Imports of Intermediate Inputs and Product Innovation in Asian Countries

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Abstract. This study examines the role of imports of intermediate inputs in product innovation in the context of ASEAN countries. While there have been many studies examining the role of exporting activities on innovation, the role played by importing activities is less explored. In fact, intermediate input imports can create "learning effects" or "learning-by-importing" effects, which helps spur innovation. Therefore, investigating the role of importing activities is of particular interest. This study contributes to a better understanding of this role of imports of intermediate inputs, which has not been extensively studied in the innovation literature. The study uses data from the "Enterprise Survey" (ES) by the World Bank, which is a large survey covering more than 135,000 firms in 135 countries. This study uses the most recent data of five large ASEAN countries (i.e., Indonesia, Malaysia, the Philippines, Thailand, and Vietnam) in 2015–2016, which forms a cross-sectional sample of 3,928 firms. Several ordinal regression models are utilized in the empirical estimation. The finding shows that imports of intermediate inputs have a significant and positive influence on the possibility of radical product innovation. The result suggests that firms should consider importing high-quality inputs to learn from new, advanced, and relevant technologies embedded in these inputs for the development of new products.

Keywords: ASEAN · Imports of intermediate inputs · Product innovation

1 Introduction

International trade plays an important role in firm innovation because firms can learn a lot of useful things from contact with the outside world (Almodóvar, Saiz-Briones, & Silverman, 2014; Bagheri et al., 2018; Jiang, Branzei, & Xia, 2016). While there have been many studies examining the role of exporting activities on innovation, the role played by importing activities is less explored. In fact, intermediate input imports can create "learning effects" or "learning-by-importing" effects, which helps spur innovation (Almodóvar et al., 2014; Seenaiah & Rath, 2018). Therefore, investigating the role of importing activities is of particular interest.

ASEAN is a dynamic region with rapid economic growth and high trade openness (Goh, Wong, & Yew, 2018). Most ASEAN countries are also aiming at changing their

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economies into a more innovative way (Economic Research Institute for ASEAN and East Asia, 2018). This may lead to the question of whether trading activities, especially imports of intermediate inputs, have any effects on innovation. Thus, this study aims to analyze the role of imports of intermediate inputs in product innovation in the context of the ASEAN region.

The study makes two contributions to the literature. First, the literature on the impact of trade on innovation is dominated by exporting activities (Jiang et al., 2016; Mattoussi & Ayadi, 2016; Olabisi, 2017). Therefore, our study contributes to the limited literature on the role of imports of intermediate inputs on innovation. Second, most papers investigating the impact of intermediate input imports on innovation concentrate on large developing economies such as China and India. There have been no papers on this topic in the ASEAN context. Hence, our study contributes as the first work in the ASEAN region.

The rest of the paper is organized as follows. The next section reviews related literature on the role of imports of intermediate inputs in product innovation. Section 3 describes data and econometric techniques. Section 4 reports empirical results and discusses their implications. The last section concludes and provides some managerial implications.

2 Theoretical Background and Hypotheses

2.1 Imports of Intermediate Inputs and Product Innovation

The literature on the impact of trade on innovation is rich. However, most of these studies focus on exporting activities rather than importing ones. The use of foreign intermediate inputs may contribute positively to the innovation process for several reasons. First, the most mentioned reason is that intermediate input imports can create "learning effects". In particular, firms, especially those in developing countries, can learn from advanced technologies and higher quality components embedded in imported materials that are produced in developed countries. As a result, they can improve their technologies and have more flexibility to create new products (Almodóvar et al., 2014; Seenaiah & Rath, 2018). Second, using inputs from foreign suppliers can enhance communication channels so that firms can learn techniques in designing and developing new products from their foreign counterparts (Keller, 2000). Third, to accommodate foreign inputs, firms may have to adjust their production processes, which may consequently result in developing new or improved products (Abubakar et al., 2019). Finally, many inputs are not available in developing countries. Therefore, imports of these inputs from foreign countries, especially advanced economies, can help domestic firms come up with new products (Shepherd, 2017).

The empirical literature on the impact of intermediate input imports on innovation focus mainly on large developing economies such as China (Chen, Zhang, & Zheng, 2017; Lu & Ng, 2012), and India (Seenaiah & Rath, 2018; Shepherd, 2017).

