

Propensity to Innovate and Firm Performance in the Developing Economies: Evidence from ASEAN Countries

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Abstract: This paper employs datasets from the Enterprise Survey conducted by the World Bank to examine the relationship between four types of innovation defined by the Oslo Manual (OECD, 2005): product innovation, process innovation, marketing innovation, organization innovation, and the firm performance in the selected developing ASEAN economies. The main objective of this paper is to understand the characteristics of innovation activities at the firm level and how various innovation types affect firm performance. The empirical results from ASEAN manufacturing firms reveal that product innovation positively affects firms' performance, while non-technological innovations are negatively related to the performance of firms. The further employed quantile regression provides more insights into the roles of innovation types on different levels of firm performance: while product and process innovations actively contribute to the small and medium-size firms (below 25th quantile and median), organizational and marketing innovations negatively affect them. Interestingly, the role of process innovation decreases when firm performance grows.

Keywords: innovation, firm-level, developing countries, quantile regression

I. Introduction

Schumpeter (1934) was one of the first who argued that economic growth is driven by innovation through a dynamic process called "creative destruction." In his view, there are five types of innovation: (1) introduction of new products,

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(2) introduction of new methods of production, (3) opening of new markets, (4) development of new sources of supply for raw materials or other inputs and (5) creation of new market structures in industries. Since then, the relationship between innovation and the performance of firms has been widely discussed, thanks to the availability of a large dataset at the firm level and the development of innovation theories (Griliches 1987; Grossman 1993; Cainelli 2006; Crespi 2014; Arora & Nath, 2015; Nguyen-Van 2021).

There is a consensus that innovation is essential for economies to catch up with developed countries. According to the growth model of Solow (1956), thanks to the diminishing marginal product of capital, the less developed countries have a chance to grow faster and, therefore, catch up with the developed countries. It is suggested that a “follower” country can increase its growth rate with technology. Lim and McAleer (2004) argued that technological catching-up is associated with innovation and capital investment.

Previous literature argued that innovation is the most fundamental source of firms' success and survival ability in the competitive, complex, and intellectual environment (Pucik, 2005; Cho and Abbing, 2010; Rajapathirana, 2018). Clearly, firms that invest in innovation activities are better equipped to introduce technological advances and tend to have higher labor productivity than those that do not (Crespi, 2014).

According to the Oslo Manual (OECD, 2005), there are four types of innovation: product, process, marketing, and organization. The Oslo Manual has been widely used as an international guideline for assessing innovation since it was first released, especially from the third edition in 2005, when marketing and organizational innovations were clearly defined (Gunday 2011; Crespi 2014; Hwang 2015). This paper, thus, follows the innovation types defined by Oslo Manual (OECD, 2005) as a reference to examine the innovation activities of manufacturing firms.

The main objective of this paper is to understand the characteristics of innovation activities at the firm level and how various innovation types affect firm performance, especially the propensity of firms in innovation activities in the context of the ASEAN developing economies. We first analyze the innovation characteristics of ASEAN manufacturing firms to have insights on firms' propensity to innovate; then we employ empirical methodology to test the effect of different innovation types on firm performance.

This paper is set out as follows. Section 2 reviews the findings in the previous papers on the relationship between types of innovation and firm performance. Section 3 analyzes the innovation characteristics of firms, while Section 4 introduces the methodology and data employed in this paper. Section 5 employs various empirical models including multiple regression and quantile regression to test the effects of innovation types on firm performance, along with other controlled variables. Section 6 concludes.

II. Literature review

A crucial question is often raised when examining the firm's behavior in innovation: why do they do that? Or, more transparent: why do firms innovate? What are their motivations when implementing innovation activities? The primary reason is to improve its performance, such as cost reduction, improve productivity, and explore and expand markets (OECD, 2005). Moreover, firms must keep innovation in their eyes to ensure their competitive advantage over competitors (Greenhalgh, 2010).

Types of innovation and firm performance

It is broadly agreed that all types of innovations positively affect the firm's innovative performance to different degrees. This impact leads to improvements in production and market performance, and hence, research on innovation and its implication on the success of a firm rapidly becomes an attractive area.

There were several attempts in the previous literature to define innovation (Schumpeter, 1934; Drucker, 1985). Later, OECD (2005) categorized the four main types of innovation including product innovation, process innovation, marketing innovation, and organizational innovation. This classification has played as a guideline for innovation analysis and assessment, especially at the firm level. Hence, in this present study, we follow this classification to investigate the innovative natures of ASEAN manufacturing firms and their impacts on firm performance.

The four innovation types are further categorized into the concepts of technological innovation (product and process) and non-technological innovation (marketing and organizational). According to Oslo Manual (OECD, 2005), product innovation is labeled as an introduction of a good or service that is new or significantly improved. There are several ways to measure this new or significantly improved such as significant enhancements in technical specifications, materials and components, or other functional characteristics. In addition, a process innovation could be defined as the implementation of a new or significantly enhanced production or delivery method. The intention of process innovation could be to decrease unit costs of production or to increase the quality of production.

Besides, turning into non-technological innovation, while marketing innovation refers to the implementation of a new marketing method involving significant changes in product design or packaging, product promotion or pricing with the main intention, is to increase firm's sales, an organization

innovation is the implementation of a new organizational method within the firm, or to be specific, the enhancement of firm's business practices. Thus, organizational innovation is intended to improve firm performance by reducing administrative costs and increasing labor productivity.

