacking strong local supporting industries. Another possible reason is that MNCs operating in Viet Nam cooperate strategically with local firms in producing intermediate inputs. This strategy might not only help foreign firms reduce some costs but could also help Vietnamese firms improve their production capability through learning and observation.

Estimated results show that firm characteristics such as the capital–labour ratio have different effects on firms' product sophistication. The positive significance of the coefficient of labour variables means that product sophistication increases with labour figures, with the capital cost remaining the same. In other words, a large firm may be in a better position to improve product sophistication than a small one. Interestingly, the coefficients with the capital–labour ratio variables (lcapperw) are statistically insignificant and even produce a positive sign for all models of both the aggregate sample and the separate product sample, indicating that more capital-intensive firms are not likely to impact product sophistication. This contrasts with our expectation but reveals that the capital–labour ratio for each local firm in Viet Nam does not reflect a real picture of the relationship between product sophistication and capital-intensive degree.

For local governance impacts, the coefficients with some individual PCI modules are statistically significant, and all produce the expected signs in our study. The coefficients of these variables reflect the impacts of the institutional quality of the province where a firm is located on the product sophistication of the firm. This

suggests a strong relationship between product sophistication and improved quality of economic governance by provincial authorities in Viet Nam to ensure fair competition. This result is in line with the Vietnamese government's efforts in enhancing institutional quality at the national level as well as in assisting provincial authorities to improve their institutional quality. Our estimates are also similar to the work of Tuyen et al. (2016). Intuitively, the regression results show that the overall positive impact of local government quality on all firms is stronger than on that of domestic firms. In terms of subcomponents – market, informal cost, transparency, and time costs – we found that the magnitude of the impacts on product sophistication are almost the same for the domestic firm model and the all firms model.

7. Policy Implications

Over recent decades, the implementation of economic and trade liberalisation has helped Viet Nam to rapidly broaden trade activities with the rest of the world. This process has taken place along with the significant improvements in Viet Nam's product structure. In this paper, we made an effort to investigate the factors governing the sophistication at the firm–multi-product level. Through borrowing methods proposed by Hausmann, Hwang, and Rodrik (2007) and Eck and Huber (2016) as well as using data from the VES for 2010–2016, our estimation results reveal compatibility in terms of coefficient magnitude between domestic firms and all firms.

In terms of FDI spillover, the estimated results indicated that horizontal spillovers have negative impacts on the product sophistication of Viet Nam's multi-product firms in all models, demonstrating that foreign participation within their own industry does not enhance the product sophistication in that industry. This suggests that Viet Nam should have policies to attract FDI flows to manufacturing sectors using the high technology and skilled labour, which in turn could help intra-industry firms benefit from horizontal FDI spillovers.

On the vertical side, regression results show that backward spillovers have disadvantageous impacts on product sophistication, revealing the negative role of FDI presence on the improvement of industry in the host country. On the contrary,

we discovered the positive role of forward spillover in all models, showing that Vietnamese domestic firms could produce more sophisticated products via absorbing new technologies from intermediate inputs provided by foreign firms. These outcomes imply that instead of becoming direct competitors with MNCs at this time, Vietnamese domestic firms may first choose to become suppliers and subcontractors for foreign partners.

We found the average number of labourers and revenue of firms to have positive effects on the product sophistication of firms, while no evidence was found to reveal a similar role for the capital–labour ratio. Thus, to increase the sophistication of products, Viet Nam should perform policies related to mergers and acquisitions or similar measures that could enhance the agglomeration process of capital and labour of firms.

Estimation shows that the PCI index (and its subcomponents) had equally positive effects on the sophistication degree of multi-product firms for both domestic firms and all firms, showing quite good performance for Vietnamese administrative activities. This implies that efforts to improve the quality of institutions – particularly enhancing transparency with an emphasis on the Vietnamese domestic sector – should continue in the coming years.

References

Aitken, B. and A. Harrison (1999), 'Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela', *American Economic Review*, 89(3), pp.605–18.

Aitken, B., G. Hanson, and A. Harrison (1997), 'Spillovers, Foreign Investment, and Export Behavior', *Journal of International Economics*, 43(1–2), pp.103–32.

