External Linkages and Product Innovation: Theory and Empirical Evidence from Subsidiaries in Vietnam

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ABSTRACT

International business literature often states that the ability to exploit external knowledge and ideas is a crucial component of the innovative performance of firms. Adopting a business network theory, we hypothesize that subsidiaries are likely to reach high levels of innovation as they engage in the networks of external linkages (i.e. backward and forward linkages) with domestic business actors. To test the proposed hypotheses, we use survey data extracted from a data set from the General Statistics Office of Vietnam for 354 subsidiaries located in Vietnam. A noticeable difference in institution-foreign firm and foreign firm-local partner relationships still remains after the 30-year period of Vietnam's revolution due to political perspectives; and this has motivated us to investigate this unique transition economy. Probit regression reveals that our hypotheses are strongly supported, in regards to controlling the characteristics of a subsidiary, a parent firm or home country. The paper provides theoretical and practical implications for international business literature.

JEL Classification : F23, O31, O32

Keywords: backward linkage, external linkage, forward linkage, multinational enterprise, subsidiary product innovation

INTRODUCTION

Existing studies have acknowledged that subsidiaries play an increasingly important role within multinational enterprises' (MNEs) competitive advantage (Anderson *et al*., 2002; De Jong *et al*., 2015; Venaik *et al*., 2005). One of the crucial drivers of this advantage is subsidiary product innovation (Phene and Almeida, 2008; Vo, 2013). Accordingly, a good understanding of subsidiary product innovation is important, as subsidiary innovation results in increased operational efficiency, better subsidiary performance in local markets and better MNE performance, through the spill-over of new knowledge and market opportunities (Ameida and Phene, 2004; Phene and Almeida, 2008; Roberts and Amit, 2003).

To date, a rich body of IB literature has examined various dimensions on subsidiary innovation within the MNE network (Ciabuschi *et al*., 2011; Figueiredo, 2011; Frost *et al*., 2002; Frost and Zhou, 2005; Phene and Almeida, 2008). These scholars addressing innovation have focused on a subsidiary's absorptive capacity and knowledge integration within the MNE network (Ciabuschi *et al*. 2011; Frost and Zhou, 2005; Phene and Almeida, 2008). These prior contributions mostly focus on a subsidiary's innovation research stream within the context of developed economies. To date, however, there is limited evidence in the literature on how external linkages – including backward and forward linkages - specifically affect subsidiary product innovation within a host country and within the context of a transition economy. Understanding this situation in the context of a transition economy is worthwhile, because underdeveloped market mechanisms and insufficient legal and regulatory conditions can impede linkage activities between foreign firms and local counterparts (Jindra *et al*., 2009). This limits a subsidiary's learning and creative capability (Andersson *et al*., 2007) in addition to its new knowledge absorptive capacity (Ricciardi, 2014); and thus hampers a subsidiary's innovation process (Phene and Ameida, 2008). For these reasons, we believe that research within the context of a transition economy can provide an ideal research setting for evaluating and investigating the outcomes of how a subsidiary's backward and forward linkages benefit its innovation in environments with high institutional uncertainty.

In order to address the aforementioned gap in the extant literature, our study examines the relationship between a subsidiary's backward and forward linkages and its product innovation in the transition economy context of Vietnam. To do so, by adopting a business network theory (Andersson *et al*., 2002; Forsgren, 2008; Forsgren *et al*., 2005), we conceptualize and empirically test a theoretical framework on the impact of backward and forward linkages on subsidiary product innovation in Vietnam. We have sought to show that a business network approach can offer insightful analyses on how a subsidiary's backward and forward linkage engagements within a transition economy can affect its product innovation. In addition, by applying a business network theory, we have developed theoretical arguments relating to the role of a subsidiary's backward and forward linkage activities within local markets, in relation to the possibilities of its product innovation. By doing so, we add new insights about how backward and forward linkages affect subsidiary product innovation within the context of a transition economy. We believe that our theoretical arguments provide a new platform in IB literature and put forward a future research agenda.