Based on the mentioned classification, Gunday et al. (2011), in their comprehensive study on the relationship of different types of innovation on firm innovative performance, have concluded that there are positive and significant impacts of a product, marketing, and organizational innovations on the innovative performance of firms, but surprisingly, no evidence for such relationship was found for process innovation. The paper also pointed out that organizational innovation is positively associated with marketing and product innovations, while marketing innovation is positively associated with product innovation.

Crespi (2014), furthermore, investigated the innovation propensity of firms from the Latin America and the Caribbean (LAC) region and suggested that the way innovation is understood in the region differs widely from that of firms in more developed countries: firms in the LAC region hardly invest in disembodied technology. Therefore, such high innovation rates may likely reflect incremental and adaptive innovation.

The impact of innovation, however, can vary depending on the region, sector, or industry examined. According to Atalay (2013), when investigating the effect of innovation on firm performance in the Turkish automotive supplier industry, technological innovation has a significant and positive impact on firm performance, while no evidence was found for non-technological innovation and firm performance.

The primary objective of firms when conducting innovation activities is to enhance competitive advantage and further increase business performance. Innovation, in this sense, plays an essential role in generating the firm's unique advantages. Fagerberg et al. (2004), in a study on country-level innovation, found that innovative countries tend to have higher productivity than the less ones.

In the reviewed studies above, one of the main objectives is to investigate the impact of innovation types on firm performance. However, the extension of this research line is limited to both horizontal and vertical. Indeed, only several studies comprehensively examined the relationship between innovation and firm performance, based on the classification of the Oslo Manual (OECD, 2005). Thus, our paper aims to figure out the effect of four individual innovation types and as well the interacting effects of technological and non-technological innovations, with a focus on ASEAN manufacturing firms.

In this sense, we hypothesize the first four hypotheses on the relationship between innovation and firm performance of ASEAN manufacturing firms:

- H1: Product innovation is positively associated with firm performance.
- H2: Process innovation is positively associated with firm performance.
- H3: Marketing innovation relates positively to the firm's performance.
- H4: Organizational innovation relates positively to the firm's performance.

Impacts of firm-level moderators on the relationship between innovation and firm performance

Previous literature also examined the moderating effect of some firm-level variables on the relationship between innovation and firm performance. Those often employed variables are firm size, firm age, export orientation, and firm ownership.

From the known studies, it is widely agreed that firm size, foreign ownership and export orientation are some variables that positively affect firm innovation's behaviors, while the role of firm size is still under debate (Crespi et al., 2014).

Since Schumpeter (1934) pointed out the importance of firm size in estimating firm performance, many researchers have applied this idea to their studies and indicated that firm size significantly and positively correlated with the innovation degrees of firms (Hwang, Dong, 2015). Large firms tend to be more innovative than small and medium firms in all types of innovation.

According to Crespi et al. (2014), firm age is traditionally used as a proxy of business experience, but there is still controversy over the impact of firm age on a firm's performance. While a few studies concluded that old firms are likely to be more innovative, more research has found no evidence to demonstrate the positive impact of firm age on innovation activities. Previous studies have shown that export-oriented firms are likely to be more active in conducting innovation activities. This is because the export firms have a higher chance of facing competition from foreign firms, especially those who export their products to developed countries. Lastly, studies on the firm level in developing countries have figured out that foreign-owned firms are likely to be more active in innovation activities rather than domestic-owned firms.

Hence, we propose the following hypotheses:

- H5: Firm size positively moderates the effect of innovation on firm performance.
- H6: Foreign-owned status positively moderates the effect of innovation on firm performance.
- H7: Export-oriented status positively moderates the effect of innovation on firm performance.
- H8: Firm age negatively affects the relationship between innovation and firm performance.

Although various studies, including theoretical and empirical, investigated the relationship between different types of innovation and firm performance, it is still limited in terms of considering all four types of innovation simultaneously in the context of developing countries. Previous studies often put their focus on technological innovation (product innovation and process innovation) and its impact on firm performance, while the impact of non-technological innovations (marketing innovation and organizational innovation) is rarely examined. In this paper, our primary objective is to examine the effect of all four defined innovation types: product innovation, process innovation, marketing innovation, and organizational innovation, on firm performance. Moreover, we also investigate the impacts of firm-level moderators on that relationship to see how and how much those variables affect a firm's innovation characteristics.

This study is expected to contribute to the literature in three aspects. First, to the best of our knowledge, this is the first study that examines the impact of all four types of innovation on the performance of manufacturing firms from developing countries in ASEAN. It also extends the understanding of the impact of less-focused non-technological innovation (marketing and organization) on the firm's performance along with technological innovation (product and process). Second, the results of our research are expected to have policy implications for the firm owners and governments in developing countries. Understanding the role of each type of innovation provides the decision-makers evident to concentrate on the appropriate mode of innovation. Lastly, this paper replies to the call for research on the innovation activity at the firm level in the dynamic region of ASEAN.

