Knowledge and Ambidexterity's Impact on Product Innovation

Javier Fernando Del Carpio

This paper aims to evaluate the relationship between external sources of knowledge and innovation ambidexterity and then analyze how innovation ambidexterity improves product innovation. This study presents evidence based on a sample of 355 low-medium-tech (LMT) firms participating in the National Survey of Innovation in the Manufacturing Industry and Knowledge-Intensive Service Firms in Peru. A structural equation model approach was applied. The results indicate a positive relationship between external sources of knowledge and exploration and exploitation, and technological innovation improves product innovation. These results provide more profound knowledge about how LMT firms in an emerging economy can apply open innovation practices to develop innovation ambidexterity, thus enhancing their product innovation capability.

Keywords: Manufacturing, External Sources of Knowledge, Innovation Ambidexterity, Product Innovation, Peru.

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1. Introduction

Low-medium-tech (LMT) firms have caught the attention of researchers and innovation policymakers. Researchers analyze the behavior of LMT firms because they carry out product innovations despite not investing much money into research and development (Santamaría et al., 2009). Moreover, innovation policymakers are interested in this type of firm due to its contribution to the GDP and ability to generate jobs (Trott & Simms, 2017). One of the characteristics of LMT firms is that they apply the open innovation model; that is to say, they seek out knowledge from diverse external market-based, institutional, and other sources that allows them to improve their ability to carry out product innovations (Mei et al., 2021).

This paper utilizes the innovation ambidexterity construct. Jansen et al. (2006) have indicated that firms, in their search to face ever more turbulent and competitive environments, see the need to develop innovation ambidexterity or innovation that is both exploratory and exploitative to improve firm performance. Among the studies that illustrate the relationship between innovation ambidexterity and product innovation is Heirati et al. (2017). They indicate that firms in emerging economies work to be competitive by developing exploratory and exploitative product innovation.

In the Latin American context, studies are recent and few and do not necessarily analyze the impact of ambidexterity on product innovation. Indeed, the research carried out can easily be summarized. For example, Acevedo and Diaz-Molina (2019) studied Chilean, Ecuadorian, and Peruvian firms to analyze the effect of political and economic uncertainty on organizational ambidexterity. Additionally, López-Zapata and Ramírez-Gómez (2021) analyzed information from more than 100 Colombian managers and found a direct relationship between firms' intellectual capital and their organizational ambidexterity. Also, Pérez, Geldes, Kunc & Flores (2019) state that companies in emerging economies carry out exploitative and exploratory innovations to improve their performance. As far as can be seen, very few studies in Latin America have focused on the relationship between innovation ambidexterity and product innovation; this fact justifies this study, which contributes to the literature on innovation ambidexterity in emerging economies.

This paper focuses on two research questions: first, how are sources of knowledge related to innovation ambidexterity? And second, how is innovation ambidexterity related to product innovation? To validate the theoretical model empirically, a sample of 355 LMT manufacturing firms was obtained from the firms that participated in the National Survey of Innovation in the Manufacturing Industry and Knowledge-Intensive Services Firms in Peru (2018). A structural equations approach was applied.

This paper contributes to the literature on innovation ambidexterity and its relationship with product innovation in the context of LMT firms in an emerging Latin American economy. In that line, Zawislak, Tello-Gamarra, Fracasso, & Castellanos (2017) point out that in Latin America, innovation has been considered a secondary factor linked to companies; whose governments have designed policies that promote innovation, but without taking into account the environment that influences the development of innovative activities of companies. Latin American companies develop their activities in an unfavorable context; for example, they must face high levels of informal activities, a condition that discourages formal companies from investing in research and development to develop innovations (Pérez., Kunc, Durst, Flores, & Geldes, 2018). As indicated by Dutrénit et al. (2019), Latin American innovation systems are characterized by their dedication to scarce financial resources, the fact that few scientists are dedicated to innovation projects, and the fact that the government mainly finances innovation researchers. It is also essential to mention what was pointed out by Peng, Wang, & Jiang (2008), who consider that companies from emerging economies carry out activities under the supervision of public institutions that are not as robust compared to more developed economies. On the other hand, it should be considered that the levels of competitiveness achieved by the Latin American economies

Universidad ESAN, Perú.
Corresponding author: jdelcarpio@esan.edu.pe

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are heterogeneous. Some economies must make more significant efforts to develop their national innovation systems to reach acceptable levels of competitiveness (Bianchi, Mingo, & Fernández, 2019).

