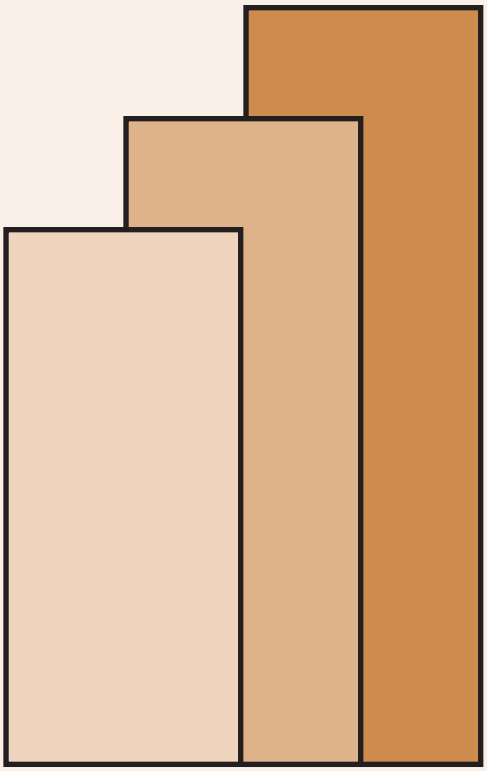
Philippine Institute for Development Studies
*Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas*

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

*Francis Mark A. Quimba and Sylwyn C. Calizo Jr.*

**DISCUSSION PAPER SERIES NO. 2017-46**





December 2017

For comments, suggestions or further inquiries please contact:
The **Research Information Department,** Philippine Institute for Development Studies
18th Floor, Three Cyberpod Centris – North Tower, EDSA corner Quezon Avenue, 1100 Quezon City, Philippines
Tel Nos: (63-2) 3721291 and 3721292; E-mail: publications@mail.pids.gov.ph
Or visit our website at https://www.pids.gov.ph

# Impact of foreign linkages on innovation activity of manufacturing firms in CALABARZON[1]

*Francis Mark A. Quimba[2] and Sylwyn C. Calizo Jr.[3]*

## 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 to innovation activities of manufacturing firms in the CALABARZON region. Utilizing a probit estimation and an IV regression to control for endogeneity brought forth by omitted variable bias, the results show that foreign linkages can indeed positively affect a firm's likelihood to undertake product innovation that involves the development of a new product using a technology new to the firm. On the other hand, process innovation has consistently shown to be positively influenced by foreign linkages. Given these results, having foreign linkages and participating in the global value chain can truly 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, supporting trainings that teach the 5S system by means of government channels TESDA and SUCs are as important. Highlighting the role of industrial parks and recognizing the value of establishment level data are also key points in this study.*

*Keywords: foreign linkages, innovation, product, process, manufacturing, CALABARZON*

---

## 1. Introduction

In more recent years, a number of studies have been made on innovation activities in the Philippines. Most of these studies 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 will be further explored.

Related to this, the question whether participating in global value chains induce knowledge transfer and innovation is left unanswered. This study attempts to answer this question. Moreover, it contributes to the existing body of literature on innovation by attempting to show 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, 2011; Albert et al., 2009; Llanto &

[1] This research benefited from the comments received during a research workshop held at the PIDS in December 11, 2017. The usual disclaimer applies. The authors would like to thank the Economic Research Institute for Southeast and East Asia (ERIA) for granting permission to use the datasets.
[2] Research Fellow, PIDS
[3] Research Analyst II, PIDS

del Prado, 2015). By using an exogenous incident, this study will strengthen the initial findings on the role of linkages on innovation activity.

This research is in line with the Philippine Development Plan (PDP) 2017-2022. In particular, the exploration of the effects of foreign linkage to firm's innovation activity would provide insight on the strategies that can be pursued for the expansion of economic opportunities in the Industrial sector." This is by addressing one of the risks to the competitiveness of the Philippines' local firms: their vulnerability to global trends of rapid technological development, innovation and uncertainty. The potential of foreign linkage as a means of establishing Philippine firms to the global value chain and market, as well as ensuring that domestic firms will continue to compete and innovate, are key points that can be contributed by this study.

This paper is organized as follows: a brief discussion on foreign linkages, innovation activity and determinants of innovation in existing literature is discussed in section 2. It is followed by a presentation of the methodology and framework. Section 4 provides a discussion of the results and findings. The final section concludes and presents policy recommendations.

## 2. Review of Related Literature

### 2.1 Foreign linkages and innovation activity

Understanding the impact of foreign linkages to the innovation activities done by firms has been growing recently. Some of the earliest studies on the subject were published by the Philippine Institute for Development Studies (PIDS) (e.g., Macapanpan, 1999; Patalinghug, 2003). Notably, Macapanpan (1999) conducted a survey of firms in order to evaluate their innovation capabilities. Throughout the past decade, PIDS has had a number of case studies looking at specific sectors or industries. For instance, Macasaquit (2008) looked into the role of linkages in facilitating innovation activities of electronics firms, whereas Quimba and Rosellon (2011) explored the innovation activities of automotive parts manufacturers and assemblers.

Based on the case of fruit juice processing firms, linkages with government institutions and access to government support programs were found to be critical for firms to upgrade their production process (Rosellon & Yasay, 2012). Ledda and del Prado (2013), meanwhile, interviewed four Philippine transnational corporations (TNCs) in order to be able to describe the role of innovation in the outward push to other countries. Rosellon and del Prado (2017a), by exploring the conduct of innovation by taking the case of the garments industry, has found that without formal Research and Development (R&D), both product and process innovations will still be possible. This is provided that the appropriate personnel and supporting mechanisms in the company are in place. In a different study, Rosellon and del Prado (2017b) explored the innovation activities in the fruit juice manufacturing industry.

Using various surveys of Philippine firms, quantitative studies have also been conducted (Macasaquit, 2011; Albert et al., 2009; Llanto & del Prado, 2015; Albert et al. 2017) and are among those that have investigated the determinants of innovation activities using firm level data. Primarily, Macasaquit (2011) 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. The 2009 Survey of Innovation activities showed that firms rely on their partners (firms within their value chain) for sources of information and innovation activity (Albert et al. 2009). Meanwhile, aside from investigating the determinants of innovation, Llanto and del Prado (2015) were also able to relate innovation with firm performance.

The analysis of innovation activities of firms has also been done at the international level. Using data from ASEAN member states, including that of the Philippines, Harvie, Narjoko and Oum (2010) found that innovation is an important determinant of Small and Medium Enterprises' (SMEs) participation in global value chains. This is because it is through these 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, the Philippines, Thailand, and Viet Nam in order 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, a variety of linkages from university and public organizations are found to have no significant relationship on innovation performance.

## 2.2 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). The size and age of firms can imply that the firm has significant financial and human resources that can be allocated to formal research and development (R&D) (Vieites & Calvo, 2011). However, in emerging markets, younger but larger firms (possibly successful start-ups) can be more innovative (Ayyagari, Demirgüç-Kunt, & Maksimovic, 2007). An enabling environment that is supportive of start-ups and entrepreneurial research is also an important determinant of innovation in emerging markets (Vieites & Calvo, 2011).

The legal structure of the firm can also influence their likelihood of innovating. Particularly, foreign-owned, multi-national corporations (MNCs), innovate more (EBRD, 2014; Serafica, 2016). Moreover, having managers with experiences in handling MNCs could further strengthen innovation capability. Market orientation as a driver of innovation posits that exporting firms are more innovative (Ayyagari, Demirgüç-Kunt, & Maksimovic, 2007).

Formal R&D leads to more innovation (EBRD, 2014); however, considering that R&D requires an adequate level of investment, small and medium enterprises (SMEs) are often left with no means to innovate formally. In place of this, innovation occurs without formal R&D - through technology adoption, minor modifications, incremental changes, imitation, or combining existing knowledge in new ways (del Prado & Rosellon, 2017; Romijn & Albaladejo, 1999). 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 human capital of the firm with degrees in STEM and previous experience in MNCs are the relevant factors that affect innovation activity of firms. Human

capital which has non-STEM degrees often led to less scientifically grounded innovation but innovation was instead towards sales and marketing improvement. Moreover, managers with prior experience in only SMEs often innovated in a simpler and less radical way (Romijn & Albaladejo, 1999).

Firms that are able to utilize information and communication technology (ICT) tend to innovate more (EBRD, 2014). It is interesting to note that firms whose investments are externally financed tend to innovate more as well, with increasing likelihood as the proportion of the financed investment increases, and where funds are sourced more from foreign than local banks (Ayyagari, Demirgüç-Kunt, & Maksimovic, 2007).

In a study of exploring the innovative behavior of Philippine firms, Albert *et al*. (2009), found that the major determinants include: active engagement in knowledge-management practices, the size of the firm, and its location inside an industrial park managed by the Philippine Economic Zone Authority (PEZA). Furthermore, the effects of innovation were often largely customer-driven. With regard to the impact of the geographic market, the study finds weak evidence that firms with geographic market limited to the local market are at risk of not being an innovator. In contrast, based on the results of 2015 PIDS SIA. Albert et al. (2017) found that firms with markets limited to the local economy tend to innovate more, while export orientation tend to have a negative relationship with process innovation. Looking at the case of the automotive industry, some MSMEs in the sector have difficulty pursuing innovation activities because of limits imposed by parent companies abroad (Quimba and Rosellon 2009). 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 GDP growth is tenuous (AJC 2017).

