Innovation and performance in Peruvian manufacturing firms: does R&D play a role?

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Abstract

Purpose – This paper aims to study whether Peruvian manufacturing firms that implement innovation have positive performance and whether R&D activities moderate these relationships.

Design/methodology/approach – Using a data set of Peruvian manufacturing firms from the 2018 National Survey of Innovation, a LOGIT model analysis was applied to 774 companies. In addition, the authors fitted different models into subsamples to explore the moderating effects of R&D on manufacturing firms. Finally, the regression models were computed using R software.

Findings – The results indicate that product, service and marketing innovation are associated positively with an increase in market share, while process and organizational innovations are associated positively with productivity. Moreover, companies with R&D are more productivity-oriented than companies without R&D.

Research limitations/implications – This study contributes to the literature on innovation management by supporting the assumption that innovation results in increased productivity and expands market demand. In addition, findings highlight that R&D is essential for boosting firms' productivity.

Practical implications – Managers should consider an appropriate combination of the innovation portfolio and R&D investments to make progress and increase performance in the company. In addition, policymakers should consider that investments to promote the development of R&D activities in manufacturing companies will likely lead to médium- or long-term returns.

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Social implications – The correct use of indicators to measure these relationships could help the policymaker to design and measure policy instruments more efficiently.

Originality/value – These results provide a deeper understanding of how the effects of innovations implemented by manufacturing firms, especially service and process innovation, improve their performance.

Keywords Innovation, R&D, Performance, Manufacturing, Peru

Paper type Research paper

1. Introduction

Innovation is essential, for even in a pandemic context, it can be considered a way out of a crisis (Lome, Heggeseth, & Moen, 2016; Van Auken, Fotouhi Ardakani, Carraher, & Khojasteh Avorgani, 2021). Numerous studies have widely validated the argument for a positive relationship between firm innovativeness and performance (Crepon, Duguet, & Mairesse, 1998; Cho & Pucik, 2005). Because companies possess heterogeneous resources and capabilities, they adopt different strategies to configure their innovation portfolio (Seclen-Luna, Opazo-Basáez, Narváez, & Moya-Fernández, 2021a). This study contributes to the theory of innovation by reinforcing the assumption that innovation involves developing new processes, new products or new organizational improvements in a company to reduce unit costs and help expand market demand.

In addition, the extant literature recognizes R&D as one of the main determinants of innovation (Conte & Vivarelli, 2014). Thus, the literature on R&D highlights that it plays a fundamental role in innovations to develop new competencies and skills necessary to seek, acquire and adapt the existing technology (Chudnovsky, López, & Pupato, 2006). While much has been studied in developed countries on R&D investments and their effects on different variables (Bae & Kim, 2003), it is now necessary to investigate the impact of innovation and R&D investments in Latin American and Caribbean (LAC) countries to enrich the literature in this region (Viglioni, de Brito, & Calegario, 2020).

The literature criticizes the LAC context because non-technological or basic commodity activities dominate this region; for example, Cuervo-Cazurra *et al.* (2019) argue that emerging market multinationals are developing the so-called "uncommoditizing" strategies. They explain that one of these strategies is the use of "tropicalized innovations", whereby firms develop innovations and brands adapted to the unique needs of emerging economies and to gain customer preferences. According to Salazar-Elena, López, Guimón, and Cancino (2020), it could be the appropriability regimes of an economy that limit or promote certain innovation strategies and their results. The higher the probability of innovation benefits appropriateness, the higher the investment in R&D, depending on the comparison with the technology acquisition benefits.

LAC countries have historically experienced low participation in R&D investment in the productive sector (Hall & Maffioli, 2008; ECLAC, 2022). However, there has been increasing progress in innovation and R&D in LAC manufacturing industries (Paula & Silva, 2021; Seclen-Luna & Morales, 2022). According to Cancino, Merigó, Urbano, and Amorós (2020) and Román, Cancino, and Gallizo (2017), this concern with understanding the determining factors of R&D investment, innovation and its results, has grown steadily in recent years. Based on the previous arguments, three main research questions arise:

RQ1. Are there positive relationships between innovation outcomes and productivity in manufacturing firms?

RQ2. Are there positive relationships between innovation outcomes and market shares in manufacturing firms?

RQ3. Are there differences in these relationships between manufacturing firms with and without R&D?

From a contextual perspective, this study demonstrates these relationships in a Latin American country such as Peru, which is subject to different factors than developed economies. Generally speaking, Peruvian companies face a large informal sector (Heredia-Pérez, Kunc, Durst, Flores, & Geldes, 2018), a lack of financial resources to develop their innovations and the innovation ecosystem's infancy (ECLAC, 2022). In addition, this research acquires importance because, even though, over the last 10 years, the Peruvian government has become active in promotion, incentives and support for the development of innovations created by companies, especially for those companies that collaborate in R&D projects with universities (Arenas & Gonzalez, 2019), little is known about their results.

