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RESEARCH PAPER

The Impact of Technological Innovation on the Performance of Vietnamese Firms

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Abstract
Technological innovation applied in production processes, product quality, and new product expansion contributes to changing firm performance. Thus, this study was conducted to investigate the impact level of technological innovation on financial performance of Vietnamese firms. Data was collected from 8,960 firms for the period of 2015-2018. Pooled OLS, FEM, and REM were employed for processing data. The results showed that there was not enough evidence to state that technological innovation influences firm performance of small and medium firms but significant impacts were found on the performance of medium and large firms. The findings also illustrated that regional determinants affect technological innovation of firms in emerging countries in general and in Vietnam in particular. The results of this research imply that successful firms are constantly creating and distributing new technological innovation and rapidly applying it to new technologies and products to have a better performance.

Keywords: technological innovation; performance; technological capacity; financial capacity

1. Introduction

Today, innovation technology has become the development trend. It has a significant impact on industries and plays an important role in business growth (Tran, 2014). Technology is seen as a critical factor in helping firms become more competitive, increase their revenues, reduce their costs, and have profit maximization (Quan & Nguyen, 2014). It has shown that many firms in the world have very distinct technological innovation plans, adapted to the financial status and business characteristics. This brings about a positive impact on the business growth, especially for large firms that are always proactive in the adaptation and innovation of technology for reducing costs, improving productivity, and achieving better operational outcomes.

Technological innovation in manufacturing linked to products, services, and processes is intended to reduce production costs by creating new combinations of inputs (Jin & Choi, 2019). Innovative technologies bring value to firms. The new technologies applied to the production process lead to significant changes in production organization, product improvement, and service quality. In addition, technological innovation is defined as the information used to develop and implement ideas and activities throughout the business process (Nham et al., 2016). Technological innovation is also important in promoting competitiveness and increasing operational performance. In many lines of business, innovation is even a business in itself, e.g., high-tech or biotechnology firms (Cusick, 2013). As a result, innovation is important in business to help firms become stronger in a competitive environment based on sustainable values.

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Firms have different financial capacities and technology application abilities. Therefore, they will consider making different technological innovation decisions. The board of management will assess the financial situation, the necessity of innovation, and a number of factors to ensure that technological innovation is the right step and brings efficiency. Many firms, especially small and medium ones, do not have the capacity to conduct technological innovations. In these cases, firm performance after technological innovation can fail to meet expectations. Thus, before deciding to come up with an innovation strategy, firm management has to consider determinants that influence this technological innovation (Azarmi, 2015). This will reduce risks involved in the application of new technologies.

However, technological innovation for sustainable development has been investigated in many countries, both developed and developing countries. However, study on technological innovation is not yet much investigated in the context of Vietnam. Some studies have not explained clearly and specifically the determinants that influence technological innovation. These studies also have not assessed the impact of technological innovation on firm performance. Determinants in these studies focus on some technology innovation issues in small and medium firms. In these studies, the impact of technological innovation on firm performance has not been shown under firm size and business lines (Amiolemen et al., 2015). Thus, the examination of the technological innovation effect on performance in the context of the countries like Vietnam is new and significant for management in pursuing innovation of technology.

In this study, technological innovation and performance are measured. In Section 2 of this article, the impact level of technological innovation on firm performance is scrutinized under the aspects of firm size, business lines, and geographical locations that prior studies, to some extent, have not been yet much investigated. In section 3, based on the findings in this research, the relationship of technological innovation and financial performance is answered. Then, the way to invest the innovation of technology and the appropriate level to investigate in order to have high financial performance are explored in Section 4.

2. Literature Review

2.1. Determinants Influencing Firm's Technological Innovation

Technological innovation is regarded as one of the most important determinants when firms want to enhance firm performance. The decision to innovate the technology of firms depends on many determinants. There are some internal factors from their business activities. However, there are also external determinants from macro economy to influence their operations. Many previous studies have investigated the determinants influencing technological innovation of firms.

Technological innovation is viewed as a method of combining manufacturing elements that result from a change in input to generate output (Schumpeter, 1939). Another concept of technological innovation has been explained more specifically in the study of Feifei and Li (2007). They deem that technological innovation is a process that includes a wide range of activities from forming new ideas, designing, modeling products, producing in large quantities, marketing, and commercializing in the market. It requires the smooth application of human knowledge to create new techniques to be applied in production and firm business activities.

Recently, technological innovation has received more attention from the management of firms, especially small and medium enterprises (SMEs). Technological innovation in the production of SMEs is investigated in the studies of Kim et al. (2012) and Shashi et al. (2019). They conclude that active technological innovation helps firms innovate their

production processes and products. That is the driving force that increases the development ability as well as competitive advantages for firms when entering new markets (Becheikh et al., 2006).

Following this trend, studies conducted by Ayyagari et al. (2011) and Lee et al. (2015) explored the issue that if a firm is innovative or not based on three criteria, namely innovation in the production process, innovation in product quality, and innovation by launching new products. In particular, they point out that many influencing factors need to be considered to get those technological innovations.

Financial Factor

Financial support policies often have a significant impact on the technological innovation of firms. Bayarçelik et al. (2014) proposed eleven determinants influencing the technological innovation of SMEs, including the financial one. It is one of four determinants that have the strongest impact on technological innovation of SMEs, besides the three determinants of management skills, technological capacity, and firm size.

Discussing how access to finance affects innovation, Kerr and Nanda (2014) argue that capital structure, especially access to banking finance, has a strong impact on innovation outcomes of firms. Meanwhile, Fombang and Adjasi (2018) also investigated the impact of formal and informal financial access in capital structure on the technological innovation of firms. They revealed that access to finance such as overdrafts, financial assets, and trade credit had encouraged technological innovation. Financing by overdraft strongly promoted technological innovation of firms in their sample countries. Meanwhile, trade credit and financial assets only boosted the innovation of firms in Nigeria, South Africa, and Cameroon.Likewise, based on a survey study, Wellalage and Fernandez (2019) specifically emphasized once again the role of formal finance for SMEs.

In addition to the determinants of financial access, capital structure, andfinancial difficulties of firms also affects the technological innovation of firms. The degree of financial difficulty influencing technological innovation of firms in Portugal was investigated in the study of Silva and Carreira (2012). They concluded that financial constraints harm investment in technological innovation. The impact of financial barriers on the success of technological innovation was examined in the study of Garcia-Quevedo et al. (2018). They detected the significant impact of financial difficulties on the choice of technology innovation projects of Spanish firms. Technological innovation project selection was found to be sensitive to financial barriers (Quan & Nguyen, 2014).

In addition, the issues of financial capacity of firms are also recognized in criteria such as revenue (Quan & Nguyen, 2014), conditions for accessing capital of the economy, market size, growth, and substitutes (Azarmi, 2015). All of these criteria can have a positive or negative impact on a firm’s decision to innovate technology.