III. Natures of Innovative Firms

We employ the dataset from the Enterprise Survey conducted by the World Bank, which is available for eight out of ten ASEAN countries (Brunei and Singapore are not covered in the Enterprise Surveys). The latest data (survey) years available for each country are:

2015: Indonesia, Malaysia, Philippines, and Vietnam

2016: Cambodia, Myanmar, and Thailand

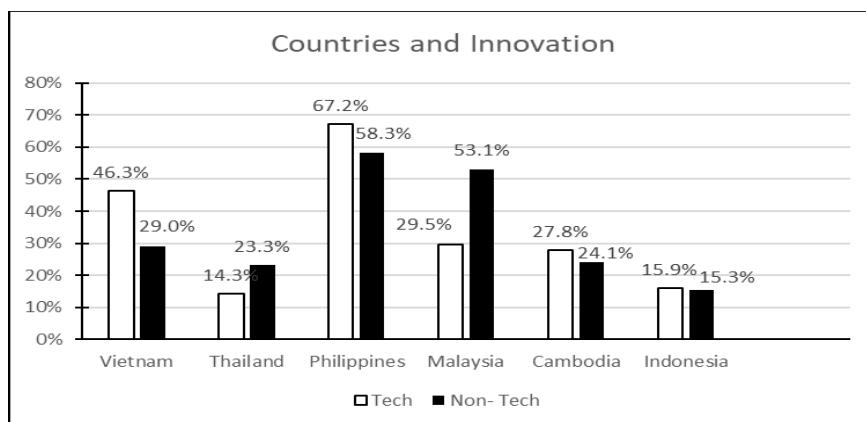
2018: Laos

However, as none of Laos and Myanmar's firms qualified for the estimation after the data cleaning process, the final sample countries in this paper are six.

Since then, we have sorted out firms that belong to the manufacturing sector, not the service sector. According to Hwang (2015), the innovation natures of service sector firms are likely to differ considerably from those in the manufacturing sector. We follow the classification from the UN's International Standard Industrial Classification (ISIC Rev 3.1) to sort out the manufacturing firms that have a 2-digit code from 15 to 37. The final observations for examination are 3064 firms.

From the sorted data, we visualize them into graphs to make it easier to observe how types of innovation vary in six selected ASEAN economies. In Figure 1, we see that firms' innovation rates are not similar across countries, despite the relative similarity in these countries' levels of development. Moreover, innovation seems not entirely correlated to the level of development of a country, as evidenced by the significantly higher rate of innovation in firms in the Philippines compared to that of firms in Thailand. Thailand, on the other hand, has a higher level of development than the Philippines.

It is also interesting to see that the rate of innovation in Cambodia is higher than in Thailand and Indonesia, the two manufacturing hubs in ASEAN in both technological and non-technological innovation.

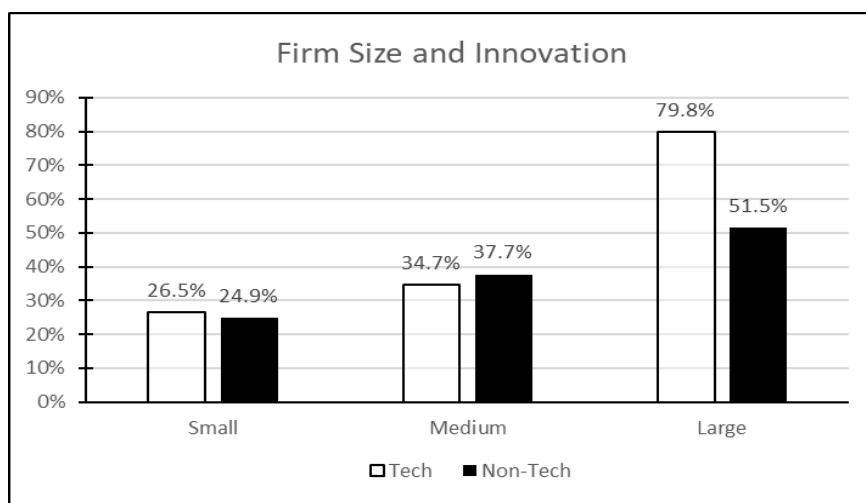


Source: The authors, based on the World Bank's Enterprise Survey.

Figure 1. Propensity to innovate in ASEAN countries. Authors' calculation based on Enterprise Survey.

There are also no easily discernable patterns among firms in different countries across Southeast Asia, at least from a purely graphical standpoint. This may stem from the fact that investing in innovation, however, can be prohibitive for many firms in developing countries. Given the uncertainty, indivisibility, and intangible nature of innovation investments, it is difficult for firms to access credit for innovation. Some of these constraints are exacerbated by the fact that

the returns on innovation can be appropriated by others due to imitation and reverse engineering. Therefore, it is difficult to negotiate a loan over insecure assets and to enter contracts using knowledge assets as collateral or guarantees (Crespi, 2014). This shows to understand firms' innovation in the case of Southeast Asia; we need to delve deeper than the country level.



Note: The firm size classification follows OECD definition, based on the number of employees: small firms are those that have from 10 to 49 employees, medium firms have 50 to 249 employees, while large firms are those that have more than 250 employees.