Our original research uses the LOGIT method with data from the 2018 National Innovation Survey of Manufacturing Industries. Our empirical analysis is based on a sample of 774 Peruvian manufacturing firms: 245 with R&D and 530 without R&D. Multiple relationships between innovation outcomes and performance are explored. The results show that product, service and marketing innovation are positively associated with an increase in market share, while process and organizational innovation are positively associated with productivity. Moreover, the results show that companies with R&D have a greater positive association between innovation strategies and productivity than companies without R&D. However, companies without R&D have a greater positive association between innovation strategies and market share than companies with R&D.

The research is organized as follows: Section 2 introduces the literature review and develops the hypotheses. Section 3 details the data sets and tests the hypotheses. The empirical results are provided in Section 4. Lastly, Section 5 provides some conclusions.

2. Literature review and hypotheses

2.1 Innovation in manufacturing firms and performance

Traditionally, the literature on innovation identifies four basic types of innovation outcomes that affect a firm's performance: product, process, organizational and marketing innovation (Gunday, Ulusoy, Kilic, & Alpkan, 2011). Companies with heterogeneous resources and capabilities adopt different strategies to configure their innovation portfolio or outcomes (Seclen-Luna *et al.*, 2021a). Because these kinds of innovation are different in nature, it is essential to analyse them accordingly. In that sense, one way to understand innovation outcomes is by distinguishing between *technological* and *non-technological* innovations (Álvarez-Coque, Mas-Verdú, & Roig-Tierno, 2017; Geldes, Felzensztein, & Palacios, 2017; Mothe & Nguyen, 2010). Even though the literature also recognizes complementarities between them (Del Carpio Gallegos & Miralles, 2021; Seclen-Luna, Moya-Fernández, Barrutia, & Ferruci, 2022). Technological innovations are defined as product and process innovations (Martínez-Ros, 2019), while non-technological innovations are associated with organizational and marketing innovations (Mothe & Nguyen, 2010). Technological innovation consists of the application of technologies to different aspects of a company to produce a significant novelty effect, while non-technological innovation is a facilitator of product and process innovations, as the success of these more tangible and visible innovations largely depends on how the organizational structures and processes co-evolve with new technologies (Armbruster, Bikfalvi, Kinkel, & Lay, 2008).

Despite the facts above, technological innovation has predominantly focused on product and process innovation in manufacturing industries, highlighting a positive relationship between product innovation and productivity (Crepon *et al.*, 1998) or sales (Kendall, Norman, Hatfield, & Cardinal, 2010). However, in some cases, empirical evidence in developing countries has shown that product innovation does not affect productivity (Heredia-Pérez, Geldes, Kunc, & Flores, 2019). In addition, service innovation has not been considered despite the well-documented relevance of service transition in manufacturing industries (Crozet & Milet, 2017). Service innovation makes the company's production more heterogeneous and allows companies to achieve better market performance (Grawe, Chen, & Daugherty, 2009). That is, service innovation can positively impact market share and sales growth rate. However, in some developing contexts, service innovation does not affect productivity (Feng, Ma, & Jiang, 2021). Consequently, it is necessary to note that the analysis of both products and services must be done separately to understand their individual effects (Seclen-Luna & Álvarez-Salazar, 2021).

On the other hand, it is also important to understand the different activities in process innovation. For instance, companies can implement new or significantly improved engineering or design activities to achieve a new production method. Moreover, companies could implement new or significantly improved logistic, distribution or storage activities, and even acquire machinery and hardware (e.g. industrial robots or machine tools, 3D printing) to improve their processes. Thus, not all these activities will affect productivity or market shares in the same way (OECD & EUROSTAT, 2018).

Although process innovation enables businesses to grow quickly and with increased efficiency in many developing countries, technology acquisition is the primary innovation strategy for manufacturing firms (Goedhuys & Veugelers, 2012). However, its positive effects on performance are less evident (Taveira, Gonçalves, & Freguglia, 2019). In any case, in Latin American countries, there is evidence that both product and process innovation influence firm productivity (Crespi & Zúñiga, 2012; Seclen-Luna, Moya-Fernández, & Pereira, 2021b), and they can be complementary. Hence, process innovation alone, without introducing new products, may be ineffective in boosting growth (Goedhuys & Veugelers, 2012). Thus, based on these arguments, we propose the following hypothesis:

H1a. Manufacturing firms that implement product innovation have positive effects on their performance.

H1b. Manufacturing firms that implement service innovation have positive effects on their performance.

H1c. Manufacturing firms that implement process innovation (production method/logistic method/acquisition of machinery) have positive effects on their performance.