It can be seen that although there are many studies investigating the determinants that promote technological innovation of firms, finance is viewed to be the most important determinant for the success of innovation. To some extent, financial capacity influences different levels of technological innovation of firms. At the same time, the financial capacity of firms with different capital sizes may have certain differences. Most of the studies so far have focused on investigating the financial capacity of SMEs, but the aspect of firm size is not filled. Therefore, to clarify the effect of the financial capacity factor on the technological innovation of firms, it is necessary to test dummy variables of firm size in the study. The addition of the size variable, emphasizing capital size, capital structure, and financial advantages or disadvantages should be put in the research model. This is supported in studies

of Penrose (1959) and Barringer and Jones (2004). In contrast, from an agility point of view, smaller firms can react more quickly because they are often less burdened by management (Miller & Toulouse, 1986). However, the firm size depends on the number of employees of firms. That is why, besides the financial scale, the number of employees was also included in this study.

Management Qualification as a Determinant

Management qualification is mentioned in many studies as effective on technological innovation of firms. However, most of the studies only focus on the technological innovation of SMEs, and there are no extensive assessments according to firm size.

Abereijo et al. (2007) maintain that management qualification is regarded as one of the important internal determinants influencing technological innovation of SMEs in Nigeria. They show that experience, knowledge of managers, and skills of human resources have an impact on the technological innovation of SMEs. This determinant is supported by the study of Phan (2019). The findings of Phan's study reveal that innovation in organization and innovation in business practices are positively associated with firm performance. Bayarçelik et al. (2014) indicate that besides financial factors, technological capabilities, and business size, management skills have a strong impact on technology innovation of SMEs. SMEs' ability to innovate is significantly related to several determinants of higher education, science or engineering education, and relevant work experience in large/multinational firms and university/research institute of the founder/manager. These are very important determinants in improving technology learning and innovation achievement in SMEs.

According to Azarmi (2005), the characteristics of those who have rights or participate in the process of technological innovation and commercialization are added, among which the education level is viewed to be the most important assessment criteria. Education level is an important factor in the selection and decision-making of technological innovation in virtually all firms in practice. The role of this factor is also confirmed in the study of Quan and Nguyen (2014). Education level also has a positive impact on the results of technological innovation of firms.

Besides, the determinant of leadership inspires and management capacity strongly influence technologicalinnovation. This result reveals the impact of management quality on technological innovation of all firms, in particular the Vietnamese firms (Nguyen et al., 2020; Pham and Hoang, 2019).

Technological Capacity as a Determinant

It can be said that it is very expensive and time consuming to develop and apply a new technology product. The number of technology research and development initiatives of firms is influenced by investment costs (Bayarçelik et al., 2014). Firms are forced to cooperate with each other to promote product development. However, this promotion is not easy. Costs and risks are high (Gnyawali & Park, 2009). According to Subrahmanya (2009), firms' technological innovations are based on internal technological capabilities. In addition, it is important to note that training on job is an ongoing process. To innovate the production process and expand new products, firms need to invest in purchasing technology, machinery, and equipment (Bayarçelik et al., 2014). This is an important basis for innovation.

Research by Quan and Nguyen (2014) also looks into the difficulty of accessing scientific and technological information for innovation. Besides, technological innovation is often influenced by a system, i.e., this innovation does not only regard individuals, but sometimes it

is a chain of links among firms. It even has links among firms and research institutes, universities, and local authorities, which will make it easier for firms to study the process and disseminate the results of innovation to everyone. Similarly, Carboni (2011) believes that the attitude of the government, reflected in the funding policies for R&D innovation activities, is an important driving force in promoting the creativity and innovation of firms. Thus, supportive policies from the government are also a determinant that needs to be investigated.

In general, finance, size, management level, and technological capacity are identified as determinants influencing technological innovation process of firms. The previous literature points out some other elements that are more or less influential such as firm culture, ideology, or organization of firm. However, prior studies mainly focus on SMEs. There are no tests or comparisons of firm size, including financial capacity and number of employees.

In addition, regions with different levels of technological development will directly affect the success of technological innovation of firms. The firm location element is inspected in the studies of McCann and Folta (2008) and Feldman and Kogler (2010). Elements about the specialization of labor and the level of technology in the business sector are also examined in the study of Prevezer (1997). Therefore, to evaluate determinants influencing technological innovation, it is necessary to add the firm location in the research model. To verify that businesses operating in locations with better technological development conditions will be more favorable in technological innovation. Therefore, we design a hypothesis as below:

Hypothesis 1 (H1): There are some determinants influencing technological innovation of firms.

H1.1: Financial factors (including capital structure and financial constraints) have an impact on technological innovation.

H1.2: Management ability has an impact on technological innovation.

H1.3: Technological capacity has a positive impact on technological innovation

2.2. Impact of Technological Innovation on Firm Performance

Firm Performance and Its Measurement

Firm performance represents the firm's level of achieving its objectives. There are some criteria to measure it, such as revenue, profitability, and other strategic goals (Cyert & March, 1992). Besides, according to Kaplan and Norton (1993), business performance is determined from traditional financial indicators expressed by specific figures and non-financial factors such as customer satisfaction, learning efforts, and employee development.

Moreover, Nguyen and Dang (2017) suggest that firm performance is measured by financial indicators such as return on assets (ROA), return on sales (ROS), and return on equity (ROE); non-financial indicators such as customer satisfaction and average number of new customers; or social performance such as creating more jobs and improving living standards for workers.

Impact of Technological Innovation on Firm Performance

Innovation is recognized as an important motivation for economic growth and development (Bosworth & Collins, 2003). Technology innovation is considered as an important strategy affecting firm performance. Firms' financial indicators such as revenue and profit are selected as the scale to evaluate firm performance. Akinwale et al. (2017) investigated the impact level of technological innovation on profitability and revenue of SMEs. Technological innovation

brings about a more competitive advantage as it innovates the technology of production process and lead to the creation of some new products.

Geroski et al. (1993) assert that firms generate profits, and are associated with the new production process, a new product, and innovation. Their study evaluated the effects of a major innovation on the profitability of United Kingdom firms. It showed the strength of innovative activities in production to create a competitive advantage and the improvement of their revenue and profitability. Manufacturing firms innovate technology to help allocate assets more efficiently.

Tajeddini (2011) conducted a study on the impact of some determinants on both effectiveness and efficiency of Iranian restaurant performance and concluded that innovation has a positive impact on operating effectiveness and a strong impact on cost efficiency.

