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Impact of Foreign Linkages on Innovation Activity of Manufacturing Firms in CALABARZON

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ABSTRACT

Despite several studies exploring innovation activities in the Philippines, no clear answer has been provided to the question of whether having foreign linkages can induce knowledge transfer and innovation. This study probes deeper into the role of foreign linkages in the innovation activities of manufacturing firms in the CALABARZON (Cavite, Laguna, Batangas, Rizal, and Quezon provinces) region. Using a probit estimation and an IV regression to control for endogeneity brought by omitted variable bias, the results show that foreign linkages can positively affect a firm's likelihood to undertake product innovation that involves the development of a new product using technology new to the firm. On the other hand, process innovation has consistently shown to be positively influenced by foreign linkages. These results indicate that having foreign linkages and participating in the global value chain can have a positive impact on both process and product innovations. Thus, it is important to highlight the need to promote stronger regional and global linkages to sustain the manufacturing growth in CALABARZON. Moreover, trainings that teach the 5S system through government channels such as the Technical Education and Skills Development Authority and state universities and colleges are as important. Highlighting the role of industrial parks and recognizing the value of establishment-level data are also key points in this study.

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INTRODUCTION

Most of the innovation studies in the Philippines (Albert et al. 2013; Albert et al. 2017; del Prado and Rosellon 2017a) have found that manufacturing firms rely on external sources of information for their innovation activities. In this study, the relationship between external linkages and innovation activity of local firms is further explored. It attempts to determine whether participating in global value chains induces knowledge transfer and innovation.

This study also contributes to existing literature on innovation by presenting a causal relationship between foreign linkages and innovation activity in firms. So far, most of the quantitative analyses on innovation activities were able to show, at best, correlations between the explanatory variables and innovation activity (Macasaquit 2009; Albert et al. 2013; Llanto and del Prado 2015). By using an exogenous incident, this study strengthens the initial findings on the role of linkages in innovation activity.

REVIEW OF RELATED LITERATURE

Linkages (foreign or domestic) and innovation activity

Innovation activities may be either product or process.[2] Product innovation is the introduction of a new product or outcome whereas process innovation is the adoption of new tools, devices, or knowledge in the technology that transform inputs to outputs (Gopalakrishnan and Damanpour 1997). Developing new products and improving on existing products are examples of product innovation whereas examples of process innovation include the adoption of activities to significantly improve process innovation such as on management, procurement, and workplace efficiency.[3]

Using a systems of innovation approach to study the sources of innovation of firms, Fukugawa (2018) explains that firms have access both to their internal resources and external resources in the form of customer feedback, inputs from suppliers, and reverse engineering of competitors' products. Academic research activities done privately and publicly are other external resources from which firms can benefit. Linkages[4] across institutions and firms both locally and internationally serve as the first step in the sequence of learning and innovation (Rasiah 2011). Linkages, both formal and informal, facilitate the dissemination of knowledge from experiences allowing firms to learn from the activities of other firms and reduce the cost of innovation, which may be too high in developing countries.

[2] The innovation literature has used various ways of classifying innovation. Gopalakrishnan and Damanpour (1997) provides an extensive survey of definitions and classification of innovation. Ariffin and Figueiredo (2006) distinguishes between routine production capability (i.e., produce goods at given levels of efficiency and given input requirements) and innovative technological capability (i.e., create, change, or improve products, processes, and production organization or equipment.)

[3] The elimination of necessary distribution steps through an enterprise-wide information system that directly connects all retail locations, distribution warehouses, and major suppliers is an example of a retail industry process innovation applicable to logistics (Furey and Diorio 1994). Process innovations that improve information exchange, such as the digitization of information and database construction, remove unnecessary procedures [See the case of improving accounts payable processes in Ford Motors Corporation as mentioned in Attaran (2004) and of improving organizational collaboration in Frito Lay as discussed in Malone and Rockart (1991).]

[4] External linkages may be ranked according to the degree of interaction or collaboration. Patra and Krishna (2015) adopts a framework developed by Ariffin (2000) that ranks external linkages from low (Rank 0) to high (Rank 4). In an ascending order, this includes (0) no linkage, (1) arm's length, (2) human resource recruitment, education, and training, (3) joint adaptation, and (4) joint research. Arm's length linkages are characterized by informal or one-off type of interactions. Employee exchanges and recruitment, on the other hand, fall under the rank 2 linkage. Ranks 3 and 4 are more formal and structured and can take many forms but the key difference is that joint adaptation modification linkages are focused on acquisition and sharing of knowledge whereas joint research is in the collaboration for developing new knowledge. However, this study adopts a more general definition of linkages as the data are not able to support Patra and Krishna's methodology.

Process innovation, in particular, that uses areas of frontier science may be difficult and expensive for firms in developing countries. Foreign partnerships or linkages may be an effective mechanism for developing innovation capabilities in frontier science of local firms or even public research institutions (Hall 2006). Such experience has been observed in China wherein Chinese firms often rely on their foreign partner's advanced technological competence, marketing expertise, or advanced managerial skills to address operational weaknesses and stimulate product and process innovation (Shenkar 1990; Luo 2002).

For the Philippines, a number of studies looked at the innovation activity in specific sectors or industries. Macasaquit (2009) studied the role of linkages in facilitating innovation activities of electronic firms. Quimba and Rosellon (2011) explored the innovation activities of automotive parts manufacturers and assemblers and found that Filipino-owned firms tend to have used external linkages more than foreign-owned firms or joint ventures.

Meanwhile, Rosellon and Yasay (2012) observed that government institutions and access to government support programs were critical for fruit juice processing firms to upgrade their production process. Ledda and del Prado (2013) interviewed four Philippine transnational corporations to identify the role of innovation in the outward push to other countries. Studying the innovation activities in the garments industry, del Prado and Rosellon (2017a) found that even without formal research and development (R&D), both product and process innovations are still possible as long as the appropriate personnel and supporting mechanisms in the company are in place.

In a different study, del Prado and Rosellon (2017b) explored the innovation activities in the fruit juice manufacturing industry. They found that upgrading the capability of local firms through sharing of knowledge has occurred in the Philippines. The study identified a case where knowledge has been shared from large foreign firms to a large firm in the country. Using the information from their foreign partners, the domestic firm was able to improve its production process and meet the requirements of the customers.

Using various surveys of Philippine firms, quantitative studies have also been conducted (Macasaquit 2009; Albert et al. 2013; Llanto and del Prado 2015; Albert et al. 2017) to investigate the determinants of innovation activities using firm-level data. Primarily, Macasaquit (2009) looked into the process by which industrial upgrading and innovation activity of electronics manufacturing firms can be facilitated by linkages with firms in their value chain and collaboration with knowledge partners. Meanwhile, the 2009 survey of innovation activities (SIA) showed that firms rely on their partners (firms within their value chain) for sources of information and innovation activity (Albert et al. 2013). Aside from investigating the determinants of innovation, Llanto and del Prado (2015) were also able to relate innovation with firm performance. Their study indicated that product and process innovations lead to an increase in sales and profits, and improved labor productivity.