This paper focuses on foreign subsidiaries in Vietnam for several reasons. Firstly, Vietnam engaged in the 1986 economic liberalization programs, by launching a reform policy known as Doi Moi, which marked the beginning of the opening up of the Vietnamese economy and resulted in a significant inflow of foreign investment. Private firms are often subjected to an unfavorable environment of discriminatory incentives and rules, with respect to finance, investment, tax and trade (Giroud, 2007). Despite the positive changes introduced by the Enterprise Law in 2000, it is expected that the level of competitiveness and international integration of local counterparts in Vietnam differs from those of its counterparts in developed economies; and subsequently the type of relationships established by foreign firms with their suppliers and customers in economies also differs (Giroud, 2007; Meschi *et al*., 2016). Secondly, the rich stream of subsidiary innovation research has mainly focused on countries within the context of developed economies (Ciabuschi *et al*., 2011; Ameda and Phene, 2008). However, analyses of the effects of backward and forward linkages on subsidiary product innovation within a transition economy context, in which economic reform was implemented but political reform was rejected (e.g., such as Vietnam), can create new insights. The reason for this situation is that such an environment bears additional uncertainty and complexity, which can affect knowledge exchange between foreign subsidiaries and local counterparts and impede their absorptive capacity (Myer, 2004). When compared to the attributes of other transition economy types, the continuing presence of a Marxist political ideology in such countries influences the values and behaviour of local managers (Meschi *et al*., 2016) and creates socialist imprinting on local partner firms, and thus results in different institution-foreign firm and foreign firm-local partner relationships. This transition context can provide useful insights into foreign firms' relations with local suppliers and customers. For this reason, this study, within the context of a transition economy such as Vietnam, can enhance new understanding about how backward and forward linkages between foreign subsidiaries and local counterparts affect product innovation within a transition economy.

THEORY AND HYPOTHESES

External linkages embody all value chain relationships created between MNE subsidiaries and local firms within the host economy. The impact of MNEs on the local economy, through external linkages, will occur predominantly amongst industries (inter-industry impact) rather than within industries (intra-industry impact), and vice versa. External linkages can be further categorized into backward and forward linkages. Backward linkages include all upstream relationships with local one-off suppliers, key suppliers or subcontractors (UNCTAD, 2001). Forward linkages include all downstream relationships developed between foreign subsidiaries and customers, (sales) agents and distributors within a host economy.

In business network literature, several studies (Engwall *et al*., 2016 Holm *et al*., 2015; Ricciardi, 2014) have shown that such relationships are often close and long term, and they are frequently important sources of knowledge development. Business network theory assumes that HQs suffer not only from a lack of knowledge about the particular innovation process at local subsidiaries, but also from genuine uncertainty about accessing and obtaining information

and knowledge at local level. The reason for this uncertainty is that HQs are a relative outsider to the local business network of the subsidiary (Andersson *et al*., 2007). Therefore, in order to enhance the quality and scale of innovation, the subsidiary needs to be embedded within the business network and adapt its products, processes and routines. It is difficult for an outsider to comprehend the situation, because they comprise a number of different and complex dependencies, involving technical, logistic, cognitive and economic know-how, which are shared between the parties (Ciabuschi *et al*., 2011).

Moreover, innovation literature has stressed that different technologies and knowledge from different sources are important to the innovation process (Phene and Almeida, 2008). The reason for this is that, when innovating, the existence of different technology and knowledge enhances the possibility of new combinations and thus fosters the likelihood of the emergence of novel ideas (Frost *et al*., 2002; Phene and Almeida, 2008). Accordingly, the re-combination of technological knowledge resources, available from both home HQs and other subsidiaries in other host countries, may facilitate a subsidiary to generate new ideas and inventions from this knowledge pool.