Technological innovation not only affects profit and revenue, but also influences other profitability indicators of firms. According to Baba et al. (2018), the effectiveness of technological innovation - including product innovation, process innovation, and advanced technology - influences firm's profitability. Innovative firms invest more capital in new technologies to improve production. They collaborate with research organizations to enhance business innovation positively and significantly. Thus, firms are encouraged to spend more money on research related to the improvement of products, equipment, and technology to create an advantage in revenue and production capacity (Akinwale et al., 2017).

Jin and Choi (2019) maintained that technological innovation contributes significantly to increased sustainable performance. Some determinants of technological innovation, product innovation, process innovation, and R&D cooperation have an important impact on sustainable performance of SMEs and large firms in the context of Korea. The results are completely consistent with previous studies. The study showed that technological innovation has a positive impact on revenue growth and profitability and a marked improvement in firm performance.

Adeyeye et al. (2013) examined the impact of technology innovation and R&D on firms' performance in service companies in the context of Nigeria. They concluded that technology innovation and R&D have a positive impact on the performance of service firms. However, the study only focused on service firms. It did not take into account the technology changes in production as well as the scale of operation and location of firms. Continuing research on the impact of technological innovation on the service firms' performance in Nigeria, the study of Akinwale et al. (2017) examined the impact of R&D, production, and process innovation on SMEs' performance in the manufacturing industry in Nigeria. It showed that more expenditure in R&D and other technologies leads to an increase SMEs' revenue, but no evidence was found to support the effect of innovation on SMEs' performance. The influence degree and regional differences of various factors influencing the green innovation efficiency of high-tech industry in China were conducted by Liu et al. (2020). However, this study only focused on the high-tech sector focused on the technological innovation in green technology. Business performance was measured based on the green technology innovation efficiency. The determinants of production process, revenue, and market share were not considered in this study. Oduro (2019) suggested that technological innovation also has a positive impact on the firm performance in sales, profit, and market share aspects. With advanced production processes, now workers only play the role of machine operators, not needing as much manpower as before. The innovation creates firm's value. Therefore, costs of manpower are saved. Moreover, the quantity and quality of products are increasingly improved. Therefore, firms increase competitiveness, meet customer expectations, expand market share, and dominate the market. The results of Akinwale's empirical research also show that innovation efforts contribute positively and significantly to product and process innovations (Akinwale,

2020). Meanwhile, production process innovation is positively significant in affecting the financial performance of Micro, Small and Medium firms (MSMEs), while the effect of product innovation, although positive, is insignificant. This implies that top management should focus more on production process innovation in order to improve financial performance of firms.

Advances in technological innovation can dramatically change an organization's performance, such as increasing sales performance, transforming business models, and stimulating innovation in other areas. Innovation in companies is an important step that plays a key role in increasing sustainable performance in all aspects. The impact of technology innovation policies on the sustainable development of firms is also much interested in the study of Tran (2014). Technological innovation is regarded as a decisive element in increasing productivity; improving the value and quality of products, goods and services; and enhancing the competitiveness of business to promote socio-economic growth.

The results of the research by Nham et al. (2016) also illustrated that technological innovation of firms include product, process, marketing, and organization. The innovation creates firm's value and takes advantage of competition of firms. However, the study only assessed the impact for the supporting industry in Hanoi, Vietnam. There are no general evaluations as for firms in different industries or firm locations. The firm size has not been put in the model of the study either.

Tajpour and Hosseini (2021) investigated the impact of entrepreneurial intention on performance development mediated by social media in digital start-ups. They conclude that successful companies are constantly renovating and distributing new knowledge and rapidly employing it to new technologies and products, and in consequence for having a better performance.

In short, there have been some studies on the impact of technological innovation on firm performance, but most of them focus only on SMEs, with less attention paid to how innovation impacts medium or large firms. Therefore, it is necessary to have more complete and extensive investigation of the impact of technological innovation on the performance of different types of firms, especially in emerging countries and Vietnam as the case study. In addition, firm location has not been examined in previous studies. Therefore, it is necessary to scrutinize the role of firm location in the model of technological innovation on firm performance. Based on the considerations, the following hypothesis is proposed:

Hypothesis 2 (H2): Technological innovation has an impact on firm performance.

H2.1: Technological innovation has a positive impact on sales of firms

H2.2: Technological innovation has a positive impact on profit of firms

H2.3: Technological innovation has a positive impact on ROA of firms

Based on the hypotheses of H1 and H2, the impact model of technological innovation on firm performance is developed as below:

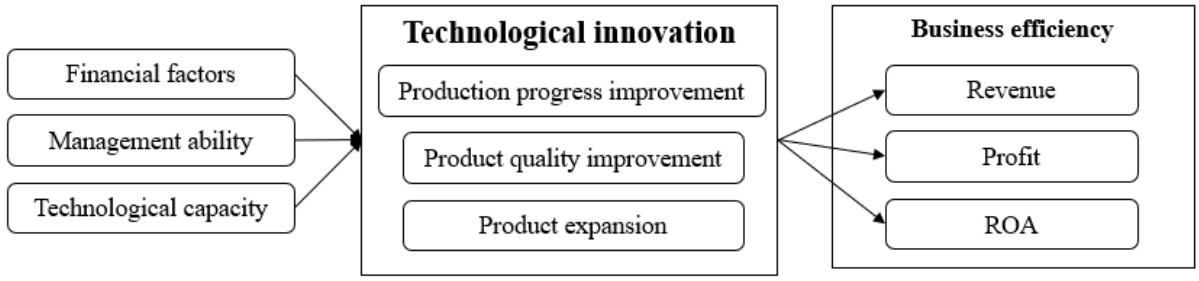

Fig. 1. Proposed Research Model

3. Research Methodology

3.1. Data Collection

Data was collected from more than 8,000 firms. To assess the impact of technological innovation on firm performance, the data was gathered from the dataset conducted annually by the General Statistics Office of Vietnam for the period between 2015 and 2018.

Based on the tax code of firms, technology innovation and performance data are filtered from two sets of data. The data has sufficient information for the period from 2015 to 2018, with information of firm performance and levels of technological innovation of those firms. The calculation of the information and the extraction of the indicators were necessary for the study. The missing observations were also removed or supplemented according to the mean or median, and the errors leading to inappropriateness or a decrease in the reliability of the regression results were also removed. The data gave in 2,240 observations for one year, so in the period of four years, we had 8,960 observations.

In the population of 2,240 firms, private firms accounted for 10.88%, limited liability firms and limited liability firms with state owned capital less than 50% comprised 36.8%, state owned firms accounted for 18.58%, and 100% foreign owned firms made up 27.37%. In addition, it can be noticed that some firms have changed the type of business ownership over the years, but this number is insignificant in the population (less than 3%).

Besides the type of business, the firm size also significantly affects technological innovation and firm performance. The information of firm sample is illustrated in Table 1 below.