## 3. Methodology

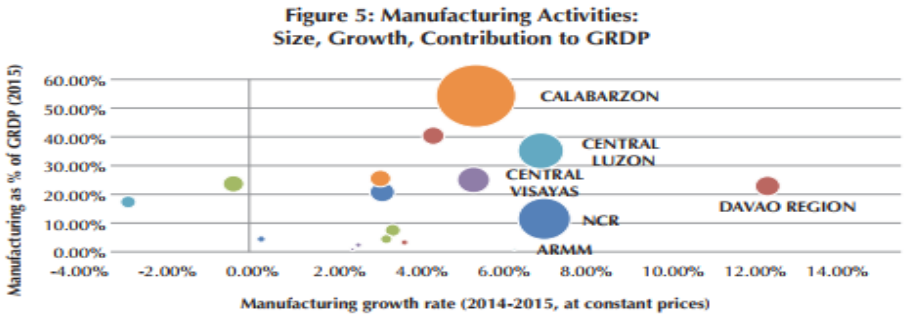
### 3.1 Datasets Profile

Primary data research on the innovation activities of firms in the Philippines has been conducted since 2008, when the Economic Research Institute for ASEAN and East Asia (ERIA) started its establishment survey in Region IV-A (CALABARZON). In this study, however, the datasets included were from the years 2011 to 2014 as earlier years have used an instrument that has a significant amount of differences to the more recent ERIA surveys. The datasets chosen were SWIC 2011, SISC 2012, SPPME 2013, and STTME 2014. All four datasets have their corresponding questionnaires, with some variations catered to refine the study. For instance, information available in the surveys include establishment size, legal structure, product and process innovation activities, human capital indicators, and market partners

**Box 1. Why CALABARZON?**

The CALABARZON region is composed of the provinces of Cavite, Laguna, Batangas, Rizal, and Quezon. It is the region with the largest size of manufacturing in the Philippines (at more

than 50.0%) as compared to other regions, the closest of which would be Central Luzon at around 40.0% (see Figure below).




Source: Department of Trade and Industry (2017)

Following, for instance, the gross value added in manufacturing of CALABARZON, Box Table 1 shows that the region contributes 38.51% to the Philippines, towering all other regions including NCR. This has been observed since 2014. Moreover, the Gross Regional Domestic Product (GRDP) of CALABARZON is second only to NCR at PhP1.23 trillion (17.17% of Philippine GDP).

**Box Table 1. Regional Accounts of the Philippines**

**REGIONAL ACCOUNTS OF THE PHILIPPINES**
Unit : In Thousand Pesos
**AT CONSTANT 2000 PRICES**

| | | GROSS REGIONAL DOMESTIC PRODUCT | | | GROSS VALUE ADDED IN MANUFACTURING | | |
|---|---|---|---|---|---|---|---|
| REGION / YEAR | | 2014 | 2015 | 2016 | 2014 | 2015 | 2016 |
| PHILIPPINES | | 7,165,477,851 | 7,600,175,069 | 8,126,403,433 | 1,666,514,290 | 1,760,988,746 | 1,884,319,587 |
| NCR | NATIONAL CAPITAL REGIO | 2,597,052,167 | 2,770,552,677 | 2,977,477,320 | 324,144,026 | 346,927,284 | 369,460,900 |
| CAR | CORDILLERA ADMINISTRATIVE REGION | 128,688,178 | 133,848,201 | 136,652,941 | 51,161,625 | 53,401,058 | 55,419,190 |
| I | ILOCOS | 224,979,174 | 237,178,755 | 257,208,121 | 11,379,814 | 11,746,774 | 12,053,768 |
| II | CAGAYAN VALLEY | 129,114,289 | 134,444,616 | 138,870,188 | 1,860,282 | 1,905,581 | 2,228,808 |
| III | CENTRAL LUZON | 668,918,294 | 706,343,196 | 773,276,165 | 227,997,026 | 243,915,171 | 286,414,729 |
| IVA | CALABARZON | 1,230,372,013 | 1,302,297,272 | 1,364,951,206 | 664,102,978 | 700,331,220 | 725,607,545 |
| | MIMAROPA REGION | 119,911,229 | 122,258,656 | 125,559,540 | 5,966,458 | 5,980,739 | 6,486,431 |
| V | BICOL | 142,760,974 | 155,449,066 | 164,372,408 | 5,172,876 | 5,363,595 | 6,009,611 |
| VI | WESTERN VISAYAS | 280,852,008 | 305,503,332 | 324,071,277 | 23,353,193 | 24,140,150 | 25,025,486 |
| VII | CENTRAL VISAYAS | 460,280,508 | 482,898,676 | 525,163,813 | 114,612,411 | 120,736,454 | 127,856,742 |
| VIII | EASTERN VISAYAS | 146,476,790 | 153,224,685 | 172,148,589 | 27,283,301 | 26,476,216 | 31,675,952 |
| IX | ZAMBOANGA PENINSULA | 146,320,802 | 157,640,786 | 165,107,955 | 39,576,819 | 40,803,243 | 41,432,423 |
| X | NORTHERN MINDANAO | 268,424,368 | 283,769,262 | 305,448,007 | 56,453,500 | 58,232,418 | 61,617,777 |
| XI | DAVAO REGION | 281,348,316 | 304,412,137 | 333,022,026 | 61,804,112 | 69,467,667 | 77,265,255 |
| XII | SOCCSKSARGEN | 196,770,182 | 203,183,377 | 213,301,758 | 48,342,520 | 48,149,934 | 52,155,565 |
| XIII | CARAGA | 92,419,812 | 96,587,795 | 99,018,770 | 2,704,152 | 2,774,111 | 2,937,845 |
| ARMM | AUTONOMOUS REGION IN MUSLIM MINDANAO | 50,788,748 | 50,582,581 | 50,753,348 | 599,197 | 637,130 | 671,562 |

Source: Philippine Statistics Authority

[1] Oxford Business Group. (2016). Calabarzon a key industrial region, adding significantly to the Philippines' GDP. *The Report: The Philippines 2016.* Retrieved from oxfordbusinessgroup.com

There is considerably a large concentration of industrial activity centered in Southern Luzon, particularly in CALABARZON where Cavite and Laguna are situated. Industrial estates proliferate the region and are accredited by the Philippine Economic Zone Authority (PEZA). Firms that fall under PEZA zones enjoy both fiscal and non-fiscal incentives from government; thus, allowing more resources to conduct R&D activities, expand, or elsewhere more productive engagements to the firm.

Because of the region's major contribution to the manufacturing sector, understanding the region's manufacturing sector is essential in order to increase or sustain growth observed in past years especially under trends that signify a slowing growth as compared to other major regions in the Philippines.

Collectively, there are a total of 855 firms surveyed in a span of 4 years (2011-2014). The 2011 SWIC only covered the provinces of Batangas, Cavite, Quezon and Rizal. Starting 2012, the province of Laguna was included in the survey. The sample firms were systematically drawn until a proportional allocation from different industries of various sizes within each province was reached. Table 1, shown below, summarizes key information of the datasets used.

*Table 1 Summary statistics: frequency, by reference year*

| Summary Statistics: Frequency, by Reference Year | | | | | |
|---|---|---|---|---|---|
| Variable | Reference Year | | | | Total |
| | 2011 | 2012 | 2013 | 2014 | |
| **Total Firms** | **207** | **236** | **213** | **199** | **855** |
| Product Innovator | 93 | 118 | 115 | 91 | 417 |
| | (44.93) | (50.00) | (53.99) | (45.73) | (48.77) |
| Non-Product Innovator | 114 | 118 | 98 | 108 | 438 |
| | (55.07) | (50.00) | (46.01) | (54.27) | (51.23) |
| Process Innovator | 85 | 100 | 120 | 120 | 425 |
| | (41.06) | (42.37) | (56.34) | (60.30) | (49.71) |
| Non-Process Innovator | 122 | 136 | 93 | 79 | 430 |
| | (58.94) | (57.63) | (43.66) | (39.70) | (50.29) |
| Firm is both Product and Process Innovator | 48 | 67 | 76 | 67 | 258 |
| | (23.19) | (28.39) | (35.68) | (33.67) | (30.18) |
| Enterprise | | | | | |
| Large | 44 | 67 | 59 | 55 | 225 |
| | (21.26) | (28.39) | (27.70) | (27.64) | (26.32) |
| Medium | 40 | 44 | 35 | 38 | 157 |
| | (19.32) | (18.64) | (16.43) | (19.10) | (18.36) |
| Small and micro | 123 | 125 | 119 | 106 | 473 |
| | (59.42) | (52.97) | (55.87) | (53.27) | (55.32) |
| Decade Established | | | | | |
| 1950-1959 | 3 | 2 | 3 | 2 | 10 |
| | (1.45) | (0.85) | (1.41) | (1.01) | (1.17) |
| 1960-1969 | 3 | 4 | 4 | 5 | 16 |
| | (1.45) | (1.69) | (1.88) | (2.51) | (1.87) |
| 1970-1979 | 10 | 13 | 10 | 8 | 41 |
| | (4.83) | (5.51) | (4.69) | (4.02) | (4.80) |
| 1980-1989 | 27 | 34 | 33 | 30 | 124 |
| | (13.04) | (14.41) | (15.49) | (15.08) | (14.50) |
| 1990-1999 | 93 | 104 | 92 | 87 | 376 |
| | (44.93) | (44.07) | (43.19) | (43.72) | (43.98) |
| 2000-2011 | 71 | 79 | 71 | 67 | 288 |
| | (34.30) | (33.47) | (33.33) | (33.67) | (33.68) |