The analysis of innovation activities of firms has also been done at the international level. Using data from member-states in the Association of Southeast Asian Nations (ASEAN), including that of the Philippines, Harvie et al. (2010) found that innovation is an important determinant of small and medium enterprises' (SMEs) participation in global value chains. It is through product and process innovations that SMEs are able to meet the requirements of higher tier firms. Furthermore, Machikita and Ueki (2010) used the establishment survey on innovation and production network conducted in Indonesia, Philippines, Thailand, and Viet Nam to examine the effects of having a variety of linkages (both internal and external) on innovation performance. They found that firms with more foreign linkages are able to introduce new products, improve procurement processes, and explore new markets more. However, firms with linkages to multinational corporations (MNCs) have fewer propensities to produce new products but have greater propensities to find new markets (Machikita and Ueki

2011). Meanwhile, various linkages with universities and public organizations were found to have no significant relationship with innovation performance (Machikita and Ueki 2010, 2011).

Globally, and East Asia in particular, Machikita and Ueki (2011) further found that in-house R&D activities not only improve upon product innovations but also extend benefits to process innovations in general. Moreover, firms with more diverse internal resources are able to explore more opportunities than those with less varieties. They also found that different linkages with local firms facilitate process innovations particularly with procurement and market creating innovations. The same authors observed that process innovation resulting from a firm's foreign linkage to MNCs does not work well with firms that are primarily engaged in the domestic market but work well with firms that have more engagements with international consumers.

Drivers of innovation

The size and age of firms matter such that innovation is found to be more common in old, large firms (EBRD 2014; Serafica 2016). This may imply that said firms have significant financial and human resources that can be allocated to formal R&D (Vieites and Calvo 2011). However, in emerging markets, younger but larger firms (possibly successful start-ups) can be more innovative (Ayyagari et al. 2007). An enabling environment that is supportive of start-ups and entrepreneurial research is also an important determinant of innovation in emerging markets (Vieites and Calvo 2011).

The legal structure of the firm can also influence its likelihood to innovate. In particular, foreign-owned MNCs innovate more (EBRD 2014; Serafica 2016). Moreover, having managers with experience in handling MNCs could further strengthen innovation capability. Market orientation as a driver of innovation posits that exporting firms are more innovative (Ayyagari et al. 2007).

Formal R&D leads to more innovation (EBRD 2014); however, considering that R&D requires an adequate level of investment, SMEs are often left with no means to innovate formally. However, innovation can still occur without formal R&D through technology adoption, minor modifications, incremental changes, imitation, or combining existing knowledge with new ways (Romijin and Albaladejo 1999; del Prado and Rosellon 2017a). This implies that cost is a significant barrier to innovation for SMEs in the Philippines (Albert et al 2013).

The EBRD (2014) study finds that the human resources of a firm with degrees in science, technology, engineering, and math (STEM) and experience in MNCs are relevant factors that affect the innovation activity of firms. Those without STEM degrees often led to less scientifically grounded innovation and more toward sales and marketing improvement. Moreover, managers with experience in SMEs only often innovated in a simpler, less radical, and less expensive way (Romijin and Albaladejo 1999).

The adoption of Lean Management principles particularly 5S (Seiri [sorting], Seiton [straightening], Seiso [shining], Seiketsu [standardizing], and Shitsuke [sustaining]) has been an attractive way for old manufacturing companies to improve production performance without large capital investments (Purohit and Shantha 2015). 5S is a workplace organizational and housekeeping methodology that aims to achieve high levels of quality through the minimization of waste. Case studies in India (Purohit and Shantha 2015), Colombia (Lamprea et al. 2015), and Indonesia (Ratnawati et al. 2016) have shown that employee satisfaction and productivity increased through the successful implementation of the 5S methodology.

Firms that are able to use information and communications technology tend to innovate more and so are firms whose investments are sourced from foreign banks (EBRD 2014). The likelihood of being an innovator also increases as the proportion of the financed investment increases (Ayyagari et al. 2007).

Innovation activities can also be driven by embeddedness. Grossetti (2018) explains embeddedness as the dependence of an identity vis-à-vis the links that it has with others. Foreign linkages as a driver of innovation comes into the equation internally through intracorporate counterparts or externally through local organizations (Patra and Krishna 2015). The reciprocal of embeddedness is decoupling or the formation of an identity. Together, both embeddedness and decoupling form a dynamic force where firms' personnel interactions first form commonalities before these detach and form identities. Firms with foreign linkages benefit from having relational chains as these facilitate learning processes with firms in their proximity particularly customers and suppliers (Heidenreich 2012). The concept of embeddedness becomes more prominent in firms with multiple and diverse linkages both domestically and internationally once relational chains expand. In essence, the whole process becomes a sophisticated form of knowledge dissemination.

The role of innovation intermediaries as bridges for knowledge dissemination is recognized by Quimba et al. (2017) as these can help facilitate innovation by providing physical and social capital. For instance, the Philippine Economic Zone Authority (PEZA) influences the operations of locators in industrial parks. Indirectly, the agglomeration of firms in industrial parks provides a conducive environment for expansion of existing network of these firms.

In a study exploring the innovative behavior of Philippine firms, the active engagement in knowledge management practices, the size of the firm, and its location inside an industrial park managed by PEZA were the major determinants found (Albert et al. 2013). Furthermore, the effects of innovation were often largely customer-driven. On the impact of the geographic market, the study found weak evidence that firms with a geographic market limited to the local economy are at risk of not being an innovator. In contrast, the results of the 2015 SIA conducted by the Philippine Institute for Development Studies (PIDS) indicated that firms catering to the domestic market tend to innovate more and their export orientation has a negative relationship with process innovation (Albert et al. 2017). Looking at the case of the automotive industry, some micro, small, and medium enterprises (MSMEs) in the sector have difficulty pursuing innovation activities because of limits imposed by parent companies abroad (Quimba and Rosellon 2011). Given these conflicting relationships, it is no surprise that the ASEAN-Japan Center finds that, for the Philippines, the relationship between participation in global value chains and gross domestic product (GDP) growth is tenuous (AJC 2017).

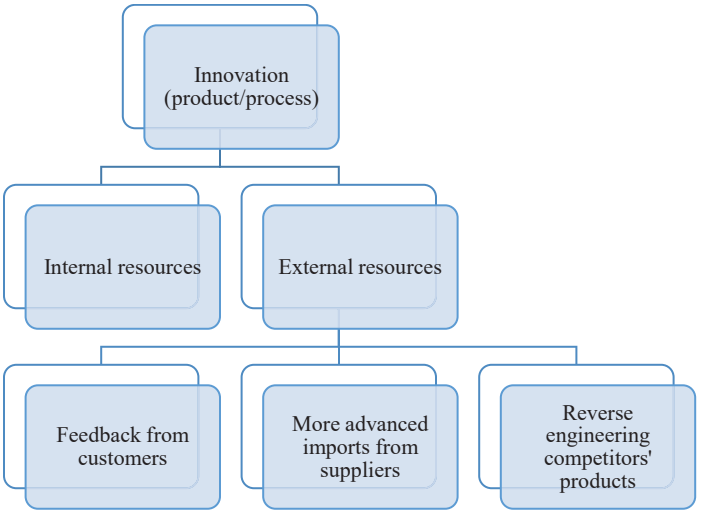
METHODOLOGY

Theoretical framework

This study is guided by the theoretical framework of Fukugawa (2018) as shown in Figure 1. The framework shows that firms innovate by using both internal resources and tapping into external resources available to them. The latter ones can be classified further into foreign and domestic sources of knowledge.

