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How Small- and Medium-Sized Enterprise Innovation Affects Credit Accessibility: The Case of Vietnam

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Abstract: Nowadays, small- and medium-sized enterprises play crucial roles in both developed and developing countries. They create new employment, fulfill the market gap, contribute to Gross Domestic Product and boost the whole economy. However, small- and medium-sized enterprises face more financial constraints than large enterprises, which prevent them from growing and expanding their activities. This paper aims to investigate how the innovation of small- and medium-sized enterprises impacts on credit accessibility in Vietnam from 2005 to 2015, through five aspects of innovation: new products, new technology, improved existing products, research and development investment, and machine innovation. The data set consists of more than 4500 observations of small- and medium-sized enterprises in Vietnam. This data set is taken from a survey conducted within the framework of cooperation among UNU-WIDER, the University of Copenhagen and Vietnamese government agencies. Using panel regression model, we found out that three out of five innovation factors significantly impact on credit accessibility. More specifically, research and development investment and new product have negative impact on credit accessibility; whereas new technology has positive impact on credit accessibility. These findings are useful for firm managers, banks and policy makers to help small- and medium-sized enterprises overcome financial constraints through innovation aspects.

Keywords: small- and medium-sized enterprise; innovation; credit accessibility; financial inclusion; Vietnam

JEL Classification: D20; M10; O30

1. Introduction

Nowadays, small- and medium-sized enterprises (SMEs) are placed among the key components of the economy in both developed and developing countries. They are internationally known as the driving force based on their enormous contributions to Gross Domestic Product (GDP) and generating new employment. They are generally presumed as the leader of environmental sustainability, economic prosperity and innovation, particularly for the economy of developing countries such as Vietnam [1].

Compared with other type of businesses, SMEs have their own outstanding features about business activities. SMEs are flexible in adapting the ever-changing market, easy establishment, low expenses, quick returns, etc. These advantages create the beneficial foundation for SMEs' operations that are undertaken in various industries. Besides, they can adapt easily to the market change, they also exploit and leverage local labor force.

SMEs play an important role in expanding economy, creating careers, contributing to diversify the products, supporting economic development, and transferring the business structures. Thanks to

the power of low investment capital and abundant labor force, over the past decades, SMEs' growth has quickly accelerated and become the dominant part among businesses [2]. SMEs supply the market with many products in all fields, create more product alternatives, meet all the needs of consumers, thereby elevate the economy. In addition, this type of business, noticeably, can contribute a great deal to the government tax.

In Vietnam, the Annual Business Report 2016 released by the Vietnam Chamber of Commerce and Industry claimed that Vietnam experienced a remarkable growth in the number of new enterprises registered and in the reduction of unemployment rate during the period 2007–2016 (see Figure 1).
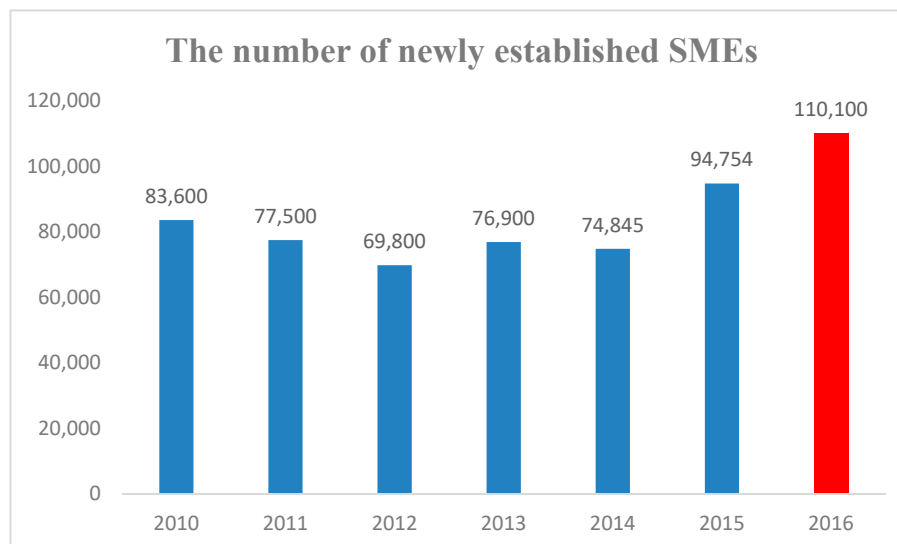

Figure 1. The number of newly established small- and medium-sized enterprises (SMEs). Source: The Vietnam Association of SMEs.

According to General Statistics Office of Vietnam, in 2020 SMEs represent more than 97 percent of total enterprises in Vietnam (see Figure 2). In accordance with these statistics, SMEs are recorded in the aspect of solving many social challenges, consisting of employment, and promoting urbanization. Vietnamese SMEs' contribution is positive to the economy. As reported by the Ministry of Finance in December 2019, over 40 percent of Vietnam's GDP and 30 percent of total budget revenue were contributed by SMEs. Thanks to SMEs, 60 percent of Vietnam's workforce was employed. The amount of tax and other fees which SMEs have contributed to government budget has increased 18.4 times after ten years from 2006 to 2016.
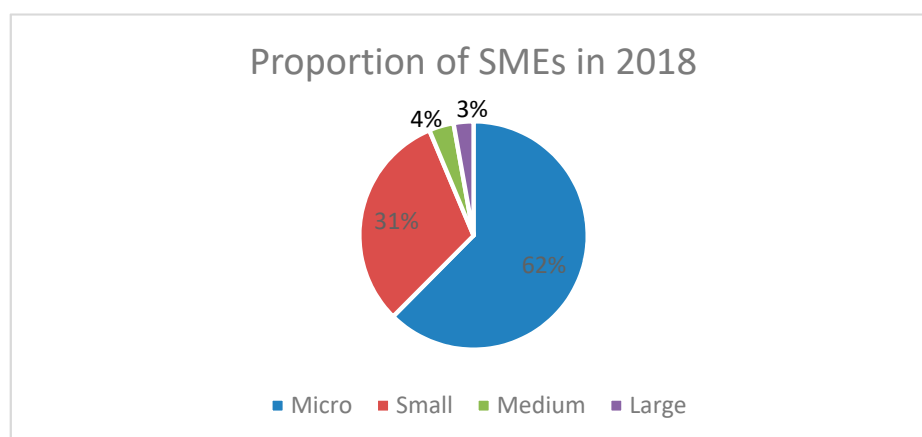

Figure 2. Proportion of SMEs in Vietnam in 2018. Source: General Statistics Office in Vietnam (2018).