This paper is structured as follows: the following section presents the literature review and the formulation of the hypotheses, followed by the methodology section, the empirical results, and then the discussion, conclusions, research limitations, and future suggested research.

2.Literature review and hypotheses

2.1 Literature review

Firms seek external sources of knowledge, for example, customers, suppliers, competitors, universities, research centers, or consultants, as these sources can improve the firms' innovation capability (Mei et al., 2021), especially their innovation ambidexterity, which allows firms to carry out both exploratory innovations (which are radical) and exploitative innovations (which are incremental) (He & Wong, 2004). It is essential to mention that Snehvrat et al. (2018) recognized that long-term firm sustainability would depend on the development of firm ambidexterity, that is, a firm's ability to exploit its current capabilities and ability to explore new capabilities to remain competitive.

2.2 External sources of knowledge and ambidexterity

The literature recognizes that firms implement strategies that allow them to have access to different external sources of knowledge and thus develop their innovation capability (Tortoriello, 2015); for example, Röd (2019) analyzed family businesses and found that these firms sought out many different sources of knowledge that allowed them to carry out incremental and radical innovations at the same time.

On the other hand, Tang et al. (2019) propose that firms that apply the open innovation strategy to obtain external knowledge have access to technology and develop capabilities, including innovation ambidexterity. According to Soto-Acosta et al. (2018), this ambidextrous capability is significant for firms. They indicate that firms that face dynamic environments have to link themselves to partners that provide them with external knowledge to develop their ambidextrous capability, which means carrying out exploratory and exploitative activities to take advantage of long-term opportunities through radical innovations and short-term opportunities through incremental innovations.

The relationships between firms, that is, the search for external knowledge, and the relationships within a firm, through its expertise and external knowledge, allow manufacturing firms to develop exploratory and exploitative innovations (Lee et al., 2019). The development of exploratory innovations means taking risks and experimenting with new ideas while developing exploitative innovations implies using already-familiar elements that need improvement (Hernández-Espallardo et al., 2011). Along these lines, Popadić et al. (2016) analyzed how the search for external knowledge aids the development of innovation ambidexterity, emphasizing that carrying out innovations demands high levels of investment and significant risks. They also indicate that innovation ambidexterity requires capabilities and resources that the firm should adequately administer to achieve optimal results.

The motives and mechanisms through which firms carry out their search for external knowledge to carry out innovation ambidexterity should be analyzed, as Kauppila (2010) mentioned, who proposed that exploratory innovation can be achieved through interactions with universities and research centers, which provide external technological knowledge, while exploitative knowledge through contracting or subcontracting can help develop capabilities and expertise that allow efficiency to be increased and costs to be decreased. Tsai and Wang (2017) indicate something similar when they specify that exploratory innovation requires firms to search for new knowledge and technologies that can help them carry out radical innovations. Meanwhile, exploitative innovations are built mainly on a firm's existing knowledge, which brings about incremental innovations. Moreover, Fernández Sastre & Vaca Vera (2017) indicate that companies are linked to various sources of information and carry out research and development activities to develop incremental and radical innovations. After having presented arguments that show the relationship between external sources of knowledge and innovation ambidexterity, the following hypotheses are proposed:

> **H1a:** External sources of knowledge are related to exploratory innovation.

> **H1b:** External sources of knowledge are related to exploitative innovation.

2.3 Ambidexterity and product innovation

Firms frequently face uncertain environments that force them to carry out exploratory and exploitative activities, in other words, to develop their ambidextrous capacity, which is a paradoxical challenge (Martin et al., 2019). Exploratory activities are oriented toward the introduction of new products, the expansion of product portfolios, the opening of new markets, and the utilization of new technologies that lead to the development of radical innovations. In contrast, exploitative activities are oriented toward the improvement of the quality of existing products, an increase in production flexibility, the reduction of costs, and the reduction of raw materials needed for production, all of which lead to the development of incremental innovations (He & Wong, 2004). Ambidexterity should be carried out in such a way as to contribute to the development of innovations, which, in turn, generates the creation of competitive advantage, making the firm more sustainable over time (Limaj & Bernroider, 2019).

The literature shows that firms that carry out exploratory activities, especially the search for external sources of knowledge and customer involvement, compensate in this way for any deficiency in their research and development activities and, therefore, can develop their ability to carry out product innovation (Lee et al., 2016). However, Heirati et al. (2017) warn that firms that pursue exploratory and exploitative product innovation can see negative results: if they focus only on product improvement, they can waste the benefits that accompany radical innovations, and if they focus too much on new product innovation, they could lose the benefits of incremental innovations. Also, Vega-Jurado, J., Kask, S., & Manjarrés-Henriquez, L. (2017)

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argue that companies that interact with universities are more likely to implement strategies that allow them to introduce product innovations.