Transfer of knowledge from foreign and domestic sources is mainly determined by the type of knowledge involved. There are three types of knowledge categories: (1) analytical, which is based on science; (2) synthetic, which draws from technology; and (3) symbolic, which is grounded on culture. These categories of knowledge differ by how knowledge is produced and transferred. Among these three, analytical knowledge is the quickest to be transferred as it can flow through the academe and licensing processes while the more challenging is synthetic knowledge as it requires the interaction between high-skilled professionals. This interaction involves the participation of engineers and scientists to gather and take a heuristic approach to learning. Finally, the more intangible symbolic knowledge is both vague and difficult to transfer as it will entail having to experience the phenomenon (i.e., learning by doing and observing).

Figure 1. How do firms innovate?



Source: Fukugawa (2018)

Profile of datasets

Primary data on the innovation activities of firms in CALABARZON have been collected since 2008 by the Economic Research Institute for ASEAN and East Asia (ERIA). This study, however, includes only datasets for the years 2011 to 2014 as earlier years have used a survey instrument that is significantly different from the more recent ERIA surveys.

A total of 855 firms were surveyed from 2011 to 2014 but Laguna was not included in the 2011 survey. The sample firms were systematically drawn until a proportional allocation from different industries of various sizes within each province was reached. Table 1 summarizes key information of the datasets used.

From the 855 firms in this study, 417 (48.8%) are identified as product innovators. Based on the ERIA survey questionnaire used in this study, a firm is considered as a product innovator if it has achieved at least one of the following: (1) introduced a new product, redesigning packaging or significantly changing appearance design of existing products; (2) introduced a new product, significantly improving existing products; (3) developed a totally new product based on the firm's existing technology; or (4) developed a totally new product based on new technology for the firm.

Meanwhile, 425 (49.7%) are identified as process innovators. The ERIA survey questionnaire used in this study lists five process-related innovation activities. A firm is considered a process innovator if it has adopted a new method or has significantly improved one of the following: (1) procurement; (2) sales management; (3) accounting; (4) inventory control; or (5) logistics. There are 258 firms (30.2%) that are engaged in both product and process innovation. In terms of firm size, majority (55.3%) are small and micro enterprises. Most firms (77.7%) were established in the period 1990 to 2011. Also, the majority of firms (66.3%) have limited R&D spending in any given year.

In terms of manufacturing principles by the firm, 66.1 percent engaged in some form of learning system. Those using the 5S system comprised 66.6 percent of firms, whereas 73.2 percent of firms observed a quality control circle. Finally, 62.9 percent of firms in the study produced final products.

Batangas, Cavite, and Laguna have the highest proportion of product innovators with more than half of firms identified as product innovators (Table 2). Meanwhile, in terms of process innovation,

Table 1. Summary statistics: Frequency by reference year

Indicator	Reference Year				Total
	2011	2012	2013	2014	
Total firms	207	236	213	199	855
Product innovator	93	118	115	91	417
Nonproduct innovator	114	118	98	108	438
Process innovator	85	100	120	120	425
Nonprocess innovator	122	136	93	79	430
Both product and process innovator	48	67	76	67	258
Enterprise					
Large	44	67	59	55	225
Medium	40	44	35	38	157
Small and micro	123	125	119	106	473
Decade established					
1950–1959	3	2	3	2	10
1970–1979	3	4	4	5	16
1970–1979	10	13	10	8	41
1980–1989	27	34	33	30	124
1990–1999	93	104	92	87	376
2000–2011	71	79	71	67	288
Research and development, (% of total sales)					
No expenditure	137	160	142	131	570
Less than 0.50%	34	35	42	39	150
0.50-0.99%	17	20	11	11	59
More than 1.00%	19	21	18	18	76
System of learning					
With	124	159	148	134	565
Without	83	77	65	65	290
Usage of 5S system					
With	129	157	147	136	569
Without	64	60	54	51	229
Export activity					
Exporter	108	145	131	113	497
Nonexporter	99	91	82	86	358
Intellectual property right					
With	38	229	65	66	398
Without	169	7	148	133	457
Industrial park location					
Inside	96	118	104	94	530
Outside	111	118	109	105	325

Table 1. Continuation

Indicator	Reference Year				Total
	2011	2012	2013	2014	
Final product produced					
Raw materials	8	11	9	7	35
Raw materials processing	14	11	7	12	44
Components and parts	53	78	52	55	238
Final products	132	136	145	125	538

5S=sort, set, shine, standardize, and sustain
Source: Authors' calculations

Batangas and Laguna were the leaders at 57.6 percent and 65.3 percent, respectively. These figures are much higher than the overall average of 49.7 percent. In Laguna, 45.7 percent of the firms surveyed undertook both product and process innovations. In contrast, only 8.0 percent of the firms in Rizal undertook both types of innovation.

Batangas, Cavite, and Laguna also have the highest proportion of respondent firms that implemented a system of learning in their firm (Table 2). They also have the highest proportion of firms that have used a 5S system in their production.

In terms of the use of intellectual property rights (i.e., patent, utility model, proprietary software rights, or trademark), Batangas and Laguna have reported more firms that hold intellectual property than those that do not have. Finally, most firms in Batangas (60.4%), Cavite (85.4%), and Laguna (81.5%) are located inside an industrial park.

Table 2. Summary statistics: frequency by location

Indicator	Province					Total
	Batangas	Cavite	Laguna	Quezon	Rizal	
Total firms	111	377	81	48	235	852
Product innovator	66	203	49	9	88	415
Nonproduct innovator	45	174	32	39	147	437
Process innovator	64	174	53	19	113	423
Nonprocess innovator	47	203	28	29	122	429
Both product and process innovator	44	115	37	4	56	256
Enterprise						
Large	37	117	44	8	17	223
Medium	30	70	12	11	33	156
Small and micro	44	190	25	29	185	473
Decade established						
1950–1959	4	0	0	3	3	10
1970–1979	7	0	0	4	5	16
1970–1979	0	14	10	5	12	41
1980–1989	13	19	6	14	72	124
1990–1999	35	215	45	14	65	374

Table 2. Continuation

Indicator	Province					Total
	Batangas	Cavite	Laguna	Quezon	Rizal	
2000–2011	52	129	20	8	78	287
Research and development, (% of total sales)						
No expenditure	71	250	55	32	159	567
Less than 0.50%	26	71	12	7	34	150
0.50–0.99%	3	24	5	3	24	59
More than 1.00%	11	32	9	6	18	76
System of learning						
With	77	281	66	24	116	564
Without	34	96	15	24	119	288
Usage of 5S system						
With	76	299	71	22	99	567
Without	35	78	10	26	136	285
Export activity						
Exporter	61	300	63	18	54	496
Nonexporter	50	77	18	30	181	356
Intellectual property right						
With	63	172	45	22	93	395
Without	48	205	36	26	142	457
Industrial park location						
Inside	67	322	66	11	63	529
Outside	44	55	15	37	172	323
Final product produced						
Raw materials	0	10	4	7	13	34
Raw materials processing	1	17	3	10	13	44
Components and parts	28	128	39	1	42	238
Final products	82	222	35	30	167	536

5S = sort, set, shine, standardize, and sustain
Source: Authors' calculations

By product category, a large portion of firms (13.7%) produce food, beverages, and tobacco products (Table 3). Following these are metal products (12.5%), other electronic products (10.8%), apparel and leather products (10.1%), and plastic and rubber products (9.2%).