Table 1. Structure of Surveyed Firms by Size

Firm size	2015		2016		2017		2018	
	No. of firms	**%**	**No. of firms**	**%**	**No. of firms**	**%**	**No. of firms**	**%**
Micro firms	119	5.31	125	5.58%	155	6.92%	204	9.11%
Small firms	1,455	64.96%	1,464	65.36%	1,432	63.93%	1,396	62.32%
Medium firms	163	7.28%	151	6.74%	153	6.83%	149	6.65%
Large firms	503	22.46%	500	22.32%	500	22.32%	491	21.92%
Total	**2,240**	**100%**	**2,240**	**100%**	**2,240**	**100%**	**2,240**	**100%**

Table 1 reveals that SMEs account for more than 70% of the firms under study, i.e., they form the majority of sample. The number of large firms accounted for about 22% of the sample. This survey data is completely consistent with the features of firm size in the context of Vietnam where almost all firms are SMEs.

Moreover, the characteristics of the firm sectors also significantly influence technological innovation. The survey results show that out of the total number of firms surveyed, about 17% of companies belong to the food production and processing industry, followed by the manufacturing of rubber and plastic products, the production of products from other non-metallic mining, and the production of products from precast metals (except for machinery and equipment). Enterprises in each industry accounts for about 9% of the surveyed data.

3.2. Variable Measurement

On the basis of the firm characteristics in the technological innovation and the results of previous studies,variables in this model were chose . Table 2 presents the way in which the variables of the study are measured.

Table 2. Variable Measurement

Variables	Coding	Details	Sources
Technological innovation	INNO1	Dummy variable, INNO1 is 1 when a firm pursues a strategy to improve the production process	Le (2019)
	INNO2	Dummy variable, INNO2 is 1 when a firm pursues strategies to improve product quality	
	INNO3	Dummy variable, INNO3 is 1 when a firm pursues a strategy of expanding a variety of products	
	INNO	Dummy variable, INNO is 1 when at least 1 out of 3 variables INNO1, INNO2, INNO3 equals 1.	
Financial factor	FIN1	Debt-to-equity ratio of firms	Kerr & Nanda (2014)
	FIN2	The scale of a firm has financial difficulties that lead to delays or obstructions in the performance of the firm	Silva & Carreira (2012)
Management ability	EDU	Dummy variable, classification based on the trained qualifications of the owner, consisting of nine types.	Abereijo et al. (2007)
Technological capacity	COST	The total cost of purchasing technology, machinery, and equipment	Bayarçelik et al. (2014)
	PRJ	Number of projects, technology research, and development initiatives of firms	
	LOI	Number of patents of firms	
Firm performance	FP1	Net revenue in sales and service provision	Jin & Choi (2019)
	FP2	Profit after corporate income tax	Baba et al. (2018)
	FP3	ROA - Return on assets	Xu et al. (2019)

The scale of a firm poses financial difficulties that lead to delays or obstructions in the performance of the firm (Appendix 1). Dummy variables of management ability are classified based on the trained qualifications of the business owner, consisting of nine types (Appendix 2).

Beside variables above, other variables affect the level of explanation for technological innovation and the impact of technological innovation on the firm performance. Control variables including firm size and firm location, which are also used in the regression model.

Control Variable of Firm Size

The impact of firm size is predicted differently from resource-based perspective (Penrose, 1959) and growth perspective (Barringer & Jones, 2004). Then, larger firms have more human resources. They have greater management skill. It is the advantage to promote firm's growths(Barringer & Jones, 2004; Penrose, 1959). In contrast, from the view of rapid growth, smaller firms can react faster because they are often less burdened by the management organization (Miller & Toulouse, 1986). In general, large human resources can be advantageous and disadvantageous for a firm. In this study, firm size was calculated based on measurement method suggested in the study of Shiu (2006):

SIZE = ln (Total labor of firms)

Control Variable of Firm Place/Location

Location is always one of factors of the success of a firm's innovation (Feldman & Kogler, 2010; McCann & Folta, 2008). Marshall (1920) maintained that firms located in developed technology areas have more advantages. The three areas have been suggested as specialized labor, specialized inputs, and knowledge spread (Prevezer, 1997). Therefore, to test this

element in the context of Vietnam, place was regarded as a dummy variable and divided into six areas of Red River Delta, Northern Midland and Mountainous, North Central and Central Coast, Central Highlands, Southeast, and Mekong Delta (Appendix 3).

3.3. Research Models and Hypotheses

To assess the impact of technological innovation on the firm performance, the models were designed for testing hypotheses as follows.

To test the hypothesis H1, the research model 1 was developed from financial and technological capacity determinants:

Model 1: Simultaneous Impact of Financial and Technological Capacity Factors on Technological Innovation of Firms

$$INNO = \beta_1 FIN1 + \beta_2 FIN2 + \beta_3 COST + \beta_4 PRJ + \beta_5 LOI + \beta_6 EDU + \beta_7 CONTROL + u \quad (1\text{-}1)$$

Based on the survey data, the data collection was discrete and non-linear. Since ordinary least squares (OLS) testing was inappropriate, the logistic model with maximum likelihood regression was selected. The maximum likelihood regression method requires an assumption of the probability distribution function form. The logistic model will specifically employ the standard logistic distribution function. The logistic model describes the relationship between p_i- dependent variable and X_2,..., X_k- independent variables through logistic distribution:

$$p_i = \frac{exp\left(\beta_1 + \beta_2 X_{2i} + ... + \beta_k X_{ki}\right)}{1 + exp\left(\beta_1 + \beta_2 X_{2i} + ... + \beta_k X_{ki}\right)} \quad (1\text{-}2)$$

The impact of X_j, j = 2,…, k on p_i is estimated by:

$$\frac{\partial p_i}{\partial X_j} = p_i\left(1 - p_i\right)\beta_1, j = 1,...,k \quad (1\text{-}3)$$

then,

$$\frac{p_i}{1 - p_i} = exp\left(\beta_1 + \beta_2 X_{2i} + ... + \beta_k X_{ki}\right) \quad (1\text{-}4)$$

or:

$$ln\left(\frac{p_i}{1 - p_i}\right) = \beta_1 + \beta_2 X_{2i} + ... + \beta_k X_{ki} \quad (1\text{-}5)$$

After linearization, the logarithm of OR ($\frac{p_i}{1-p_i}$) ratio has a linear relationship with dependent variables. If the estimation is positive, the ratio will be proportional to the explanatory variables. If it is not, the estimation is negative.