Recently, the issue of finance accessibility of SMEs has become the topic drawing much interest from managers, investors, banks, and policy makers. SMEs can borrow money from different sources such as banks, capital fund organizations, issue stock, relatives, etc. Among capital sources, bank credit is seen as the least risky one and it offers the tremendous amount of capital.

Nonetheless, small- and medium-sized businesses are more financially pressured than large businesses because of the collateral shortage, lack of management skills of owners, lack of network, information asymmetries, etc., which is difficult for banks to evaluate. According to the statistics of the Vietnam Chamber of Commerce and Industry, SMEs' ability to access credit through the commercial banks system is still limited, up to 70 percent of SMEs currently do not have access to bank credit. In which, more than 30 percent of SMEs cannot access bank capital and another 30 percent said that it is very difficult to access this source of capital. Those 70 percent of SMEs must continue using their own capital or borrowing from other sources with very high costs and risks. The ratio of outstanding loans to SMEs accounts for an average of 22–25 percent of total outstanding loans for the entire economy in the period 2012–2017 [3].

The SME sector in Vietnam has difficulty in accessing formal loans for the following reasons. From the SMEs side, the level of information transparency of SMEs has not met the expectations of investors in the financial market and credit institutions. The development level of SMEs is still low due to the size and capital constraints, outdated technology, poor governance, low productivity. Additionally, SMEs often lack collateral, do not have the habit of buying hedging insurance, lack understanding of mechanisms, policies, products—services and packages of financial institutions, guarantee programs and government support. From the credit institutions' side, credit institutions do not have specific products and services suitable for SME customers. The existing products are not diversified, not flexible, and require complicated and cumbersome credit procedures. The diversity and scale of capital of institutional investors in Vietnam is low in terms of quantity, type, and scale of working capital. Other types of financial intermediary institutions develop slowly and mainly focus on large listed enterprises. These affect the ability of SMEs to diversify capital mobilization channels [3].

If SMEs face barriers when asking for the loan, would that be easier for innovative SMEs? Does SMEs' innovation impact on their ability to access to credit? These questions have arisen recently. Innovation is known as the provision of new merchandises or processes, new service, modern technologies, creative thoughts or idea, research and development activity with more efficient version to organize business [4]. Innovative small firms—those introducing new products, processes, or business models—are important to create new markets, achieve rapid growth, and help the economy recover. Innovative SMEs have been entitled as the motivation of boosting the economy and equal growth. In addition, it has a great influence on expanding SMEs' competitive position. Therefore, investing in innovative activities is urgent in improving and renovating product quality, services, and cost savings, which are the core conditions for boosting competency. As innovative small firms can lack the internal resources to successfully commercialize innovations, external finance plays a particularly important role [5]. The survey of Hay and Kamshad [6] shows that investment into innovation is the most common plan for expansion. Successful innovation investment plans will have a multiplier effect by mobilizing autonomous resources from businesses and simulating the creation of new companies and industries [7].

On the other hand, despite the noticeable performance of innovative SMEs, there are many constraints that prevent firms from innovating. Large firms with more capital funds allow them to make improvement to a variety of innovative projects that would eventually generate income to continuously work on the next ones. In case of SMEs, they normally focus on developing a single innovative project due to the lack of availability such as capitals, management skills, etc. Furthermore, the capital of SMEs is limited, so the investments in upgrading, renewing equipment or process are not made frequently that result in being stagnant. Credit accessibility of innovative SMEs is lower, since innovation is viewed as a risk nature relating to the likelihood of unsuccessful future products, the uncertainty of expected future returns and the high sunk cost storage. Overall, there is a trade-off

between project risk and return that the bank must have to carefully consider before making the decision whether to allow SMEs to take out the loan.

In the light of the foregone, this paper investigates the impact of SMEs' innovation on their credit accessibility in Vietnam. The proxy for credit accessibility is the formal loan, which is the amount originally borrowed from banks and formal credit institutions and represents the most important current formal loan. The investigated research questions are: (i) whether each of the five innovation factors has positive impact on formal loan, (ii) whether fully innovative firms have any advantages getting the formal loan compared to the non-innovative firms. This study will fill the gap of the research on Vietnamese SMEs and provide recommendations for the government, managers, and banks to help increase SMEs credit accessibility.

2. Literature Review

2.1. SMEs Concepts

There are different ways to define and categorize SMEs across countries. Being considered as SMEs, they are required to meet these criteria such as the number of employees, the fixed assets, management skills, applied technology production capacity, economic growth, total sale turnover and the unique issues experienced by SMEs [8], which makes it difficult to capture the shape of SMEs in specific countries [9].

In general, the most popular standard to categorize the global definition of SMEs leans on the total labor force. Nonetheless, based on the distinction in population areas in the world or even in different states or provinces within the same countries, the number of employees for each type of SMEs will be divided accordingly [10].

According to the stipulation of Decree No. 56/2009/ND-CP of Vietnam in August 2009, the definition of SMEs was published. SMEs stand for micro-, small- and medium-sized enterprises, which are defined as founded enterprises and registered business under Enterprise Law. Micro-, small- and medium-sized businesses are identified based on the strength of total capital and labor scale across different industries (see Table 1).