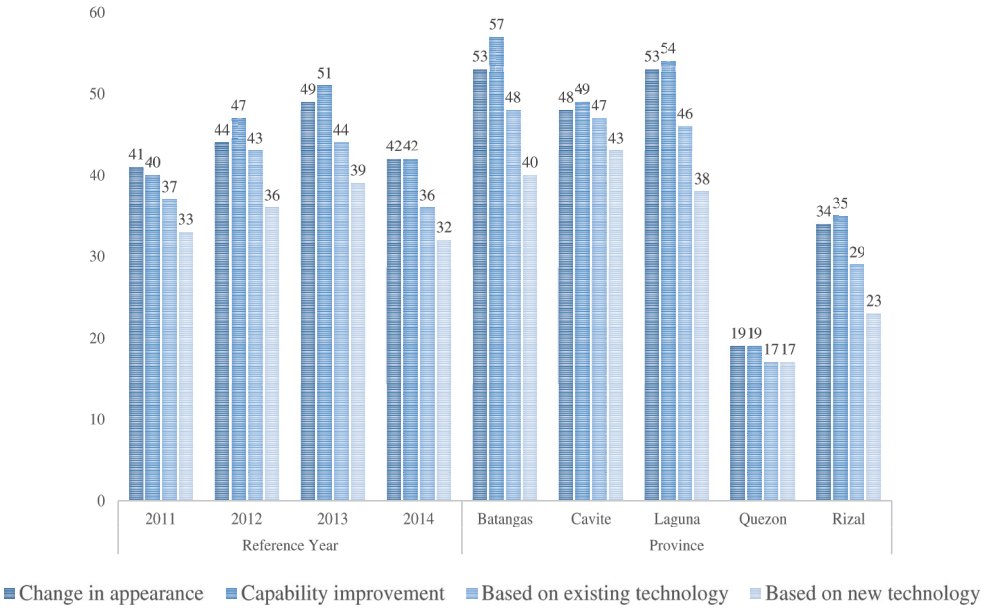
Disaggregating the product innovation activity conducted by firms, producing a new product using a technology new to the firm is the least common product innovation activity conducted from 2011 to 2014 (35.0%) (Figure 2). Moreover, product innovation mostly occurred in Batangas, Cavite, and Laguna. Quezon province fell below the regional average of about 37.7 percent across all activities. For all provinces, the most common product innovation activity is the manufacture of a new product involving a change in appearance or packaging, or the manufacture of a new product involving an improvement in product quality or usability.

Table 3. Number of respondent firms by year and main product

Activity	Reference Year				Total
	2011	2012	2013	2014	
Total firms	207	236	213	199	855
Apparel, leather	24	22	21	19	86
Automobile, autoparts	16	20	11	15	62
Chemicals, chemical products	5	10	9	8	32
Computers and computer parts	0	5	8	3	16
Food, beverages, tobacco	25	30	32	30	117
Iron, steel	5	6	5	3	19
Machinery equipment, tools	11	10	15	10	46
Metal products	25	32	21	24	102
Nonferrous metals	0	1	4	4	9
Other electronics and components	23	30	20	19	92
Other nonmetallic mineral products	11	12	11	9	43
Other transportation equipment and parts	4	3	3	2	12
Others, not elsewhere classified	17	18	10	10	55
Paper, paper products, printing	5	7	7	7	26
Plastic, rubber products	20	18	22	19	79
Precision instruments	2	1	5	3	11
Textiles	7	6	4	6	23
Wood, wood products	7	5	5	8	25

Source: Authors' calculations

Figure 2. Product innovation in respondent firms by reference year and by province (%)

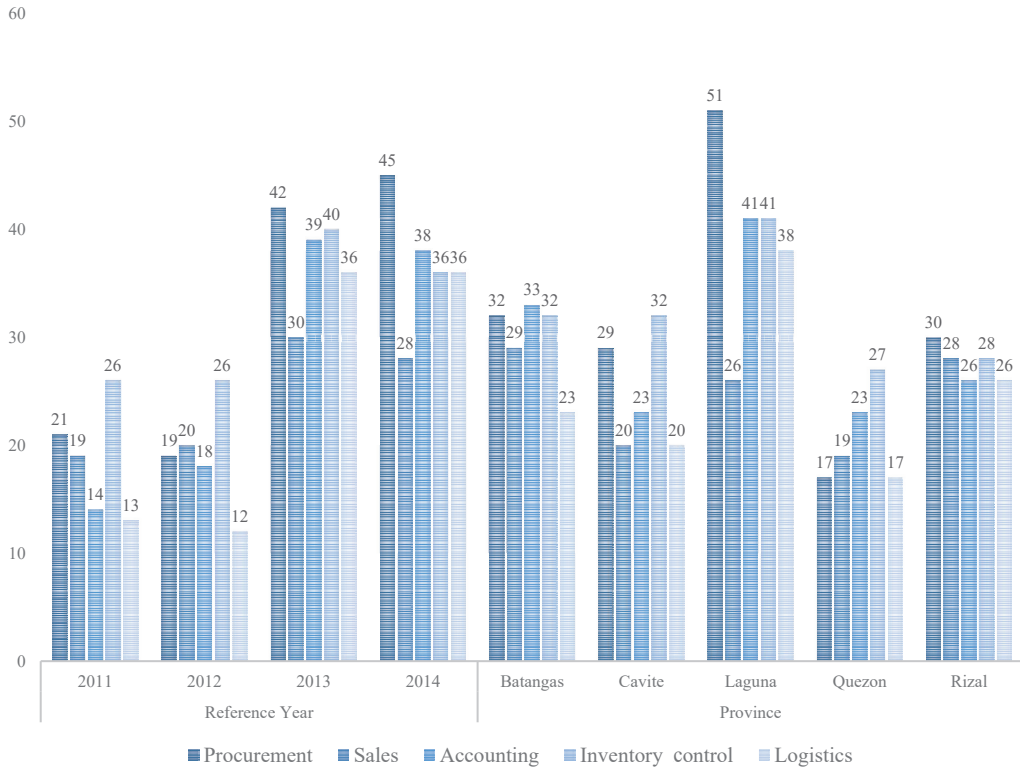


Source: Authors' calculations

On the other hand, when it comes to process innovation activities, there is a marked increase in the number of process innovations in 2013 (Figure 3). Further research is necessary to ascertain the reasons for this trend since the survey instrument is designed to let firms indicate the conduct of innovation activity without specifying the innovations. This strategy allows the firms to still maintain their innovation activities as their competitive advantage with rival firms. Most firms reported the conduct of process innovations in procurement. Among the provinces in CALABARZON, Laguna is notably the most active in process innovation.

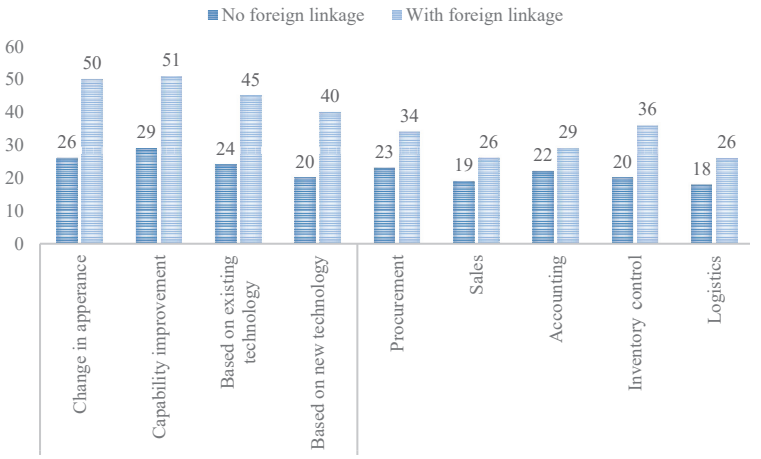
Finally, relating the number of firms that engage in product or process innovation with having a foreign linkage, more firms with foreign linkages engage in product innovations (Figure 4). Based on the ERIA survey questionnaire of this study, having foreign linkages is defined as having satisfied any of the following conditions: (1) engages in export activity; (2) has an MNC or joint venture (JV) customer in a foreign country that is reportedly a 'very important' or 'somewhat important' source of information and technology; or (3) has an MNC or JV supplier in a foreign country that is reportedly a 'very important' or 'somewhat important' source of information and technology. While still more firms engage in process innovations, the difference is relatively small as compared to that of product innovation activities.