From a non-technological innovation perspective, there have been multiple approaches within the different strands of literature. However, there is a certain consensus in the literature that refers to organizational innovations as comprising changes in the structure and processes of an organization due to implementing new managerial and working practices, such as the implementation of teamwork in production, supply chain management or quality management systems (OECD & EUROSTAT, 2018). Furthermore, it could be understood as organizational innovation when companies acquire any software (e.g. ERP, CAD) to improve their internal processes (personal tasks, quality control, etc.). The literature has found evidence on organizational innovation and firm performance (Arranz, Arroyabe, Li, & Fernandez de Arroyabe, 2019). Moreover, some research suggests a complementary relationship between technological and organizational innovation (Geldes *et al.*, 2017).

On the other hand, marketing innovation refers to a firm's commitment to new or significantly improved marketing methods (e.g. promotion techniques, product positioning or pricing) that enable firms to use their resources efficiently to meet the demand of customers and create superior customer values (OECD & EUROSTAT, 2018). Thus, marketing innovation can relate to other parts of the firm, such as R&D, human resources and finance (Prabhu, 2015). Furthermore, literature on this issue has recognized the effects of marketing innovation on firm performance; for example, Gotteland, Shock, and Sarin (2020) stated that a proactive market orientation and market pioneering have a significant positive impact on the sales per employee and the growth rate of a firm. Thus, based on these arguments, we propose the following hypothesis:

H2a. Manufacturing firms that implement organizational innovation have positive effects on their performance.

H2b. Manufacturing firms that implement marketing innovation have positive effects on their performance.

2.2 R&D in manufacturing firms and performance

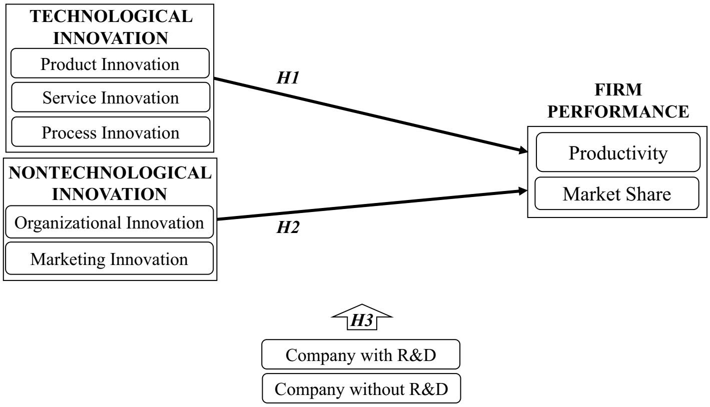
The literature widely recognizes R&D as one of the main determinants affecting successful technological innovation's realization (Conte & Vivarelli, 2014). Furthermore, empirical studies have indicated a positive association between R&D and firm performance, pointing to R&D activities as a positive predictor of firm productivity (Tsai & Wang, 2004) and market value performance (Bae & Kim, 2003; Wang, Du, Koong, & Fan, 2017). Nevertheless, there is evidence that firms tend to be involved in non-R&D activities, such as minor modifications or incremental changes to products and processes, imitations or the adoption of innovations; for example, acquiring knowledge embodied in new machinery and equipment is usually oriented to short-term returns. Moreover, the role of non-R&D can be positive or negative depending on the efficiency of the purchased equipment; for example, if the existing machinery and equipment are outdated, they do not contribute to productivity (Mariev, Nagieva, Pushkarev, Davidson, & Sohag, 2022).

LAC countries have historically experienced low participation in R&D investment in the productive sector (Hall & Maffioli, 2008; ECLAC, 2022), even though there is a definite and increasing progress in innovation and R&D in LAC manufacturing industries (Paula & Silva, 2021; Seclen-Luna & Morales, 2022). However, innovation and technology gaps remain problematic (Viglioni *et al.*, 2020), especially since R&D investments in the LAC are also more skewed and concentrated on a small number of firms; specifically, larger firms tend to innovate more frequently. This may be due to the development of economies of scale and scope in the production of knowledge (Crespi & Zúñiga, 2012), although, in some cases, their R&D productivity is negative (Tsai, Hsieh, & Hultink, 2011). In any case, Chudnovsky *et al.* (2006) pointed out that internal R&D and technology acquisition expenditures enhance the probability of product or process innovation, which in turn attain higher productivity levels than non-innovators, even in low-tech industries (Del Carpio Gallegos & Seclen-Luna, 2022). Thus, based on these arguments, we propose the following hypothesis:

H3a. Manufacturing firms with R&D have a greater positive effect on the relationship between innovation outcomes and productivity than manufacturing firms without R&D.

H3b. Manufacturing firms with R&D have a greater positive effect on the relationship between innovation outcomes and market shares than manufacturing firms without R&D.

Figure 1 presents the hypothesis formulated in a conceptual model.



Source: Own elaboration

Figure 1.
Conceptual model

3. Methodology

3.1 Data and sample

The information comes from the National Innovation Survey of Manufacturing Industries and KIBS of Peru, carried out in 2018 by the National Institute of Statistics and Informatics. The survey included data from 2015 to 2017 (It is triennial) and used random sampling stratified by location, industry and company size. The final sample of the survey was 1,541 manufacturing companies. As this study focuses on companies that have carried out product, service, process, organizational and marketing innovations to increase their productivity and market share, we selected 774 manufacturing companies (Table 1).