What should be considered is that the literature shows many different results when the relationship between exploitative and exploratory innovation and product innovation is analyzed. On the other hand, Lee et al. (2019) have found that exploitation is negatively related to radical product innovation and positively related to incremental product innovation, while exploration is positively associated with radical product innovation and negatively related to incremental product innovation. These results encourage more research on this topic to identify which variables determine the relationship between innovation ambidexterity and product innovation.

After having presented the arguments related to innovation ambidexterity and product innovation, the following hypotheses are proposed:

H2a: Exploratory innovation is related to product innovation.

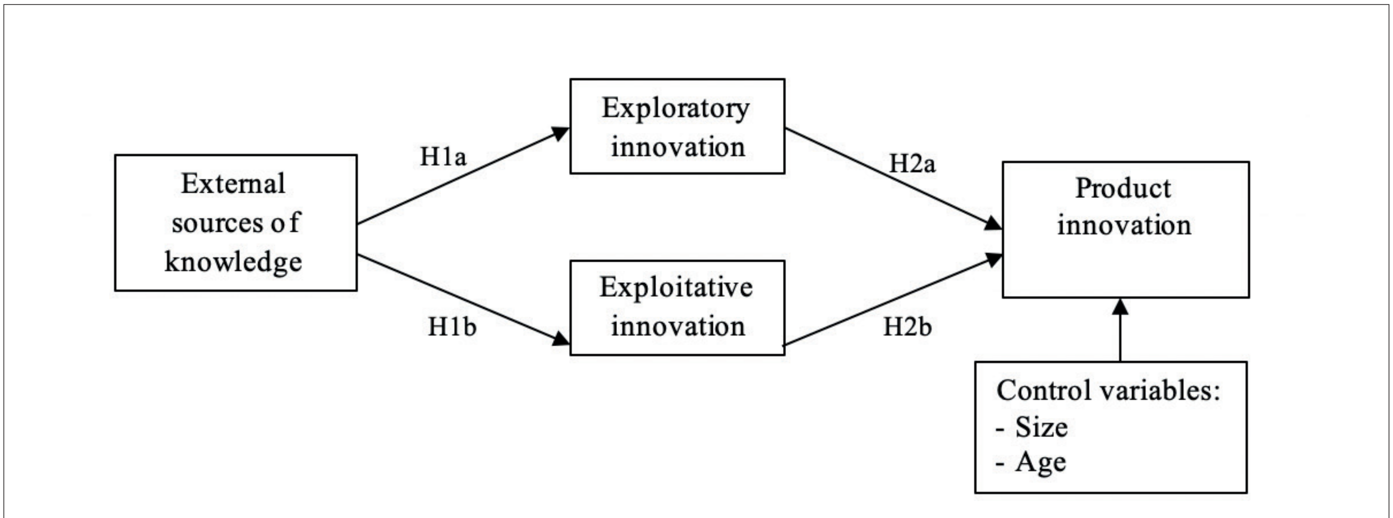
H2b: Exploitative innovation is related to product innovation.

3. Methodology

3.1 Data

This study focuses its attention on the Peruvian manufacturing industry. The unit of analysis is the Peruvian manufacturing firm that participated in the 2018 National Survey of Innovation in the Manufacturing Industry and Knowledge-Intensive Services Firms in Peru. This survey was carried out by the Peruvian National Institute of Statistics and Informatics (INEI). The fieldwork produced 2229 completed surveys over three consecutive years (2015-2017). The sample consists of 355 low-medium-tech manufacturing firms.

Figure 1. Conceptual model



Source: The authors.

3.2 Variables

The dependent variable is "product innovation," a qualitative, nominal variable that explains the new products that the firm has introduced in the market, according to Lee et al. (2016) and Gronum (2012). It consists of three polytomous items, which are, in order of importance, (1) new good, (2) new service, and (3) significantly improved service. Each is assigned a value according to the following dichotomous classification: 1: Yes and 2: No.