Table 1. SME categories in Vietnam.

	Micro Enterprise	Small Enterprise		Medium Enterprise	
	Number of Laborers	Total Capital	Number of Laborers	Total Capital	Number of Laborers
Agriculture, Forestry and Fishery	≤10	≤20 bill VND	11–200	≤100 bill VND	201–300
Industry and Construction	≤10	≤20 bill VND	11–200	≤100 bill VND	201–300
Trade and Service	≤10	≤10 bill VND	11–50	≤50 bill VND	51–100

Source: Vietnamese Government's Decree No. 56/2009/ND-CP.

In the newly established Law on Facilitating SME sector (No. 04/2017/QH14), an enterprise is considered a SME if it meets either of the following criteria: (i) total capital should not exceed VND 100 billion; or (ii) total turnover of the preceding year should not exceed VND 300 billion. In addition, micro-, small-, and medium-sized enterprises are identified differently in the fields of agriculture; forestry and fishery; industry and construction; trade and services [9]. Specific criteria of each enterprise category are stipulated in Decree No. 39/2018/NĐ-CP of Vietnam in March 2018.

In this research, we consider enterprises as SMEs based on the capital scale criteria in accordance with the Decree No. 56/2009/ND-CP.

2.2. Access to Finance and the Demand of SMEs' Credit

Nonetheless, enterprises need a huge amount of capital for their different purposes, and in case of SMEs, the demand of capital becomes higher. Based on Vietnam Survey, more than 60 percent of SMEs apply for loans [11] (see Figure 3).
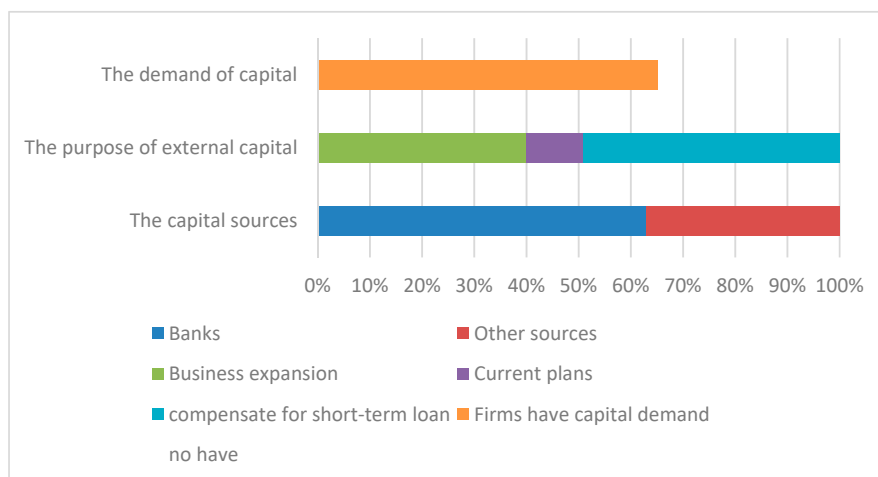
Figure 3. The demand of capital, the purpose, and capital sources [11].

Any obstacles preventing SMEs from breaking out would seriously become a threat toward the economic development. According to [12] the areas that SMEs most identified as barriers or high barriers to growth are financial constraints (60 percent), government regulations and procedures (44 percent), market access (38 percent), marketing (37 percent), and human capital (33 percent). Facing external financial constraints is considered as the main barrier of the stable growth of SMEs. Thanh et al. [13] stated that the barriers of SMEs when approaching external finance are the shortage of collateral, insufficient experience in operating businesses of owners, not taking part in production networks; which led to the reasons why SMEs find it hard to get the credit accessibility from the financial organizations. SMEs are seen riskier to pay back the loan to the lender than larger ones.

Access to finance is known as the capability to get the financial service, such as credit accessibility, deposit, payments, etc., which are provided by banks, stock markets, private equity, financial institutions. Access to credits allows SMEs to utilize productive assets to enhance productivity and economy of scale [14]. It provides national economics with the key to boost their growth as well as the existence, the creation, and the development of firms, and especially for small and innovative enterprises [5,15]. As mentioned above, SMEs have shortage of capital or cumulative capital is limited, basically, they need credit for their daily operation, enhance productivity, invest in the asset, adapt technology, etc. Evidence from [16] showed that financial barriers restraint firms from developing and SMEs are among the most constrained category.

There are two common financial sources that firms can access. Firstly, internal finance includes cash in hand and retained earnings. The second one is external finance, including equity finance and debt finance. The survey in Muhoza by Harelimana [17] recorded that 38.8 percent of SMEs used both external and internal sources of finance. Around 25.5 percent ran the business with external money, while the rest of them used within internal ones. Similar findings also agreed that the companies using external finance to upgrade relatively faster in their business at different growth stages [10]. These evidences lead to the point that external finance is extremely vital in small- and medium-sized enterprises' operation.

In Vietnam, equity financing has not been available for SMEs since those companies are not capable of meeting the standard of releasing stock. Therefore, finance in debt form has been chosen. The most common external money source that SMEs rely on is the bank lending source. Since the bank credit is less risky and the supply of capital source is more abundant than other credit institutions and immediate partners. Nonetheless, under 60 percent of total SMEs get credit from the banks, while the rest have access to the unofficial capital channel. Furthermore, among the enterprises that borrowed capital from formal debt form, only one third of businesses are approved with loans of 50 percent or more, one fifth of businesses are only allowed to borrow at 25 percent compared to capital requirements [9]. These numbers display that the demand of capital of SMEs is quite high and

SMEs have not been able to get enough capital as expected yet. The reasons that become financial constraints of SMEs involved in the requirement of guarantee assets, the requirement of financial report, the requirement of management skills, etc.

In conclusion, bank loans apply for both SMEs and large firms; however, it is believed that SMEs is confronted with more disadvantages. Besides, a large number of previous empirical papers support that credit constraints intend to harm the development of SMEs [18].