Alfaro, L. and A. Charlton (2009), 'Intra-Industry Foreign Direct Investment', *American Economic Review,* 99(5), pp.2096–119.

Banks, G. (2015), 'Institutions to Promote Pro-Productivity Policies: Logic and Lessons', *OECD Productivity Working Papers Series,* 2015-01, Paris: OECD Publishing.

Bayudan-Dacuycuy, C. and J.A.Y. Lim (2017), 'Export Sophistication, Export-Led Growth and Product Space: Evidence from Selected Asian Economies', *Journal of Asian and African Studies*, 52(1), pp.3–20.

Bernard, A.B. and J.B. Jensen (2004), 'Why Some Firms Export', *The Review of Economics and Statistics*, 86(2), pp.561–69.

Can, M. and G. Gozgor (2018), 'Effects of Export Product Diversification on Quality Upgrading: An Empirical Study', *The Journal of International Trade and Economic Development*, 27(3), pp.293–313.

Carluccio, J. and T. Fally (2013), 'Foreign Entry and Spillovers with Technological Incompatibilities in the Supply Chain', *Journal of International Economics,* 90(1), pp.123–35.

Córcoles, D., C. Díaz-Mora, and R. Gandoy (2014), 'Product Sophistication: A Tie that Binds Partners in International Trade', *Economic Modelling*, 44(S1), pp.33–41.

Costinot, A. (2009), 'On the Origins of Comparative Advantage', *Journal of International Economics*, 77(2), pp.255–64.

Eck, K. and S. Huber (2016), 'Product Sophistication and Spillovers From Foreign Direct Investment', *Canadian Journal of Economics/Revue Canadienne d'Économique*, 49(4), pp.1658–84.

Fang, Y., G. Gu, and H. Li (2015), 'The Impact of Financial Development on the Upgrading of China's Export Technical Sophistication', *International Economics and Economic Policy*, 12(2), pp.257–80.

Felipe, J., U. Kumar, and A. Abdon (2013), 'Exports, Capabilities, and Industrial Policy in India', *Journal of Comparative Economics*, 41(3), pp.939–56.

Franco, C. and S. Sasidharan (2010), 'MNEs, Technological Efforts and Channels of Export Spillover: An Analysis of Indian Manufacturing Industries', *Economic Systems*, 34(3), pp.270–88.

Fu, X. (2011), 'Processing Trade, FDI and the Exports of Indigenous Firms: Firm-Level Evidence from Technology-Intensive Industries in China', *Oxford Bulletin of Economics and Statistics*, 73(6), pp.792–817.

Fukase, E. (2013), 'Export Liberalization, Job Creation, and the Skill Premium: Evidence from the US–Vietnam Bilateral Trade Agreement (BTA)', *World Development*, 41(1), pp.317–337.

Goldberg, P.K., A.K. Khandelwal, N. Pavcnik, and P. Topalova (2010), 'Imported Intermediate Inputs and Domestic Product Growth: Evidence from India', *The Quarterly Journal of Economics*, 125(4), pp.1727–67.

General Statistic Office (various years), 'Viet Nam Enterprise Survey'. Ha Noi: General Statistics Office of Viet Nam.

Ha, H.V. and T.Q. Tran (2017), 'International Trade and Employment: A Quantile Regression Approach', *Journal of Economic Integration*, 32(3), pp.531–57.

Harrison, A. and A. Rodríguez-Clare (2010), 'Trade, Foreign Investment, and Industrial Policy for Developing Countries', in D. Rodrik and M. Rosenzweig (eds.) *Handbook of Development Economics,* Vol. 5. Amsterdam: North-Holland, pp.4039–214.

Hausmann, R. and B. Klinger (2006), 'Structural Transformation and Patterns of

Comparative Advantage in the Product Space', *Center for International Development Working Paper,* No. 128, Cambridge, MA: Harvard University.

Hausmann, R., J. Hwang, and D. Rodrik (2007), 'What you Export Matters', *Journal of Economic Growth*, 12(1), pp.1–25.

Hill, H. (2000), 'Export Success Against the Odds: A Vietnamese Case Study', *World Development*, 28(2), pp.283–300.