On the other hand, the independent variables are "external sources of knowledge," "exploratory innovation," and "exploitative innovation." The "external sources of knowledge" variable is composed of 3 factorial items: (1) sources of market knowledge, (2) sources of institutional knowledge, and (3) other sources of knowledge, according to Derbyshire (2014) and Vrontis et al. (2017). "Exploratory innovation," used by Derbyshire (2014) and Vrontis et al. (2017), is represented by the degree of importance (1=none, 2=low, 3=medium, 4=high) of the following items: (1) newly introduced product (good or service), (2) new product feature, (3) the firm's ability to keep participating in the market, (4) the firm's ability to increase its participation in the market, and (5) the firm's ability to open new markets abroad. These items are qualitative and nominal. "Exploitative innovation" represents the degree of importance (1=none, 2=low, 3=medium, 4=high) of the following items: (1) improvement in product quality (goods or services), (2) increase in production flexibility (reduction in setup times), (3) reduction in unit costs (materials and energy), (4) reduction in labor costs, and (5) increase in productivity (in labor, in the capital); these items are qualitative and nominal.

3.3 Method of analysis

AMOS version 27 software was used to estimate a covariance model of two-step structural equations. In the first place, the measurement model was calculated when the relationship between the indicators and the latent construct was determined through confirmatory factor analysis (CFA). In the second place, the structural model was estimated; it shed light on the relationships between the constructs through the coefficients and the levels of statistical significance.

4. Results

The results are presented in four stages: first, the descriptive statistics; second, the results of the factor analysis; third, the results of the measurement model; and fourth, the results of the structural model.

4.1 Descriptive statistics

Table 1 presents the descriptive statistics of the firms included in the sample. The firms have been classified according to their age and size.

Table 1. Number of firms by age and size

Firm age	**Number**	**Percentage**
Young (27 years old)	233	66%
Moderate (28-45 years old)	66	18%
Old (≥46 years old)	56	16%
Total	355	
Firm size		
Small (50 employees)	140	39%
Medium (51-250 employees)	139	39%
Large (≥251 employees)	76	22%
Total	**355**	

Source: INEI and the authors.

4.2 Factor analysis

For the analysis of the variables "external sources of knowledge," "exploratory innovation," "exploitative innovation," and "product innovation," SPSS software was used to run an Exploratory Factor Analysis (EFA) to determine which items measure each factor, as pointed out by Dobni (2008).

To then proceed with the confirmatory factor analysis, as indicated by Cabrera et al. (2008) recommend verifying the adequacy of the sample is measured through the Kaiser-Meyer-Olkin (KMO) statistic, which should be greater than 0.5; moreover, they recommend that the Bartlett test of sphericity should be applied to verify multivariate normality: the p-value should be less than 0.05. The analysis can continue when these two conditions are met (Rossoni et al., 2016). The results are shown in Table 2. According to Beavers et al. (2013), to verify reliability and validity, the percentage of the total variance explained must be used; the following results have been obtained: 73.71% for external sources of knowledge, 67.71% for exploratory innovation, 80.32% for exploitative innovation, and 44.17% for product innovation.

Table 2. Factorial loading of the variables for manufacturing firms

Variable	**Indicator**	**Factorial loadings**	**Goodness of fit**
External sources of knowledge ESK	ESK1	0.879	KMO: 0.713
	ESK2	0.836	Barlett: 382.022 (p=0.001)
	ESK3	0.860	
Exploratory innovation	ERI1	0.836	KMO: 0.760
	ERI2	0.792	Barlett: 1228.529 (p=0.001)
	ERI3	0.879	
	ERI4	0.904	
	ERI5	0.685	
Exploitative innovation	ETI1	0.767	KMO: 0.875
	ETI2	0.940	Barlett: 1725.269 (p=0.001)
	ETI3	0.938	
	ETI4	0.893	
	ETI5	0.931	
Product innovation	PI1	0.521	KMO: 0.466
	PI2	0.825	Barlett: 42.494 (p=0.001)
	PI23	0.612	

Source: IBM SPSS Statistics software and the authors.

4.3 Measurement model

The research data were analyzed and submitted to various tests to verify their validity and reliability. To measure internal consistency, this study has used the Composite Reliability (CR) Index, for which values must be greater than 0.7; the convergent validity indicator, through the Average Variance Extracted (AVE), for which values must be greater than 0.5; the multicollinearity analysis indicator, measured by the variance inflation factor (VIF), for which values must be less than 5; and the coefficient of determination (.

Table 3 shows the values of the indicators of reliability, convergent validity, and multicollinearity analysis, as well as the coefficient of determination for the research model. For convergent validity, the indicators comply with the established values. Likewise, the multicollinearity analysis results hold for all the variables, and the variance inflation factor does not exceed a value of 5. Additionally, the model's coefficient of determination is 0.920, indicating a proper relationship between the dependent and independent variables.