2.3. Innovative SMEs

Innovation is introduced to play an essential role to meet the new requirement or existing market needs. It takes place through the provision of new products or processes, new service, advanced technologies, modern idea, creative thoughts, research and development (R&D) with more powerful versions to organize the business [4].

Nowadays, innovation has been considered a driving force behind firm dynamics [19]. Innovation and technology pose a tremendous opportunity for Vietnam's SMEs to increase global market access, succeed past the startup phase, aim for and achieve high growth, and better engage with international and environmental standards. Innovative firms are more likely to have better firm performance on the basis of higher profits and revenues [12]. Innovative firms are also more likely to export, according to Nguyen et al. in 2008 [20].

Investing in innovation becomes urgent in upgrading product quality, services, and cost savings, which are the core conditions for boosting competency. Innovative SMEs have been entitled as the motivation of boosting the economy and equal growth. Additionally, it has a great impact on expanding SMEs' competitive position.

However, despite the noticeable performance of SMEs, there are a lot of barriers that prevent firms from innovation, such as high costs, the high uncertainty of success, weak authorization, etc. Among them, lack of external finance becomes a main obstacle that SMEs have to confront in their innovative operations. For SMEs, the capital is limited, so the investments to upgrade, renew equipment or process are made infrequently that results in obsolete technology. The study of Le et al. in 2019 examined the relation between SMEs' capacity to access external capital and innovation in Vietnam and found that SMEs with a high debt ratio tend to be more innovative [21]. The research of Tran and Vu in 2018 indicated the positive relation between government support and SMEs' innovation [22].

Empirical evidences show that the innovative SMEs' demand for borrowing external loan is higher [15]. However, innovative firms are not given enough credit as they want, which can be seen most directly in corporate investment in R&D [15]. Lee et al. showed that innovative SMEs which introduce new products or process have a higher demand for finance compared to other businesses; however, they have to face difficulties to receive the loan [23].

Several researches found proofs of the basic problems in financial provision for the innovative project of SMEs. The first reason of innovative SMEs' restricted credit accessibility is the uncertain success of the innovative activity [19]. Banks always make wise decisions whenever lending loans to innovative SMEs. Since it is not sure that R&D activities will completely succeed and innovation projects are considered as high specific sunk cost, which might fail to guarantee money back to the banks [24]. This also leads to the reason why bank investment in innovative firms is rated as high risk, especially in SMEs [25]. Unlike large firms, SMEs might not be able to diversify their innovative projects in order to cover the unexpected failure.

From the view of lenders, information asymmetries and agency problems are also the main impediments behind credit provision, which hesitate financial intermediaries from investment in SMEs. As highlighted by the report of Petersen and Rajan [26], the SMEs cannot meet enough necessary requirements, which include the skills, the documentaries, the potential investments for external suppliers. One of the surveys of Hernández-Cánovas and Martínez-Solano [27] reported that SMEs have ability to obtain the loan, but at the same time suffer from the higher cost of debt than large sized firms because asymmetric information is deducted when the enterprises are larger. It would be more

challenging for innovative SMEs as expected. The last disadvantage of innovative investment is that completed innovative products might not be widely used [28].

2.4. Factors Affecting Credit Accessibility

As highlighted in previous studies, SMEs' characteristics have a great impact on evaluating the credit accessibility from banks. The characteristics are classified as firm size, firm age, firm ownership, total asset, ROE, ROA, etc.

Several surveys stated that firm age is a signal to know the loan repayment ability. Thanks to the experience through many years of operation, maturity firms are high examined in access to finance than younger firms, since young businesses are often caught difficult in credit accessibility due to informational disparities. The survey of Abdullah and Manan [29] found that the financial assistance service gives equal chance to both young and mature businesses to borrow money for supporting their daily operation; therefore, it proves there is no significant influence of firm age in external finance accessibility.

Moreover, ownership types are theoretically considered as a positive factor to access to finance. With regard to ownership types, state-owned enterprises are admitted to face less financial constraints from banks or financial institutions, thanks to the government connection [30], while as noted by Drakos and Giannakopoulos [31], non-state-owned enterprises are struggling with many problems which come from collateral requirement, related documentaries, lack of relationship with banks.

Another study of Mina et al. [28] was conducted in US, they found that both product innovation and process innovation have positive relation with credit accessibility; while in the survey of Freel [25], innovation movements reach the negative success from loan application.

In Vietnam, according to Thanh et al. [13], Nguyen et al. [32], the factors preventing Vietnam SMEs from accessing to finance are lack of governance experience, pledgeable assets, a close relationship with commercial banks, and they leave the gap for innovation factor.

Therefore, this paper fulfills this gap by shedding light on the impact of SME innovation on credit accessibility in Vietnam.

3. Methodology

3.1. Data

This research employs the Vietnam SME database tracking over 2500 enterprises from ten provinces over time. The survey is collected biennially, and is a collaborative effort of UNU-WIDER, the Development Economics Research Group (DERG) at the University of Copenhagen, the Central Institute for Economic Management (CIEM), and the Institute of Labor Science and Social Affairs (ILSSA) in Vietnam [30,31]. According to UNU-WIDER, the survey instrument is composed of three modules: (i) a main enterprise questionnaire for owners or managers; (ii) an employee questionnaire administered to a random subset of employees in a quarter of randomly selected enterprises; and (iii) an economic accounts module. Firm characteristics, performance, history, employment, business environment, etc., are obtained from the enterprise-level survey [33,34].