Huber, S. (2017), 'Indicators of Product Sophistication and Factor Intensities: Measurement Matters', *Journal of Economic and Social Measurement*, 42(1), pp.27–65.

Iwamoto, M. and K. Nabeshima (2012), 'Can FDI Promote Export Diversification and Sophistication of Host Countries? Dynamic Panel System GMM Analysis', Institute of Developing Economies, *IDE Discussion Paper,* No. 347, Tokyo: Institute of Developing Economies, Japan External Trade Organization (JETRO).

Jarreau, J. and S. Poncet (2012), 'Export Sophistication and Economic Growth: Evidence from China', *Journal of Development Economics*, 97(2), pp.281–92.

Javorcik, B.S. (2004), 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages', *The American Economic Review*, 94(3), pp.605–27.

Javorcik, B.S. (2008), 'Can Survey Evidence Shed Light on Spillovers from Foreign Direct Investment?', *The World Bank Research Observer*, 23(2), pp.139–59.

Kien, T.N. and Y. Heo (2009), 'Impacts of Trade Liberalization on Employment in Vietnam: A System Generalized Method of Moments Estimation', *The Developing Economies*, 47(1), pp.81–103.

Kočenda, E. and K. Poghosyan (2018), 'Export Sophistication: A Dynamic Panel Data Approach', *Emerging Markets Finance and Trade*, 54(12), pp.2799–814.

Krishna, P. and A. Levchenko (2009), 'Comparative Advantage, Complexity and Volatility', *NBER Working Paper*, No. 14965, Cambridge, MA: National Bureau of Economic Research (NBER).

Kruger, M., W. Steingress, and S. Thanabalasingam (2017), 'Product Sophistication and the Slowdown in Chinese Export Growth', *Bank of Canada Staff Discussion Paper,* No. 15. Ottawa: International Economic Analysis, Bank of Canada.

Kwan, C.H. (2002), 'The Rise of China and Asia's Flying-Geese Pattern of Economic Development: An Empirical Analysis Based on US Import Statistics', *RIETI Discussion Paper*, No. 02-E-009. Tokyo: Research Institute of Economy, Trade, and Industry.

Lall, S., J. Weiss, and J. Zhang (2006), 'The 'Sophistication' of Exports: A New Trade Measure', *World Development*, 21(2), pp.222–237.

Le, T.T. (2007), 'Does Foreign Direct Investment Have an Impact on the Growth in

Labor Productivity of Vietnamese Domestic Firms?', *RIETI Discussion Paper Series,* 07-E-021, Tokyo: Research Institute of Economy, Trade and Industry.

Levchenko, A.A. (2007), 'Institutional Quality and International Trade', *The Review of Economic Studies*, 74(3), pp.791–819.

Li, A.X. (2015), 'State-Society Synergy and Export Sophistication', *Economics and Politics*, 27(3), pp.433–58.

Lin, F., E.O. Weldemicael, and X. Wang (2017), 'Export Sophistication Increases Income in Sub-Saharan Africa: Evidence From 1981–2000', *Empirical Economics*, 52(4), pp.1627–49.

Lin, P. and K. Saggi (2003), 'Backward linkages under foreign direct investment', Mimeo, Southern Methodist University, https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=esam2003&paper_id=172.

Malesky, E. (2014), *The Vietnam Provincial Competitiveness Index: Measuring Economic Governance for Private Sector Development,* 2013 Final Report, PCI Report No. 9. Ha Noi: Vietnam Chamber of Commerce and Industry and United States Agency for International Development.

Martincus, C.V. and A. Gallo (2009), 'Institutions and Export Specialization: Just Direct Effects?', *Kyklos*, 62(1), pp.129–49.

McCaig, B. (2011), 'Exporting Out of Poverty: Provincial Poverty in Vietnam and US market access', *Journal of International Economics*, 85(1), pp.102–13.

Memiş, E. and Ö. Özay (2018), 'Changing Structure of Exports and Product Sophistication in the East and Southeast Asian Region', *The International Trade Journal*, 1-24, DOI:10.1080/08853908.2018.1445050.

Minh, N.K., N.B. Hoang, and N.T. Hau (2014), 'Effects of FDI on Efficiency Convergence in Manufacturing of Machinery Industry', *Journal of Economics and Development Studies,* 2(2), pp.79–92.