Business network theory (Engwall *et al*., 2016; Holm *et al*., 2015; Andersson *et al*., 2007; Forsgren, 2008; Forsgren *et al*., 2005; Hallin *et al*., 2011) proposes that networks exist both within a multinational enterprise and within the local environment of asubsidiary. Subsidiaries differ in terms of their history, quality and level of linkages inside and outside the MNE (Forsgren *et al*., 2005). Linkages also may evolve and develop over time from those characterized by arm's-length interactions, to relationships based on mutual trust, adaptation and the willingness to make the relation-specific investments needed for successful innovation (Lane and Lubatkin, 1998; Uzzi, 1997; Narula and Martínez-Noya, 2014). Relationships with other business and institutional actors are important because, through a mutual adaption process with counterparts, subsidiaries can develop technological and organizational competencies that strengthen the use of dispersed resources and enable new knowledge flows at asubsidiary and within the MNE (Andersson *et al*., 2002; Gulati, 1998; Gulati *et al*., 2000; Dicken, 2011). Adopting a business network approach, we argue that high levels of both backward and forward linkages are likely to enhance subsidiary product innovation.

A high level of backward linkages is likely to enable a subsidiary to incorporate valuable resources from the network and foster learning opportunities, due to several reasons. Firstly, a high level of backward linkages implies strong ties and intensive interactions between a subsidiary and its specific local suppliers. Through these ties and interactions, a level of information exchange and opportunities for new information identification is fostered (Andersson *et al*., 2005; Andersson *et al*., 2002). These ties and interactions strengthen the learning abilities of a subsidiary (Uzzi, 1997) and improve a subsidiary's capability to assimilate new information (Andersson *et al*., 2002; Santangelo, 2012; Yamin and Andersson, 2011).

Secondly, a high level of backward linkages motivates trust-building between asubsidiary and local suppliers, which increases the likelihood of a local partner revealing institutional type knowledge. Increased relationships thus expose a subsidiary to multiple sources of valuable assets that are available within the host environment. As a result, they increase the likelihood

of exploiting such sources, especially in cases where knowledge is tacit or requires trust-based relationships to be grasped effectively (Holm *et al.*, 2015). As a result, there is an accumulation of valuable resources and learning opportunities that support subsidiary innovation. Thus, we posit the following:

Hypothesis 1: Backward linkages have a positive effect on subsidiary product innovation.

A subsidiary with a high level of forward linkages has extensive relationships with customers and other (sales) agents within its business network. These relationships bring two benefits to the subsidiary innovation process. Firstly, actors within the network are willing to share new knowledge about recent technological opportunities and allow access to other resources (Andersson *et al.*, 2005; Holm *et al.*, 2015; Narula and Martínez-Noya, 2014). In particular, the process of new knowledge exchange becomes easier, due to high levels of mutual understanding and optimal cognition (Grant, 1996; Hansen, 1999). By combining valuable resources and new knowledge, subsidiaries are likely to create new ideas, invent new business initiatives with new directions, and develop new technologies that are all conducive to innovation (Andersson *et al.*, 2007; McDonald *et al.*, 2008; Yamin and Andersson, 2011).

Secondly, high levels of forward linkages align with high levels of trust and better adaption and cooperation between a subsidiary and its customers within a network that fosters relation-specific investments. As a result, the possibilities and opportunities for investments in innovation are likely to improve. Subsidiary literature also asserts that close relationships help subsidiaries to have a better understanding of customer needs (Kotler and Armstrong, 1991), which are acknowledged drivers for continuous innovation. From these perspectives, we posit:

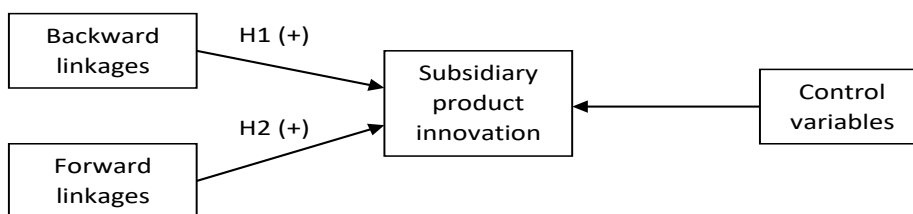*Hypothesis 2: Forward linkages have a positive effect on subsidiary product innovation.*

Figure 1: Theoretical framework

RESEARCH METHODS

Sample and data

We tested our hypotheses using survey data conducted and gathered by the General Statistics Office of Vietnam (GSO) (per cooperation with the World Bank) from June 2009 to January 2010; and this firm-level survey is part of a larger project in Eastern Asia and Pacific countries.