| Summary Statistics: Frequency, by Reference Year | | | | | |
|---|---|---|---|---|---|
| Variable | Reference Year | | | | Total |
| | 2011 | 2012 | 2013 | 2014 | |
| R&D (% of Total Sales) | | | | | |
| No Expenditure | 137 | 160 | 142 | 131 | 570 |
| | (66.18) | (67.80) | (66.67) | (65.83) | (66.67) |
| Less than 0.50% | 34 | 35 | 42 | 39 | 150 |
| | (16.43) | (14.83) | (19.72) | (19.60) | (17.54) |
| 0.50-0.99% | 17 | 20 | 11 | 11 | 59 |
| | (8.21) | (8.47) | (5.16) | (5.53) | (6.90) |
| More than 1.00% | 19 | 21 | 18 | 18 | 76 |
| | (9.18) | (8.90) | (8.45) | (9.05) | (8.89) |
| System of Learning | | | | | |
| With | 124 | 159 | 148 | 134 | 565 |
| | (59.90) | (67.37) | (69.48) | (67.34) | (66.08) |
| Without | 83 | 77 | 65 | 65 | 290 |
| | (40.10) | (32.63) | (30.52) | (32.66) | (33.92) |
| Usage of 3S or 5S System | | | | | |
| With | 129 | 157 | 147 | 136 | 569 |
| | (62.32) | (66.53) | (69.01) | (68.34) | (66.55) |
| Without | 78 | 79 | 66 | 63 | 286 |
| | (37.68) | (33.47) | (30.99) | (31.66) | (33.45) |
| Usage of QC Circle | | | | | |
| With | 143 | 176 | 159 | 148 | 626 |
| | (69.08) | (74.58) | (74.65) | (74.37) | (73.22) |
| Without | 64 | 60 | 54 | 51 | 229 |
| | (30.92) | (25.42) | (25.35) | (25.63) | (26.78) |
| Export Activity | | | | | |
| Exporter | 108 | 145 | 131 | 113 | 497 |
| | (52.17) | (61.44) | (61.50) | (56.78) | (58.13) |
| Non-Exporter | 99 | 91 | 82 | 86 | 358 |
| | (47.83) | (38.56) | (38.50) | (43.22) | (41.87) |
| Intellectual Property Right | | | | | |
| With | 38 | 229 | 65 | 66 | 398 |
| | (18.36) | (97.03) | (30.52) | (33.17) | (46.55) |
| Without | 169 | 7 | 148 | 133 | 457 |
| | (81.64) | (2.97) | (69.48) | (66.83) | (53.45) |
| Industrial Park Location | | | | | |
| Inside | 96 | 236 | 104 | 94 | 530 |
| | (46.38) | (100.00) | (48.83) | (47.24) | (61.99) |
| Outside | 111 | 0 | 109 | 105 | 325 |
| | (53.62) | (0.00) | (51.17) | (52.76) | (38.01) |
| Final Product Produced | | | | | |
| Raw Materials | 8 | 11 | 9 | 7 | 35 |
| | (3.86) | (4.66) | (4.23) | (3.52) | (4.09) |
| Raw Materials Processing | 14 | 11 | 7 | 12 | 44 |
| | (6.76) | (4.66) | (3.29) | (6.03) | (5.15) |
| Components and Parts | 53 | 78 | 52 | 55 | 238 |
| | (25.60) | (33.05) | (24.41) | (27.64) | (27.84) |
| Final Products | 132 | 136 | 145 | 125 | 538 |
| | (63.77) | (57.63) | (68.08) | (62.81) | (62.92) |

Source: Authors' calculations using various ERIA surveys
Note: Numbers in parenthesis indicate percent of column total.

Of 855 firms incorporated in the study, 417 (about 48.77%) are identified as product innovators (see Table 3 for the criteria used to identify firms' innovation activity). A slightly larger number of firms (425 or about 49.71%) are identified to be process innovators. Curiously, there are 258 firms that are engaged in both product and process innovation accounting for around 30.18%. In terms of firm size, majority (55.32%) are small and micro enterprises. Most firms (661 of 885 or about 77.66%) were established in the period 1990-2011. Majority (567 of 855 or about 66%) of the firms have limited R&D spending in any given survey year.

With regards to manufacturing principles adopted by the firm, 66.08% engage in some form of learning system. Those utilizing the 3S or 5S system (see Box 2) are a handful, comprising 66.55% whereas those that observe a Quality Control (QC) circle are at a majority of 73.22%. Finally, as shown in Figure 1 below, most firms in the study are involved in the production of final products at 62.92%.

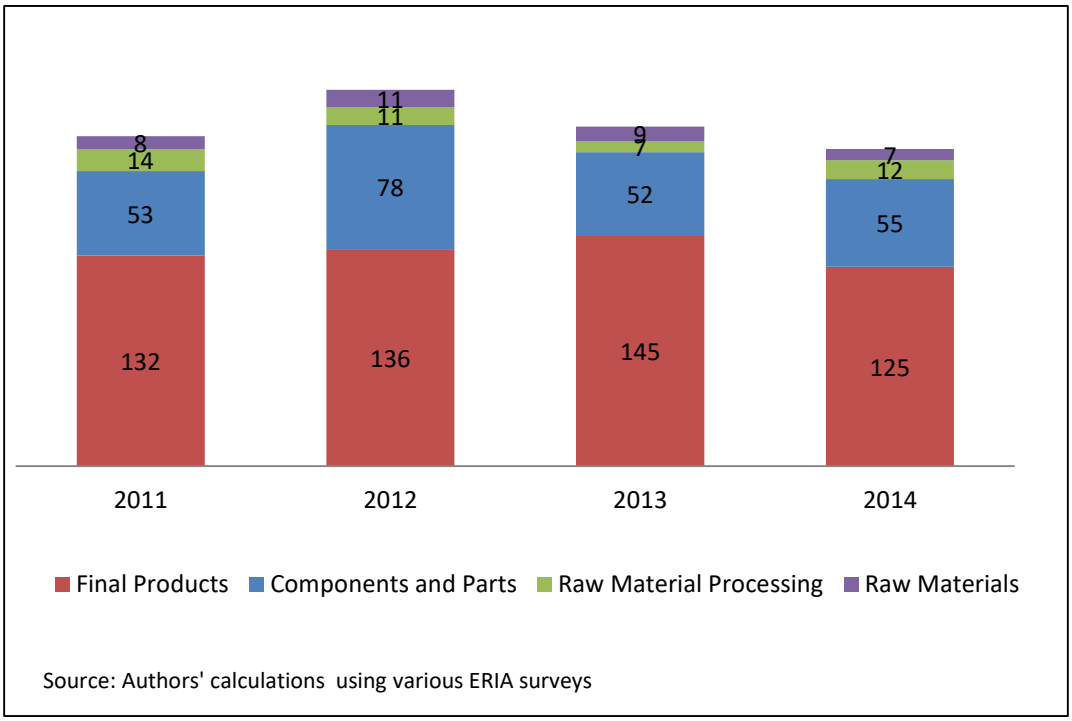



*Figure 1 Type of products of respondent firms by year*

With regards to the breakdown of firms across the five provinces involved, Table 2 shows that Batangas, Cavite and Laguna have the highest proportion of product innovators, with more than 50% of firms identified as product innovators. In terms of process innovation, Batangas and Laguna lead the pack at 57.6% and 65.3%, respectively. This is much higher than the overall average of 49.65%. In Laguna, 45.7% of the firms surveyed undertook both product and process innovation activities. In contrast, only 8 percent of the firms in Rizal undertook both types of innovation activities.

Consistent to the observation that Batangas, Cavite and Laguna lead in the conduct of innovation activities, Table 2 also shows that these same provinces also have the highest proportion of respondent firms who implemented a system of learning in their firm. Furthermore, it is also these three provinces that have the highest proportion of firms that have used 3S or 5S system in their production.

In terms of the usage of intellectual property rights, it is only in the provinces of Batangas and Laguna where there are more firms that have intellectual property than those who do not. This results to an average of 46.36% of the firms having intellectual property.

Finally, it can be observed that most firms in Batangas (67 of 111 firms or 60%), Cavite (322 of 377 firms or about 85.4%), and Laguna (66 of 81 firms or 81.48%) are located inside an industrial park (Table 2).