3.2 Measurement of variables

Essentially, it is possible to identify two groups of variables. The first set of variables considers firm performance, while the second deals with innovation outcomes; all were measured on a dichotomous scale, similar to previous studies (Heredia-Pérez *et al.*, 2019). This research uses both increased productivity and increased market shares by companies as an indicator of firm performance. However, it does not analyse the relationship between innovation and actual productivity but the perception of innovative firms on the perceived benefits of innovation in terms of greater efficiency in business processes and market shares in terms of greater sales due to innovation. This perspective is different and valuable to show, for instance, how innovation met innovative firms' expectations. Thus, to measure these variables, respondents were asked: (1) "From the innovation that your company implemented during the 2015–2017 period, was there increased productivity (in terms of an improved workforce)?"; and (2) "From the innovation that your company implemented during the 2015–2017 period, was there an increase in the market share of the company (in terms of sales or customers)?". This method of measuring managers' perceptions has been used by previous studies, such as Powell, Lovallo, and Caringal (2006), and it is helpful to show how their managerial experience helps to perceive the results of innovation (Seclen-Luna *et al.*, 2021b). *Perception* in this sense includes all the cognitively interpreted information that managers use to make decisions (Mezias & Starbuck, 2003).

On the other hand, the independent variables are: product, service, process and organizational and marketing innovations. To measure these variables, we used the

Industry	With R&D	Without R&D	Total absolute	Total (%)
Food products processing	62	73	135	17.44
Beverage manufacturing	5	10	15	1.94
Manufacture of textile products	14	35	49	6.33
Garment manufacturing	2	43	45	5.81
Manufacture of leather products and related products	4	20	24	3.10
Wood production and manufacture of wood and cork products	5	17	22	2.84
Manufacture of paper and related products	2	21	23	2.97
Printing and playback of recordings	4	25	29	3.75
Manufacture of coke and petroleum refining products	1	7	8	1.03
Manufacture of chemical substances and products	40	26	66	8.53
Manufacture of pharmaceutical products, medicinal chemicals	16	8	24	3.10
Manufacture of rubber and plastic products	18	47	65	8.40
Manufacture of other non-metallic mineral products	14	22	36	4.65
Manufacture of common metals	6	11	17	2.20
Manufacture of fabricated metal products, except machinery	13	59	72	9.30
Manufacture of computer products, electronics and optics	1	5	6	0.78
Electrical equipment manufacturing	7	17	24	3.10
Manufacture of machinery and equipment n.c.p.	8	21	29	3.75
Manufacture of motor vehicles, trailers and semi-trailers	6	9	15	1.94
Manufacture of other transport equipment	2	6	8	1.03
Furniture manufacturing	5	17	22	2.84
Other manufacturing industries	5	17	22	2.84
Repair and installation of machinery and equipment	4	14	18	2.33
Total	245	530	774	100

Source: Own elaboration from ENIIMSEC database (2018)

Table 1. Sample composition by manufacturing firms

questions included in the national survey related to innovation, for example, (1) “During the 2015–2017 period, did your company improve or introduce new products to the market?”, and (2) “During the 2015–2017 period, did your company improve or introduce new services in your company?”.

Lastly, this research considered the relevance of expenditure on R&D as a moderating variable in this relationship and measured it on a dichotomous scale (Crespi & Zúñiga, 2012). To control the sample, we included information on firm size and firm age variables. The extant literature shows that traditional large firms are better positioned to exploit technological acquisition and technological innovations because they have easier access to external funding for innovation and cover the fixed costs of the R&D activities needed to develop new products (Shefer & Frenkel, 2005). By contrast, smaller firms tend to carry out technological acquisition and aim at process innovation (Conte & Vivarelli, 2014). All of the above is usually consistent with the accumulated experience; however, evidence shows that younger firms invest more in R&D than older firms (Mariev *et al.*, 2022). Table 2 shows the definitions of the variables used in this study.

3.3 Method and tests

Following the research objectives, this work estimated the effects of innovation on manufacturing firms’ performance. The descriptive data and regression models were computed using R software, a widely used software because of its many advantages: it is very flexible, robust and easily accessible. In addition, we used t-tests to assess