Minondo, A. (2010), 'Exports' Quality-Adjusted Productivity and Economic Growth', *The Journal of International Trade and Economic Development*, 19(2), pp.257–87.

Nguyen, D.X. (2016), 'Trade Liberalization and Export Sophistication in Vietnam', *The Journal of International Trade and Economic Development*, 25(8), pp.1071–89.

Nguyen, V.C. (2015), 'The Impact of Trade Facilitation on Poverty and Inequality: Evidence from Low- and Middle-Income Countries', *The Journal of International Trade and Economic Development*, 24(3), pp.315–40.

Pham, X.K. (2008), 'The Impact of Foreign Direct Investment on the Labor Productivity in Host Countries: The Case of Vietnam', *VDF Working Paper Series*, No. 0814, Vietnam Development Forum, October 2008.

Poghosyan, K. and E. Kočenda (2016), 'Determinants of export sophistication: Evidence from Monte Carlo simulations', *IOS Working Papers*, No. 360.

Regensburg, Germany: Leibniz Institute for East and Southeast European Studies (IOS).

Rodríguez-Clare, A. (1996), 'Multinationals, Linkages, and Economic Development', *American Economic Review,* 86(4), pp.852–73.

Rodrik, D. (2006), 'What's So Special About China's Exports?', *China and World Economy*, 14(5), pp.1–19.

Schott, P.K., C. Fuest, and K. O'Rourke (2008), 'The Relative Sophistication of Chinese Exports', *Economic Policy*, 23(53), pp.5–49.

Smarzynska Javorcik, B. (2004), 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages', *The American Economic Review*, 94(3), pp.605–27.

Sutton, J. and D. Trefler (2011), 'Deductions from the Export Basket: Capabilities, Wealth and Trade', *NBER Working Paper Series,* No. 16834. Cambridge, MA: National Bureau of Economic Research (NBER).

Swenson, D.L. and H. Chen (2014), 'Multinational Exposure and the Quality of New Chinese Exports', *Oxford Bulletin of Economics and Statistics*, 76(1), pp.41–66.

Topalova, P. and A. Khandelwal, (2011), 'Trade Liberalization and Firm Productivity: The Case of India', *Review of Economics and Statistics*, 93(3), pp.995–1009.

Thorbecke, W. and H.K. Pai (2015), 'The Sophistication of East Asian Exports', *Journal of the Asia Pacific Economy*, 20(4), pp.658–78.

Tran, T.H. (2008), 'Current Status of Vietnam Standard Industry and Product Classifications', United Nations Workshop on International Economic and Social Classifications, 24–27 November, Bangkok.

Tran T.B., R.Q. Graffon, and T. Kompas (2009), 'Institutions Matter: The Case of Vietnam', *The Journal of Socio-Economics*, 38(1), pp.1–12.

Tuyen, Q.T., H.V. Vu, T.T. Doan, and H.D. Tran (2016), 'Corruption, Provincial Institutions and Manufacturing Firm Productivity: New Evidence from a Transitional Economy', *Estudios de Economía*, 43(2), pp.199–215.

Usui, N. (2011), 'Transforming the Philippine Economy: 'Walking on Two Legs'', *ADB Economics Working Paper Series,* No. 252, Manila: Asian Development Bank.

Vietnam Chamber of Commerce and Industry (various years), Provincial Competitiveness Index. http://eng.pcivietnam.org/

Wang, Z. and S.-J. Wei (2010), 'What Accounts for the Rising Sophistication of China's Exports', in R. Feenstra, and S. J. Wei (eds.) *China's Growing Role in World Trade.* Chicago: University of Chicago Press, pp.63–104.

Weldemicael, E. (2012), 'Determinants of Export Sophistication', The University of Melbourne, https://pdfs.semanticscholar.org/1992/e3dfd06ced9fe997d0b26843a660d93c4dc8.pdf

World Bank (various years), World Integrated Trade Solution database. https://wits.worldbank.org/

Xu, B. (2010), 'The Sophistication of Exports: Is China Special?', *China Economic Review*, 21(3), pp.482–93.