Table 3. Reliability and validity indicators for manufacturing firms

Latent variable	CR	AVE	VIF	R^2
External sources of knowledge	0.884	0.726	2.042	
Exploratory innovation	0.919	0.702	4.151	0.998
Exploitative innovation	0.942	0.766	3.425	0.729
Product innovation	0.810	0.629		0.920
Referential values	**>0.7**	**>0.5**	**<5**	

CR, Composite reliability; AVE, Average variance extracted; VIF, Variance inflation factor.
Source: AMOS and SPSS software.

As for discriminant validity, the Fornell & Larcker (1981) criterion is used, which establishes that the square root of the variance extracted (AVE), shown in the diagonals and in bold in Table 4, must be greater than the correlations between the latent variables. For the present study, it can be seen that the model complies with the discriminant validity tests for LMT manufacturing firms.

Table 4. Discriminant validity of manufacturing firms

	External sources of knowledge	Exploratory innovation	Exploitative innovation	Product innovation
External sources of knowledge	**0.852**			
Exploratory innovation	0.685	**0.838**		
Exploitative innovation	0.646	0.824	**0.875**	
Product innovation	0.393	0.495	0.405	**0.793**

Source: AMOS software.

4.4 Structural model

To verify that the structural model complies with the different goodness-of-fit indicators, as indicated by Hair et al. (2017), Table 5 shows that the goodness-of-fit indices are reasonable. Indeed, CMIN divided by the degrees of freedom equals a value of less than 5; the CFI, NFI, RFI, IFI, and TLI indicators are more significant than 0.9; and the RMSEA indicator is less than 0.08. In this way, having verified that both the measurement and structural models meet the goodness of fit, the standardized coefficients obtained can be analyzed.

Table 5. The goodness of fit index for LMT firms

Indices	Structural model
CMIN/DF<5	2.775
CFI>0.9	0.959
NFI>0.9	0.938
RFI>0.9	0.914
IFI>0.9	0.960
TLI>0.9	0.943
RMSEA<0.08	0.071

Source: AMOS software.

When Table 6 is reviewed, the standardized coefficients obtained through the structural model can be seen. It can be pointed out that the variable "external sources of knowledge" has a positive relationship with "exploratory innovation" because its coefficient is positive and statistically significant; "external sources of knowledge" also has a positive relationship with "exploitative innovation," with a positive and statistically significant coefficient; likewise, "exploratory innovation" has a positive relationship with "product innovation," with a positive and statistically significant coefficient, while "exploitative innovation" has a negative relationship with "product innovation," with a negative and statistically insignificant coefficient.

Table 6. Results of the structural model

Hypotheses	Coefficient	P-value
H1a: ESK→ERI	0.997***	0.001
H2a: ERI→PI	1.063***	0.001
H1b: ESK→ETI	0.854***	0.001
H2b: ETI→PI	-0.149	0.117

Note: ESK: External sources of knowledge; ERI: Exploratory innovation; ETI: Exploitative innovation; PI: Product innovation. P-value: *p≤0.1; **p≤0.05; ***p≤0.001
Source: AMOS software.

The control variables are shown below in Table 7. It can be seen that both firm age and firm size possess positive coefficients, but neither is statistically significant. In other words, in an LMT firm, neither the size nor the age of the firm influences the development of product innovation.

Table 7. Result of the control variables

Hypothesis	Coefficient	P-value
Firm size	0.071	0.237
Firm age	0.007	0.898

P-value: *p≤0.1; **p≤0.05; ***p≤0.001
Source: AMOS software.

5. Discussion

This paper proposes a theoretical model that shows that external sources of knowledge are related to innovation ambidexterity and how this approach helps product innovations come about. As Crescenzi and Gagliardi (2018) proposed, ambidexterity helps firms explore and exploit external sources of knowledge and improve firms' innovation capability. In this sense, hypotheses 1a and 1b have been validated (p-value<0.001) for LMT manufacturing firms. The results are similar to those obtained by Röd (2019), who analyzed family businesses and empirically verified a positive relationship between different sources of external knowledge, like suppliers, competitors, customers, universities, research centers, consultants, government agencies, and innovation ambidexterity. Mei et al. (2021) also found similar results as they analyzed how different sources of external knowledge are related to ambidextrous product innovation. That is to say, lower-tech manufacturing firms that are exposed to other external sources of knowledge are better able to carry out exploratory and exploitative innovation.