To ensure the selected logistic model is suitable, the Linktest and Hosmer - Lemeshow test are conducted. With linktest testing, if a regression equation (or the same form of regression) is built correctly, it will not be possible to find an additional meaningful independent variable. This regression tests the model by adding an independent variable, which will be considered a lack of important variables if the added variable makes sense. With each estimation results, the _hat variable with p-value < 0.05 illustrates that the independent variables in use has statistical significance, and the _hatsq (the variable that is assumed after adding another explanation variable to the model) has p-value > 0.05, meaning that the other explanation

variable added has no statistical significance. From there, it is possible to assure that the model uses the appropriate variables as well without missing important variables.

Through Hosmer-Lemeshow test, the distribution probability of observed values is hypothesized as H_0. This test compares the observed values with the estimated ones. The more similar these two values are, the more suitable the model is. The P-value > 0.05 will show that there is not enough evidence to reject H_0.

Based on hypothesis H2, the regression model is developed as follows:

Model 2: The Impact of Technological Innovation on Sales

$$FP1 = \beta_1 INNO1 + \beta_2 INNO2 + \beta_3 INNO3 + \beta_2 CONTROL + u \quad (2\text{-}1)$$

Model 3: The Impact of Technological Innovation on Profit

$$FP2 = \beta_1 INNO1 + \beta_2 INNO2 + \beta_3 INNO3 + \beta_2 CONTROL + u \quad (2\text{-}2)$$

Model 4: The Impact of Technological Innovation on Productivity

$$FP3_t = \beta_1 INNO1_{t-k} + \beta_2 INNO2_{t-k} + \beta_3 INNO3_{t-k} + \beta_2 CONTROL + u \quad (k = 0,..,3 \quad (2\text{-}3)$$

The model assesses the impact of technological innovation on firm performance. Dependent variables are linear and panel data. The Breusch-Pagan LM Test, F-test, and Hausman Test will be employed for selecting the optimal model between the Pooled OLS, REM, and FEM.

For OLS method, the basic assumptions are: (i) Research samples are random and independent; (ii) Expect the random error equal to 0; (iii) The random error is the same; (iv) There is no perfect multicollinearity between independent variables.

For Pooled OLS method, the assumption is that the regression coefficient is unchanged and constant over time. According to Gujarati and Porter (2009), another important assumption is that independent variables must be strictly exogenous, which means they will not depend on past, present, and future values of random errors. The model of the relationship between dependent variable Y and independent variables X_2,..., X_k through the equation is as follows:

$$Y_{it} = \beta_{1i} + \beta_2 X_{2it} + ... + \beta_k X_{kit} + u_{it} \quad (2\text{-}4)$$

where

Y_{it} is the dependent variable value of individual i during the period t

X_{2it},..., X_{kit} is the value of X_2, …, X_k independent variables of individual i in the period t.

However, the assumption of the model is unlikely in practice, given that the intercept coefficients are unchanged between observed individuals and are constant over time. This can lead to random errors that are correlated with the explanatory variables, which in turn cause biased estimator and inconsistent estimator.

For FEM approach, the assumption is also that each variable has its intercept coefficient. This intercept coefficient is constant over time. It means that the specified impact is considered independent (Gujarati & Porter, 2009).

The model of the relationship between dependent variable Y and independent variables X_2,..., X_k through an equation is as follows:

$$Y_{it} = \beta_{1i} + \beta_2 X_{2it} + ... + \beta_k X_{kit} + u_{it} \quad (2\text{-}5)$$

where

Y_{it} is the dependent variable (Yi during the period t)

X_{2it}, …, X_{kit} is the value of independent variables, X_2,..., X_k of each variable i in the period t

β_{1i} is the intercept coefficient of each coefficient i

By considering separate intercept coefficients, the model analyzes this correlation between the residuals of each dependent variable and explanation variables, thereby controlling and separating the influence of characteristics (which are unchanged over time) from the explanation variables so that the effects of the explanatory variable on the dependent variable are estimated.

For REM method, the random error is divided into two parts as the random error of each dependent variable and the random error based on time series and cross-section analysis (Gujarati & Porter, 2009). The model comes from the following equation:

$$Y_{it} = \beta_{1i} + \beta_2 X_{2it} + \ldots + \beta_k X_{kit} + u_{it} \quad (2\text{-}6)$$

However, the REM model assumes that the coefficient β_1 is a random variable with an average γ_1 of the coefficient isas follows:

$$\beta_{1i} = \gamma_1 + \varepsilon_i \left(i = 1, 2, ..., n\right) \quad (2\text{-}7)$$

Instead of the original model, we have:

$$Y_{it} = \gamma_1 + \beta_2 X_{2it} + ... + \beta_k X_{kit} + \varepsilon_i + u_{it} \quad (2\text{-}8)$$

$$\Leftrightarrow Y_{it} = \gamma_1 + \beta_2 X_{2it} + ... + \beta_k X_{kit} + w_{it} \quad \text{where} \quad w_{it} = \varepsilon_i + u_{it} \quad (2\text{-}9)$$

Where

w_{it} is a composite error term.

ε_i is a random error term with a mean value of zero.

u_{it} is a random error, which is the combined time series and cross-section error component and is called the idiosyncratic term because it varies over cross-section.

From the above results, we analyze the impact of each innovation strategy on each group of firms or the dataset.

Selection Tests of Pooled OLS, FEM, and REM

According to previous studies by Gujarati and Porter (2009) and Baltagi (2005), to choose models with the appropriate approach, tests should be estimated as follows:

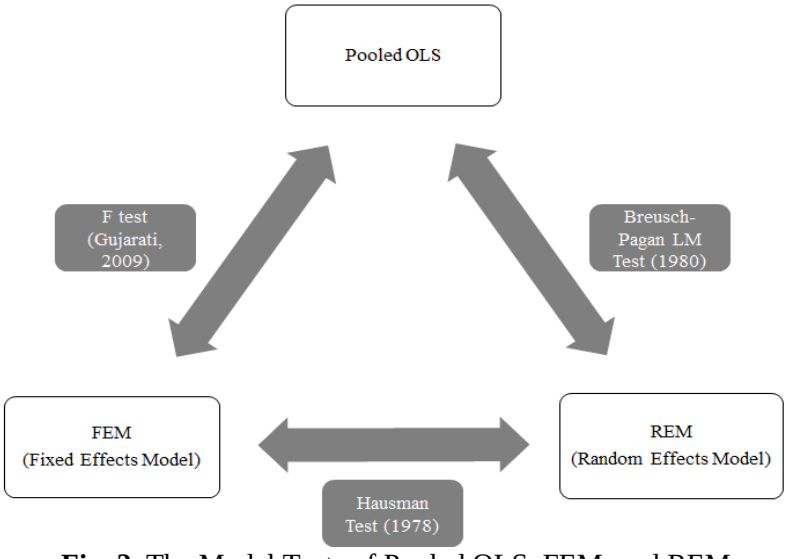

Fig. 2. The Model Tests of Pooled OLS, FEM, and REM

Hausman TEST

The test is used for differentiating between FEM and REM methods in explaining dependent variables. According to Hausman (1978), the null and alternative hypotheses are defined as follows:

H0: The appropriate model has random effects.