At present the data set is available for the years 2005, 2007, 2009, 2011, 2013 and 2015 in ten cities and provinces consisting of Ha Noi, Ho Chi Minh, Hai Phong, Long An, Phu Tho, Quang Nam, Nghe An, Khanh Hoa, Lam Dong, Ha Tay. To be more specific, there are over 4500 observations which stand for more than 2500 SMEs. The SMEs are defined under Vietnamese Law as previously mentioned in Section 2 and these SMEs successfully applied for the formal loan. The enterprises have one of the following ten ownership types which are household, private, partnership, collective, limited liability company, joint-stock company with state capital, joint-stock company without state capital, joint venture with foreign capital, central state enterprise, and local state enterprise. The total number of SMEs operated each year is summarized in Table 2. Noticeably, the data set takes the unbalanced panel form, and the existing SMEs in the database vary every year.

Table 2. The number of SMEs each year in the sample.

Year	Total Number of SMEs
2005	1039
2007	935
2009	979
2011	704
2013	612
2015	1006

Source: Authors' calculation.

3.2. Research Model

We use the panel regression model to investigate the impact of firm's innovation on access to external finance. The linear regression equation is given as follows:

$$\textbf{Access to credit}_{it} = \alpha + \beta\ \textbf{Firm Innovation}_{it} + \gamma\ \textbf{Firm Characteristics}_{it} + \eta_{it}$$

where **Access to credit** is the dependent variable. Here, we use the most important current formal loan of SME i at time t, which is the amount originally borrowed from banks and formal credit institutions, as the proxy for access to the formal financial system. The dependent variable indicates the level of external finance accessibility of every single SME i in year t. Besides, α, β, γ are constant, and η is the error term.

Firm Innovation includes the independent variables. The measurement of innovation consists of five types of innovation: new product, improved product, new technology, machine innovation and R&D investment.

Besides dependent and independent variables, this paper also considers control variables, **Firm characteristics**, for a range of business characteristics. Total asset, firm ownership, firm age and main business operation location are taken into account.

3.3. Variables

3.3.1. Dependent Variables

In this paper, **Access to credit** is measured based on the most important current formal loan, the amount of money originally borrowed, measured in million VND.

3.3.2. Independent Variables

The independent variables consist of activities related to innovation within company as follows.

New product: is a dummy variable taking the value 1 when SME has produced a new product since the previous survey, and 0 otherwise.

Improved Product: is a dummy variable taking the value 1 when SME has made any major improvements of existing products or changed specification since the previous survey, and 0 otherwise.

New Technology: is a dummy variable taking the value 1 when SME has introduced new production processes or new technology since the previous survey, and 0 otherwise.

Machine Innovation: is the amount of money (measured in million VND) that the firm has invested in machinery or equipment since the previous survey, divided by total asset (also measured in million VND).

R&D investment: is the amount of money (measured in million VND) that the firm has invested in research and development activities since the previous survey, divided by total asset (also measured in million VND).

3.3.3. Control Variables

The first control variables are chosen as follows.

Firm Age: is the number of years the enterprise has run business.

Total Asset: is the total asset of the firm, measured in million VND.

Besides, in the data set there are enterprises among the ten ownership types and coming from ten provinces. The preliminary regression results suggest we consider the significant factors which are the following.

Ownership Type 5: is also a dummy variable, equal to 1 for a limited liability company, equal to 0 otherwise.

Ownership Type 7: is also a dummy variable, equal to 1 for a joint-stock company without state capital, equal to 0 otherwise.

Province 2: is a dummy variable, equal to 1 if the main area of business and production activity is in Ho Chi Minh City.

Province 3: is a dummy variable, equal to 1 if the main area of business and production activity is in Hai Phong City.

Province 6: is a dummy variable, equal to 1 if the main area of business and production activity is in Phu Tho province.

4. Results and Discussion

We use STATA software to run panel regression model. The Pooled OLS (Pooled Ordinary Least Squares), FEM (Fixed Effect Model), REM (Random Effect Model) are compared to find the most suitable model. Then, robust standard errors will be used to deal with heteroscedasticity and autocorrelation problems if applicable.

4.1. Descriptive Statistics

The variables' descriptive statistics are given in Table 3, with the total number of observations over the period of six years equal to 5275. According to this table, the average formal loan amount is VND 765.32 million. In terms of location, 18.19 percent of total firms mainly operate business in Ho Chi Minh City, 7.88 percent in Hai Phong City, 12 percent in Phu Tho province. Regarding ownership types, 26.86 percent of total firms are limited liability companies, 5.45 percent are joint-stock companies without state capital. The average firm age is 12.86 years, while average total asset is VND 4844.21 million. Concerning innovation factors, about 16.36 percent of total firms have implemented a new product, 43.41 percent improved product, 20.79 percent introduced new process or new technology, average machine innovation investment to total asset is 55.58, research and development investment to total asset on average is 25.91.

Table 3. Descriptive Statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Formal Loan	5275	765.3216	4125.537	0.05	172,316.6
Province 2	5275	0.1819905	0.3858733	0	1
Province 3	5275	0.0788626	0.2695497	0	1
Province 6	5275	0.1279621	0.3340793	0	1
Ownership Type 5	5275	0.2686256	0.4432867	0	1
Ownership Type 7	5275	0.0545972	0.2272138	0	1
Total Asset	5275	4844.218	23358.57	2.35	1,045,000
Firm Age	5275	12.86408	9.009828	2	72
New Product	5275	0.1636019	0.369949	0	1
Improved Product	5275	0.4341232	0.4956882	0	1
New Technology	5275	0.2079621	0.405888	0	1
Machine Innovation	4567	55.58546	125.3854	0	1683.111
R&D investment	4564	25.912	132.7345	0	2953.121

Source: Authors' calculation.

In Table 4, the Pearson correlation coefficients are given, varying in the range from −0.1807 to 0.3598 among independent variables, which support no evidence of multicollinearity. Variance Inflation Factors (VIFs) are also reported in Table 5 to double-check no multicollinearity problem. All the VIF values are smaller than 5, which support no evidence of multicollinearity (see also Appendices C and D).

Table 4. Pearson correlation coefficients.