Table 2.
Definition and scales of variables

Variable	Definition	Scales	References
Dependent variables			
Productivity	A value of 1 indicates the perception of a company's manager on the increase of productivity in terms of greater efficiency in business processes from innovation; 0 = otherwise	Dichotomous	Mezias and Starbuck (2003), Seclen-Luna *et al.* (2021b)
Market share	A value of 1 indicates the perception of a company's manager on the increased market share in terms of greater sales and customers from innovation; 0 = otherwise	Dichotomous	
Independent variables			
Product innovation	A value of 1 indicates that the firm has introduced new or significantly improved products in the last three years; 0 = otherwise	Dichotomous	Geldes *et al.* (2017), Goedhuys and Veugelers (2012), Heredia-Pérez *et al.* (2019), Li and Vermeulen (2021), OECD & EUROSTAT (2005), Seclen-Luna and Morales (2022), Tsai *et al.* (2011)
Service innovation	A value of 1 indicates that the firm has introduced new or significantly improved services in the last three years; 0 = otherwise	Dichotomous	
Process innovation – Production method	A value of 1 indicates that the firm has implemented new or significantly improved engineering, design or test activities for production in the last three years; 0 = otherwise	Dichotomous	
Process innovation – Logistic method	A value of 1 indicates that the firm has implemented new or significantly improved logistic, distribution or storage activities in the last three years; 0 = otherwise	Dichotomous	
Process innovation – Acquisition of machinery and hardware	A value of 1 indicates that the firm has acquired machinery and hardware (e.g. industrial robots or machine tools, 3D printing) in the last three years; 0 = otherwise	Dichotomous	
Organizational innovation	A value of 1 indicates that the firm has acquired software for its internal processes (e.g. ERP, CAD) in the last three years; 0 = otherwise	Dichotomous	
Marketing innovation	A value of 1 indicates that the firm has implemented new or significantly improved promotion techniques, product positioning or pricing in the last three years; 0 = otherwise	Dichotomous	
Moderating variables			
Expenditure on internal R&D activities	A value of 1 indicates that the firm had expenditure on internal R&D activities in the last three years; 0 = otherwise	Dichotomous	Crespi & Zúñiga (2010), Seclen-Luna and Morales (2022)
Control variables			
Firm size	Number of workers (permanent full-time workers)	Logarithm	Del Carpio Gallegos and Seclen-Luna (2022)
Firm age	Time from the foundation of the firm (except for firms with three years or less)	Logarithm	

Source: Own elaboration

whether there are differences between innovative companies with and without R&D investment. Finally, the research used LOGIT models to test the hypotheses. We emphasize that this technique is widely used in research studies in the context of innovation and company performance. Thus, the work fitted LOGIT models for firm performance as:

$$Y_i = \beta_0 + \beta_1 \mathrm{PRODIN}_i + \beta_2 SERVIN_i + \beta_3 \vartheta_i + \beta_4 ORGIN_i + \beta_5 MARKIN_i + \Omega_i + \varepsilon_i \quad (1)$$

$$Y_j = \alpha_0 + \alpha_1 PRODIN_j + \alpha_2 \mathrm{SERVIN}_j + \alpha_3 \vartheta_j + \alpha_4 ORGIN_j + \alpha_5 MARKIN_j + \Omega_j + \varepsilon_j \quad (2)$$

$$Y_k = \delta_0 + \delta_1 PRODIN_k + \delta_2 \mathrm{SERVIN}_k + \delta_3 \vartheta_k + \delta_4 ORGIN_k + \delta_5 MARKIN_k + \Omega_k + \varepsilon_k \quad (3)$$

where Y is the dependent variable of each regression model, and the sub-index i refers to the total number of firms. The sub-index j refers to the firms with R&D, whereas the sub-index k refers to the firms without R&D. $PRODIN_{i,j,k}$ is the variable product innovation, $SERVIN_{i,j,k}$ is the variable service innovation, $\vartheta_{i,j,k}$ is a vector of process innovation variables including production method, logistic method and acquisition of machinery. $ORGIN_{i,j,k}$ is the variable organizational innovation, $MARKIN_{i,j,k}$ is the variable marketing innovation. $\Omega_{i,j,k}$ is a vector of control variables including firm size and firm age, and $\varepsilon_{i,j,k}$ is the error term.

We fitted a regression model using each dependent variable proposed in the research, i.e. productivity and market shares. Thus, to support *H1a* and *H1b*, β_1 and β_2 must be positive and significant, respectively. Positive and significant β_3 vector coefficients would support *H1c*. On the other hand, to support *H2a* and *H2b*, β_4 and β_5 must be positive and significant. Finally, to support *H3a* and *H3b*, $\alpha_k > \delta_k$ for $k = 1,\ldots,5$.

4. Results and discussion

Table 3 shows the statistical summary according to R&D investment in companies. The results indicate that despite a low proportion of companies with R&D investments (31.6%), they have implemented more innovation than companies without R&D. Furthermore, it is possible to observe that the production method is the most systematic way of innovating for companies and services. The t-tests confirm that there is a difference in means. This study grouped innovative companies according to their investments in R&D because this activity could be considered crucial resource for creating innovation, even in a crisis (Lome *et al.*, 2016), and also has positive associations with business performance, such as productivity (Tsai & Wang, 2004) and market value performance (Wang *et al.*, 2017). These criteria acquire high relevance because, in contexts where innovation ecosystems are not mature, R&D activities are incipient and may not be attractive for companies, especially when competition from unregistered firms reduces R&D incentives and therefore may not be a differentiator for competition, thus affecting companies' productivity (Heredia-Pérez *et al.*, 2018).