Xu, B. and J. Lu, (2007), 'The Impact of Foreign MNEs on Export Sophistication of Host Countries: Evidence from China', China Europe International Business School. http://www.ceibs.edu/facultyCV/xubin/xu-lu.pdf

Xu, B. and J. Lu (2009), 'Foreign Direct Investment, Processing Trade, and the Sophistication of China's Exports', *China Economic Review*, 20(3), pp.425–39.

Yao, S. (2009), 'Why Are Chinese Exports Not So Special?', *China and World Economy*, 17(1), pp.47–65.

Yu, C. and X. Hu (2015), 'Sophistication of China's Manufactured Exports and Determinants', *Transnational Corporations Review*, 7(2), pp.169–89.

Zhu, S. and X. Fu (2013), 'Drivers of Export Upgrading', *World Development*, 51, pp.221–33.

Appendix A. Other Tables

Table A1: Summary Statistics on FDI Spillover, EXS, and Multi-Product Firms' Characteristics for All Industry

Year	Backward (%)	Forward (%)	Horizontal (%)	EXS ($)	Revenue (D million)	Capperw (D million)	Average number of labourers per firm
2010	10.6	13.5	31.6	20,681.7	161,791.7	640.5	211.6
2011	12.7	12.7	28.0	20,951.6	335,699.3	664.7	183.3
2012	10.7	14.7	32.6	21,053.4	324,888.2	926.3	283.8
2013	11.6	13.9	32.5	19,599.1	222,130.4	859.4	235.7
2014	12.4	15.8	35.3	21,916.9	440,875.8	1,017.3	364.7
2015	12.6	14.7	38.5	20,366.0	551,277.2	1,099.4	457.6
2016	12.8	15.6	40.1	19,693.3	669,436.2	1,117.2	285.3

Capperw = capital per worker, D = dong, EXS = product sophistication of firms, FDI = foreign direct investment.
Source: Authors' estimation.

Table A2: Summary Statistics on FDI Spillover, EXS, and Multi-Product Firms' Characteristics by Industry

Year	Industry	Backward (%)	Forward (%)	Horizontal (%)	EXS ($)	Revenue (D million)	Capperw (D million)	Average number of labourers per firm
2010	Mining and quarrying	5.4	7.4	1.4	19,117.1	136,171.4	1,854.4	136.6
2011		5.6	5.7	1.4	20,240.4	197,824.4	477.2	153.3
2012		5.6	6.6	0.9	19,575.3	717,246.7	2,867.1	239.2
2013		5.2	6.7	1.1	18,957.1	449,335.0	3,128.8	190.4
2014		6.2	6.3	1.6	24,267.6	595,492.3	4,403.6	214.0
2015		6.0	8.9	2.0	23,949.0	1,271,063.0	2,057.3	674.6
2016		7.3	8.3	4.0	24,770.1	1,275,715.0	1,723.3	204.8
2010	Food products and beverages	3.3	12.2	28.0	15,159.1	318,033.4	887.3	221.1
2011		4.1	11.9	31.7	15,594.8	524,710.4	963.7	197.9
2012		3.8	9.7	25.2	17,055.3	501,363.8	1,189.8	260.5
2013		3.9	6.1	24.3	15,782.7	482,860.4	1,359.3	227.9
2014		3.8	11.6	29.0	19,143.7	646,945.3	1,534.3	278.9
2015		5.3	10.7	31.9	19,232.5	788,332.5	1,597.5	323.3
2016		4.6	11.4	33.3	15,896.6	995,552.1	1,729.4	238.4
2010	Tobacco products	6.6	0.4	0.6	36,999.6	2,388,732.0	938.3	1,333.7
2011		7.0	0.5	0.5	25,612.6	3,186,646.0	1,019.8	1,551.8
2012		7.1	0.7	0.0	21,183.3	2,725,226.0	1,239.8	1,173.0
2013		6.9	0.7	0.0	20,281.0	3,156,533.0	1,457.9	1,119.2
2014		7.3	0.6	0.0	72,777.3	2,855,938.0	2,264.9	947.4
2015		6.9	0.6	0.0	18,058.5	2,553,651.0	2,033.5	965.0
2016		7.2	0.7	0.0	35,937.8	3,576,713.0	2,454.9	1,208.8
2010	Textiles and apparel	21.4	10.3	40.0	14,292.4	94,806.0	144.0	529.4
2011		23.5	9.1	32.1	15,093.3	123,510.6	149.2	453.6