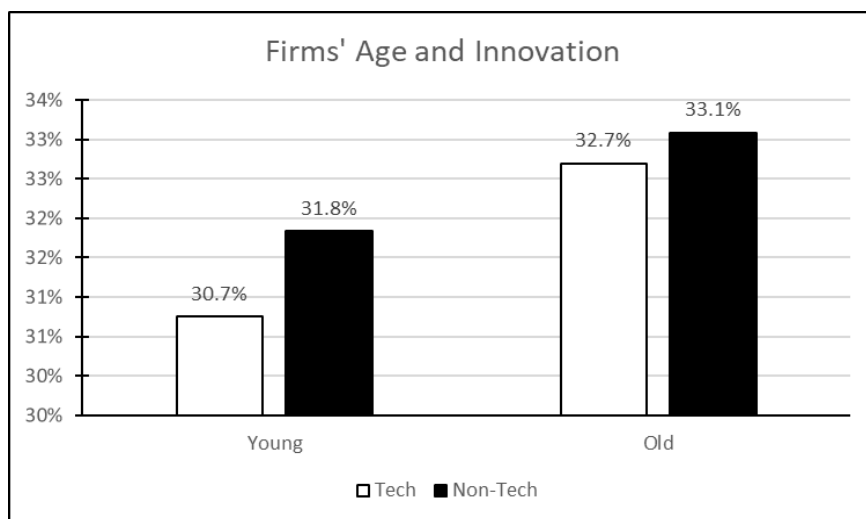
Source: The authors, based on the World Bank's Enterprise Survey.

Figure 2. Propensity to innovate based on the firm size.

According to Fig. 2, large firms tend to be more innovative than small and medium firms. About eight out of ten large manufacturing firms innovated, introducing either a new or significantly improved product or process. This is a significantly larger percentage than that of small and medium, in which out of three and four out of ten firms of the same category respectively innovated, introducing either a new, improved product or process. As for marketing and organization innovation, large firms also tend to innovate more, as five out of ten large firms introduced innovation to marketing or organizational structure. This ratio is only four out of ten for medium firms and three out of ten for small firms. Large firms also have a higher ratio of having both product and process innovation than small and medium firms.

It is also worth noting that the difference between technological and non-technological innovations in small and medium firms is not significant, with an approx. 2-3% gap between both types of innovation. This gap, however, is large

when it comes to large firms (approx. 30%), showing the behaviors of big manufacturing companies in the ASEAN region tend to focus more on technological innovation. This could be because the FDI attraction strategy of developing ASEAN countries leads to the establishment of big foreign-owned manufacturing enterprises. These enterprises, however, are likely to focus on technological innovation to support their export-oriented objective while applying and copying their “mother company” marketing and organizational structure.

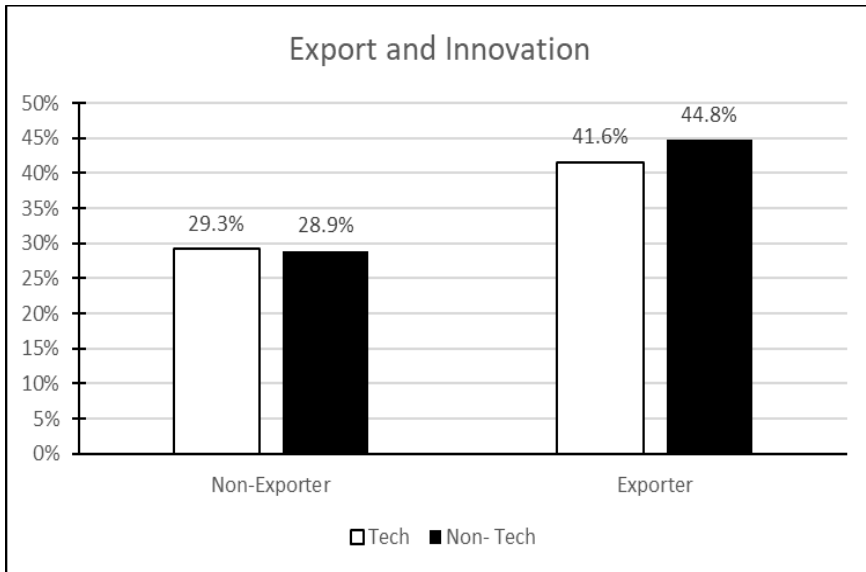


Note: Young firms are those under ten years of operation till the survey year, while old firms are those over ten years of operation until the survey year.

Source: The authors, based on the World Bank’s Enterprise Survey.

Figure 3. The difference in innovation between young and old firms.

In Fig. 3, we can see both young and old firms are relatively similar in the percentage of implementing technological innovation (product and process) as well as non-technological innovation (marketing and organization). Despite the difference not being too significant, this results in line with the previous literature, which indicates that old firms tend to have a higher rate of innovation activities thanks to their rich resource and knowledge in the advantage of investment in innovation activities.

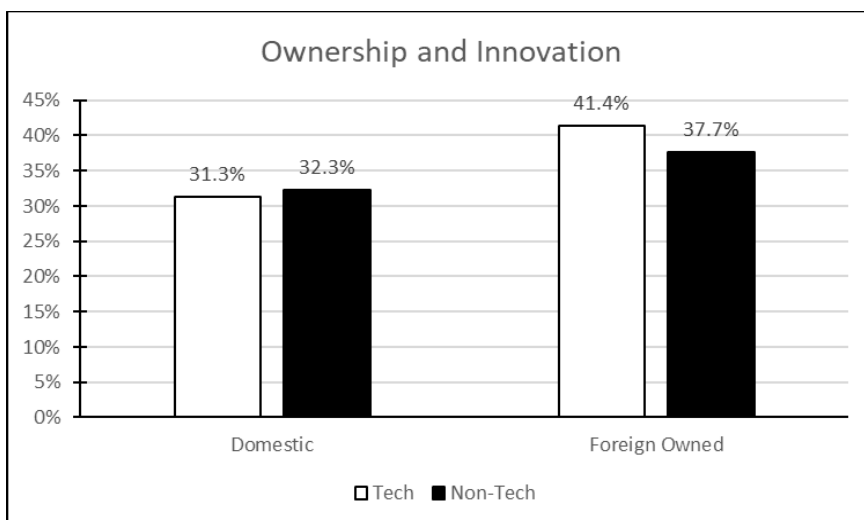


Note: Exporting firms are those who have more than 10% of sales from direct export.