*Table 2 Summary statistics: frequency, by location*

| Summary Statistics: Frequency, by Province | | | | | | |
|---|---|---|---|---|---|---|
| Variable | Province | | | | | Total |
| | Batangas | Cavite | Laguna | Quezon | Rizal | |
| **Total Firms** | **111** | **377** | **81** | **48** | **235** | **852** |
| Product Innovator | 66 | 203 | 49 | 9 | 88 | 415 |
| | (59.46) | (53.85) | (60.49) | (18.75) | (37.45) | (48.71) |
| Non-Product Innovator | 45 | 174 | 32 | 39 | 147 | 437 |
| | (40.54) | (46.15) | (39.51) | (81.25) | (62.55) | (51.29) |
| Process Innovator | 64 | 174 | 53 | 19 | 113 | 423 |
| | (57.66) | (46.15) | (65.43) | (39.58) | (48.09) | (49.65) |
| Non-Process Innovator | 47 | 203 | 28 | 29 | 122 | 429 |
| | (42.34) | (53.85) | (34.57) | (60.42) | (51.91) | (50.35) |
| Firm is both Product and Process Innovator | 44 | 115 | 37 | 4 | 56 | 256 |
| | (39.64) | (30.50) | (45.68) | (8.33) | (23.83) | (30.05) |
| Enterprise | | | | | | |
| Large | 37 | 117 | 44 | 8 | 17 | 223 |
| | (33.33) | (31.03) | (54.32) | (16.67) | (7.23) | (26.17) |
| Medium | 30 | 70 | 12 | 11 | 33 | 156 |
| | (27.03) | (18.57) | (14.81) | (22.92) | (14.04) | (18.31) |
| Small and micro | 44 | 190 | 25 | 29 | 185 | 473 |
| | (39.64) | (50.40) | (30.86) | (60.42) | (78.72) | (55.52) |
| Decade Established | | | | | | |
| 1950-1959 | 4 | 0 | 0 | 3 | 3 | 10 |
| | (3.60) | (0.00) | (0.00) | (6.25) | (1.28) | (1.17) |
| 1960-1969 | 7 | 0 | 0 | 4 | 5 | 16 |
| | (6.31) | (0.00) | (0.00) | (8.33) | (2.13) | (1.88) |
| 1970-1979 | 0 | 14 | 10 | 5 | 12 | 41 |
| | (0.00) | (3.71) | (12.35) | (10.42) | (5.11) | (4.81) |
| 1980-1989 | 13 | 19 | 6 | 14 | 72 | 124 |
| | (11.71) | (5.04) | (7.41) | (29.17) | (30.64) | (14.55) |
| 1990-1999 | 35 | 215 | 45 | 14 | 65 | 374 |
| | (31.53) | (57.03) | (55.56) | (29.17) | (27.66) | (43.90) |
| 2000-2011 | 52 | 129 | 20 | 8 | 78 | 287 |
| | (46.85) | (34.22) | (24.69) | (16.67) | (33.19) | (33.69) |

| Summary Statistics: Frequency, by Province | | | | | | |
|---|---|---|---|---|---|---|
| Variable | Province | | | | | Total |
| | Batangas | Cavite | Laguna | Quezon | Rizal | |
| R&D (% of Total Sales) | | | | | | |
| No Expenditure | 71 | 250 | 55 | 32 | 159 | 567 |
| | (63.96) | (66.31) | (67.90) | (66.67) | (67.66) | (66.55) |
| Less than 0.50% | 26 | 71 | 12 | 7 | 34 | 150 |
| | (23.42) | (18.83) | (14.81) | (14.58) | (14.47) | (17.61) |
| 0.50-0.99% | 3 | 24 | 5 | 3 | 24 | 59 |
| | (2.70) | (6.37) | (6.17) | (6.25) | (10.21) | (6.92) |
| More than 1.00% | 11 | 32 | 9 | 6 | 18 | 76 |
| | (9.91) | (8.49) | (11.11) | (12.50) | (7.66) | (8.92) |
| System of Learning | | | | | | |
| With | 77 | 281 | 66 | 24 | 116 | 564 |
| | (69.37) | (74.54) | (81.48) | (50.00) | (49.36) | (66.20) |
| Without | 34 | 96 | 15 | 24 | 119 | 288 |
| | (30.63) | (25.46) | (18.52) | (50.00) | (50.64) | (33.80) |
| Usage of 3S or 5S System | | | | | | |
| With | 76 | 299 | 71 | 22 | 99 | 567 |
| | (68.47) | (79.31) | (87.65) | (45.83) | (42.13) | (66.55) |
| Without | 35 | 78 | 10 | 26 | 136 | 285 |
| | (31.53) | (20.69) | (12.35) | (54.17) | (57.87) | (33.45) |
| Usage of QC Circle | | | | | | |
| With | 81 | 298 | 67 | 34 | 144 | 624 |
| | (72.97) | (79.05) | (82.72) | (70.83) | (61.28) | (73.24) |
| Without | 30 | 79 | 14 | 14 | 91 | 228 |
| | (27.03) | (20.95) | (17.28) | (29.17) | (38.72) | (26.76) |
| Export Activity | | | | | | |
| Exporter | 61 | 300 | 63 | 18 | 54 | 496 |
| | (54.95) | (79.58) | (77.78) | (37.50) | (22.98) | (58.22) |
| Non-Exporter | 50 | 77 | 18 | 30 | 181 | 356 |
| | (45.05) | (20.42) | (22.22) | (62.50) | (77.02) | (41.78) |
| Intellectual Property Right | | | | | | |
| With | 63 | 172 | 45 | 22 | 93 | 395 |
| | (56.76) | (45.62) | (55.56) | (45.83) | (39.57) | (46.36) |
| Without | 48 | 205 | 36 | 26 | 142 | 457 |
| | (43.24) | (54.38) | (44.44) | (54.17) | (60.43) | (53.64) |
| Industrial Park Location | | | | | | |
| Inside | 67 | 322 | 66 | 11 | 63 | 529 |
| | (60.36) | (85.41) | (81.48) | (22.92) | (26.81) | (62.09) |
| Outside | 44 | 55 | 15 | 37 | 172 | 323 |
| | (39.64) | (14.59) | (18.52) | (77.08) | (73.19) | (37.91) |
| Final Product Produced | | | | | | |
| Raw Materials | 0 | 10 | 4 | 7 | 13 | 34 |
| | (0.00) | (2.65) | (4.94) | (14.58) | (5.53) | (3.99) |
| Raw Materials Processing | 1 | 17 | 3 | 10 | 13 | 44 |
| | (0.90) | (4.51) | (3.70) | (20.83) | (5.53) | (5.16) |
| Components and Parts | 28 | 128 | 39 | 1 | 42 | 238 |
| | (25.23) | (33.95) | (48.15) | (2.08) | (17.87) | (27.93) |
| Final Products | 82 | 222 | 35 | 30 | 167 | 536 |
| | (73.87) | (58.89) | (43.21) | (62.50) | (71.06) | (62.91) |

Source: Authors' calculations using various ERIA surveys.
(Percent to total firms in parentheses)

*Table 3. Selected indicator questions and corresponding response criteria*

| Question | Response Criteria |
|---|---|
| **Product Innovator** | A firm is considered as a product innovator if it has achieved any of the below four (4) activities. |
| Introduced a new product, redesigning packaging or significantly changing appearance design of your existing products | Product Innovator if firm answers has conducted or achieved r. Non-Product Innovator otherwise. |
| Introduced a new product, significantly improving your existing products | |
| Development of a totally new product based on the "existing" technologies for your establishment | |
| Development of a totally new product based on "new" technologies for your establishment | |
| **Process Innovator** | A firm is considered as a process innovator if it has adopted a new or significantly improved a method for any of the following: |
| Procurement | Process Innovator if firm answers a yes or achieved in at least one indicator. Non-Process Innovator if firm answers a no, tried, or not tried yet in all indicators. |
| Sales Management | |
| Accounting | |
| Inventory Control | |
| Logistics | |

**Box 2. 5S System in Manufacturing Firms**

The 5S is a simple set of principles adopted by firms in order to reduce waste namely it stands for as:

*Sort* – whether needed (keeps) or not (discards);
*Straighten* – arrangement of things such that the items needed the most are nearest;
*Shine* – keeping things and workplace clean and dirt-free;
*Standardize* – doing everything according to the principle to eliminate variation; and,
*Sustain* – developing a sense of ownership and responsibility to keep to the standards

The system functions as a set of housekeeping principles meant to organize work areas that emphasizes the importance of a clean, orderly and standardized visual organization (Jakubiec & Brodnicka, 2016). In effect, it helps to eliminate waste related to uncertainty, waiting, searching for information by reducing clutter, and making everything clear and predictable. In the manufacturing sector, and that of the automotive industry especially (e.g., Toyota Motors), the 5S system has already been ingrained that it no longer counts as a form of innovation but is instead treated as a form of mantra or standard to be followed by the firm's employees and management. In many ways, the 5S system falls under the symbolic form of knowledge and entails a more cultural transfer of knowledge taken from experiencing it.

Browsing through the specific products being produced by these firms, there is, on average, a large portion of firms (117 of 855 or about 14%) that produce food, beverages, and tobacco products. About 107 firms, or 12%, produce metal products, Other electronic products (11%), apparel and leather products (10%) and plastic and rubber products (9%) complete the top 5 products of the respondent firms in the CALABARZON (Table 4).