Lu and Ng (2012), employing data from the World Bank's "Survey of Chinese Enterprises" in early 2003, found that firms' importing activities are associated with more engagement in incremental innovation. It is argued that competitive pressure from

imports is possibly the underlying mechanism of imports' positive impact on incremental innovation.

Chen et al. (2017), using the dataset of Chinese manufacturing firms from 2000 to 2006, found that intermediate input imports raise importing firms' R&D intensity. They developed a theoretical model that explains the mechanism of imports stimulating innovation is through "cost-reducing knowledge spillovers".

Within the context of India, Shepherd (2017) used the most recent survey of the World Bank's "Enterprise Surveys" for Indian firms in 2014, which constructs the sample of 7,161 firms in 19 sectors to investigate the role of importing activities in innovation. The results show that input importers are more likely to introduce new products compared to non-importers. The rationale for this relationship is that importing activities can spur access to superior foreign inputs that encourage new product development.

Seenaiah and Rath (2018), based on the sample of 190 manufacturing firms during the period from 2011 to 2013, found that import intensity positively affects innovation activities. They argue that by importing inputs, firms can reduce production costs and enhance product quality, which consequently encourages them to do innovation.

Recent studies have also investigated the role of intermediate input imports in smaller developing countries. For example, Şeker (2012) studied a sample of more than 40 developing countries. Fritsch and Görg (2015) investigated in the context of 28 emerging economies countries in Central and Eastern Europe, the Baltic, and Central Asia. Bos and Vannoorenberghe (2019) studied this problem in the case of five developing countries (Ghana, Tanzania, Kenya, Uganda, and Bangladesh). These studies show the positive impact of intermediate input imports on innovation.

Overall, there is solid empirical evidence to support the positive impact of intermediate input imports on innovation. Based on the above discussion, we formulate the following hypothesis:

Hypothesis 1: Imports of intermediate inputs are associated with more possibility of radical product innovation.

3 Theoretical Background and Hypotheses

3.1 Data

The study uses data from the "Enterprise Survey" (ES), which is a large survey covering more than 135,000 firms in 135 countries. The ES focuses on firms' business operation and their evaluation of the business environment that may constrain or support their operation (World Bank, 2018). The ES forms a representative sample of private firms in each surveyed countries with the questions answered by business owners and top managers. The methodology and questionnaire are uniform across countries, which allows us to investigate and compare different countries together.

We use the most recent data of five large ASEAN countries (i.e., Indonesia, Malaysia, the Philippines, Thailand, and Vietnam) in 2015–2016, which forms a cross-sectional sample of 3,928 firms. Specifically, except the ES 2016 in Thailand, data for the remaining four countries come from the ES 2015. Finally, we only focus on manufacturing firms in our analysis. According to the "International standard industrial classification of all

Table 1. Summary of firms in the sample

Country	Number of firms	Percentage
Indonesia	1,064	27.09
Malaysia	536	13.65
Philippines	985	25.08
Thailand	672	17.11
Vietnam	671	17.08
Total	3,928	100

economic activities" (ISIC) (Revision 3.1) used in the ES, the two-digit industry codes for manufacturing firms are between 15 and 37 (United Nations Statistical Division, 2002).

Table 1 presents the distribution of firms from five ASEAN countries in our sample. The figures vary by country. Some countries have a higher representation than others. Indonesia accounts for the largest representation (1,064 firms), representing about 27% of the sample. On the contrary, Malaysia has the lowest number of firms (536 firms), representing only 14% of the sample.

3.2 Methods

To examine the role of imports of intermediate inputs in product innovation, we estimate the following model:

$$Innovation_i = \beta_0 + \beta_1 Importing_i + \beta_2 Control_i + \varepsilon_i$$

Dependent Variable
Our measure of product innovation (*Innovation)* has an ordinal characteristics with three values: *Innovation* = 0 if the firm did not conduct product innovation during the last three years, *Innovation* = 1 if the firm conducted "new-only-to-the-firm" innovation during the last three years, and *Innovation* = 2 if the firm introduced "new-to-the-market" innovation during the last three years. As such, the higher value indicates a greater degree of innovation radicalness.

Independent Variables
Our independent variable of interest is *Importing*. *Importing* is a continuous variable that represents the percentage of material inputs or supplies having a foreign origin. Thus, *Importing* has the value ranging from 0 to 100.