Figure 3. Process innovation in respondent firms by reference year and by province (%)



Source: Authors' calculations

Figure 4. Innovation activity of firms by foreign linkage status (%)



Source: Authors' calculations

Econometric model

This study aims to quantify the relationship between innovation activity and external international linkages using the following econometric specification: $Ii = \alpha + \rho Li + \beta Xi + \varepsilon i$ wherein I is 1 if innovator or 0 if non-innovator, L is the presence of foreign linkages, X is a vector of explanatory variables, which include indicators on establishment size, assets, R&D spending, management characteristics, being located in an industrial park, and other similar indicators, and ε is the error term. As the determinants of doing product innovation may be different from that of process innovation, estimations for product and process innovation will be estimated separately with their respective components.

Since L might be correlated to unobservables (captured by εi) that might result in selection-on-unobservables, an instrument variable approach was used. Omitted variables that might confound the results include domestic firm's attitude toward risk or the overall working environment of the firm. Innovation behavior can also affect the decision to engage with foreign partners resulting in a possible simultaneity issue in the probit model.

The instrument for foreign linkages is the GDP growth rate of the partner country that the firm has identified. The top three countries were selected, and its average is taken for the current year. This study exploits the exogeneity of GDP growth rate of countries and its relationship with foreign linkages. This exogenous variable directly affects Philippine firms through their linkage with their customers and/or suppliers but it does not, however, directly affect Philippine firms' innovation activity. Technically, it can be shown that the instrument is partially correlated with foreign linkages once other exogenous variables have been netted out (Wooldridge 2002). This makes the variable a valid instrument for foreign linkages. By using this, issues on simultaneity and omitted variable bias could be addressed.

The model was estimated using instrument variable estimation with the average GDP growth rate of the partner country as identified by the firm as the instrument for foreign linkages. As

noted by Angrist and Pischke (2009), the model can be estimated using the STATA command *ivreg* estimation procedure despite innovation activity and foreign linkages being both binary. The estimated coefficients can be interpreted as the marginal effects.

DISCUSSION

Results of the probit estimation

The marginal effects of changes in the explanatory variable to the probability of being a product or process innovator are presented in Table 4. Consistent with the literature (Albert et al. 2013; EBRD 2014; Llanto and del Prado 2015; Serafica 2016; Albert et al. 2017), large firms were found to be more likely to be an innovator. This positive relationship reflects how a large, well-established firm engages in product or process innovation to maintain its competitiveness.

The marginal effects of 0.151 and 0.110 indicate a positive and significant relationship between R&D spending and the probability of conducting product and process innovation, respectively. This result provides evidence to the theory that firms rely on internal sources of information particularly R&D to conduct innovation activities (Fukugawa 2018). This study also finds a positive and significant relationship between the probability of being a product innovator and the adoption of a learning system that is consistent with the results of prior studies (Albert et al. 2013; Albert et al. 2017).

Table 4. Summary results of the probit estimation in innovation

Variables	Product Innovator		Process Innovator	
	Coefficient	Robust Standard Errors	Coefficient	Robust Standard Errors
Medium firms	0.0225	0.0516	-0.00838	0.0489
Large firms	0.124***	0.0470	0.0977**	0.0460
Age	-0.000249	0.00189	0.000238	0.00178
R&D expenditure	0.151***	0.0219	0.110***	0.0204
Foreign linkages	0.0705	0.0509	0.118**	0.0485
Has a learning system	0.0935*	0.0531	0.131**	0.0510
Produces components	0.0358	0.0747	-0.0517	0.0729
Produces final products	0.149**	0.0630	-0.0198	0.0645
Uses 5S system	0.160***	0.0450	0.0817*	0.0451
Utilizes a quality-control circle	-0.0168	0.0553	-0.0423	0.0538
100% Filipino-owned firm	-0.0286	0.0521	0.0762	0.0520
Top management				
is engineer	-0.0286	0.0405	0.0511	0.0388
has MNC experience	0.000293	0.0414	-0.000153	0.0401
is founder or founder's family	-0.0970**	0.0411	-0.119***	0.0402
Firm has an IPR	0.0614*	0.0802	0.0346	0.0363
Industrial park location	0.0802	0.0518	-0.0500	0.0519

R&D = research and development; 5S = sort, set, shine, standardize, and sustain; MNC = multinational corporation; IPR = intellectual property rights
Source: Authors' calculations, *** p<0.01, ** p<0.05, * p<0.10

Knowledge management practices and learning systems facilitate the transfer of knowledge from external sources to and within the firm contributing to a higher probability to innovate. Another manufacturing principle that is also positively and significantly associated with product innovation activity is the adoption of the 5S system. To incorporate an analysis in the relationship of value chain participation and innovation behavior, dummy variables indicating whether a firm is a 'parts and components' manufacturer or a 'final products' manufacturer were included in the model.

Compared to manufacturers of raw materials, firms that produce final products are more likely to be product innovators. For food manufacturers producing final products, this finding is plausible as they have more room to modify production processes to produce new products. Firms that have an intellectual property rights (IPR) are more likely to be product innovators because these IPR, when commercialized, could be new products sold in the market.

Firms that are completely Filipino-owned are likely to engage in process innovation but not in product innovation. The case of automotive parts manufacturers and assemblers (Quimba and Rosellon 2011) provides an explanation for this as Filipino-owned firms could not be dictated by parent companies regarding improvements of processes allowing them to engage in process innovations while remaining true to the product specifications of their customers.

The regression results show that the background of the top management influences the innovation activity of the firm. Firms where the top management is a founder or is a founder's family member are less likely to conduct either product or process innovation. An explanation for the negative relationship is that whenever the top management is the founder or a founder's family member, it is likely that the top management has a greater commitment to maintain the status quo and, thus, avoid innovation activities.

The study also finds that having foreign linkages is a positive influence to the conduct of process innovation only. There is a need to understand this result in the context of the components of process innovation. This result reveals the need for a more detailed analysis of the determinants of innovation and each of the components of the type of innovation activity involved.

To achieve this, the determinants of product innovation components have been calculated (Table 5). Results similar to Table 4 have been found particularly for the following variables: large firm, R&D expenditure, learning system, final product, and use of a 5S system. What changes, however, is with the variable on the top management being a founder or a founder's family member. Specifically, the case of the product innovation in changing appearance shows the variable of top management being a founder or a founder's family member to be nonsignificant albeit it remains to be a negative determinant to the other product innovation activities.

Being located in an industrial park has a positive influence for a majority of product innovation components. This finding reiterates that location matters to product innovation activities. Moreover, it is possible that since firms are located adjacent to one another in an industrial park, this could lead to a greater degree of embeddedness and expands the linkage network firms have. This point provides support that innovation intermediaries such as PEZA can indirectly influence innovation by providing a conducive environment for innovation activities to improve. Interestingly, the presence of an IPR is nonsignificant when product innovation is disaggregated across its components. Foreign linkages remain to be a nonsignificant influence to product innovation.