H1: The appropriate model has fixed effects.

If *(Prob > Chi2)* is less than 0.05, which means the null hypothesis is rejected, it can be assumed that the estimated results from the FEM are more appropriate.

Breusch-Pagan Lagrange Multiplier Test

The test is employed to choose between Pooled OLS and REM, which is better at explaining dependent variables. The null hypothesis suggests that no significant differences have been observed between individuals. The null and alternative hypotheses are defined as follows:

H0: Pooled OLS model fits the data.

H1: The REM model fits the data.

If *(Prob > Chi2)* is less than 0.05, which means that the null hypothesis is rejected, it can be assumed that the estimations from the FEM are more appropriate.

F-Test

F-test is used to choose between Pooled OLS and REM methods and see which method has better estimates in explaining dependent variables. The null and alternative hypotheses are defined as follows:

H0: Pooled OLS model fits the data.

H1: FEM model fits the data.

If *(Prob > F)* is greater than 0.05, the null hypothesis is accepted, which means that there is no difference of estimations when considering both characteristics and time factors. Then it can be concluded that the estimation from the FEM model is more appropriate.

Dynamic Regression Model - Distributed-Lag Model

By analyzing time-series metrics, if the regression model includes not only the current values but also the lagged values (past values) of the explanations (X variables), that model is called the distributed-lag model. These models are also known as dynamic models because they describe how variables have the relationship with their past values. Based on the study of Gujarati and Porter (2009), a distributed-lag model is calculated as follows:

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + u_t \quad (3\text{-}1)$$

The OLS method can be used to estimate a purely distributed-lag model, although there will likely be problems with multi-linearity because the serial latency values of an independent variable tend to be related to each other.

Although there will be problems in the estimation, dynamic models will be useful because they take into consideration the time factor, which makes the theory of static economics dynamic. These models help differentiate the short-term and long-term reactions of dependent variables according to the change of a unit of the explained variable value.

We selected techniques for processing data based on the prior studies of Gujarati and Porter (2009), Baltagi (2005), and Hausman (1978).

4. Results and Discussion

4.1. Determinants Influencing the Technological Innovation of Firms

The impact of determinants on technological innovation is estimated by the logistic model with the maximum likelihood estimating method, the results of which are shown in Table 3 below.

Table 3. Impact of Determinants on Technological Innovation

	Coefficient		**Coefficient**
R-squared = 0.1196		**R-squared = 0.1196**	
FIN1	0.0007479 (*)	EDU_2	-0.5282168 (**)
FIN2_1	0.1267051	EDU_3	-0.195445
FIN2_2	0.3203832	EDU_4	0.0710928
FIN2_3	0.0869193	EDU_5	-0.2124526
FIN2_4	0.1475163	EDU_6	-0.2684655
FIN2_5	0.2516376	EDU_7	-0.5271947 (**)
FIN2_6	-1.658709 (***)	EDU_8	0.8050777
FIN2_7	-1.101145 (***)	EDU_9	0.0421194
FIN2_8	0.5698156 (***)	SIZE	0.0975478 (***)
FIN2_9	0.6229155 (***)	PLACE_2	0.0741036
FIN2_10	0.6818302 (***)	PLACE_3	-0.5326271 (***)
Cost	0.00000901 (*)	PLACE_4	-0.1137009
PRJ	-0.0097277	PLACE_5	-0.2609703 (*)
Loi	0.0690486	PLACE_6	0.5125256 (***)
		_cons	2.361135 (***)

*Note: *, **, *** signs show statistical significance of 10%, 5%, and 1%, respectively*

as Table 3 indicates, the relatively high level of financial constraints (at levels 6 and 7) has a negative impact on technological innovation with a coefficient that is less than -1. This is consistent with the findings of Quan and Nguyen (2014) and Silva and Carreira (2012). However, the higher levels of financial constraints have a positive impact on technological innovation. This shows that large firms have good financial capacity, and their technology innovation will have more influence on the firm performance. Therefore, they should opt for an innovation decision on technology. This finding is supported in previous studies of Silva and Carreira (2012) and Quan and Nguyen (2014). Miller and Toulouse (1986) also show that smaller firms can react more quickly. Meanwhile, Vietnamese large firms in this study have good financial capacity. They are better adapted to technological innovation. Besides, the findings also show that large firms with no financial difficulty and too much financial difficulty are more interested in technological innovation than other enterprises, and it is suitable for the Vietnamese firms. Thus, hypothesis H1.1 is accepted. That is, financial factors (including capital structure and financial constraints) have an impact on technological innovation.

In addition, professional qualifications also have a certain impact on the change in technology innovation. The results are somewhat different from those of Quan and Nguyen (2014) and Abereijo et al. (2007). The findings also reveal that the larger the firms are, the more positively the technological innovation will change. Similar results can be seen in the study of Quan and Nguyen (2014). Firm location also impacts firm's decision of technology innovation. In particular, firms situated in the North Central, Central Coast, and Southeast in Vietnam have greater advantages than the companies located in other parts of the country. This result is fully consistent with the level of development of the regions in Vietnam. In regions with developed economies, the conditions to support technological innovation for businesses will be better. State agencies have many policies to promote science and

technology and to set the ground for the application of new technologies in the products of Vietnamese firms.

Meanwhile, most of the previous studies only focus on assessing the impact of technological innovation on the business activities of SMEs in a specific field or region. These studies do not show that technological innovation differs among firms in different geographical regions. In this study, the impact of technological innovation on firm performance was found to be different in each sector and geographical location. That is, technological innovation adapts to the development of each business sector and region.

However, the determinants of capital structure and technological capability are not greatly effective in technological innovation. These results are not supported by the findings of Bayarçelik et al. (2014), but are quite similar to the conclusions made in the study of Amiolemen et al. (2015). Technology innovation activities for firms are primarily impacted by market demand determinants that are more likely to be sources of technological motivation. The foregoing results are completely suitable in the economic context of Vietnam, a developing country. Therefore, hypothesis H1.2 is accepted. That is, management ability has an impact on technological innovation. However, there is no evidence to affirm that hypothesis H1.3 can be accepted or not.

Of the total number of firms in Vietnam, nearly 80% of them are micro, small, and medium-sized. Developing and innovation of proprietary technology is not of interest for these firms. Therefore, financial and technological elements do not significantly affect the technological innovation. Meanwhile, the determinants of leadership, business culture, and operating environment have more impact on the business development and operation of firm sample.