This 2009 survey database offered us the opportunity to measure the dependent variable (i.e., subsidiary innovation), the key independent variables (i.e., backward linkages and forward linkages), in addition to headquarters, subsidiary and country characteristics. The GSO used a method of stratified random sampling, ordered by firm size, industry and region, on both domestic- and foreign-owned manufacturing and service firms.

The survey was conducted by the use of face-to-face interviews and also through a designed questionnaire in thirteen provinces located in five regions: Red River Delta (Ha Noi, Hai Duong and Hai Phong), North Central Coast (Thanh Hoa and Nghe An), Mekong River Delta (Can Tho, Long An and Tien Giang), South Central Coast (Khanh Hoa and Da Nang), and Southeast (Ho Chi Minh City, Binh Duong and Dong Nai). The representative of each firm who participated in the interview was a board member of the firm, the chairperson of a section, or the head of department. A total of 3131 eligible firms (both domestic- and foreign-owned firms) were selected. Among these 3131 firms, 1607 out of the 3131 firms are foreign-owned firms and the rest are domestic firms. According to a 2006-2011 Report from the Ministry of Planning and Investment of Vietnam (p.14), the total of FDI firms operating in Vietnam in 2009 was 6548. This implies that approximately 24.9 percent of the foreign firms were randomly selected from the total population (6548 foreign firms) to serve for the survey.

The selected firms were then used as a frame for the selection of a sample, with the aim of obtaining interviews at firms with five or more employees, according to the GOS' plan. After contacting and then sending the questionnaire in advance, by telephone calls and/or fax with the assistance of local Statistics Offices, together with the requirement about firm size, 35.45 percent of the 3131 firms agreed to participate in a face-to-face interview. The enterprises were divided into three groups: small-scale enterprises consisting of 5 to 19 employees; medium-scale enterprises consisting of 20 to 99 employees; large-scale enterprises consisting of more than 99 employees (full-time employees). After checking the response questionnaires, it could be seen that 1050 responding firms fulfilled the requirements of the survey (the questionnaire response rate is approximately 33.53 percent). Among these responses, 367 out of 1050 firms were foreign-owned firms (subsidiaries), which were the subject of our study. After corrections for missing values, due to incomplete responses to the aim of this study, the usable and final observations for this study are 354. The parent firms of these subsidiaries (home country) cover 36 countries worldwide.

Measures of variables

Dependent variable: subsidiary product innovation

By adapting the Oslo Manual guidelines (OECD, 2005), subsidiary product innovation is defined as "the implementation of a new or significantly improved good (or service) during the last three years (2007-2009)". The product innovation must be new or significantly improved for the foreign subsidiary (but not necessarily new to the market or new to the world). With this definition, we followed and the measured the method of product innovation in the study of Vo (2013) and the so-called Community Innovation Surveys as used by various European

Statistical Offices, in an effort to provide a harmonized way of measuring and comparing innovation in Europe[1]. Based on this method, our dependent variable is dichotomous and equals 1, if the subsidiary introduced product innovations (between 2007 and 2009) have been mainly developed by its own activities, or 0 if the product innovations have been developed by other actors, or if the subsidiary did not introduce any product innovations during the reference period.

Independent variables

Backward linkages

Backward linkages reflect a subsidiary's relationships with local suppliers. The level of backward linkages refers to the quantity of linkages between subsidiaries and local suppliers (Vo, 2013; Jindra *et al*., 2009). They describe the process of how a company, within a given sector, purchases its goods, products, or supplies from a company in a different sector; these are called inputs (UNCTAD, 2001; Giroud, 2007). Subsidiaries can benefit from spillovers and transfer of knowledge embodied in the products, processes and technologies of local firms (Giroud, 2007; Jindra *et al*., 2009). Following the study of Jindra *et al*. (2009), the extent of backward linkages is measured by the share of supplies sourced from domestic suppliers outside the MNE network, in relation to total supplies (in %). The higher percentage means that the level of backward linkages between subsidiaries and local suppliers is higher.