Source: The authors, based on the World Bank's Enterprise Survey.

Figure 4. Propensity to innovate between exporters and non-exporters.

We can clearly see that firms tend to innovate more when they are exporting firms. Exporting firms, from what we can see in Fig. 4, have a higher innovation rate in all categories compared to non-exporting firms. This fits in with the argument that exporting forces the firms to compete with other international competitors and thus propels them into adopting a more proactive stance on innovation, fewer other firms surpass them.



Note: Domestic-owned firms are classified as firms with less than 49 percent point share by foreign, while foreign-owned firms are those with more than 50 percent point share by foreign.

Source: The authors, based on the World Bank's Enterprise Survey.

Figure 5. Propensity to innovate of domestic and foreign-owned firms.

Similar to exporting firms and non-exporting firms, firms with a high percentage of foreign ownership tend to conduct more innovative activities than domestic firms or firms with a low percentage of foreign ownership. From Fig. 5, we see that for all categories, except marketing-only innovation and both marketing and organization innovation, firms with high foreign ownership innovate more than domestic firms.

This might correlate with other factors, such as foreign firms that may be bigger, tend to be export-oriented (serving as part of multinational cooperations), and tend to innovate more. Foreign expertise and other unaccounted factors might also contribute to this difference that demands further investigation.

IV. Methodology

In order to further investigate how types of innovation affect firm performance, this paper employs an empirical model to test whether the above-mentioned relationship is significant and, if yes, how much they are correlated. We use both multiple regression and quantile regression to determine the relationship between firms' performance and several other variables. Several variables are used, and they are described below.

Variable descriptions

- Dependent variable: We measure the firm performance as the logarithm of the total firm sales. This can be used as a proxy for firm performance.

- Independent variables: As the core objective of this paper is to investigate the relationship of all types of innovation with firm performance, we set out various independent variables as follows:

+ PDI as product innovation has the value of 1 if the firm conducted product innovation only and zero otherwise. (In ES's questionnaire, this variable is measured by a yes/no question: *During the past three years, has this establishment introduced any new or significantly improved products or services?*)

+ PCI as process innovation, similarly, has the value of 1 if the firm carried out process innovation only and zero otherwise. (This variable is measured in ES's questionnaire by the following question: *During the past three years, has this establishment introduced any new or significantly improved methods of manufacturing products or offering services?*)

+ PDIxPCI as the interacting variable of product innovation and process innovation, has the value of 1 if the firm conducted both product and process innovation activities simultaneously and zero otherwise.

+ MKI as marketing innovation has the value of 1 if the firm implemented marketing innovation only and zeroed otherwise. (In ES's questionnaire, this variable is measured by a question: *During the past three years, has this establishment introduced new or significantly improved marketing methods?*).

+ ORI as organizational innovation, take the value of 1 if the firm carried out organizational innovation only, and zero otherwise. (In the ES's survey, this variable is measured by the following question: *During the past three years, has this establishment introduced new or significantly improved organizational structures or management practices?*)

+ MKIxORI as the interacting variable of marketing innovation and organizational innovation, has the value of 1 if the firm conducted both marketing and organizational innovation activities simultaneously and zero otherwise.

- Control variables: This paper employs four firm-level control variables to investigate their potentially moderating effects on the relationship between innovation and firm performance. Those effects are partially determined by previous studies.

+ Firm age: Measured by the number of operation years.

+ Firm size: Since first recognized by the well-known work of Schumpeter (1942), firm size has always been considered an essential variable that could affect innovation behavior as well as firm performance. This study measures firm size by the number of employees of the firm.

+ Export-oriented: measured by the percentage of export (including direct and indirect export) on the firm’s total sales.

+ Firm ownership: Percentage of foreign ownership in the firm.

The regression model is as follows:

$$\ln FP = \beta_0 + \beta_1 PDI + \beta_2 PCI + \beta_3 PDI \times PCI + \beta_4 MKI + \beta_5 ORI + \beta_6 MKI \times ORI + \beta_7 Control + \varepsilon$$

Table 1. Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev	Min	Max
<i>FP</i>	3,064	15.396	3.638	3.146	26.749
<i>PDI</i>	3,064	.223	.416	0	1
<i>PCI</i>	3,064	.253	.435	0	1
<i>ORI</i>	3,064	.251	.434	0	1
<i>MKI</i>	3,064	.240	.427	0	1
<i>PDIxPCI</i>	3,064	.149	.356	0	1
<i>MKIxORI</i>	3,064	.159	.365	0	1
<i>Age</i>	3,064	19.594	12.429	2	162
<i>Export</i>	3,064	19.755	34.037	0	100
<i>Size</i>	3,064	174.725	606.882	2	20,000
<i>Ownership</i>	3,064	10.922	28.325	0	100

Source: The authors, based on the World Bank’s Exterprise Survey

V. Empirical results

1. Innovations and firm performance – Linear regression

According to the overall regression result (Column 1), despite having a positive sign among those main variables, the coefficients are not statistically significant; it means that the relationship between innovation-measured variables and firm performance could not be distinguished from chance in the

full sample case. We argue that there are other factors that affect this relationship and hence need to be examined in detail. Those heterogeneity might be income groups specific or country specific. We therefore investigate the impact of innovation on firm performance under the effect of those factors by dividing our sample into sub-samples based on income groups and country-based (Column 2 to Column 9).