*Table 4 Number of respondent firms by year and main product*

| 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 |
| Non-Ferrous Metals | 0 | 1 | 4 | 4 | 9 |
| Other Electronics and Components | 23 | 30 | 20 | 19 | 92 |
| Other Non-Metallic Mineral Products | 11 | 12 | 11 | 9 | 43 |
| Other Transportation Equipment and Parts | 4 | 3 | 3 | 2 | 12 |
| Others | 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 using various ERIA surveys

Meanwhile, disaggregating the product innovation activity conducted by firms (Figure 2), shows that at an average proportion of about 35%, producing a new product using technology new to the firm is the least common product innovation activity conducted during the period 2011-2014. As mentioned earlier, product innovation mostly occurs in Batangas, Cavite, and Laguna while, Quezon province falls below the regional average at around 37.65% 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 the product quality or usability (Figure 2).

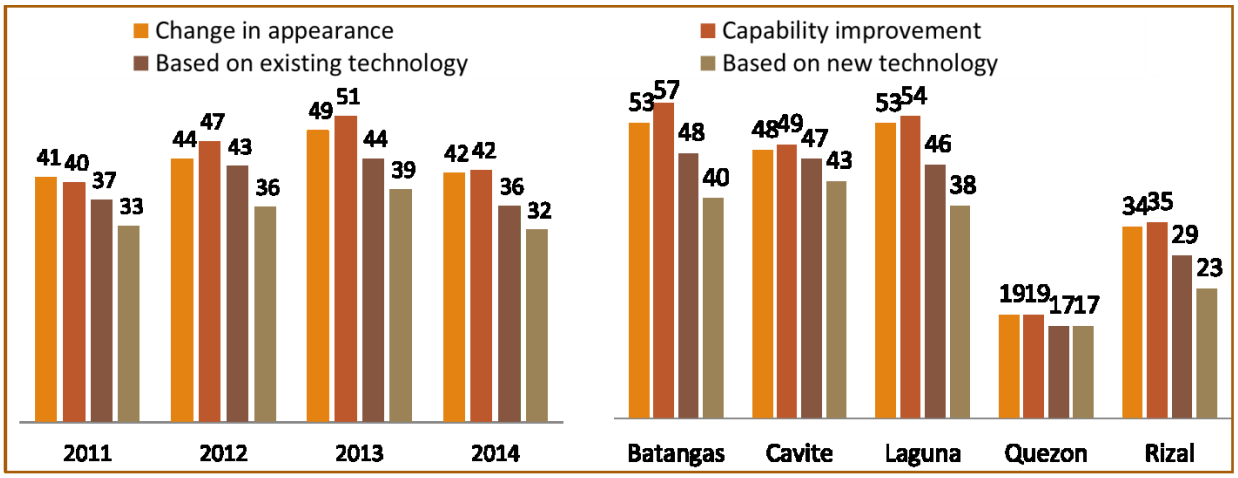



*Figure 2 Product innovation in respondent firms by year and by province (%)*

On the other hand, when it comes to process innovation activities, there is a marked increase in the number of process innovations in the year 2013 (Figure 3). Further research is still necessary to ascertain the reasons for this trend because the current 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 activites as their competitive advantage with rival firms. Most firms reported the conduct of process innovations in procurement. From among the provinces in CALABARZON, the Laguna province is notably the most active in process innovation.

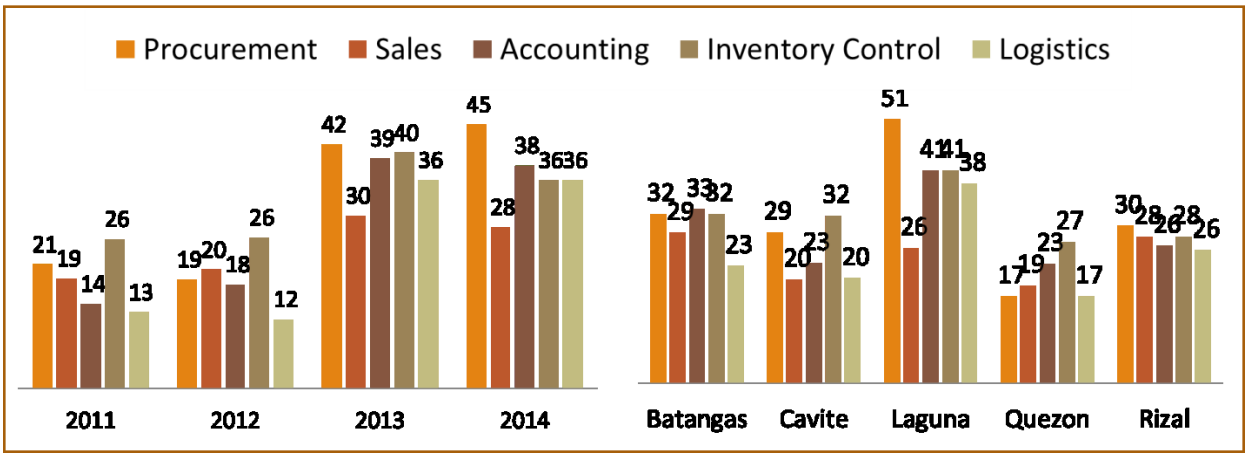



*Figure 3 Process innovation in respondent firms by year and by province (%)*

Finally, when it comes to bridging the number of firms that engage in product or process innovation in relation to their having a foreign linkage, it would seem that more firms with foreign linkages engage in product innovations (see Figure 4 below). Foreign linkages in this study is understood to be a firm that satisfies any of the following conditions namely (1) it engages in export activity, (2) it has a Multinational Corporation (MNC) or a Joint Venture (JV) customer in a foreign country that is a very important or somewhat important source of information and technology (as categorical answers defined in the ERIA questionnaire), or (3) it has an MNC/JV supplier in a foreign country that is 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.

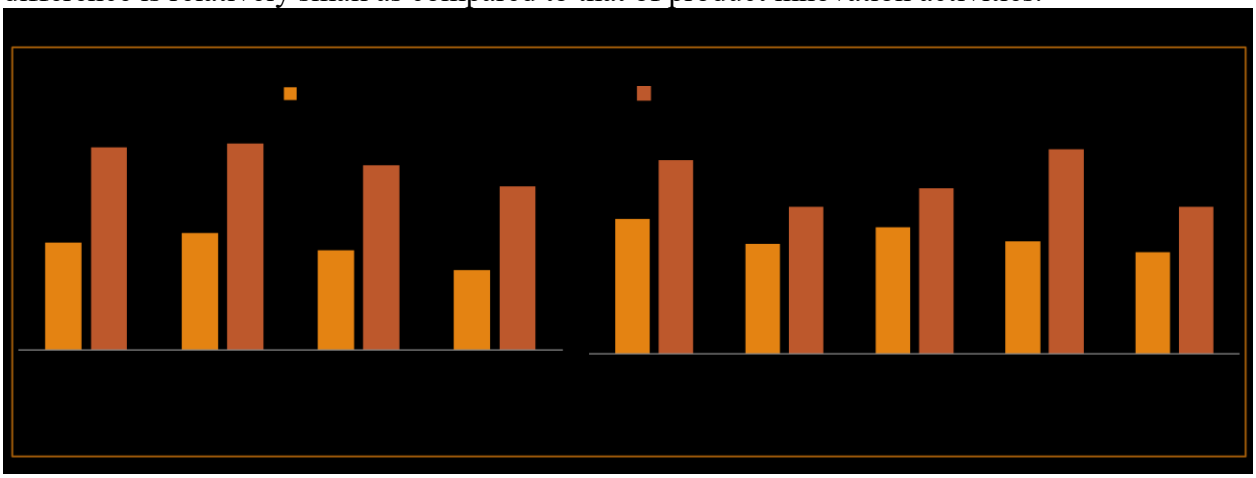


*Figure 4 Innovation activities of firms with foreign linkages (%)*

### 3.2 Data Processing and other sources of data

All data processing activities have been conducted using STATA 14. Because of small changes made to the survey instrument annually, some earlier indicators have to be recoded to match the more recent indicators. For instance, responses under the indicator "What particular functions have the top management performed in your firm?" has undergone changes in both the number of choices and on the options presented. The annual real GDP growth rate was obtained from the World Bank, and from the Asian Development Bank for Taiwan. All other indicators have been sourced from its corresponding ERIA dataset.

### 3.3 Theoretical Framework

This study is guided by the theoretical framework shown in Figure 5 (Fukuda 2017). Figure 5 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: analytical (science-based), synthetic (technology-based), and symbolic knowledge (culture-based). These categories of knowledge differ by how knowledge is produced, and consequently, transfer mechanisms. Among these three, analytical knowledge is the quickest to be transferred as it can flow through the academe and licensing processes, whereas the more challenging synthetic knowledge requires the interaction between highly-skilled professionals that involve 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).