	Formal Loan	Province 2	Province 3	Province 6	Ownership Type 5	Ownership Type 7	Total Asset
Formal Loan	1.0000						
Province 2	0.1426	1.0000					
Province 3	0.0121	−0.1380	1.0000				
Province 6	−0.0251	−0.1807	−0.1121	1.0000			
Ownership 5	0.1476	0.1997	−0.0028	−0.1233	1.0000		
Ownership 7	0.0561	−0.0312	0.0783	−0.0121	−0.1456	1.0000	
Total Asset	0.5120	0.0789	0.0291	−0.0368	0.1526	0.0422	1.0000
Firm Age	−0.0371	−0.1378	0.0236	−0.0069	−0.2053	−0.0458	−0.0157
New Product	−0.0054	0.0172	0.0132	−0.0145	0.0095	0.0020	0.0177
Improved Product	0.0672	0.0637	0.0275	−0.0229	0.0965	0.0134	0.0876
New Tech	0.1255	0.0828	0.0026	−0.0802	0.1384	0.0352	0.1441
Machine Innovation	0.0256	0.0278	−0.0143	0.0024	0.0491	0.0184	0.0081
R&D invest.	−0.0336	0.0300	−0.0329	−0.0079	0.0534	0.0504	−0.0465

	Firm Age	New Product	Improved Product	New Technology	Machine Innovation	R&D Investment
Firm Age	1.0000					
New Product	−0.0300	1.0000				
Improved Product	−0.1143	0.2082	1.0000			
New Technology	−0.0929	0.2406	0.3598	1.0000		
Machine Innovation	−0.1165	0.0997	0.0899	0.2261	1.0000	
R&D investment	0.0290	−0.0751	−0.0703	−0.653	−0.0431	1.0000

Source: Authors' calculation.

Table 5. The values of Variance Inflation Factor (VIF).

Variable	VIF	1/VIF
New Technology	1.28	0.784121
Improved Product	1.18	0.846303
Ownership Type 5	1.16	0.863572
Province 2	1.10	0.910489
Firm Age	1.08	0.925286
New Product	1.07	0.930725
Province 6	1.07	0.932857
Total Asset	1.07	0.935077
Machine Innovation	1.07	0.935961
Ownership Type 7	1.05	0.950892
Province 3	1.05	0.952301
R&D investment	1.03	0.975570
Mean VIF	**1.10**	

Source: Authors' calculation.

4.2. Empirical Results

This research implements the panel regression model for 4564 observations in six years after excluding the observations missing at least one variable in the model. The panel regression model examines the effect of innovative activities including new products, improved products, R&D investment, modern machine and equipment, advanced technologies on credit accessibility. Besides, some firm's characteristic components are also included.

First, to compare between Fixed Effect Model and Random Effect Model (REM), Hausman Test is applied. The REM is preferred since p-value is 0.662 greater than 0.05 (see Appendix A).

To compare between Pooled OLS and REM, Breusch and Pagan Lagrange multiplier test is conducted. Pooled OLS is preferred since p-value is 1.00 greater than 0.05 (see Appendix B).

Consequently, Pooled OLS is the appropriate model. Robust standard error (Rogers, 1993) is used to deal with heteroscedasticity and autocorrelation (see Appendix E).

Thus, using the results from Table 6, the linear regression equation is obtained as follows:

Access to credit $_{it}$ =
$-$ 169.17 + 1083.22 Province 2 + 204.12 Province 3 + 314.19 Province 6
+ 399.45 Ownership Type 5 + 0.099 Total Asset
$-$ 321.78 New Product + 429.09 New Technology $-$ 0.51 R&D investment + η_{it}

Table 6. The regression results with Robust standard error.

Variables	Access to Credit
New Product	−321.78 *** (119.38)
Improved Product	7.39 (182.36)
New Technology	429.09 ** (169.08)
Machine Innovation	0.31 (0.28)
R&D investment	−0.51 *** (0.15)
Firm Age	1.22 (3.84)
Total Asset	0.099 *** (0.027)
Ownership Type 5 (Limited Liability company)	399.45 *** (138.99)
Ownership Type 7 (Joint-Stock Company without state capital)	541.59 (334.06)
Province 2 (Ho Chi Minh City)	1083.22 *** (265.55)
Province 3 (Hai Phong City)	204.12 * (123.61)
Province 6 (Phu Tho province)	314.19 ** (127.67)

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Authors' calculation.

According to this equation, on average, Province 2 (Ho Chi Minh City) has the highest impact on formal loan, justifying the fact that Ho Chi Minh City offers a dynamic business environment as the economic capital of Vietnam. Thus, if SME has main business operation in Ho Chi Minh City then formal loan rise is VND 1083.22 million. New technology has the second important impact level, thus if SME has introduced new technology then the formal loan rise is VND 429.09 million. Next if the firm is a limited liability company then the formal loan rise is VND 399.4 million, suggesting these companies are more in credit demand and better meet the bank requirements. Hai Phong city, Phu Tho province, Total Asset also have positive relationship with formal loan.

On the other hand, new product and R&D investment have negative relationship with formal loan. If SME has produced a new product, then formal loan fall if VND 321.78 million. If the ratio of R&D investment to total asset increases 1 unit then formal loan decreases by VND 0.51 million.

To summarize, if the firm is only one-factor innovative then formal loan increases with new technology, decreases with new product and R&D investment. Next, if the firm is partly innovative by having introduced new technology and new product but not investing in R&D then formal loan increases by VND 107.31 million. For a fully innovative firm, formal loan increases when the ratio of R&D investment to total asset is less than or equal to 210.41 units, which means the firm is innovative but limiting their investment in R&D activities.

4.3. Discussion

First, the results show that new product and R&D investment have the negative relation with credit accessibility at 1% significance level. This result is consistent with [25]. The introduction of novel products over the preceding two years is significantly negatively associated with the formal loan amount. This implies firms may get more formal loan for the first plan of new product than the next ones.