Moreover, this study has allowed for the empirical verification that firms that apply the exploratory innovation approach are better able to carry out product innovation; in other words, hypothesis 2a has been validated (p-value<0.001) for LMT manufacturing firms. This result coincides with the findings of Popadić et al. (2016). They conducted an empirical study and found a positive, statistically significant relationship between exploratory innovation and product innovation, measured through the introduction of product innovations and the percentage of sales of new products.

Hypothesis 2b, which proposed a relationship between exploratory innovation and product innovation, was not validated (p-value>0.10). However, although not statistically significant, the relationship was negative, as Popadić et al. (2016) predicted. They conducted an empirical study and reported a negative, statistically significant relationship between exploratory innovation and innovation performance, which they measured using product innovation.

Santamaría et al. (2009), when they analyzed LMT firms, found that firm size influenced the development of product innovation, whereas, for firm age, the coefficient was negative and not statistically significant. The literature indicates that obtaining a negative coefficient means that young firms are more likely to take risks and innovate. In contrast, more mature firms have more resources to carry out innovative behavior (Abd Aziz & Samad, 2016).

Conclusions, theoretical and business implications, limitations, and future research

5.1 Conclusions

If the results obtained are taken into account, it can be seen that LMT firms that seek external sources of knowledge, like market-based sources (customers, suppliers, and competitors), institutional sources (like universities and research centers), and other sources (like conferences, scholarly journals, and associations), can obtain knowledge that allows them to use an innovation ambidexterity approach; that is to say, carry out exploratory activities to introduce new products, expand their product portfolio, seek out new markets, or use new technologies, as well as carry out exploitative activities to improve product quality, increase the flexibility of the production process, and reduce production costs and materials used.

It can also be concluded that exploratory innovation contributes to product innovation development, with well-known benefits: satisfied customers, opening new markets, and creating a competitive advantage. The findings of Lee et al. (2019) should be taken into account: high- and low-tech Korean firms possess different innovative behaviors, which is why exploitative innovation helps lower-tech firms carry out incremental and not radical innovations.

5.2 Theoretical implications

This paper contributes to the literature on LMT manufacturing firms' product innovation. First, LMT firms are open to identifying external sources of knowledge that allow them to use innovation ambidexterity, introduce new or improved products, improve their quality, and reduce production costs. Second, it can be verified that LMT firms that focus on exploratory activities can carry out product innovations better. The literature recognizes that firms more likely to carry out product innovations are also more likely to develop competitive advantages and perform better.

5.3 Business and policymaking implications

This study also has business and policymaking implications in terms of the promotion of innovation. Indeed, the managers of LMT manufacturing firms should be cautious when implementing innovation ambidexterity because to use it effectively; they should find an appropriate balance between exploratory and exploitative activities. If they focus only on developing new products, they could lose the benefits of incremental improvements to their products. At the same time, managers should seek to connect with external sources of knowledge, especially from the market and institutions, as customers provide knowledge that is valuable for new or improved product launches; suppliers provide new technologies or new materials; competitors provide examples to follow; universities support firms in the development of technology transfer projects, and consultants offer technical experience and expertise.

Meanwhile, policymakers recognize that innovation makes firms more competitive globally. In this sense, innovation promotion policies should encourage a link between LMT firms and different external sources of knowledge to improve the former's innovation capability. Connections with universities should especially be encouraged, as these relationships provide the technical expertise needed to develop product innovations. It is important to remember that as a firm introduces innovative products, its performance improves so that it can become an organization that generates jobs, pays taxes, and satisfies societal needs.

It is recognized that Peruvian manufacturing companies face a business context that is not conducive to developing innovations, high levels of informal companies that discourage formal companies from developing innovations, and scarce financial resources to develop research and development projects. As well as institutions for the protection of intellectual property with limitations to exercise their functions

5.4 Limitations and future research

This study has four limitations that should be considered when designing future research. First, the measurement of product innovation was based on the dichotomous responses to four questions in an innovation survey carried out in Peru. It is suggested that future surveys be formulated to measure product innovation better. Second, this study focuses on a sample of 355 firms within the following industries: the manufacture of rubber products, the production of nonmetallic products, the production of metallic products, etc. It is suggested that other industries, such as the manufacture of food, drinks, textiles, and clothing, should also be analyzed. Third, due to the study's transversal nature, its results cannot be generalized. It is suggested that longitudinal studies be undertaken in the future. Fourth, this study has used product innovation as a dependent variable; product innovation is one form of technological innovation, and it would be recommendable to include nontechnological types of innovation, like marketing and organizational innovation, in the future.

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