Table 2. Effect of types of innovation on firm performance

	Overall (1)	Income groups		Country-based regression					
		LMIC (2)	UMIC (3)	Cambodia (4)	Indonesia (5)	Malaysia (6)	Philippines (7)	Thailand (8)	Vietnam (9)
PDI	0.062 (0.110)	0.153 (0.120)	-0.610** (0.297)	-0.467 (0.476)	-0.384 (0.341)	-0.972 (0.640)	0.604*** (0.178)	-0.561** (0.253)	-0.033 (0.185)
PCI	0.021 (0.120)	0.045 (0.143)	0.074 (0.211)	-0.281 (0.464)	-0.125 (0.433)	0.092 (0.226)	0.461** (0.207)	0.015 (0.300)	-0.584*** (0.168)
ORI	0.135 (0.116)	0.277** (0.137)	-0.443** (0.212)	-0.758 (0.661)	0.819* (0.455)	-0.085 (0.229)	0.398** (0.184)	-1.410*** (0.335)	-0.123 (0.174)
MKI	0.103 (0.113)	0.309** (0.138)	-0.410** (0.178)	0.300 (0.433)	0.984*** (0.357)	0.725*** (0.297)	0.099 (0.192)	-0.932*** (0.200)	0.225 (0.195)
PDIxPCI	-0.104 (0.171)	-0.145 (0.192)	-0.002 (0.397)	1.903* (0.816)	-0.306 (0.589)	0.393 (0.702)	-0.609** (0.268)	0.606 (0.409)	0.306 (0.260)
ORIxMKI	0.026 (0.172)	0.092 (0.205)	0.482* (0.287)	-0.235 (0.963)	0.942 (0.606)	-0.256 (0.382)	-0.126 (0.285)	1.592*** (0.391)	0.250 (0.271)
Age	0.339*** (0.052)	0.013*** (0.003)	0.016*** (0.005)	0.001 (0.023)	0.017** (0.006)	0.008 (0.009)	0.014*** (0.004)	0.020*** (0.006)	0.004 (0.005)
Export	0.0008 (0.001)	-0.0006 (0.001)	0.007*** (0.002)	-0.002 (0.003)	0.011*** (0.002)	-0.005* (0.003)	0.0004 (0.001)	0.008*** (0.002)	-0.005*** (0.001)
Size	0.073*** (0.025)	0.132*** (0.031)	-0.041 (0.041)	-0.00003 (0.0001)	-0.0001 (0.0001)	-0.001*** (0.0002)	0.187*** (0.052)	0.197*** (0.047)	0.037 (0.043)
Owner -ship	0.003** (0.001)	0.006*** (0.001)	-0.015** (0.004)	0.005 (0.004)	0.016*** (0.005)	0.002 (0.004)	0.006*** (0.001)	-0.017*** (0.004)	0.003* (0.002)
Country dummy	Yes	Yes	Yes	-	-	-	-	-	-
R- Squared	0.7940	0.6969	0.5540	0.0714	0.1883	0.2381	0.1204	0.1762	0.0547
Obs	3,064	2,149	915	107	663	240	844	575	535

Notes: Robust standard errors are reported in parentheses. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels, respectively. In order to save on space, the estimates of constant terms are not reported.

The control variables we put in are the age of firms, the percentage of exports in firms' sales, the size of firms (based on the number of employees), and the percentage of foreign ownership of the firms. Among those variables, firm age, firm size, and foreign ownership are statistically significant, and they all positively affect firm performance.

We further divide the full sample into two sub-samples: lower-middle income countries (LMIC) and upper-middle income countries (UMIC) to account for the potential heterogeneous factors caused by income differences between countries. The results are presented in Column 2 and Column 3 for LMIC and UMIC, respectively. We found that there is a difference in direction between the two country groups among the four main interesting variables. While in the case of LMIC, marketing and organizational innovations have a positive impact on firm sales, the opposite sign is found in the case of UMIC for product, marketing, and organizational innovations. Interestingly, the interaction between marketing and organizational innovations in UMIC is seen to have a positive effect on firm performance.

The results from the single country regressions (Column 4 to Column 9), however, present different interpretations. Product innovation only has a positive coefficient and is significant only in the case of the Philippines. In other countries, product innovation has negative coefficients and is not significant, leading to the role of product innovation in firm performance not being clear. Process innovation, on the other hand, is significant with a positive coefficient in the case of the Philippines and is significant with a negative coefficient in the case of Vietnam. For the rest of the countries, process innovation is not significant, leading to the role the variable plays in firm performance being unclear. The situation is the same for the remaining main variables, as it is shown that there is an inconclusive result among them. The great degree of variation between the degree of significance and the coefficients of each variable for each country makes it hard to arrive at the general conclusion for the impact of each variable on the performance of firms when we take into account the results from all countries. This shows that there are bigger factors that exist within each country that have greatly influenced a firm's performance aside from the existing variables.