Besides, new technology has positive impact on credit accessibility at 5% significance level. This result is similar to some other previous papers such as [28], when determining impact of innovation on credit accessibility. The results show that if SMEs introduced new production processes or new technology, they would receive more credit ability from the financial intermediaries. As we know, production process and technology play an important role in directly influencing the productivity of enterprises. Innovative production processes and new technologies are needed to make enough inventories for customer satisfaction. Additionally, innovative technology will prevent the business from wasting fuel production as well as being stagnant.

Finally, according to the regression results, the product improvement and machine innovation have no significant impact on credit accessibility. This may infer that banks and credit institutions pay no attention to the firm plan of product improvement and machine innovation.

In terms of control variables, the findings show that firm ownership (limited liability company) has positive relation with formal loan. This may imply these firms successfully obtain higher bank credit. Among provinces, Ho Chi Minh City, Hai Phong, Phu Tho positively impact credit accessibility, supporting the higher level of dynamism of these cities and provinces. Total Asset has positive relation with credit accessibility, which is consistent with the result in [28]. Firm Age, however, has no relation with credit accessibility for SMEs, supported by Malesky and Taussig [35].

5. Conclusions

There is no doubt about the crucial role of external fund accessibility for SMEs. Using the data set from a survey of SMEs conducted in Vietnam in six years 2005, 2007, 2009, 2011, 2013, 2015 of ten cities and provinces, including Ha Noi, Ho Chi Minh, Hai Phong, Long An, Phu Tho, Quang Nam, Nghe An, Khanh Hoa, Lam Dong, and Ha Tay, this research explores how innovative factors such as new product, improved product, new technology, machine innovation, and R&D investment impact on SMEs' credit accessibility.

The research found out that three out of five factors relating to innovation affect credit accessibility. They include new products, R&D investment and new technology. Specifically, new product and R&D investment have significantly negative effects, while new technology has a significantly positive effect on credit accessibility. These results are consistent with [25,28]. SMEs with higher total asset, firms located in Ho Chi Minh City, Hai Phong City, Phu Tho province, and limited liability companies also obtain more formal loan on average.

These results provide us with recommendations for SMEs, the government and financial institutions in the long-term. In general SMEs need to increase formal loan to expand their business operation, finance their current plans and pay short-term debts (see Figure 3). To overcome the

current problem of credit accessibility for SMEs, it would be more effective to focus on implementing a comprehensive plan of several measures as follows.

First, if SMEs' strategy is to go partly innovative then they should focus on new technology or production process to increase formal loan. If SMEs decide to go fully innovative then they should have implemented new product and introduced new technology solutions to reduce costs and improve efficiency, meanwhile limiting their investment in R&D.

Second, the government needs to set up specialized organizations to support SMEs from various aspects. These specialized organizations advise SMEs to overcome difficulties in technology, human resources, market, product quality, etc., in the direction of encouraging SMEs to develop. Incentive and supportive policies should be implemented consistently, flexibly, effectively and throughout the development of the SME system. New technology or new production process should be of a particular interest. Investing in R&D should be taken into account but at a reasonable investment proportion. This result is consistent with [36] as implemented by the Australian government in 2020 with significant additional support for non-R&D innovation over the next 5–10 years, in addition to more traditional R&D.

Third, the implementation of government credit support should be implemented selectively and focused. Firms located in Ho Chi Minh City, Hai Phong City, Phu Tho province, and limited liability companies are more dynamic in terms of formal loan amount obtained, should be encouraged. [36] also suggests that some key growth sectors should be prioritized. Supporting SMEs to access credit should be a component of the overall SME support system, along with other support programs such as capacity building, training, tax incentives, finance and business environment improvement programs to increase efficiency.

Fourth, there should be a platform for sharing information of stakeholders, including tax authorities, business registration, bank credit information, etc., helping banks and SMEs to share and transparent information, better serving SME credit rating and rating. Thus SMEs would overcome poor information transparency to build trust with not only credit institutions but also financial investors, securities investment funds and other financial intermediaries, helping SMEs step by step diversify capital sources for their development process.

Fifth, the government should continue to further promote the role of capital mobilization of the stock market in providing medium- and long-term capital for SMEs. In particular, it is necessary to accelerate the process of developing the corporate bond market. Currently, there are very few enterprises exploiting this capital source and therefore the room for development of the corporate bond market is huge. On the other hand, it is necessary to facilitate the development of new types of financial intermediary institutions such as investment banks, venture capital funds, and SME investment funds. The development of the above types of financial intermediary institutions will facilitate direct connection of new business ideas of startups with investors in the financial market, thereby solving the problem of capital for SMEs.

Finally, for the financial institutions, it is necessary to proactively upgrade the system; invest in building a digital financial platform to improve the accessibility and provision of financial services to SMEs; enhance the search and access to cheap capital sources from preferential programs of domestic and foreign organizations to finance specific business fields of SMEs that are approved by the government; design specific loan products which are suitable for SME customers according to each industry group to flexibly respond to customer requirements; improve and simplify the lending process. Moving towards applying big data technology in banking operations will better help the bank grasp information about its business operations, product usage trends as well as evaluate reputation in customer credit relationship [3].

To conclude, Industry 4.0 brings up many opportunities for innovative SMEs participating in global value chain. Managers, banks and policy makers should pay more attention to innovative technology activities of SMEs to help them boost their business development and contribute to

economic growth. This research shed light on some ideas of the strategic plans that help innovative SMEs overcome the finance barriers and access more capital fund.