Table 4 reports the LOGIT regression models considered. The estimation included an appropriate indicator of the model's significance of regression (McFadden), consistent with previous studies (Li & Vermeulen, 2021).

Regarding productivity, if the analysis is focused on the total sample, on the one hand, the results indicate that those innovative companies that implemented the production method ($p < 0.01$), logistic method ($p < 0.01$) and organizational innovation ($p < 0.05$) are associated positively with productivity. Thus, the results support *H1c* (except acquisition machinery) and *H2a*. Therefore, the results are consistent with previous studies that show that process innovation (Seclen-Luna *et al.*, 2021b) and organizational innovation (Arranz

Table 3. Summary of statistics for companies according to R&D investments

	(1) With R&D		(2) Without R&D		(3) Difference in means	
Variables	Mean	SD	Mean	SD	Diff.	*t*-test
Product innovation	0.6025	0.4904	0.1868	0.3901	0.4157	>0.0000***
Service innovation	0.0984	0.2984	0.0792	0.2704	0.0191	0.3945
Process innovation – Production method	0.7090	0.4551	0.5604	0.4968	0.1486	>0.0000***
Process innovation – Logistic method	0.2951	0.4570	0.2113	0.4086	0.0838	0.0148**
Process innovation – Acquisition of machinery	0.3525	0.4787	0.2509	0.4340	0.1015	0.0050***
Organizational innovation	0.2992	0.4588	0.1981	0.3990	0.1011	0.0032***
Marketing innovation	0.2663	0.4429	0.1490	0.3564	0.1173	0.0003
Size (Workers)	618.0943	1,509.3185	197.0472	402.7536	421.0471	>0.0000***
Age	29.2623	19.0968	21.8038	14.8379	7.4585	>0.0000***

Source: Own elaboration

Table 4.
LOGIT regression models

Variable	Productivity Total sample (1)	Productivity With R&D (2)	Productivity Without R&D (3)	Market share Total sample (4)	Market share With R&D (5)	Market share Without R&D (6)
(Intercept)	−0.3526 (0.3798)	1.3333 (0.8862)	−0.5582 (0.4518)	0.2096 (0.3972)	1.1584 (1.0031)	0.2031 (0.4657)
Product innovation	−0.0262 (0.1748)	−0.1072 (0.3201)	−0.1270 (0.2422)	1.0152*** (0.2034)	0.6623** (0.3350)	1.0879*** (0.2971)
Service innovation	0.0752 (0.2910)	−0.1954 (0.5341)	0.2134 (0.3575)	0.9304** (0.3695)	0.0936 (0.5939)	1.3957*** (0.4746)
Process innovation – Production method	1.3138*** (0.1641)	0.9370*** (0.3362)	1.4080*** (0.1960)	0.9201*** (0.1722)	0.0385 (0.3640)	1.1888*** (0.2075)
Process innovation – Logistic method	0.5757*** (0.1982)	1.7988*** (0.4529)	0.1278 (0.2358)	0.0590 (0.2031)	0.6714 (0.4144)	−0.1733 (0.2456)
Process innovation – Acquisition machinery	0.1610 (0.1878)	−0.2592 (0.3540)	0.2841 (0.2291)	0.1001 (0.1982)	0.4480 (0.3933)	−0.0776 (0.2367)
Organizational innovation	0.4063** (0.1999)	0.7019* (0.3835)	0.4255* (0.2474)	−0.0859 (0.2058)	0.2419 (0.4052)	−0.1204 (0.2529)
Marketing innovation	0.1228 (0.2115)	0.4114 (0.3806)	−0.0603 (0.2671)	0.8896*** (0.2504)	0.5097 (0.4183)	1.0963*** (0.3198)
Log(Size)	0.0980* (0.0563)	−0.0128 (0.1032)	0.0944 (0.0718)	−0.0470 (0.0587)	−0.0732 (0.1068)	−0.0537 (0.0742)
Log(Age)	−0.2461* (0.1261)	−0.5225** (0.2440)	−0.1693 (0.1534)	−0.0839 (0.1308)	−0.2394 (0.2548)	−0.0447 (0.1594)
AIC	949.4399	273.9334	671.1186	875.8179	251.2893	625.7222
BIC	995.9556	308.9460	713.8473	922.3336	286.3019	668.4509
McFadden	0.0931	0.1442	0.0940	0.0914	0.0567	0.1100
Log likelihood	−464.7199	−126.9667	−325.5593	−427.9089	−115.6446	−302.8611
Deviance	929.4399	253.9334	651.1186	855.8179	231.2893	605.7222
Num. obs.	774	245	530	774	245	530

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$
Source: Own elaboration

et al., 2019) positively affect manufacturing companies' productivity. That is, process innovation and organizational innovation are related to increased efficiency in companies. Also, it could be understood as a certain complementarity between technological and non-technological innovation (Geldes *et al.*, 2017). On the other hand, it is possible to see that product innovation (Heredia-Pérez *et al.*, 2019) and service innovation (Feng *et al.*, 2021) do not have any statistically significant effect on productivity. Thus, these results do not support *H1a* and *H1b*.