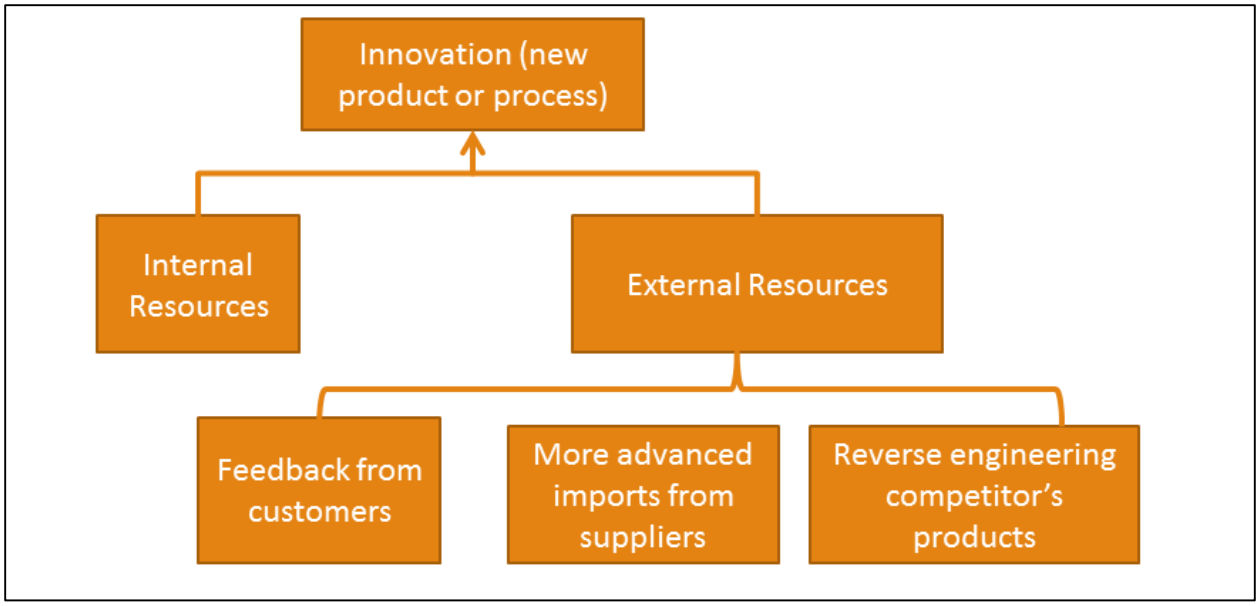


*Figure 5 How do firms innovate? (as taken from Fukuda, 2017)*

### 3.4 Econometric Model

Using the innovation-related surveys conducted by the Philippine Statistics Authority (PSA previously the National Statistics Office) in CALABARZON, spanning 2011-2014, this study aims to quantify the relationship between innovation activity and external international linkages using the following econometric specification:

$$I_i = \alpha + \rho L_i + \beta X_i + \varepsilon_i \qquad (1)$$

Where I is innovation activity (1 if innovator while 0 otherwise); L is the presence of external 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 others while $\varepsilon_i$ is the error term. As the determinants of doing product innovation may be different from that of process innovation, equation (1) will be estimated separately for product and process innovation and their respective components.

Since L might be correlated to unobservables[4] (captured by $\varepsilon_i$) which might result in selection-on-unobservables, an instrument variable approach was used. The instrument for foreign linkages is the GDP growth rate of the partner country that the firm has identified (at most, the top 3 firms, to which case the average GDP is taken in 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 also partially correlated with foreign linkages,

[4] Omitted variables that might confound the results include domestic firm's attitude towards risk or the overall working environment of the firm. Innovation behavior can also affect the decision to engage with foreign partners resulting to a possible simultaneity issue in the probit model.

once other exogenous variables have been netted out (Wooldridge, 2002). This makes the variable a valid instrument for foreign linkages. By utilizing 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 & 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.

## 4. Discussion

### 4.1 Results of probit estimation

From the estimation results of equation 1, the marginal effects of changes in the explanatory variable to the probability of being a product or process innovator are presented in Table 5. Consistent with existing literature (Llanto and Del Prado 2015, Albert et al. 2009, Albert et al. 2017, EBRD 2014, Serafica 2016), large firms were found to be more likely 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 2017). Consistent with the findings of Albert et al. 2017 and Albert et al. 2009, this study also finds a positive and significant relationship between the likelihood of being a product innovator and the adoption of a learning system. Knowledge management practices and learning systems facilitate the transfer of knowledge from external sources to, and within, the firm contributing to higher likelihood 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 (base), firms who produce final products are more likely to be product innovators. This finding seems plausible as food manufacturers who manufacture final products have more room to modify production processes to produce new products. Firms that have an Intellectual Property Rights (IPR) are more likely to innovate in products, but does not show to be a significant influence to process innovation.

On the other hand, firms that are completely Filipino-owned are likely to engage in process innovation, but do not show the same significance in product innovation.

With regard to the relationship of product innovation activity with the top management characteristics of the firm, the 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 the founder's family member, it is likely that they would have greater commitment to maintain the status quo of the firm, and thus, avoiding any innovation activities.

In terms of the impact of the main variable of interest–presence of foreign linkages in the firm, the study finds that having foreign linkages is a positive influence, only to the conduct of process innovation, while it does not present a significant relationship with product innovation. While the non-statistically significant results between product innovation and foreign linkages is consistent with other studies (Albert et al. 2009; Llanto and del Prado, 2017, Albert et al. 2017), the results for process innovation are incongruent with the findings of Albert et al. 2017 which finds the relationship to be negative and significant. This result reveals the need for a more detailed analysis of the determinants of innovation, and the type of innovation activity.

*Table 5. Summary results of the probit estimation in innovation*

| **Summary results of the probit estimation in innovation** | | |
|---|---|---|
| | | |
| VARIABLES | Product Innovator | Process Innovator |
| Medium Firms | 0.0225 | -0.00838 |
| | (0.0516) | (0.0489) |
| Large Firms | 0.124*** | 0.0977** |
| | (0.0470) | (0.0460) |
| Age | -0.000249 | 0.000238 |
| | (0.00189) | (0.00178) |
| R&D Expenditure | 0.151*** | 0.110*** |
| | (0.0219) | (0.0204) |
| Foreign Linkages | 0.0705 | 0.118** |
| | (0.0509) | (0.0485) |
| Has a Learning System | 0.0935* | 0.131** |
| | (0.0531) | (0.0510) |
| Produces Components | 0.0358 | -0.0517 |
| | (0.0747) | (0.0729) |
| Produces Final Product | 0.149** | -0.0198 |
| | (0.0630) | (0.0645) |
| Uses 3S or 5S System | 0.160*** | 0.0817* |
| | (0.0450) | (0.0451) |
| Utilizes a QC Circle | -0.0168 | -0.0423 |
| | (0.0553) | (0.0538) |
| 100% Local Firm | -0.0286 | 0.0762 |
| | (0.0521) | (0.0520) |
| Top Management is Engineer | -0.0286 | 0.0511 |
| | (0.0405) | (0.0388) |

| Summary results of the probit estimation in innovation | | |
|---|---|---|
| | | |
| VARIABLES | Product Innovator | Process Innovator |
| Top Management has MNC Experience | 0.000293 | -0.000153 |
| | (0.0414) | (0.0401) |
| Top Management is Founder/Founder's Family | -0.0970** | -0.119*** |
| | (0.0411) | (0.0402) |
| Firm has an IPR | 0.0614* | 0.0346 |
| | (0.0373) | (0.0363) |
| Industrial Park Location | 0.0802 | -0.0500 |
| | (0.0518) | (0.0519) |

Notes: *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

Table 6 presents the determinants of product innovation components (see Table 6). This would show similar results as those found in Table 5, particularly to the variables large firm, R&D expenditure, learning system, final product, and on the use of a 3S or a 5S system. What changes, however, is with the variable on the top management being a founder or part of the founder's family. Specifically, the case of the product innovations in changing appearance shows the variable of top management being a founder or part of the founder's family to be non-significant, albeit it remains to be a negative determinant to the other product innovation activities.

Including the industrial park location variable, it would show that it is a positive influence for a majority of product innovation components. This finding reiterates that location matters to product innovation activities. Interestingly as well is that the presence of an IPR is non-significant when product innovation is disaggregated across its particulars. Foreign linkages here remain to be a non-significant influence to product innovation.

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

| Summary results of the probit estimation in product innovation | | | | |
|---|---|---|---|---|
| Marginal Effects | Change in Appearance | Capability Improvement | Based on Existing Technology | Based on New Technology |
| Medium Firms | -0.0114 | 0.0244 | 0.0247 | -0.0157 |
| | (0.0508) | (0.0515) | (0.0501) | (0.0466) |
| Large Firms | 0.145*** | 0.139*** | 0.0775* | 0.0494 |
| | (0.0469) | (0.0471) | (0.0470) | (0.0443) |
| Age | -0.000384 | -0.000706 | -0.00170 | -0.00242 |
| | (0.00187) | (0.00187) | (0.00184) | (0.00178) |
| R&D Expenditure | 0.145*** | 0.157*** | 0.162*** | 0.130*** |
| | (0.0213) | (0.0215) | (0.0206) | (0.0185) |
| Foreign Linkages | 0.0604 | 0.0399 | 0.0312 | 0.0537 |
| | (0.0501) | (0.0507) | (0.0496) | (0.0466) |
| Has a Learning System | 0.112*** | 0.0814 | 0.106** | 0.117** |
| | (0.0535) | (0.0527) | (0.0529) | (0.0487) |
| Produces Components | 0.0480 | 0.0214 | -0.00202 | -0.00634 |
| | (0.0757) | (0.0746) | (0.0737) | (0.0721) |
| Produces Final Product | 0.186*** | 0.168*** | 0.129** | 0.116* |
| | (0.0616) | (0.0618) | (0.0609) | (0.0601) |
| Uses 3S or 5S System | 0.121*** | 0.124*** | 0.0921** | 0.106*** |
| | (0.0443) | (0.0450) | (0.0439) | (0.0411) |