Year	Industry	Backward (%)	Forward (%)	Horizontal (%)	EXS ($)	Revenue (D million)	Capperw (D million)	Average number of labourers per firm
2012		23.6	13.1	43.9	15,045.5	166,910.8	188.4	696.0
2013		24.6	12.5	42.4	8,811.7	153,471.7	182.2	629.3
2014		23.0	13.3	43.4	13,671.7	260,558.6	190.3	1,043.3
2015		23.8	12.7	46.4	10,892.0	316,384.2	232.6	1,142.9
2016		22.2	12.6	43.4	9,232.0	286,115.8	252.6	792.9
2010	Wood, paper, and paper products	6.0	22.1	10.9	26,356.4	37,823.6	590.9	70.4
2011		6.4	16.2	12.6	26,012.4	75,463.3	549.5	57.6
2012		6.1	24.0	8.9	25,527.6	55,180.6	654.9	80.9
2013		6.8	23.7	11.4	25,523.0	50,828.2	688.4	74.4
2014		6.1	26.0	9.1	26,955.1	80,878.5	554.4	101.4
2015		7.4	25.0	13.5	25,446.5	113,939.8	745.5	126.3
2016		9.3	26.6	16.1	24,131.3	114,550.3	821.0	79.7
2010	Coke and refined petroleum products	2.3	7.9	0.0	37,507.3	33,400,000.0	109,640.4	134.0
2011		0.2	2.4	2.1	23,720.9	30,000,000.0	41,060.5	297.7
2012		30.3	7.3	1.5	21,549.3	15,500,000.0	33,559.7	261.8
2013		19.7	6.6	19.8	16,890.2	61,926.8	732.3	65.8
2014		28.9	10.0	1.4	34,412.6	34,200,000.0	33,946.9	579.0
2015		12.6	6.2	0.0	20,117.0	11,200,000.0	28,065.7	306.7
2016		19.3	6.9	3.0	23,152.8	8,325,820.0	27,335.4	244.0
2010	Chemicals and chemical products	5.9	17.9	44.8	28,172.5	248,570.3	948.9	185.1
2011		5.3	16.8	48.8	27,531.4	299,401.6	1,085.1	154.7
2012		7	18.8	43.7	28,231.4	340,623.2	1,295.6	195.4
2013		7.4	19.1	45.3	27,368.6	369,794.6	1,760.8	180.9

Year	Industry	Backward (%)	Forward (%)	Horizontal (%)	EXS ($)	Revenue (D million)	Capperw (D million)	Average number of labourers per firm
2014		9.5	19.5	46.4	31,881.6	507,301.7	1,838	227.3
2015		7.5	18.3	41.3	30,207.6	543,634.3	1,807	238.5
2016		7.6	19.1	44	29,299.9	464,873.6	2,127.2	171.9
2010	Rubber and plastic products	11.3	12.4	20.8	22,228.4	140,893.1	601.2	210.6
2011		14.5	13	19.9	24,180.4	234,661.6	677.6	165.7
2012		7.8	12.2	21.8	22,755.9	186,665.9	787.1	212.4
2013		13.4	14.6	21.4	24,124.1	175,057.3	833	179.3
2014		15.5	13.3	20.8	25,177.6	244,548.8	939.1	240.4
2015		11	13.2	28.6	23,358.4	331,701.5	1,065.7	276.5
2016		17.3	18	27.8	24,330.3	318,748.6	1,066.3	190
2010	Basic metals	11.7	21.6	26.8	23,415.6	114,574.1	696.7	70.7
2011		18.6	21.7	23.4	23,348.9	239,162.8	1,202	59.8
2012		12.8	27.1	15.5	23,791.2	204,835.3	1,593.6	90.2
2013		13.4	26.6	10.8	24,152	148,088.5	960.7	67.1
2014		15.5	31.2	24.1	24,536.3	201,654.2	1,129.8	101.2
2015		15	29.5	19.9	23,306.6	387,350.4	2,076.1	158.1
2016		15.9	31.4	16.8	24,580.6	489,372.5	2,192.5	88.7
2010	Machinery and equipment, electrical equipment, computers, electronics, and optical products	17.3	14.8	36.1	34,033.1	231,449.6	751.9	223.5
2011		19	16.8	44.7	33,015.2	780,001.9	722.3	248.9
2012		15.7	29.6	54.7	35,084.4	1,163,464	891.7	446.7
2013		16	24.5	59.5	32,338.5	324,259.8	884	302.9