To test the fit of the model, the Hosmer- Lemeshow test was carried out. P-value was found to be 0.7164 (more than 0.05), meaning that the model has a good fit with the survey data. In the descriptive error test, the _hat factor was not found to be significant. The explanatory variables of the model were found to fit the survey data. The results had no problems such as missing important variables or misidentifying function forms. Therefore, the regression models were fully fitted and significant. Therefore, the estimated results were reliable.

4.2. Impact of Technological Innovation on Firm Performance

The results of Breusch-Pagan LM, F-test, and Hausman test showed that the selection of the model between Pooled OLS, FEM, or REM fitted the data. The estimated results without the intercept coefficients and the coefficients of the control variables are presented below.

Impact of Technological Innovation on Sales

For testing and analysis purposes, the dataset was divided into smaller datasets based on the firm size. Through regression analysis, the model that fitted each dataset was chosen. The estimated results are illustrated in Table 4 below.

Based on the obtained results, the p-value of all tests were found to be less than 5%, implying that that the REM model was more suitable than Pooled OLS (by Breusch-Pagan LM test), FEM was more suitable than Pooled OLS (by F-test), and FEM was more suitable than REM (by Hausman test). These findings revealed that the FEM could be employed to further analyze the impact of innovation on sales by firm size.

Table 4. Choosing a Model to Test the Impact of Technological Innovation on Sales by Firm Size

	Micro firms	Small firms	Medium firms	Large firms
Breusch-Pagan LM test				
Chi-sq	35.563	3459.4	139.81	973.9
Df	1	1	1	1
p-value	0.0003	0.0000	0.0000	0.0000
F test				
F	2.2035	8.1892	4.2086	6.7745
df1	146	1436	153	498
df2	430	4292	446	1478
p-value	0.0001	0.0000	0.0000	0.0000
Hausman test				
Chi-sq	22.707	74.633	52.054	52.255
Df	13	18	16	17
p-value	0.04533	0.0009	0.0072	0.0126

Table 5. Impact of Technological Innovation on Sales

Coefficient	Micro firms	Small firms	Medium firms	Large firms
FEM				
INNO1	-2,862.05	2,749.9	106,581 (*)	-141,336 (*)
INNO2	5,920.2	4,988.6	88,891	196,816 (**)
INNO3	-9,230.55 (**)	-3,959.1	-64,711	363,321 (***)
R-squared	0.065573	0.10373	0.21345	0.25197

*Note: *, **, *** show statistical significance of 10%, 5%, and 1%, respectively.*

As Table 5 indicates, the FEM results show that most coefficients of technological innovation are not significant. There are insufficient evidences to confirm that technological innovation of micro and small firms affects sales, and it has a negative impact on revenues. Meanwhile, the effects of technological innovation on revenue of medium firms are significant, as their value is higher than 0 at a significance level of 10%. This means that the innovation of production processes obviously has a positive impact.

However, technological innovation was found to have the strongest impact on large firms. These firms produce new goods and services with higher quality, and this brings more revenue for them. The estimated results support the conclusion when the coefficients are positive at significant levels of 1% and 5%, respectively.

The results above agree with the findings of Akinwale et al. (2017) for small and medium firms. The previous studies conclude that the innovation in product process has positive impact on the firm performance, while product innovation has a negative impact on it. Moreover, the results of research conducted by Jin and Choi (2019) are also partly the same as the findings of this study.

It can be concluded from these findings that technological innovation has a positive impact on sales of firms. Therefore, hypothesis H2.1 is accepted. However, only large firms' sales are affected by technological innovation. Meanwhile, there is no evidence to reveal that technological innovation has a positive impact on SMEs's sales.

Impact of Innovation on Profit

The Breusch-Pagan LM test, F-test, and Hausman test showed that different models are fit with firms that have different sizes. The FEM model is optimal for small and medium firms, and the REM model is the most appropriate for large firms. The results are revealed in Table 6 below:

Table 6. The Results of Breusch-Pagan LM Test, F-Test, and Hausman Test

	Micro firms	Small firms	Medium firms	Large firms
Breusch-Pagan LM test				
Chi-sq	2.9935	1125	47.16	567.06
Df	1	1	1	1
P-value	0.0836	0.0000	0.0000	0.0000
F-test				
F	0.85791	3.3084	2.4874	4.1968
Df1	146	1436	153	498
Df2	430	4292	446	1478
P-value	0.8629	0.0000	0.0000	0.0000
Hausman test				
Chi-sq	13.395	37.454	36.616	27.418
Df	13	18	16	17
P-value	0.4178	0.004571	0.002374	0.05222

Based on the findings above for the firms with different sizes, there is no evidence to conclude that the technological innovation of micro-firms influences profits. However, the coefficients estimated by Pooled OLS model are positive. This shows that profits of firms are increased when they apply technological innovation. The results are shown in Table 7 below:

Table 7. Impact of Technological Innovation on Profits

Coefficient	Micro firms	Small firms	Medium firms	Large firms
	Pooled OLS	FEM	FEM	REM
INNO1	1190.25	-110.94	-324.8	-19790.3 (***)
INNO2	310.36	550.05	11917.1 (**)	1535.9
INNO3	154.15	-412.94	-7219.7	30665.3 (***)
R^2	0.020752	0.026973	0.13731	0.11339

*Note: *, **, *** signs show statistical significance of 10%, 5% and 1% respectively*

Some discussions arise from Table 7. Similar to micro firms, technological innovation on profits of small firms is not clear. Moreover, the coefficient of determination (R^2) indicates that about 2% of profit fluctuations are explained by the technological innovation of a firm. Besides, FEM results display that the coefficient of product quality innovation is significant at 5%, implying that it has a more positive impact than other technological innovations. Thus, it can be said that product quality innovation of firms will generate more profit than others, estimated at an average of 11,917 million Vietnamese dong (called VND).

The impact of technological innovation on profits of large firms is projected by REM model. The impact on the profit of the production process innovation and the expansion of new products are significance at 1%. While the product innovation has a positive impact on profit, the innovation of the production process has a negative effect. That is, the latter type of innovation makes the profit of firms decrease. This implies that the innovation of the production process would take more costs. Thus, the innovation strategy of large firms has not achieved optimal performance.

The results above are supported by previous studies, including Geroski et al. (1993) and Akinwale et al. (2017). However, the previous findings only focus on the technological innovation of SMEs, and there are no extensive assessments of the effect of firm size. According to Geroski et al. (1993), the profitability and sales of SMEs in United Kingdom are impacted by technological innovation. Nonetheless, the research only evaluated the effects of a major innovation on increasing the profitability of SMEs. The study by Akinwale et al. (2017) research investigated the impact level of technological innovation on profitability and

sales of SMEs. However, the study only focused on service firms and did not assess the technology changes in production as well as the scale of operation and location of firms.