Nevertheless, when the analysis considers the moderation of the R&D, it is possible to find some slight differences. Innovative companies with R&D have similar results to the total sample, that is, companies that implemented production method ($p < 0.01$), logistic method ($p < 0.01$) and organizational innovation ($p < 0.05$) are positively associated with productivity; similarly, innovative companies without R&D that implemented the production method ($p < 0.01$) and organizational innovation ($p < 0.1$) are positively associated with productivity. Thus, although there seems to be no substantial difference, it is possible to find that the coefficient associated with the production method to increase productivity is higher in firms without R&D (1.4080***) than in firms with R&D (0.9370***). However, logistic methods that are more significant statistically have a greater effect (1.7988***) for companies with R&D for increasing productivity than companies without R&D. In addition, the effect of organizational innovation is more statistically significant (0.7019*) for companies with R&D to increase productivity than companies without R&D. Thus, these results support *H3a*. In any case, it is possible to affirm that innovative companies are mainly prone to implement process and organizational innovation to increase their productivity. This search for efficiency is perhaps a specific characteristic of companies in developing countries such as Peru, where companies' innovation capacities cannot be transversal in all markets.

Regarding market share, if the analysis is focused on the total sample, on the one hand, the results indicate that those innovative companies that implemented product innovation ($p < 0.01$), service innovation ($p < 0.05$) and production method ($p < 0.01$) are positively associated with increasing their market shares. Thus, results support *H1a*–*H1c* (except logistic method and acquisition of machinery) and *H2b*. Therefore, the results are consistent with previous studies that show product innovation (Kendall *et al.*, 2010), service innovation (Grawe *et al.*, 2009) and process innovation (Cho & Pucik, 2005), as well as marketing innovation (Gotteland *et al.*, 2020), have positive effects on their market value performance. Moreover, it could be understood as a certain complementarity between technological and non-technological innovation (Del Carpio Gallegos & Miralles, 2021).

On the other hand, when the analysis considers the moderation of R&D into account, it is possible to find differences. For example, innovative companies with R&D that only implemented product innovation ($p < 0.05$) are associated positively with increased market share; similarly, innovative companies without R&D that implemented product innovation ($p < 0.01$), service innovation ($p < 0.01$), production method ($p < 0.01$) and marketing innovation ($p < 0.01$) are also associated positively with increased market shares. Therefore, these results show that different innovation efforts from manufacturing companies without R&D aim to increase their market share in terms of more significant sales (Wang *et al.*, 2017). Thus, these results do not support *H3b*. Perhaps one reason for this result is the Peruvian business context, where low proportion of manufacturing companies invest in R&D (13%) and whose spending represents only 7.8% of the total spending on innovation activities (PRODUCE, 2020).

Consequently, innovative companies with R&D are mainly prone to implement product innovation to increase their market share, while innovative companies without R&D make innovative efforts (product, service, process and marketing innovation) to increase their sales. At this point, it is important to highlight that although the sample size may affect the statistical inference, the data used in the analyses correspond to a survey carried out by the official Peruvian institute of statistics at the national level. Therefore, we can assume that the sample is representative and of sufficient size for the inference analysis.

Lastly, the particularities related to the companies' context (size) can positively affect their productivity. For example, the biggest companies implementing process and organizational innovations are more prone to increase their productivity. By contrast, younger firms are more prone to implement process and organizational innovations to increase their productivity than older ones (Del Carpio Gallegos & Seclen-Luna, 2022), particularly companies with R&D (Table 5).

5. Conclusions and implications

5.1 Theoretical contributions

The first contribution evidences the effects of innovation outcomes (technological and non-technological) on productivity and market shares in Peruvian manufacturing firms in a complementary way. On the one hand, process and organizational innovations are related to productivity, that is, innovative companies carry out these strategies to obtain more efficiency in their business processes, particularly companies with R&D. Nevertheless, as in other studies (Taveira *et al.*, 2019), it is possible to observe that the acquisition of machinery does not have positive associations with productivity. Therefore, investing in knowledge and human capital could benefit Peruvian companies, especially in taking advantage of new technologies and incorporating them their production processes. This is especially important since 67% of innovative companies acquired or leased capital goods in the Peruvian manufacturing industry during 2015–2017 (PRODUCE, 2020). In any case, all the results show a complementarity between technological and non-technological innovations to increase productivity.

On the one hand, results show that product, service and marketing innovation are related to market share. That is, innovative companies address these strategies mainly towards meeting customers' needs, particularly companies without R&D. This is consistent with previous studies, such as Seclen-Luna *et al.* (2021a), who found that product and service innovation had positive effects on sales in manufacturing firms in Peru between 2012 and 2014. Moreover, it is possible to see that companies with R&D that achieve product innovation can increase their sales, while companies without R&D need to implement other kinds of innovation besides product innovation. In other words, companies without R&D need a complementarity between technological and non-technological innovations to increase sales.