The interacting variables (PDIxPCI and ORIxMKI) also provide us with some interesting findings. In the case of Cambodia, conducting both types of technological innovation will help to improve firm performance. However, doing the same does not ensure a similar effect in the case of the Philippines as the interacting effect is negative, even though implementing product innovation and process innovation separately generates a positive impact. Interestingly, firms from Thailand, when conducting marketing innovation and organizational innovation, will probably cause a negative effect on firm sales, but when adopting these two non-technological innovations simultaneously, the interacting effect will enhance firm performance.

To this end, we are informed that the high percentage of innovation implementation does not ensure the effect of innovation would be positive. For instance, among the top three countries that have the highest innovation rate (revealed in Figure 1), only the Philippines has a positive effect on three out of

four main innovation variables (except marketing innovation), while in the case of Malaysia, only marketing innovation is seen to have a positive impact. Especially, despite the relatively high rate of process innovation (ranked 3rd in the six countries), this innovation type is negatively associated with manufacturing firms from Vietnam. This circumstance posits that even in the case that firms conducting innovation, the effect, however, could be negative. Hence, we need to further examine other factors that might correlate to this relationship.

The regression results of other control variables, however, tell a different story with the innovation natures of ASEAN firms. From Figure 5, it is seen that despite foreign-owned firms tending to innovate more than domestic firms, the effect of high foreign-shared firms on firm performance is negative. Specifically, in country-based analysis, only Thailand is observed to have a negative effect from foreign ownership on firm sales, while in the case of Indonesia, the Philippines, and Vietnam, the impacts are seen to be positive. Thus, we believe that the interactions of the control variables and innovation might be affected by other country-based heterogenous factors.

2. Effects of innovation on different degree of firm performance – Quantile regression

To further examine the effect of each type of innovation on firms depending on the level of performance of firms, we employ quantile regression introduced by Koenker and Bassett (1978) on the same dataset. The standard least squares regression can present the overall view of the average effect of the independent variables on the dependent variable, but it may not provide enough insights as well as a complete picture of the relationship. According to Coad and Rao (2008), employing quantile regression when estimating the effect of innovation activities on firm growth could provide a comprehensive picture to understand how the effect of innovation varies on different levels of a firm's performance.

Table 3 presents the results of quantile regression of innovation types on different levels of performance of firms. Product innovation is strongly significant and positive for firms with performance below the 25th quantile and the median of all firms' performance. The coefficient of product innovation also drops from the 25th quantile to the median signals us that the role of product innovation decreases when firm growth. It is suggested that product innovation has an essential contribution to the performance of small and medium manufacturing firms from ASEAN. However, it is unclear about the role of product innovation on larger firms (75th quantile) as the result is insignificant.

Results of process innovation, besides, provide a different story: it has a positive impact on firms below the median with the strongest positive impact on

firms from the 25th quantile to the median. Process innovation, however, diminishes when firm performance moves above the median line to the 75th quantile and becomes unclear for firms with performance in the top 25th quantile.

Organizational innovation and marketing innovation, however, have a negative and significant impact on firms with performance below the median line. The effects of both innovation types became unclear when examining firms with performance above the median line to the 75th quantile.

Table 3. Effect of types of innovation on firm performance according to different

	25 th quantile	Median	75 th quantile	OLS
PDI	1.627*** (0.227)	1.055*** (0.336)	0.381 (0.323)	1.132*** (0.256)
PCI	0.516* (0.269)	0.643*** (0.24)	-0.701* (0.369)	0.088 (0.24)
ORI	-1.044*** (0.318)	-1.101*** (0.376)	0.121 (0.409)	-0.827*** (0.246)
MKI	-1.043** (0.327)	-1.095*** (0.341)	0.039 (0.324)	-0.607** (0.251)
PDIxPCI	-0.561 (0.372)	0.256 (0.405)	0.878* (0.515)	0.068 (0.367)
ORIxMKI	0.476 (0.309)	-0.356 (0.482)	0.143 (0.574)	0.145 (0.365)
Age	0.001 (0.006)	-0.036*** (0.005)	0.041*** (0.007)	-0.026*** (0.005)
Export	0.001 (0.002)	0.000 (0.002)	0.004 (0.003)	0.001 (0.002)
Size	0.000 (0.000)	0.001*** (0.0002)	0.0005*** (0.0001)	0.0002** (0.0001)
Ownership	-0.001 (0.002)	-1.012*** (0.002)	-0.11** (0.004)	-0.004* (0.002)
Adjusted R-squared	0.0233	0.026	0.022	0.0256
Obs	3,064	3,064	3,064	3,064

Notes: Robust standard errors are reported in parentheses. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels, respectively. In order to save on space, the estimates of constant terms are not reported.