Control Variables
We employ some standard control variables that are widely used in previous studies to control for characteristics of the firm, industry, and country (Fernández & Gavilanes, 2017; Fritsch & Görg, 2015; Liu & Qiu, 2016; Silva, Gomes, & Lages, 2017). First, we

account for the role of R&D activities by constructing a dummy variable *R&D*. *R&D* is equal to 1 if the firm performed formal R&D during the last three years and equal to 0 otherwise.

Second, we construct the variable *Age* to take into the time in operation of the firm. As suggested by previous studies, we use the natural logarithm of the firm's total years in operation in the model specification.

Third, we take into account the heterogeneity in terms of firm scale by constructing the variable *Size,* which is measured by the natural logarithm of the total number of employees.

Fourth, *Country* is a vector of dummy variables to control for possible country effects among five ASEAN countries. Thus, we have five dummy variables for five ASEAN countries.

Finally, *Industry* represents a vector of dummy variables to account for industry heterogeneity. In particular, we generate 23 dummy variables that represent the two-digit industry classification of the manufacturing firms.

Empirical Strategy

Because our dependent variable measuring the degree of innovation is constructed in an ordinal fashion, the use of an ordered logit model (OLM) is a common possibility. A crucial assumption of the OLM is the "parallel regression/proportional odds" assumption. However, the Brant test often shows that this assumption is violated in empirical research (Long & Freese, 2006; Williams, 2006). The reason for the common violation of this assumption is that the "parallel regression/proportional odds" assumption requires "unchanged slope coefficients in every response category", which is considered to be overly restrictive (Williams, 2006). As a result, we rely on ordinal regression methods that can relax the "parallel regression/proportional odds" assumption. More specifically, we utilize the generalized ordered logit model (GOLM) by Williams (2006). The advantage of the GOLM is that it only requires "partial proportional odds models". We use the gologit2 command with the autofit option in Stata to estimate the GOLM (Williams, 2006).

4 Results and Analysis

4.1 Descriptive Statistics

Table 2 reports the aggregate descriptive statistics of the main variables in the whole sample. Totally, innovation activities were adopted by more than 21% of firms. Formal R&D activities, which entail high costs, are conducted only by 15% of firms.

Table 3 presents the classification of firms based on types of product innovation and imports of intermediate inputs. Nearly 37% of firms imported material inputs. In addition, it is interesting to find that firms involved in importing material inputs tend to innovate more than those without importing activities. In particular, about 60% of firms importing material inputs have "new-only-to-the-firm" product innovation, and 53% of firms importing material inputs have "new-to-the-market" product innovation.

Table 2. Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Innovation	3,928	0.35	0.71	0	2
Innovation = 0	3,102 (78.97%)				
Innovation = 1	278 (7.08%)				
Innovation = 2	548 (13.95%)				
Importing	3,805	17.71	30.27	0	100
R&D	3,867	0.15	0.36	0	1
Age (log)	3,928	2.79	0.62	0	4.38
Size (log)	3,928	3.98	1.45	0.69	9.90

Innovation = 0: no innovation.
Innovation = 1: "new-only-to-the-firm" innovation.
Innovation = 2: "new-to-the-market" innovation.

Table 3. Classification of firms based on types of product innovation and imports of intermediate inputs

		Imports of intermediate inputs		
Product innovation		No	Yes	Total
	0	2,124	978	3,102
	Percentage	68.47	**31.53**	100
	1	110	168	278
	Percentage	39.57	**60.43**	100
	2	255	293	548
	Percentage	46.53	**53.47**	100
	Total	2,489	1,439	3,928
	Percentage	63.37	36.63	100

Innovation = 0: no product innovation.
Innovation = 1: "new-only-to-the-firm" product innovation.
Innovation = 2: "new-to-the-market" product innovation.

Table 4 summarizes the pairwise correlation coefficients with significance levels between the main exploratory variables. It is important to find that the correlation coefficients between the main exploratory variables are lower than 0.5. Thus, there is no concern of a multicollinearity issue (Dormann et al., 2013).