| Summary results of the probit estimation in product innovation | | | | |
|---|---|---|---|---|
| Marginal Effects | Change in Appearance | Capability Improvement | Based on Existing Technology | Based on New Technology |
| Utilizes a QC Circle | -0.0111 | 0.0290 | -0.0227 | 0.0119 |
| | (0.0565) | (0.0551) | (0.0567) | (0.0537) |
| 100% Local Firm | -0.0191 | -0.0640 | -0.0784 | -0.0564 |
| | (0.0513) | (0.0515) | (0.0494) | (0.0469) |
| Top Management is | -0.0116 | -0.0299 | -0.0498 | -0.0437 |
| Engineer | (0.0398) | (0.0399) | (0.0387) | (0.0370) |
| Top Management has | 0.0302 | -0.0271 | 0.00388 | -0.0336 |
| MNC Experience | (0.0406) | (0.0410) | (0.0399) | (0.0377) |
| Top Management is | -0.0564 | -0.0916** | -0.0806** | -0.0689* |
| Founder/Founder's Family | (0.0406) | (0.0408) | (0.0398) | (0.0384) |
| Firm has an IPR | 0.0308 | 0.0531 | 0.0582 | 0.0551 |
| | (0.0369) | (0.0371) | (0.0361) | (0.0344) |
| Industrial Park Location | 0.0892* | 0.0675 | 0.0992** | 0.0894* |
| | (0.0513) | (0.0519) | (0.0500) | (0.0480) |

Notes: *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

Similary, the determinants of process innovation by component show that firms with large R&D spending are still more capable to undertake process innovations (see Table 7). Moreover, the same result from Table 5 regarding the use of learning system is obtained. However, what is interesting is that, whereas both the final product and the use of a 3S or 5S system is non-significant in the aggregate, here it has been significant to select sub-activities. For instance, producing final products is a negative influence to innovating in sales-related processes, whereas the use of a 3S or 5S system is a positive influence to procurement and logistics innovation.

*Table 7 Summary results of the probit estimation in process innovation components*

| Summary results of the probit estimation in process innovation | | | | | |
|---|---|---|---|---|---|
| Marginal Effects | Procurement | Sales | Accounting | Inventory | 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** | 0.0200 | 0.0404 | 0.115*** | 0.0881** |
| | (0.0426) | (0.0389) | (0.0400) | (0.0428) | (0.0392) |
| Age | 0.00225 | -0.000277 | 0.00305** | -0.00177 | 0.00202 |
| | (0.00168) | (0.00150) | (0.00152) | (0.00168) | (0.00142) |
| R&D Expenditure | 0.0751*** | 0.0502*** | 0.0464*** | 0.0428** | 0.0696*** |
| | (0.0170) | (0.0150) | (0.0162) | (0.0169) | (0.0148) |
| Foreign Linkages | 0.0276 | 0.0716* | 0.0329 | 0.103** | 0.0388 |
| | (0.0450) | (0.0376) | (0.0423) | (0.0431) | (0.0396) |
| Has a Learning System | 0.0936** | 0.133*** | 0.147*** | 0.0799* | 0.111*** |
| | (0.0430) | (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) | (0.0710) | (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 a 3S or 5S System | 0.0763* | 0.0518 | 0.0230 | 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) | (0.0480) | (0.0490) | (0.0485) |
| 100% Local Firm | 0.0938** | 0.0808* | 0.0329 | 0.0335 | 0.0224 |
| | (0.0458) | (0.0416) | (0.0439) | (0.0469) | (0.0422) |
| Top Management is | 0.0227 | 0.0252 | 0.0463 | 0.0532 | 0.0641** |

| | | | | | |
|---|---|---|---|---|---|
| Engineer | (0.0353) | (0.0328) | (0.0335) | (0.0354) | (0.0323) |
| Top Management has | 0.0412 | -0.0172 | -0.0254 | 0.00984 | -0.00396 |
| MNC Experience | (0.0361) | (0.0324) | (0.0337) | (0.0365) | (0.0321) |
| Top Management is | -0.0956*** | -0.0310 | -0.0884** | -0.152*** | -0.0844*** |
| Founder/Founder's Family | (0.0363) | (0.0330) | (0.0346) | (0.0360) | (0.0327) |
| Firm has an IPR | -0.0448 | 0.0381 | 0.00182 | 0.0541 | -0.0521* |
| | (0.0327) | (0.0298) | (0.0308) | (0.0330) | (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) |

Notes: *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

A similarly interesting note would be on the location of the firm in an industrial park. The results would suggest 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 limited need for process innovation. However, foreign linkages that have previously been significant in the aggregate are found to be non-significant in select processes, namely that of procurement, accounting, and logistics.

### 4.2 Results of the first stage regression: determinants of foreign linkages

The first stage regression results of the instrument variable approach are presented as Table 8. The GDP growth rate of the foreign country with whom the firm has linkages with is positive, and is a significant determinant of probability of having foreign linkages (see Table 8)[5]. Moreover, those practicing a 3S or 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.

*Table 8 Determinants of foreign linkages*

| Determinants of Foreign Linkages | |
|---|---|
| **Variables** | **Foreign Linkages** |
| 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) |

[5] This shows that condition 2 for a valid instrument, i.e. that the instrument is partially correlated with the endogenous variable once other exogenous variables have been netted out (Wooldridge 2002), is satisfied. Other tests also show that the instrument is not a weak instrument.

| Determinants of Foreign Linkages | |
|---|---|
| **Variables** | **Foreign Linkages** |
| Produces Final Products | 0.0419 |
| | (0.0479) |
| Uses a 3S or 5S System | 0.120*** |
| | (0.0340) |
| Utilizes a QC Circle | -0.00646 |
| | (0.0377) |
| 100% Local Firm | -0.180*** |
| | (0.0353) |
| Top Management is Engineer | 0.0788*** |
| | (0.0258) |
| Top Management has MNC Experience | 0.0232 |
| | (0.0250) |
| Top Management is Founder/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 |

Notes: *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

## 4.3 Results of IV regression

As shown in Table 9, having foreign linkages can increase the probability of firms to innovate new products using technology new to the firm by 35.20%; an interesting result considering foreign linkages having been consistently non-significant both on the aggregate (product innovation) and on the disaggregate (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 which would involve technology new to the firm.

Meanwhile, R&D expenditure remains to be a significant determinant of product innovation across all types of sub-activities as it is with large firms – a consistent finding since the probit estimations. Finally another robust result would be as regards to firms whose top management is a founder or part of the founder's family are all less likely to innovate in products.

*Table 9 Summary results of the IV regression in product innovation*

| Summary results of the IV regression in product innovation | | | | | |
|---|---|---|---|---|---|
| Marginal Effects | Product Innovation | Change in Appearance | Capability Improvement | Based on Existing Technology | Based on New Technology |
| Medium Firms | 0.0208 | -0.0148 | 0.0201 | 0.0220 | -0.0124 |
| | (0.0456) | (0.0458) | (0.0456) | (0.0448) | (0.0445) |
| Large Firms | 0.111** | 0.139*** | 0.127*** | 0.0620 | 0.0304 |
| | (0.0434) | (0.0437) | (0.0438) | (0.0440) | (0.0434) |
| Age | -0.000373 | -0.000252 | -0.000644 | -0.00160 | -0.00243* |

| Summary results of the IV regression in product innovation | | | | | |
|---|---|---|---|---|---|
| Marginal Effects | Product Innovation | Change in Appearance | Capability Improvement | Based on Existing Technology | Based on New Technology |
| | (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) |
| 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 | 0.0260 | 0.0111 | -0.00555 | -0.00514 |
| | (0.0614) | (0.0587) | (0.0588) | (0.0600) | (0.0624) |
| Produces Final Products | 0.116** | 0.154*** | 0.135*** | 0.0916* | 0.0750 |
| | (0.0523) | (0.0492) | (0.0507) | (0.0510) | (0.0542) |
| Uses a 3S or 5S System | 0.139*** | 0.117** | 0.108** | 0.0576 | 0.0480 |
| | (0.0464) | (0.0457) | (0.0461) | (0.0453) | (0.0455) |
| Utilizes a QC Circle | -0.0141 | -0.00614 | 0.0228 | -0.0208 | 0.00224 |
| | (0.0440) | (0.0449) | (0.0442) | (0.0449) | (0.0453) |
| 100% Local Firm | -0.0216 | -0.0384 | -0.0575 | -0.0311 | 0.0221 |
| | (0.0601) | (0.0600) | (0.0591) | (0.0573) | (0.0570) |
| Top Management is | -0.0311 | -0.00458 | -0.0283 | -0.0591 | -0.0680* |
| Engineer | (0.0384) | (0.0383) | (0.0376) | (0.0373) | (0.0371) |
| Top Management has | -0.00172 | 0.0283 | -0.0241 | -0.00429 | -0.0447 |
| MNC Experience | (0.0367) | (0.0367) | (0.0363) | (0.0362) | (0.0362) |
| Top Management is | -0.0872** | -0.0468 | -0.0802** | -0.0787** | -0.0754** |
| Founder/Founder's Family | (0.0372) | (0.0370) | (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 | 0.0620 | 0.0305 |
| | (0.0508) | (0.0523) | (0.0522) | (0.0516) | (0.0518) |
| Foreign Linkages | 0.0705 | -0.0507 | 0.0139 | 0.175 | 0.352** |
| | (0.181) | (0.183) | (0.184) | (0.181) | (0.175) |
| Constant | 0.133 | 0.100 | 0.153 | 0.103 | -0.0215 |
| | (0.109) | (0.110) | (0.108) | (0.107) | (0.107) |
| Observations | 855 | 855 | 855 | 855 | 855 |
| R-squared | 0.192 | 0.178 | 0.190 | 0.176 | 0.113 |

Notes: *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

On the other hand when it comes to process innovation (see Table 10), the same results as with the probit estimation can be observed. For instance, firms that are 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 from the founder's family, or the firm being located in an industrial park, can all be negative influences to the likelihood of the firm to innovate in processes. Finally, in keying towards the effects of foreign linkages, it would seem that it is positively related to process innovations in particular to sales and inventory control-related activities, or more generally with an effect size of 48.00%. 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.