Forward linkages

The relationships between foreign subsidiaries and local customers (sales) agents capture the forward linkages. Foreign subsidiaries gain more than pecuniary benefits by selling their products to local customers (Yamin and Otto, 2004). They can also benefit from a new source of demand from customers to increase their specialization and flexibility and adapt their product to the conditions of the local market (Jindra *et al*., 2009). In turn, enhanced capabilities, through local customer relationships, will facilitate local knowledge to a subsidiary. Similarly, following Jindra *et al*. (2009), we measured the extent of forward linkages, through the share of sales to domestic customers outside the MNE network, in total sales (in %).

Control variables

We included three sets of control variables in our model. The first set accounts for subsidiary characteristics. Firstly, we included the R&D intensity of the subsidiary – measured by the share of revenue invested in R&D in the subsidiary's total sales – because it is well-known that R&D intensity is an important determinant of a subsidiary's innovative performance (Simões *et al*., 2002; Taggart and Hood, 1999). Secondly, we included subsidiary size – measured by the natural logarithm of the number of employees at the subsidiary – because a large subsidiary has more resources and knowledge available that allows for higher innovation (Ciabuschi *et al*., 2011). Thirdly, we included the age of the subsidiary – calculated by subtracting the

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[1] For more information we refer to http://ec.europa.eu/eurostat/statistics-explained/index.php/Innovation_statistics.

year the subsidiary was founded from the year 2009 – because older subsidiaries may have lower innovation levels than younger ones, due to their continued use of outdated knowledge and experience and their resistance to new approaches (Taggart and Hood, 1999). Fourthly, we included export sales – the share of exports in total sales. According to Gűnther (2006), foreign subsidiaries play a positive role for innovation in a host country, since factors which positively influence innovation – e.g. size, R&D, export intensity and more recent technology – particularly benefit foreign subsidiaries.

The second set of control variables concerns the headquarters' characteristics. Firstly, we control for the entry mode because the subsidiary's level of innovation, in terms of a green-field investment or an acquisition, may be different. We account for this by including a dummy variable that is at one, when the subsidiary is an M&A location (including joint ventures), and zero otherwise (Jindra *et al.*, 2009; Slangen, 2011). Secondly, we control for the international experience of the MNE (parent firm), because the more experienced firms may know how to choose which new knowledge and technology in the host country is necessary for that subsidiary's innovative performance, better than the inexperienced ones. For this situation, we account by asking the year when the MNE first operated a business in a foreign country and then subtract from the year 2009.

The third set of control variables relates to a country's characteristics; specifically, we control for home-country effects. The headquarters of the subsidiaries in the sample stem from 36 different countries, but we just included one dummy to differentiate between developing and developed home countries, due to the fact that subsidiaries in developed countries have the advantage of 'foreignness' in innovation, through the transfer of product innovations from other parts of the MNE (Un, 2011). In addition, we also argue that headquarters from developed countries, by definition, may have a stronger inclination to innovate because their competitive environment requires them to do so in order to survive, compared to those from developing countries. According to the World Bank, a developed country is defined as a nation having a GDP per capita upwards US $12,000 per year. Following up previous studies (Un, 2011; Vo, 2013), we constructed one home-country dummy, that is, we distinguished whether the MNE comes from a developed country.

3.2.3 Estimation method

With the measurement of the dependent variable above, we use Probit regression in this study to estimate the impact of vertical linkages on subsidiary innovation. This specification can be described as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

where: Y is the dependent variable;

      β_0 is the intercept, the value of Y when X is zero;

      $\beta_{1,2}$ are the regression coefficients of the independent variables;

      $X_{1,2}$ are the observed values of the independent variables;

      $\beta_{3 \to 9}$ are the regression coefficients of the control variables;

      $X_{3 \to 9}$ are the observed values of the control variables, and

      ε is the error term or residual.

EMPIRICAL RESULTS

Main regression results

Means, standard deviation and correlations for subsidiary product innovation are provided in Table 1. Our measure of product innovation is dichotomous; for which, Probit estimates are appropriate.