Table 4. Pairwise correlation

	Importing	R&D	Age (log)	Size (log)
Importing	1			
R&D	0.185***	1		
Age (log)	-0.016	0.047***	1	
Size (log)	0.250***	0.267***	0.206***	1

* p < .10; ** p < .05; *** p < .01

4.2 Empirical Results

Table 5 reports the results from the estimation of both the GOLM and OLM. We begin the analysis with the standard OLM, and the results are presented in Model 3 and 4. To test the popular "parallel regression/proportional odds" assumption, we run the "Brant test", and the results (not presented here for brevity) show strong evidence that this assumption is violated. As a result, we have evidence to conclude that the GOLM is a good alternative. It is also important to learn that the results estimated by both the standard OLM and GOLM are similar, which provides evidence to support the robustness of our results.

The results show, first of all, that imports of intermediate inputs are associated with more possibility of radical product innovation in Model 1 and 2, which supports Hypothesis 1. Our results agree with other prior studies in developing countries (e. g., Bos & Vannoorenberghe, 2019; Lu & Ng, 2012; Seenaiah & Rath, 2018; Şeker, 2012). The main mechanisms for this effect are possibly as follows. Intermediate input imports create "learning effects" or "learning-by-importing" effects. Firms in these ASEAN developing countries generally have lower technological progress compared to those in advanced countries. Therefore, they can learn from advanced technologies and higher quality components embedded in imported materials from developed countries. Consequently, they can improve their technologies and have more flexibility to create new products. Furthermore, there are many intermediate inputs that cannot be produced in ASEAN countries. In such situations, imports of these inputs, especially from developed economies, can contribute significantly to the process of making new products.

As for the effects of the control variables, we find some important results. As for the role of R&D, we find strong evidence that R&D directly stimulates innovation. The positive and significant coefficients of *R&D* in Model 1 and 2 show that firms with formal R&D activities are likely to innovate at a higher degree of radicalness. As depicted in Tidd and Bessant's seminal work, the role of R&D in product innovation in a manufacturing context follows the following mechanism. It begins with identifying interesting products to develop and reviewing established scientific knowledge to support the research process. Then a series of designed experiments in laboratories follow. If there are small-scale successes, they will be manufactured in pilot plants or in prototypes. Gradually, an increasing commitment and involvement of resources, skills, and knowledge sets follow. Finally, the new product is commercially introduced to the market (Tidd & Bessant, 2018).

Table 5. GOLM and OLM results for the effects on radical product innovation

	GOLM		**OLM**
	Model 1		Model 2
	(1)	(2)	
Importing	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)
R&D	1.667***	1.507***	1.586***
	(0.109)	(0.115)	(0.104)
Age (log)	0.341***	0.341***	0.336***
	(0.076)	(0.076)	(0.076)
Size (log)	0.097***	0.097***	0.100***
	(0.033)	(0.033)	(0.033)
Country (dummy variables)	Yes	Yes	Yes
Industry (dummy variables)	Yes	Yes	Yes
Constant	-3.290***	-3.953***	
	(0.774)	(0.775)	
/cut1			3.322
			(0.772)
/cut2			3.921
			(0.773)
LR χ^2	725.88		653.9
Prob > χ^2	0.0000		0.0000
Observations	3,748		3,748

Numbers in parenthesis denote standard errors. * p < .10; ** p < .05; *** p < .01.
(1) no product innovation vs. "new-only-to-the-firm" or "new-to-the-market" product innovation.
(2) no or "new-only-to-the-firm" product innovation vs. "new-to-the-market" product innovation.

Firm size (*Size*) has positive and statistically significant coefficients in all models, suggesting that larger firms tend to be more innovative. It is possible that larger firms might have more tangible and intangible resources to upgrade existing knowledge, which leads to more innovation.

Furthermore, firm age (*Age*) also has positive and statistically significant coefficients in all models, suggesting that older firms tend to be more innovative. The possible explanation is that older firms can accumulate more knowledge stock about technologies, customers, and markets, which helps contribute positively to their innovation efforts.

5 Conclusion

This study explores the role of imports of intermediate inputs in product innovation in the context of the ASEAN region. Our econometric evidence suggests that imported inputs have a significant and positive influence on the possibility of radical product innovation.

The study has some important implications from a management perspective. The results highlight the positive role of importing intermediate inputs in promoting radical product innovation. This suggests that the management should pay more attention to this activity. Specifically, firms should consider importing high-quality inputs to learn from new, advanced, and relevant technologies embedded in these inputs for the development of new products.

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