Thus, previous findings have shown the impact level of technological innovation on sale and profitability of SMEs. However, this impact was not very clear in our study, as there was not sufficient evidence to confirm the effects on the Vietnamese SMEs and it was only recognized in Vietnamese large firms. Nevertheless, the findings obtained for large firms in Vietnam helped confirm hypothesis H2.2.

Impact of Technological Innovation on Return on Assets (ROA)

In general, the results obtained in this study were not significant. The impact of technology innovation on ROA was not supported. However, the innovation of firms was found to have a positive impact on ROA. That is to say, the assets of firms do not increase its profit when it innovates technology.

To further explore the findings, the distributed-lag model was applied to test the impact of technological innovation on ROA with lag variable in 1, 2, and 3 periods of technological innovation. The estimated results with the lag variable are shown in Table 8 below.

Table 8. The Impact of Technological Innovation on ROA

Coefficient	No lag	1 period lagged	2 periods lagged	3 periods lagged
INNO1	-0.04241972	0.0010636	0.01837107	0.00973543
INNO2	-0.03751387	0.0193230	0.01783999	-0.00874018
INNO3	-0.01014746	0.0025352	0.01363125	0.01374955
R2	0.00132490	0.0017962	0.00490040	0.00878450

*Note: *, **, *** signs show statistical significance of 10%, 5%, and 1%, respectively*

The distributed-lag models in periods 1, 2, and 3 are regressiven. The impact of innovation in the medium term was tested, but no significant result was achieved. The above findings show that technological innovation did not have any immediate impact on ROA in the short and medium-term. Thus, it can be suggested that it takes time for technological innovation to be effective for firms. Thus, hypothesis H2.3 cannot be supported.

5. Conclusion

The effects of technology innovation on firms are significantly different when the firms' size, place, and line of business change. The results of this study showed that there was not sufficient evidence to conclude the positive or negative impacts of technological innovation on the performance of SMEs in the context of Vietnam as a developing country. The fact is that developing countries have some weaknesses of technology development. Technology policies of the state and firms' abilities adapting for new technologies are still weak. Other results on human resource restructuring and technological innovation views of management are consistent with the findings of Akinwale et al. (2017).

Thus, the level of technological development of different regions and countries will significantly influence the technological innovation of firms. However, the developed regions with a high level of technology are in better conditions to innovate than the developing regions. In developed countries, technological innovation can significantly change the firm performance. However, these innovations have not even been tested in developing countries. In the context of Vietnam, technological innovation only affects the performance of large firms. The innovations significantly influence organization's structure and allocation of assets.

The results also show that the scale of business activities strongly impacts technological innovation of firms. In particular, technological innovation has a positive association with sales and profits of medium and large firms. However, there is not enough evidence to confirm the effect of technological innovation on ROA in the short and medium-term.

Moreover, it can be seen that technological innovation in the production process, product quality, and new product expansion has certain effects on firm performance in the sales, profits, and ROA aspects. The control variables of firm size and firm location have positive effects on the impact assessment by different firms.

This study enriches the theoretical framework about the relationship between renovation of technology and firm performance. It can also help emerging countries like Vietnam in balancing technological renovation and performance. The study also stresses the importance of constant renovation of new technologies and employing them in business in order to have a better firm performance and achieve the objectives. Therefore, it has good implications for Vietnamese firms in different sizes and lines of business.

However, there is a limitation that the survey data was limited to only four years. Therefore, it was not possible to prove the given hypothesis. If data is gathered in a longer period of time, it is possible to estimate the impact with lag variable, and the reliability of findings will be higher. In addition, technological innovation level in different sectors and economic development conditions needs to be further studied. In addition to the impacts of technological innovation on ROA, it is necessary to consider other variables such as ROE, Tobin's Q, earnings per share (EPS), and sustainable development prospects of firms.

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Appendix 1: Financial Difficulties Variables

Firms define the level of financial difficulties/constraints on a scale of 0-10, where 0 means no financial difficulties in technological innovation and 10 represents the highest level of financial difficulties.

Take level 0 as the base attribute. With dummy variables taking a value of 1, the decision to innovate technology of firms, in this case, will be affected more positively / negatively than in the case of firms having no financial difficulties in technological innovation.

Variables	Description
FIN_21	Takes the value of 1 if firm's financial constraints level is 1
FIN_22	Takes the value of 1 if firm's financial constraints level is 2
FIN_23	Takes the value of 1 if firm's financial constraints level is 3
FIN_24	Takes the value of 1 if firm's financial constraints level is 4
FIN_25	Takes the value of 1 if firm's financial constraints level is 5
FIN_26	Takes the value of 1 if firm's financial constraints level is 6
FIN_27	Takes the value of 1 if firm's financial constraints level is 7
FIN_28	Takes the value of 1 if firm's financial constraints level is 8
FIN_29	Takes the value of 1 if firm's financial constraints level is 9
FIN_210	Takes the value of 1 if firm's financial constraints level is 10

Appendix 2: The Leader's Management Ability Variables

The ability of business management is divided based on the leaders' education level into 9 groups of untrained, trained for less than 3 months, primary, intermediate, college, university, master, doctoral, and other qualifications.

Take the untrained level as the base attribute. With dummy variables taking a value of 1, the decision to innovate technology of firms, in this case, will be affected more positively or negatively than in the case of firms with an untrained leader.

Variables	Description
EDU_2	Takes the value of 1 if leader's education level is "trained for less than 3 months"
EDU_3	Takes the value of 1 if leader's education level is "primary"
EDU_4	Takes the value of 1 if leader's education level is "intermediate"
EDU_5	Takes the value of 1 if leader's education level is "college"
EDU_6	Takes the value of 1 if leader's education level is "university"
EDU_7	Takes the value of 1 if leader's education level is "master"
EDU_8	Takes the value of 1 if leader's education level is "doctoral"
EDU_9	Takes the value of 1 if leader's education level is "other qualifications"

Appendix 3: Place Variables

The operational location/place of a firm is divided into six areas of Northern midland and mountainous, Red River Delta, North Central and Central Coast, Central Highlands, Southeast, Mekong River Delta.

Take the Northern midland and mountainous as the base attribute. With dummy variables taking a value of 1, the decision to innovate technology of firms, in this case, will be affected more positively or negatively than in the case of firms located in the Northern midland and mountainous

Variables	Description
PLACE_2	Takes the value of 1 if a firm is located in Red River Delta
PLACE_3	Takes the value of 1 if a firm is located in North Central and Central Coast
PLACE_4	Takes the value of 1 if a firm is located in Central Highlands
PLACE_5	Takes the value of 1 if a firm is located in Southeast
PLACE_6	Takes the value of 1 if a firm is located in Mekong River Delta