In preparing the data for the regression analysis, we performed the usual tests to obtain reliable estimates (Hair *et al*., 2006). The latter yielded satisfactory results: neither heteroskedasticity nor non-normality is an issue (White and Jarque-Bera tests with p=0.27 and p=0.31, respectively). The maximum value of the correlation coefficients is 0.35, which is well below the threshold of 0.80, thus indicating that there are no issues with multicollinearity (Neter *et al*., 1985). We also tested for possible biases caused by collinearity among variables by calculating the variance inflation factor (VIF) for each of the regression coefficients (see Table 1). The VIF values for all variables in the model are below 2.0 and thus well below the cut-off value of 5.6 recommended by Hair *et al*. (2006). The likelihood ratio tests of the chi-square distributions for all models were significant, thus indicating that our final model fits the data significantly better than a model without any predictors. The results from the Probit regression analyses are summarized in Table 2.

The regression results offer two conclusions. Firstly, the various fit parameters show that our models fit the data increasingly well. Regarding subsidiary innovation, Table 2 shows that the log likelihood value improves from -236.72 in Model 1 to -74.32 in Model 4. This means Model 4 is able to explain that effect better than others. Also, the estimates remain robust in terms of sign and significance levels. Model 1 is a model with control variables and a constant only. The main effects were added in Models 2, 3 and 4, respectively. The Pseudo-R2 improves from 3.52 percent in Model 1 to 39.71 percent in Model 4. The parameter estimates remain robust in terms of sign and significance levels. In Models 2 and 3, the two effects of subsidiary – forward linkages and backward linkages – were included, respectively. The results show that both forward and backward linkages are positively and significantly related to subsidiary innovation ($\beta = 0.025$, $p < 0.01$ for forward linkages; $\beta = 0.022$, $p < 0.01$ for backward linkages).

Model 4 includes both forward and backward linkages, and shows they are positively and significantly related to subsidiary innovation. Model 4 shows that forward linkages ($\beta = 0.045$, $p < 0.01$), and backward linkages ($\beta = 0.042$, $p < 0.01$) increase the level of innovation of subsidiaries. Taken together, it can be concluded that we cannot reject Hypotheses 1 and 2, since they are supported by the data. Our results generally support the business network perspective, which suggests that subsidiaries need to be embedded within the local network of business relationships. The last column in Table 2 presents the marginal effect of vertical linkages on the subsidiary's innovation. The marginal effect analysis shows that a home country dummy has the largest effect on subsidiary innovation, followed by forward linkages and then backward linkages.

Table 1. Statistical description and correlations: the dependent variable is subsidiary innovation (n=354)

		VIF	Mean	S.D	1	2	3	4	5	6	7	8	9
1	Subsidiary innovation (innovated)	1,11	0.51	0.5									
2	Forward linkages (%)	1,23	66.35	41.62	0.60***								
3	Backward linkages (%)	1,22	56.45	39.88	0.59***	0.14***							
4	R&D intensity (%)	1,18	7	6.61	0.10*	0.01	0.07						
5	Age of subsidiary	1,02	9.77	7.85	0.02	0.04	0.06	-0.02					
6	Size of subsidiary (number of employees)	1,66	239.18	471.22	-0.03	0.02	-0.05	0.01	0.11**				
7	Export sales (%)	1,25	59.29	37.88	-0.04	-0.04	-0.06	0.35***	-0.05	0.13**			
8	Parent's international experience (year)	1,09	29.8	13.43	-0.04	0.01	-0.02	0.04	0.06	-0.03	-0.03		
9	Parent's entry mode (M&A)	1,08	0.23	0.42	0.02	0.07	0.01	-0.05	-0.03	0.01	0.10*	-0.13**	
10	Home country dummy (developed country)	1,12	0.72	0.45	0.17***	0.05	0.07	0.05	0.04	0.03	-0.03	-0.13**	0.02

* $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

Table 2. The effect of external linkages on subsidiary innovation (Probit estimates)