*Table 10 Summary results of the IV regression in process innovation*

| Summary results of the IV regression in process innovation |
|---|

| Marginal Effects | Process Innovation | Procurement | Sales | Accounting | Inventory Control | Logistics |
|---|---|---|---|---|---|---|
| Medium Firms | 0.00238 | 0.0437 | 0.000838 | -0.0117 | -0.0147 | -0.00194 |
| | (0.0470) | (0.0442) | (0.0408) | (0.0410) | (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* | -0.00180 | 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) |
| Has a Learning | 0.0720 | 0.0454 | 0.0879** | 0.133*** | 0.0368 | 0.0902** |
| System | (0.0541) | (0.0488) | (0.0445) | (0.0437) | (0.0497) | (0.0430) |
| 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 | -0.0387 | 0.0515 | -0.111** | -0.0179 | 0.0437 | 0.0291 |
| Products | (0.0646) | (0.0539) | (0.0556) | (0.0554) | (0.0572) | (0.0489) |
| Uses a 3S or 5S | 0.0251 | 0.0376 | 0.0150 | 0.0167 | 0.0201 | 0.0635 |
| System | (0.0500) | (0.0456) | (0.0439) | (0.0441) | (0.0462) | (0.0412) |
| Utilizes a QC Circle | -0.0384 | -0.0171 | -0.0676* | -0.0420 | -0.0318 | -0.0749* |
| | (0.0488) | (0.0411) | (0.0398) | (0.0404) | (0.0424) | (0.0391) |
| 100% Local Firm | 0.159** | 0.146** | 0.144** | 0.0427 | 0.0867 | 0.0360 |
| | (0.0647) | (0.0619) | (0.0573) | (0.0572) | (0.0613) | (0.0539) |
| Top Management is | 0.0129 | -0.000520 | -0.00225 | 0.0383 | 0.0327 | 0.0531 |
| Engineer | (0.0404) | (0.0379) | (0.0357) | (0.0354) | (0.0375) | (0.0341) |
| Top Management has | -0.0200 | 0.0257 | -0.0256 | -0.0242 | -0.00407 | -0.00586 |
| MNC Experience | (0.0390) | (0.0365) | (0.0335) | (0.0342) | (0.0371) | (0.0324) |
| Top Management is | -0.127*** | -0.103*** | -0.0422 | -0.0883*** | -0.157*** | -0.0858*** |
| Founder | (0.0400) | (0.0362) | (0.0340) | (0.0342) | (0.0361) | (0.0320) |
| Firm has an IPR | 0.0180 | -0.0503 | 0.0285 | 0.00221 | 0.0438 | -0.0510* |
| | (0.0348) | (0.0323) | (0.0304) | (0.0302) | (0.0321) | (0.0283) |
| Industrial Park | -0.0980* | -0.0250 | -0.116** | -0.0344 | -0.132** | -0.0986** |
| Location | (0.0560) | (0.0541) | (0.0510) | (0.0494) | (0.0536) | (0.0483) |
| Foreign Linkages | 0.480** | 0.289 | 0.350** | 0.0780 | 0.345* | 0.118 |
| | (0.192) | (0.196) | (0.177) | (0.177) | (0.192) | (0.169) |
| Constant | 0.108 | -0.0910 | 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 |

Notes: *** p<0.01, ** p<0.05, * p<0.10, robust standard errors in parentheses

## 5. Summary, Conclusion and Policy Recommendations

In summary, 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. Moreover, having foreign linkages can increase the probability of a firm to conduct significant improvements in sales and in inventory processes.

Meanwhile, in controlling for sources of endogeneity, additional information has shown that foreign linkages can 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 35.20%, whereas the observed relationships in the probit model for process innovation remains true as well after the control with a general effect of 48.00%. It can 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.

### 5.1 Policy Recommendations

Before recommending policies, it important to review current policies related to strengthening foreign linkages of firms in the Philippines. Two chapters in the most recent Philippine development plan emphasize the importance of linkages to the Philippine domestic economy. Chapter 15 which focuses on ensuring a strong macroeconomic performance of the local economy 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 Philippine Development Plan's Chapter 9 on expanding economic opportunities in industry and services through Trabaho and Negosyo, highlights the goal of the government to be able to develop globally competitive businesses - particularly the MSMEs - through the full implementation of the Comprehensive National Industrial Strategy (CNIS). The PDP promotes inter-firm 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 DTI has recently launched its new industrialization strategy coined as $i^3S$ (inclusive, innovation-led industrialization 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, remove obstacles to growth and subsequently attract more investments, and finally, by 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 business and the investment environment.

With these policies in place backed by the results and 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 therefore to be wary of policies that might be detrimental to the formation of backward linkages. For instance, Manasan (2017) in her evaluation of one component of the TRAINS, has found that the proposed change in VAT treatments of indirect exports from zero-rated to VAT-able will have perverse effects on backward linkages of export activity;

(2) Support trainings on the 5S system through government institutions such as TESDA programs on TPS, 5S, or kaizen, together with efforts coming from State Universities and Colleges (SUCs) in the Visayas region teaching TPS and 5S;

(3) Support the Development of R&D capability of firms;

(4) Highlight the role of innovation intermediaries; and,

(5) Recognize the value of establishment level data on innovation activities of firms. Particularly, there can be a measure of where the firm is innovating across the global value chain. Perhaps there is the possibility that the effects of innovation can be differently assessed in different nodes across the chain albeit 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 linkages or 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 looking at the exchange of highly-skilled personnel.

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

**References**


Arcangel, X.(8 Aug 2013). Fil-Am architect wants the PHL as a test bed for innovative 'Living Walls.' *GMA News*. Retrieved from www.gmanetwork.com

Albert, J., Aldaba, R., Quimba, F., Jaque, J., Gabales, B., & Yasay, D.(2013*). Innovative behavior of local firms: Results of the 2009 pilot survey of innovation activities conducted under the DOST-IDRC project: Towards an innovation-led development path in the Philippines*. Department of Science and Technology, International Development Research Centre, and Philippine Institute for Development Studies. Retrieved from serp-p.pids.gov.ph

Ayyagari, M., Demirgüç-Kunt, A., & Maksimovic, V.(2007). *Firm innovation in emerging markets*. World Bank Policy Research Working Paper Series. Retrieved from demo-ipp.nuvole.org

del Prado, F. & Rosellon, M.(2017). *Achieving innovation without formal R&D: Philippine case study of garment firms.* Philippine Institute for Development Studies. Retrieved from serp-p.pids.gov.ph

Enriquez, L.(11 Sep 2017). *Disruptive technologies in the life sciences*. Presented at the Philippine Institute for Development Studies.

European Bank for Reconstruction and Development (EBRD).(2014). Drivers of innovation. *Transition Report 2014.* Retrieved from www.ebrd.com

Fukugawa, N.(n.d.). *Theoretical framework for innovation policy in and for ASEAN*. Japan: Tohoku University. [Unpublished Manuscript].

Manila FAME.(28 Apr 2016). *Design Center of the Philippines presents innovative, sustainable, and retrospective designs at Manila FAME*. Retrieved from manilafame.wordpress.com

Nathan, M. & Lee, N.(2011). *Does cultural diversity help innovation in cities? Evidence from London firms*. Spatial Economics Research Centre. Retrieved from eprints.lse.ac.uk

Romijn, H. & Albaladejo, M.(1999). Det*erminants of innovation capability in small UK firms: An empirical analysis.* Queen Elizabeth House, University of Oxford. Retrieved from www3.qeh.ox.ac.uk

Sawhney, M., Wolcott, R., & Arroniz, I.(2006). The 12 different ways for companies to innovate. *MIT Sloan Management Review 47*(3), 75-81. Retrieved from www.sloanreview.mit.edu

Serafica, R.(2016). *Service innovation in Philippine industries*. Philippine Institute for Development Studies. Retrieved from serp-p.pids.gov.ph

Segerstrom, P.(1990). *Innovation, imitation and economic growth.* USA, MI: Michigan State University.

Vieites, A. & Calvo, J.(2011). A study on the factors that influence innovation activities of Spanish big firms. *Technology and Investment 2,* 8-19. doi: 10.4236/ti.2011.21002