Similarly, the determinants of process innovation by component show that firms with large R&D spending are still more capable to undertake process innovations (Table 6). Moreover, the same result from Table 4 on the use of a learning system is obtained. However, what is interesting is that while both the final product and the use of a 5S system is nonsignificant in the aggregate, it has been significant to select subcomponents. For instance, producing final products is a negative influence

Table 5. Summary results of the probit estimation in product innovation components

Variables	Product Innovation	Change in appearance	Capability improvement	Based on existing technology	Based on new technology
Medium firms	0.0208	-0.0148	0.0201	0.022	-0.0124
	-0.0456	-0.0458	-0.0456	-0.0448	-0.0445
Large firms	0.111**	0.139***	0.127***	0.062	0.0304
	-0.0434	-0.0437	-0.0438	-0.044	-0.0434
Age	-0.000373	-0.000252	-0.000644	-0.0016	-0.00243*
	-0.00148	-0.00147	-0.00146	-0.00148	-0.00147
R&D expenditure	0.128***	0.133***	0.137***	0.144***	0.118***
	-0.0172	-0.0183	-0.0176	-0.0177	-0.0194
Foreign linkages	0.0705	-0.0507	0.0139	0.175	0.352**
	-0.181	-0.183	-0.184	-0.181	-0.175
Has a learning system	0.0784	0.104**	0.0725	0.0646	0.0576
	-0.0495	-0.0508	-0.0498	-0.0511	-0.0511
Produces components	0.0234	0.026	0.0111	-0.00555	-0.00514
	-0.0614	-0.0587	-0.0588	-0.06	-0.0624
Produces final products	0.116**	0.154***	0.135***	0.0916*	0.075
	-0.0523	-0.0492	-0.0507	-0.051	-0.0542
Uses 5S system	0.139***	0.117**	0.108**	0.0576	0.048
	-0.0464	-0.0457	-0.0461	-0.0453	-0.0455
Utilizes a QC circle	-0.0141	-0.00614	0.0228	-0.0208	0.00224
	-0.044	-0.0449	-0.0442	-0.0449	-0.0453
100% Filipino-owned firm	-0.0216	-0.0384	-0.0575	-0.0311	0.0221
	-0.0601	-0.06	-0.0591	-0.0573	-0.057
Top management					
is engineer	-0.0311	-0.00458	-0.0283	-0.0591	-0.0680*
	-0.0384	-0.0383	-0.0376	-0.0373	-0.0371
has MNC experience	-0.00172	0.0283	-0.0241	-0.00429	-0.0447
	-0.0367	-0.0367	-0.0363	-0.0362	-0.0362
is founder or founder's family	-0.0872**	-0.0468	-0.0802**	-0.0787**	-0.0754**
	-0.0372	-0.037	-0.0372	-0.0361	-0.0371
Firm has an IPR	0.0522	0.0297	0.0459	0.0467	0.0385
	-0.0323	-0.0324	-0.0323	-0.0319	-0.0321
Industrial park location	0.0669	0.0921*	0.0587	0.062	0.0305
	-0.0508	-0.0523	-0.0522	-0.0516	-0.0518
Constant	0.133	0.1	0.153	0.103	-0.0215
	-0.109	-0.11	-0.108	-0.107	-0.107
Observations	855	855	855	855	855
R-squared	0.192	0.178	0.19	0.176	0.113

R&D = research and development; 5S = sort, set, shine, standardize, and sustain; QC = quality control; MNC = multinational corporation; IPR = intellectual property rights
Source: Authors' calculations, *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

Table 6. Summary results of the probit estimation in process innovation components

Variables	Procurement	Sales	Accounting	Inventory Control	Logistics
Medium firms	0.0399	-0.00538	-0.0129	-0.0182	0.00161
	-0.0456	-0.0397	-0.0416	-0.0443	-0.0408
Large firms	0.0968**	0.02	0.0404	0.115***	0.0881**
	-0.0426	-0.0389	-0.04	-0.0428	-0.0392
Age	0.00225	-0.000277	0.00305**	-0.00177	0.00202
	-0.00168	-0.0015	-0.00152	-0.00168	-0.00142
R&D expenditure	0.0751***	0.0502***	0.0464***	0.0428**	0.0696***
	-0.017	-0.015	-0.0162	-0.0169	-0.0148
Foreign linkages	0.0276	0.0716*	0.0329	0.103**	0.0388
	-0.045	-0.0376	-0.0423	-0.0431	-0.0396
Has a learning system	0.0936**	0.133***	0.147***	0.0799*	0.111***
	-0.043	-0.0378	-0.0394	-0.0446	-0.0388
Produces components	0.0686	-0.0931*	-0.0737	0.00726	-0.0215
	-0.0683	-0.0497	-0.0567	-0.071	-0.0585
Produces final products	0.0728	-0.0940*	-0.0162	0.0571	0.0369
	-0.0572	-0.0511	-0.0543	-0.0617	-0.0513
Uses 5S system	0.0763*	0.0518	0.023	0.0607	0.0751**
	-0.0394	-0.0356	-0.0384	-0.0404	-0.0349
Utilizes a QC circle	-0.0227	-0.0799*	-0.0471	-0.0326	-0.0870*
	-0.0477	-0.0478	-0.048	-0.049	-0.0485
100% Filipino-owned firm	0.0938**	0.0808*	0.0329	0.0335	0.0224
	-0.0458	-0.0416	-0.0439	-0.0469	-0.0422
Top management					
is engineer	0.0227	0.0252	0.0463	0.0532	0.0641**
	-0.0353	-0.0328	-0.0335	-0.0354	-0.0323
has MNC experience	0.0412	-0.0172	-0.0254	0.00984	-0.00396
	-0.0361	-0.0324	-0.0337	-0.0365	-0.0321
is founder or founder's family	-0.0956***	-0.031	-0.0884**	-0.152***	-0.0844***
	-0.0363	-0.033	-0.0346	-0.036	-0.0327
Firm has an IPR	-0.0448	0.0381	0.00182	0.0541	-0.0521*
	-0.0327	-0.0298	-0.0308	-0.033	-0.0292
Industrial park location	0.0229	-0.0692*	-0.0225	-0.0929**	-0.0786*
	-0.0463	-0.0415	-0.0435	-0.0465	-0.0418

R&D = research and development; 5S = sort, set, shine, standardize, and sustain; QC = quality control; MNC = multinational corporation; IPR = intellectual property rights
Source: Authors' calculations, *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

to innovating in sales-related processes whereas the use of a 5S system is a positive influence to procurement and logistics innovation.

The location of the firm in an industrial park has interestingly shown as well that firms located in industrial parks are less likely to innovate in sales, inventory, and logistics processes. Perhaps, this stems from the fact that firms situated in an industrial park have easier access to customers within the same park and access to improved logistics services. Thus, the results are implying a limited need for process innovation. However, foreign linkages that have previously been significant in the aggregate are found to be significant only for select processes, such those of sales and inventory control. [5]

Results of the first-stage regression: Determinants of foreign linkages

The first-stage regression results of the instrument variable approach are presented in Table 7. The GDP growth rate of the foreign country with which the firm has linkages is a positive and significant determinant of the probability of having foreign linkages. This shows that the condition that the instrument is partially correlated with the endogenous variable once other exogenous variables have been netted out is satisfied (Wooldridge 2002). Other tests also show that the instrument is not a weak instrument.