Year	Industry	Backward (%)	Forward (%)	Horizontal (%)	EXS ($)	Revenue (D million)	Capperw (D million)	Average number of labourers per firm
2014		21.7	33.8	67.2	35,263.5	1,825,811	1,011.6	561.1
2015		20.6	23.5	72.1	32,710.2	1,711,709	974	646.6
2016		19.8	24.8	74.4	33,385.6	3,127,071	1,070.9	666.9
2010	Other transport equipment	16.5	15.7	61.6	24,514.4	687,269.4	908.7	303
2011		18.9	19.5	67.3	25,570.9	1,144,163	972.6	341.1
2012		16.2	8.9	59	26,740.4	790,720.8	1,272.1	415.9
2013		16.8	9.2	52.2	26,497.6	833,260.5	1,585.8	379.4
2014		19.9	11.8	47.5	29,827.8	1,051,691	1,300	450.8
2015		21.6	12.7	53.7	25,388.5	1,230,661	1,329.3	586.4
2016		22.6	11	50.7	26,175.1	1,741,125	1,521.9	496.4
2010	Other manufacturing	9.7	5.2	49.8	16,539.6	51,067.1	241.5	172.6
2011		10.5	5.5	30.6	16,625.5	71,786.5	264.7	137.1
2012		8.8	4.4	53.3	16,393.9	77,519.5	305.6	219
2013		9.1	4.1	53.9	15,130.4	63,118.5	327.8	167.8
2014		10.2	4	56.3	15,330.5	109,524.1	313.6	267.9
2015		9.4	4.4	56.8	13,749.8	145,748	341.6	321.8
2016		9.7	4.3	62.8	14,842.1	123,257.6	355.2	161.1

Capperw = capital per worker, D = dong, EXS = product sophistication of firms, FDI = foreign direct investment.
Source: Authors' estimation.

Appendix B. Variables

B1: Independent Variables

labourer	Log of the number of workers of the firm; firm-level variable.
lcapperw	Log of the capital–labour ratio (capital per worker); industry-level variable.
$horizontal_{jt}$	Variable reflecting intra-industry (horizontal spillover) effect, measures the degree of foreign presence in sector *j* at time *t*, which is defined as the foreign-equity participation averaged over all firms in the sector and weighted by each firm's share of the sectoral output.
backward	Backward spillovers: measured by the extent to which industry *k* (with a foreign presence) uses products of industry *j* as an intermediate good; industry-level variable.
forward	Forward spillovers: measured by the extent to which products of industry *m* are used as intermediate goods in industry *j*; industry-level variable.
lrevenue	Log of total sales of the firm to control for the firm size.

B2: Provincial Competitiveness Index Subcomponents

(**Adapted from Malesky, 2013**)

Entry costs	A measure of (i) the time it takes a firm to register and acquire land, (ii) the time it takes to receive all the necessary licenses needed to start a business, (iii) the number of licenses required to operate a business, and (iv) the perceived degree of difficulty in obtaining all licenses/permits.
Transparency and access to information	A measure of whether firms have access to the proper planning and legal documents necessary to run their businesses, whether those documents are equitably available, whether new policies and laws are communicated to firms and implemented predictably, and the business utility of the provincial webpage.
Time costs and regulatory compliance	A measure of how much time firms waste on bureaucratic compliance, as well as how often and for how long firms must shut their operations down for inspections by local regulatory agencies.
Informal charges	A measure of how much firms pay in informal charges, how much of an obstacle those extra fees pose for their business operations, whether payment of those extra fees results in expected results or 'services', and whether provincial officials use compliance with local regulations to extract rents.

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