	Innovation				Marginal effect (dy/dx)
	(1)	(2)	(3)	(4)	
Constant	-0.34 (0.26)	-2.12 (0.35)***	-1.63 (0.32)***	-5.75 (0.86)***	
Control variables					
R&D intensity (%)	0.04 (0.02)**	0.06 (0.02)***	0.03 (0.02)*	0.07 (0.03)**	0.03 (0.01)**
Age of subsidiary	0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)	-0.01 (0.01)	-0.00 (0.00)
Size of subsidiary (number of employees)	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Export sales (%)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Parent's international experience (year)	-0.00 (0.01)	-0.01 (0.01)	-0.00 (0.01)	-0.01 (0.01)	-0.00 (0.00)
Parent's entry mode (M&A)	0.10 (0.17)	-0.06 (0.19)	0.09 (0.19)	-0.21 (0.29)	-0.08 (0.11)
Home country dummy (developed country)	0.45 (0.15)***	0.54 (0.18)***	0.49 (0.17)***	0.62 (0.25)**	0.24 (0.09)***
Main variables					
Forward linkages (%)		0.025 (0.00)***	–	0.045 (0.01)***	0.018 (0.00)***
Backward linkages (%)			0.022 (0.00)***	0.042 (0.01)***	0.017 (0.00)***
N	354	354	354	354	
Pseudo-R^2	0.2952	0.3391	0.3024	0.3971	
Log likelihood	-236.72	-162.15	-171.16	-74.32	
P_value	0.042	0.000	0.000	0.000	

Standard errors are listed in parentheses. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

The significant results for the control variables are in line with expectations. Table 2 shows that a higher R&D intensity has a significant and positive effect on subsidiary innovation (with $\beta = 0.07$, $p < 0.05$). In addition, this result indicates that subsidiaries located in developed countries have a significant and positive impact on subsidiary innovation, compared to subsidiaries in developing countries (with $\beta = 0.62$, $p < 0.05$)

Robustness analyses

In order to explore the robustness of the above finding on subsidiary product innovation, we performed two additional analyses. Table 3 reports these results.

Table 3. Robustness analysis of subsidiary product innovation

	Original results	Additional tests	
	Initial results extracted from Table 2 [Model (4)]	Panel A: Logit regression	Panel B: Alternative measure for backward and forward linkages
Constant	-5.75 (0.86)***	-11.68 (2.25)***	-8.28 (4.02)**
Control variables			
R&D intensity (%)	0.07 (0.03)**	0.12 (0.06)*	0.14 (0.05)*
Age of subsidiary	-0.01 (0.01)	-0.02 (0.02)	-0.03 (0.03)
Size of subsidiary (number of employees)	-0.00 (0.00)	-0.00 (0.00)	-0.01 (0.01)
Export sales (%)	-0.00 (0.00)	-0.01 (0.01)	-0.03 (0.02)
Parent's international experience (year)	-0.01 (0.01)	-0.02 (0.02)	-0.00 (0.01)
Parent's entry mode (M&A)	-0.21 (0.29)	-0.32 (0.50)	-0.22 (0.30)
Home country dummy (developed country)	0.62 (0.25)**	1.17 (0.46)**	1.01 (0.32)**
Main variables			
Forward linkages (%)	0.045 (0.01)***	0.093 (0.02)***	0.352 (0.01)***
Backward linkages (%)	0.042 (0.01)***	0.089 (0.02)***	0.282 (0.01)***
N	354	354	354
Pseudo-R^2	0.3971	0.4131	0.2912
Log likelihood	-74.32	-70.39	-75.42
P_value	0.000	0.000	0.000

Standard errors are listed in parentheses. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

We determined whether our results were robust for the measure of the dependent variable, i.e. the subsidiary innovation. As a test for robustness, we estimated the Logit models using the same control and main variables as our Probit models. This did not affect the regression results (with $\beta = 0.093$, $p < 0.01$ for forward linkages, and $\beta = 0.089$, $p < 0.01$ for backward linkages). As an additional analysis for a robustness test, in Panel B, we alternatively measured

forward and backward linkages as the total of cost subsidiary purchased input from domestic suppliers and the total of sales sold to domestic customers, respectively. The Probit regression revealed that the results do not change (with $\beta = 0.352$, $p < 0.01$ for forward linkages, and $\beta = 0.282$, $p < 0.01$ for backward linkages). Two additional analyses confirmed again that our results are robust.