Moreover, those practicing a 5S system and/or a learning system have an increased likelihood of having foreign linkages. Understandably, firms with purely Filipino capital are less likely to have foreign linkages. Finally, firms where the manager is an engineer, a founder, or a founder's family member are positive determinants of the likelihood of a firm to have foreign linkages.

Results of the IV regression

As shown in Table 8, having foreign linkages can increase the probability of firms to innovate new products using technology new to the firm by 35.2 percent. This is despite foreign linkages having been consistently nonsignificant both for the aggregate (product innovation) and the disaggregated (product innovation components) probit estimations. This result may reflect the fact that, after having controlled for omitted variables and the possible simultaneity, foreign linkages increase the likelihood of firms to undertake the most difficult form of product innovation that would involve a technology new to the firm.

Meanwhile, R&D expenditure remains to be a significant determinant of product innovation across all types of subactivities as it is with large firms. This is consistent with the probit estimation results. It further supports the findings of Llanto and del Prado (2015) wherein firm performance is improved by innovation activities, thus, increased R&D capability will be beneficial for the industry. Finally, another robust result was with firms whose top management is a founder or part of the founder's family as being less likely to undertake product innovation.

On the other hand, when it comes to process innovation (Table 9), the same results as with the probit estimation can be observed. For instance, firms doing R&D are still more likely to conduct process innovations. The same goes with that of having a learning system. As with the probit estimation, producing final products, having the top management as a founder or a founder's family member, or the firm being located in an industrial park can all be negative influences to the likelihood of the firm to innovate in processes.

[5] By participating in regional procurement and following internationally accepted accounting standards, domestic firms with foreign linkages may likely have limited room for innovation in the procurement (including logistics) and accounting systems, respectively.

Table 7. Determinants of foreign linkages

Variables	Coefficient	Robust Standard Errors
Average foreign GDP growth	0.0541***	0.00753
Medium firms	-0.0299	0.0344
Large firms	0.0362	0.0289
Age	0.000753	0.00145
R&D expenditure	0.0280**	0.0131
Has a learning system	0.152***	0.0363
Produces components	-0.0579	0.0505
Produces final products	0.0419	0.0479
Uses 5S system	0.120***	0.0340
Utilizes a quality-control circle	-0.00646	0.0377
100% Filipino-owned firm	-0.180***	0.0353
Top management		
is engineer	0.0788***	0.0258
has MNC experience	0.0232	0.0250
is founder or founder's family	0.0547**	0.0273
Firm has an IPR	0.0299	0.0245
Industrial park location	0.146***	0.0333
Constant	0.393***	0.0694
Observations	855	

GDP = gross domestic product; R&D = research and development; 5S = sort, set, shine, standardize, and sustain; MNC = multinational corporation; IPR = intellectual property rights
Source: Authors' calculations, *** p<0.01, ** p<0.05, * p<0.10

Table 8. Summary results of the IV regression in product innovation components

Variables	Product Innovation	Change in appearance	Capability improvement	Based on existing technology	Based on new technology
Medium firms	0.0208	-0.0148	0.0201	0.022	-0.0124
	-0.0456	-0.0458	-0.0456	-0.0448	-0.0445
Large firms	0.111**	0.139***	0.127***	0.062	0.0304
	-0.0434	-0.0437	-0.0438	-0.044	-0.0434
Age	-0.000373	-0.000252	-0.000644	-0.0016	-0.00243*
	-0.00148	-0.00147	-0.00146	-0.00148	-0.00147
R&D expenditure	0.128***	0.133***	0.137***	0.144 ***	0.118***
	-0.0172	-0.0183	-0.0176	-0.0177	-0.0194

Table 8. continuation

Variables	Product Innovation	Change in appearance	Capability improvement	Based on existing technology	Based on new technology
Foreign linkages	0.0705	-0.0507	0.0139	0.175	0.352**
	-0.181	-0.183	-0.184	-0.181	-0.175
Has a learning system	0.0784	0.104**	0.0725	0.0646	0.0576
	-0.0495	-0.0508	-0.0498	-0.0511	-0.0511
Produces components	0.0234	0.026	0.0111	-0.00555	-0.00514
	-0.0614	-0.0587	-0.0588	-0.06	-0.0624
Produces final products	0.116**	0.154***	0.135***	0.0916 *	0.075
	-0.0523	-0.0492	-0.0507	-0.051	-0.0542
Uses 5S system	0.139***	0.117**	0.108**	0.0576	0.048
	-0.0464	-0.0457	-0.0461	-0.0453	-0.0455
Utilizes a QC circle	-0.0141	-0.00614	0.0228	-0.0208	0.00224
	-0.044	-0.0449	-0.0442	-0.0449	-0.0453
100% Filipino-owned firm	-0.0216	-0.0384	-0.0575	-0.0311	0.0221
	-0.0601	-0.06	-0.0591	-0.0573	-0.057
Top management					
is engineer	-0.0311	-0.00458	-0.0283	-0.0591	-0.0680*
	-0.0384	-0.0383	-0.0376	-0.0373	-0.0371
has MNC experience	-0.00172	0.0283	-0.0241	-0.00429	-0.0447
	-0.0367	-0.0367	-0.0363	-0.0362	-0.0362
is founder or founder's family	-0.0872**	-0.0468	-0.0802**	-0.0787 **	-0.0754**
	-0.0372	-0.037	-0.0372	-0.0361	-0.0371
Firm has an IPR	0.0522	0.0297	0.0459	0.0467	0.0385
	-0.0323	-0.0324	-0.0323	-0.0319	-0.0321
Industrial park location	0.0669	0.0921*	0.0587	0.062	0.0305
	-0.0508	-0.0523	-0.0522	-0.0516	-0.0518
Constant	0.133	0.1	0.153	0.103	-0.0215
	-0.109	-0.11	-0.108	-0.107	-0.107
Observations	855	855	855	855	855
R-squared	0.192	0.178	0.19	0.176	0.113

R&D = research and development; 5S = sort, set, shine, standardize, and sustain; QC = quality control; MNC = multinational corporation; IPR = intellectual property rights
Source: Authors' calculations, *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