VI. Conclusions and Implications

This study employs the available dataset from the Enterprise Survey in order to explore the innovation behaviors of ASEAN manufacturing firms. We first

analyze the characteristics of innovation in ASEAN countries based on several classifications such as firm age, firm size, export orientation and ownership to see whether there is any difference in the innovation implementation of a firm. We then further empirically test the correlation between types of innovation on firm performance while keeping other independent controlled. In addition, to take into account the potential heterogeneous factors that may exist in the different country groups, we divide the sample into two sub-groups: lower-middle income countries and upper-middle income countries. The quantile regression approach is also employed to provide a more comprehensive view of the effect of innovation types on different quantiles of firm performance.

The preliminary analysis based on various classifications is conducted using the extracted data, and the results are revealed in Section 3. The innovation's "taste" of firms, however, is unbalanced. There is a significant difference in innovation implementation between countries with Vietnam, the Philippines and Malaysia that are the top three countries, where firms have a special focus on conducting innovative activities. Especially, while the Philippines achieved the highest percentage in conducting both product and process innovation, Malaysia is the one most focused on marketing and organizational innovations. Other classifications such as firm size, firm age, exporting activity, and foreign ownership also give us some insights. While small and medium firms keep their technology and non-technology innovation activities similar in terms of percentage, large firms are more likely to focus on technology innovation, with the difference between both types being as much as 30%. Moreover, firm age seems to have little impact on the innovation behaviors of firms, as both young and old firms tend to have a similar percentage of innovation activities in either technological or non-technological. Interestingly, exporting firms have a higher innovation rate in comparison with non-exporters. This implies that in the context of ASEAN countries, the firms with international activities put their focus more on innovation implementation to enhance their comparative advantage to achieve their foreign market success. Similarly, foreign-owned firms have higher innovative activities than domestic-owned, signaling us that FDI is still one of the main mechanisms of innovation in developing countries.

The empirical results are quite different from what we expected. The impact of product innovation is in line with hypotheses, as it significantly and positively affects the firm performance, while the result from process innovation is insignificant, making the effect of this type of innovation still unclear in the case of ASEAN manufacturing firms.

The results of non-technological innovation (marketing and organization) are not in line with the hypotheses, as both marketing and organizational innovations are negatively related to the performance of the firm. Although this is not an often-seen result in previous studies, we found that this is supported by

the study of Atalay (2013). Thus, it is reasonable to argue that the negative results of non-technological innovation only happen in some circumstances and in unique conditions.

Keeping in mind that other heterogeneous characteristics might affect the relationship between innovation and firm performance, we regress this relationship in country-based and income group-based to have a clearer view. In the case of LMIC, marketing and organizational innovations have positive effects on firm sales, but when it comes to UMIC, surprisingly, the impacts of those variables, including product innovation, are negative. We also found that the interaction between marketing and organizational innovation, however, produced a positive effect on firm performance.

The effect of types of innovation on the performance of firms is also different, depending on how well they perform. Based on the results from quantile regression, it has been shown that product and process innovations have a positive impact on low-performance firms (Q25 and Q50), while for organizational and marketing innovations, the impacts are negative at similar quantiles. Besides, it is revealed that process innovation, despite having a positive impact at lower quantiles, has a negative effect on a firm that achieves high sales performance (Q75). This is considerable to the managers of firms that are in this quantile when deciding the type of innovation that should be implemented.

Results from other control variables also support the hypotheses, except with ownership. Surprisingly, the result shows that foreign-owned manufacturing firms in ASEAN are not correlated to firm performance. This could be because the objective of these firms is exporting, and it is more effective to “import” innovation and apply model/structure rather than implement innovation activities.

However, when we take into consideration the results from single-country regressions, the result becomes less coherent, and it is inconclusive. This shows that there are greater factors that are at work besides the already existing variables and more research needs to be done to investigate this problem.

All in all, there are numerous implications to policy makers and firm managers derived from our results. Firstly, there is the existence of heterogeneous factors in specific countries that might have potential effects on the impact of innovation on firm sales. For instance, the effect of process innovation in Vietnam and the Philippines is different, with the positive effect that is seen in the case of the Philippines and otherwise for Vietnam. Similarly, the impact of marketing innovation is also inconclusive. Therefore, the decision makers from these ASEAN countries should keep in mind those differences before implementing any innovation activities. Secondly, the results are also inconsistent even between low and high performance. While product, marketing, and organizational innovation are seen to have consistent effects at the lower

quantiles (Q25 and Q50), the different signs of process innovation between lower and higher quantiles imply that there are other factors that might exist in firms that perform better (Q75). Indeed, while process innovation has a positive effect at lower quantiles, firms that belong to higher quantiles tend to be negatively affected by this innovation type. Thus, firm managers should be sensitive to their innovation activities with regard to their firm performance. Thirdly, firms from ASEAN's upper-middle income countries (Thailand and Malaysia), when conducting non-technological innovation, are encouraged to implement both marketing and organizational innovations simultaneously. The interacting effect of these two types of innovation will cause a positive effect on firm performance, while implementing only one of them might create a negative impact.

This study, despite trying to investigate the relationship between innovation effort and firm performance of manufacturing firms from ASEAN, is not exempt from limitations. The relatively low in terms of R-squared from the regressions of Cambodia and Vietnam (under 10%) suggests that there are heterogeneities that might affect firm performance in these countries. In addition, there is general agreement that innovation should make firms better off, but the ASEAN context does not thoroughly follow it due to the existence of specific circumstances and conditions in this region, suggesting that future studies should attempt to figure it out.

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