DISCUSSION AND CONCLUSION

This study advances our understanding of subsidiary product innovation by building on business network theory to predict a linear relationship between the level of external linkages (forward and backward linkages) of subsidiary and product innovation. Building on a dataset of 354 subsidiaries in Vietnam, the empirical results show that the levels of forward linkages and backward linkages are positively associated with subsidiary innovation. This suggests that engaging in various types of linkages and succeeding in creating beneficial relationships, through linkage activities with local suppliers and customers and multinational subsidiaries, can strengthen the learning abilities of the subsidiary (Holm et al., 2015; Engwall et al., 2016) and improve the subsidiary's capability to assimilate new information. Strengthening linkages with local partners motivates trust building between the subsidiary and local suppliers, which then increases the likelihood of the local partner revealing institutional type knowledge and sharing specific local resources. Through combining valuable resources and new knowledge, subsidiaries are likely to create new ideas, invent new business initiatives with new directions, and develop new technologies that are all conducive to innovation (Andersson et al., 2007; McDonald et al., 2008; Yamin and Andersson, 2011; Ricciardi, 2014). If applied to in Vietnam's case, the uncertainty and complexity of the business environment seemingly prevents foreign subsidiaries from engaging with domestic firms and absorbing new knowledge; but the results of this study haves provend the opposite. The reason is that Vietnamese government's policy revolution significantly increases appropriate support with respect to foreign investors in terms of engaging with domestic firms.

Before we derive the implications of our findings, we should first discuss the limitations of the study that could serve as routes for follow up research. Firstly, the data used were collected at the MNE affiliate level. Therefore, this study cannot capture the role of the effect of backward and forward linkages on innovation beyond the perception of subsidiary managers (Ciabuschi et al., 2011). For example, given the role of different subsidiaries, some subsidiary managers granted a low decision-making autonomy within the local market, so their engagement activities with local suppliers or customers are likely to be limited, and that impedes knowledge change (Cantwell, 2001). In addition, the study cannot know the role of a headquarters in shaping and designing local networks, because headquarters can manage the complexities of multiple linkages (Myer et al., 2011). Hence, we have not yet distinguished the role of linkages at different levels, i.e., the subsidiary, division/business area, or headquarters. Future research, therefore, can take these into account by considering the linkage activities of subsidiaries at multi-levels. Secondly, although we control for the characteristics of subsidiary, parent, industry and home country, this paper did not examine the role of other factors, such as a subsidiary's

absorptive capacity that is required to engage in local networks and management initiatives in response to local incentives. These factors could affect subsidiaries' linkages with local counterparts (Meyer *et al.*, 2011). For example, a subsidiary's absorptive capacity required to engage in local networks in developing countries could be different from those in developed countries (Figueiredo, 2011). Subsidiaries located in dynamic environments, which witness rapid levels of economic development, may have more opportunities and the wherewithal to adopt new roles within the global MNE network. They can quickly adapt and acquire new updated interventions. Thus, it is likely to have opportunities to learn and motivate innovation activities. Taken together these factors facilitating the expansion and development of local and regional products and markets, by subsidiaries through linkage activities, are prompted by growth opportunities in the host and other emerging neighboring economies. Future research should take this situation into account.

In spite of these limitations, the study offers important implications for our scholarly and practical understanding of the relation between backward and forward linkages and subsidiary innovation. Our results imply that, in order to enhance the level of innovation at subsidiary level, local subsidiaries should engage with both local suppliers and customers as much as possible. Their primary (but not the only) motivation is towards reducing costs. Vertical alliances are especially important within global production networks and global value chains, and they are especially common for development. This implication confirms that business network theory plays an important role in explaining the functions of subsidiaries within the innovation process of the MNE network. It allows access to valuable market understanding, and the joint resources of network partners can be usefully leveraged to achieve higher customer satisfaction, and higher reactivity and flexibility (Holm *et al.*, 2015). Moreover, a more protected and predictable environment is provided, and more resources are available for long-term investments and market effectiveness. As a consequence, an innovation path can be taken that would have been impossible for a single organization alone. If reciprocal trust between network partners is high (Engwall *et al.*, 2016; Holm *et al.*, 2015), business networking allows rational division of labor, specialization, risk sharing, cultural exchange and cross-fertilization: all factors that are expected to positively influence an organization's innovation capabilities.

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