Table 9. Summary results of the IV regression in process innovation components

Variables	Process Innovation	Procurement	Sales	Accounting	Inventory Control	Logistics
Medium firms	0.00238	0.0437	0.000838	-0.0117	-0.0147	-0.00194
	-0.047	-0.0442	-0.0408	-0.041	-0.0432	-0.0397
Large firms	0.0708	0.0810*	0.00475	0.0398	0.102**	0.0812**
	-0.0454	-0.0434	-0.0402	-0.0409	-0.0435	-0.0387
Age	-0.000332	0.00181	-0.000721	0.00293*	-0.0018	0.00194
	-0.00169	-0.00167	-0.00158	-0.00155	-0.00151	-0.00142
R&D expenditure	0.0859***	0.0694***	0.0471**	0.0474**	0.0361*	0.0746***
	-0.0185	-0.0193	-0.0185	-0.0188	-0.0187	-0.0181
Foreign linkages	0.480**	0.289	0.350**	0.078	0.345*	0.118
	-0.192	-0.196	-0.177	-0.177	-0.192	-0.169
Has a learning system	0.072	0.0454	0.0879**	0.133***	0.0368	0.0902**
	-0.0541	-0.0488	-0.0445	-0.0437	-0.0497	-0.043
Produces components	-0.0362	0.0714	-0.0937	-0.0659	0.0193	-0.0179
	-0.0717	-0.0589	-0.0613	-0.0597	-0.0639	-0.0531
Produces final products	-0.0387	0.0515	-0.111**	-0.0179	0.0437	0.0291
	-0.0646	-0.0539	-0.0556	-0.0554	-0.0572	-0.0489
Uses 5S system	0.0251	0.0376	0.015	0.0167	0.0201	0.0635
	-0.05	-0.0456	-0.0439	-0.0441	-0.0462	-0.0412
Utilizes a QC circle	-0.0384	-0.0171	-0.0676*	-0.042	-0.0318	-0.0749*
	-0.0488	-0.0411	-0.0398	-0.0404	-0.0424	-0.0391
100% Filipino-owned firm	0.159**	0.146**	0.144**	0.0427	0.0867	0.036
	-0.0647	-0.0619	-0.0573	-0.0572	-0.0613	-0.0539
Top management						
is engineer	0.0129	-0.00052	-0.00225	0.0383	0.0327	0.0531
	-0.0404	-0.0379	-0.0357	-0.0354	-0.0375	-0.0341
has MNC experience	-0.02	0.0257	-0.0256	-0.0242	-0.00407	-0.00586
	-0.039	-0.0365	-0.0335	-0.0342	-0.0371	-0.0324
is founder or founder's family	-0.127***	-0.103***	-0.0422	-0.0883***	-0.157***	-0.0858***
	-0.04	-0.0362	-0.034	-0.0342	-0.0361	-0.032
Firm has an IPR	0.018	-0.0503	0.0285	0.00221	0.0438	-0.0510*
	-0.0348	-0.0323	-0.0304	-0.0302	-0.0321	-0.0283
Industrial park location	-0.0980*	-0.025	-0.116**	-0.0344	-0.132**	-0.0986**
	-0.056	-0.0541	-0.051	-0.0494	-0.0536	-0.0483
Constant	0.108	-0.091	0.0454	0.124	0.0738	0.0708
	-0.125	-0.117	-0.111	-0.112	-0.118	-0.103
Observations	855	855	855	855	855	855
R-squared	0.044	0.044	0.011	0.058	0.058	0.093

R&D = research and development; 5S = sort, set, shine, standardize, and sustain; QC = quality control; MNC = multinational corporation; IPR = intellectual property rights
Source: Authors' calculations, *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

Finally, having foreign linkages is positively related to process innovations particularly in sales and inventory control activities. In general, foreign linkages were estimated to increase by 48.0 percent the likelihood to conduct process innovation. This result is as expected as process innovation resulting from foreign linkages would usually come from customers and thus would affect sales and inventory control. The study of del Prado and Rosellon (2017b) provides some evidence of this in their analysis of fruit juices. They found that foreign linkages were used to expand the market (improve sales) of the firm.

SUMMARY, CONCLUSION, AND POLICY RECOMMENDATIONS

The probit regression has indicated that having foreign linkages is positively associated with being a process innovator but does not present the same significant effect to product innovation activities. This is consistent with the findings of Machikita and Ueki (2011) wherein firms with foreign linkages have more propensity to find new markets as compared to their propensity to develop new products. Moreover, foreign linkages develop and expand the degree of embeddedness that a firm has with them, thus, allowing for process innovations to develop. Likewise, having foreign linkages can increase the probability of a firm to conduct significant improvements in sales and inventory processes.

Meanwhile, by controlling for sources of endogeneity, it was shown that foreign linkages have a positive and significant impact on the probability that a firm will undertake product innovation that involves the development of a new product using technology new to the firm by 35.2 percent. The observed relationships in the probit model for process innovation also remains true with an overall effect of 48.0 percent. It should be noted then that internal resources to the firm are also important determinants of both product and process innovation. Being in an industrial zone has been associated positively with foreign linkages.

Policy recommendations

It is important to review current policies related to strengthening foreign linkages of firms in the Philippines. Two chapters in the *Philippine Development Plan (PDP) 2017-2022* emphasize the importance of linkages to the Philippine domestic economy. Chapter 15 in the PDP that focuses on ensuring a strong macroeconomic performance of the local identified the following strategies: expanding market access particularly for MSMEs, increasing the competitiveness of Philippine exports through the adoption of best practices, and supporting innovation in key industries and facilitate trade through stronger linkages and connectivity.

The PDP's Chapter 9 on expanding economic opportunities in industry and services through 'Trabaho at Negosyo' highlights the goal of the government to be able to develop globally competitive businesses particularly for MSMEs through the full implementation of the Comprehensive National Industrial Strategy (CNIS). The PDP promotes interfirm cooperation as a means of increasing the competitiveness, innovativeness, and resilience of industries and services.

The full implementation of the CNIS is central to the development of the industrial sector in the country. However, given the rapidly changing global landscape in terms of innovation, the Department of Trade and Industry has launched its new industrialization strategy coined as i^3S (inclusive innovation industrial strategy). The overall goal is the creation of globally competitive and innovative industries through the following channels: growth-oriented action to upgrade industries and move them up the value chain, removal of obstacles to growth and subsequently attract more investments, and deepening the participation in regional and global value chains by domestic firms. Key points under the i^3S include the building of new industries, clusters, and agglomeration together

with the empowerment of MSMEs notwithstanding the need to ease the conduct of doing business and the investment environment.

With these policies in place and given the findings of this study, the policy recommendations include the following:

(1) Promote stronger regional and/or global linkages to sustain manufacturing growth in the region. It is important to be wary of policies that might be detrimental to the formation of linkages.

(2) Support trainings on the 5S system through government institutions such as the Technical Education and Skills Development Authority programs on Trainee Performance Space (TPS), 5S, or kaizen, together with efforts coming from state universities and colleges in the Visayas region teaching TPS and 5S.

(3) Support the development of R&D capability of firms. For instance, the PDP 2017-2022 highlights four strategies to develop science, technology, and innovation in the Philippines (Chapter 4) that can help encourage innovation. The i^3S is an example of a policy that can move this support forward.

(4) Highlight the role of innovation intermediaries. Expanding relational chains and linkages both domestically and internationally helps to facilitate the degree of embeddedness of firms. This knowledge dissemination dynamic allows for reducing the inefficiencies of innovation's trial-and-error nature. The role of intermediaries, such as PEZA, is also important as institutions like this can provide an environment conducive for innovation.

(5) Recognize the value of establishment-level data on the innovation activities of firms. Particularly, there can be a measure of where the firm is innovating across the global value chain. There is a possibility that the effects of innovation can be differently assessed in different nodes across the chain although this would require a more detailed questionnaire catered to this inquiry.

Areas for further research related to this study's findings include distinguishing between forward and backward linkages in the model. Future researches can explore how each type of linkage can contribute to strengthening industries in the Philippines. Other variables that can be included in the model relate to identifying how information is being transmitted from foreign partners to the domestic firm through data on the exchange of high-skilled personnel. Apart from these, exploring innovation activities based on technological capacity-building levels (Ariffin and Figueiredo 2006) and of external linkages' degree of activity (Patra and Krishna 2015) will shed light as to where Philippine firms' innovation efforts are concentrated or directed.

Exploring the relationship of market power with innovation activity can also be interesting although it would require the use of another dataset. The rationale for investigating market power is that its relationship with the innovation activities of firms is ambiguous, that is, innovation may be pursued to increase market power or market power may induce more innovation.

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