This research has been using panel regression model to investigate the impact of innovation factors on credit accessibility using SMEs database from UNU-WIDER. Other research papers have been using logistic regression model, Tobit regression method, etc., to study various aspects of financial inclusion and credit accessibility. Future research could be undertaken with a more comprehensive database using these approaches. More detailed analysis may also be obtained with sub-categories of SMEs across industries to provide recommendations for key growth sectors.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Hausman Test Comparing Fixed Effect Model and Random Effect Model

```
. hausman fixed random

Note: the rank of the differenced variance matrix (8) does not equal the number of coefficients being tested (10); be sure this is
      what you expect, or there may be problems computing the test.  Examine the output of your estimators for anything
      unexpected and possibly consider scaling your variables so that the coefficients are on a similar scale.

                   —— Coefficients ——
                   (b)          (B)            (b-B)      sqrt(diag(V_b-V_B))
                  fixed        random        Difference          S.E.

          p2    -1118.422     1083.226       -2201.649         5493.515
          o5     134.9806     399.4583        -264.4778         261.8821
          o7     90.34423     541.5944        -451.2502         419.0061
          ta     .1028248     .0999344         .0028905         .0043796
         age    -4.088345     1.220464        -5.308809         14.05563
    new_prod    -503.0888    -321.7897        -181.2991         182.3049
  improved_p~d  -122.4525     7.395506        -129.848          159.729
    new_tech     243.7028     429.0965        -185.3937         184.3228
    machine2     .2682859     .3115019         -.043216         .6243606
         rd2    -.3360067    -.5161401         .1801334         .4572399

                          b = consistent under Ho and Ha; obtained from xtreg
             B = inconsistent under Ha, efficient under Ho; obtained from xtreg

     Test:  Ho:  difference in coefficients not systematic

                  chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        5.87
                Prob>chi2 =      0.6620
```

Appendix B. Breusch-Pagan Lagrange Multiplier Test Comparing Pooled OLS and Random Effect Model

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

    loan[id,t] = Xb + u[id] + e[id,t]

    Estimated results:
                            Var        sd = sqrt(Var)

             loan       1.67e+07          4085.68
                e       1.51e+07         3882.355
                u              0                0

    Test:   Var(u) = 0
                      chibar2(01) =      0.00
                    Prob > chibar2 =   1.0000
```

Appendix C. VIF

```
. vif
```

Variable	VIF	1/VIF
new_tech	1.28	0.784121
improved_p~d	1.18	0.846303
o5	1.16	0.863572
p2	1.10	0.910489
age	1.08	0.925286
new_prod	1.07	0.930725
p6	1.07	0.932857
ta	1.07	0.935077
machine2	1.07	0.935961
o7	1.05	0.950892
p3	1.05	0.952301
rd2	1.03	0.975570
Mean VIF	1.10	

Appendix D. Correlation Coefficients among Variables

```
. pwcorr loan p2 p3 p6 o5 o7 ta age new_prod improved_prod new_tech machine2 rd2
```

	loan	p2	p3	p6	o5	o7	ta
loan	1.0000						
p2	0.1426	1.0000					
p3	0.0121	-0.1380	1.0000				
p6	-0.0251	-0.1807	-0.1121	1.0000			
o5	0.1476	0.1997	-0.0028	-0.1233	1.0000		
o7	0.0561	-0.0312	0.0783	-0.0121	-0.1456	1.0000	
ta	0.5120	0.0789	0.0291	-0.0368	0.1526	0.0422	1.0000
age	-0.0371	-0.1378	0.0236	-0.0069	-0.2053	-0.0458	-0.0157
new_prod	-0.0054	0.0172	0.0132	-0.0145	0.0095	0.0020	0.0177
improved_p~d	0.0672	0.0637	0.0275	-0.0229	0.0965	0.0134	0.0876
new_tech	0.1255	0.0828	0.0026	-0.0802	0.1384	0.0352	0.1441
machine2	0.0256	0.0278	-0.0143	0.0024	0.0491	0.0184	0.0081
rd2	-0.0336	0.0300	-0.0329	-0.0079	0.0534	0.0504	-0.0465

	age	new_prod	improv~d	new_tech	machine2	rd2
age	1.0000					
new_prod	-0.0300	1.0000				
improved_p~d	-0.1143	0.2082	1.0000			
new_tech	-0.0929	0.2406	0.3598	1.0000		
machine2	-0.1165	0.0997	0.0899	0.2261	1.0000	
rd2	0.0290	-0.0751	-0.0703	-0.0653	-0.0431	1.0000

Appendix E. The Results with Robust Standard Error

```
. xtreg loan p2 p3 p6 o5 o7 ta age new_prod improved_prod new_tech machine2 rd2, vce(cluster id)
```

Random-effects GLS regression	Number of obs	=	4,564
Group variable: id	Number of groups	=	2,467

R-sq:		Obs per group:		
within = 0.1678			min =	1
between = 0.3429			avg =	1.9
overall = 0.2603			max =	6

		Wald chi2(12)	=	206.05
corr(u_i, X) = 0 (assumed)		Prob > chi2	=	0.0000

(Std. Err. adjusted for 2,467 clusters in id)

loan	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]	
p2	1083.226	265.559	4.08	0.000	562.7402	1603.712
p3	204.1239	123.6136	1.65	0.099	-38.15438	446.4022
p6	314.192	127.6716	2.46	0.014	63.96032	564.4237
o5	399.4583	138.9987	2.87	0.004	127.0258	671.8908
o7	541.5944	334.0655	1.62	0.105	-113.1619	1196.351
ta	.0999344	.0274886	3.64	0.000	.0460577	.1538111
age	1.220464	3.847667	0.32	0.751	-6.320825	8.761752
new_prod	-321.7897	119.3893	-2.70	0.007	-555.7884	-87.791
improved_prod	7.395506	182.3677	0.04	0.968	-350.0386	364.8296
new_tech	429.0965	169.0831	2.54	0.011	97.69969	760.4932
machine2	.3115019	.2850781	1.09	0.275	-.2472408	.8702446
rd2	-.5161401	.1585075	-3.26	0.001	-.8268091	-.2054711
_cons	-169.1732	92.11566	-1.84	0.066	-349.7166	11.3702

sigma_u	0	
sigma_e	3882.3549	
rho	0	(fraction of variance due to u_i)

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