The second contribution is that our results empirically validate the theoretical argumentation that in contexts where innovation ecosystems are not mature, R&D activities are incipient and not a differentiator for competition between companies (Heredia-Pérez *et al.*, 2018). It is essential to address this point, as it highlights that Peru companies cannot transfer the costs of a more significant investment in R&D to prices since it is the dominant structure in the markets in which they participate. Therefore, acquiring technology would be more attractive than focusing on its development and promoting innovation.

This analysis leads us down two paths. On the one hand, when analysing the scope of innovation in Peruvian manufacturing companies, it is observed that innovation is new to the firm (70.5% process innovation and 43.6% product innovation). Thus, the innovative effort is more geared towards updating than being new to the market. On the other hand, the investment in R&D represents only 7.8% of the total investment in innovation activities by manufacturing companies, and they invested 0.14% of their sales in R&D activities (PRODUCE, 2020). Does this mean that investment in R&D is not attractive for manufacturing firms? Of course not.

Table 5. Summary of the validation of the hypotheses

Hypothesis	Productivity		Market share	
	With R&D	Without R&D	With R&D	Without R&D
H1a: Manufacturing firms that implement product innovation have positive effects on their performance	NO	NO	YES	YES
H1b: Manufacturing firms that implement service innovation have positive effects on their performance	NO	NO	NO	YES
H1c: Manufacturing firms that implement process innovation (production method) have positive effects on their performance	YES	YES	NO	YES
H1c: Manufacturing firms that implement process innovation (logistic method) have positive effects on their performance	YES	NO	NO	NO
H1c: Manufacturing firms that implement process innovation (acquisition of machinery) have positive effects on their performance	NO	NO	NO	NO
H2a: Manufacturing firms that implement organizational innovation have positive effects on their performance	YES	YES	NO	NO
H2b: Manufacturing firms that implement marketing innovation have positive effects on their performance	NO	NO	NO	YES
H3a: Manufacturing firms with R&D have a greater positive effect on the relationship between innovation outcomes and productivity than manufacturing firms without R&D	YES	N.A	N.A	
H3b: Manufacturing firms with R&D have a greater positive effect on the relationship between innovation outcomes and market shares than manufacturing firms without R&D	N.A	N.A	NO	

Source: Own elaboration

The implication from the previous results is that any evaluation of the impact on R&D investment made by a firm or industry must, firstly, have a long-term orientation, and, secondly, attract the generation of intermediate evaluations of results, where non-traditional measurements can be established. Among these, we can mention servitization, incorporation of green technology, appropriability of the benefits of absorption of external knowledge, an innovative and resilient culture or even the grand challenges of COVID-19 impact.

5.2 Managerial contributions

Firstly, since several kinds of innovations outcomes (product, service, process, organizational and marketing innovation) have a positive association with productivity and market share, managers should consider proper management of their innovation portfolio, particularly because the joint execution of diverse innovation types can produce greater effect on company's performance (Damanpour *et al.*, 2009). In addition, training and knowledge-updating activities are necessary in a world that adjusts to investing more in R&D to the extent that quality levels and self-generation of exploitation results are validated or presented in a sustainable manner.

Secondly, policymakers should seek to understand whether investments to promote the development of R&D activities in manufacturing companies imply medium or long-term returns. Something fundamental in public programs is to advance the transparency of the results and thereby improve the development of sound public policies. Programs with more significant potential should substitute those with low-impact evaluations. The decision on the benefits of innovating internally, or acquiring technology to add it to the activities of a company, is still valid in practice, particularly in contexts of developing economies, such as Peru, where various public agents promote the development of internal innovations, over the acquisition of technology, as a way of gaining competitiveness in the markets. Nevertheless, since the benefits of developing innovation activities with effects on sales and profits in the short term are not clear, and the debate on the benefits of acquiring technology from abroad is not closed either, it will be relevant to continue studying the effects of more robust investments in innovation or technological acquisition in the different markets and industries. We hope this is useful for company executives evaluating incorporating more technology and those who want to increase their resources invested in research and development activities.

6. Limitations and further research

As in any scientific study, one of the limitations of this study is that, in developing countries, the same R&D result indicators are often used for firms that participate in developed markets. Hence, the evaluations of the relationships between traditional analysis variables do not generate the same results. Furthermore, the lack of measurement of intermediate result indicators does not facilitate the analysis. In addition, the low number of observations for the study variables restrict the analysis at an industrial level; thus, interpretations are only at the manufacturers' level as a whole and not by industrial branches.

Any extrapolation of the results must be made with caution. The differences in this work in relation to those in other studies are due to the characteristics of a developing economy, with a different situation than that of developed countries. Likewise, given the nature of Peru, with different contexts from other countries with the same level of development, other differences that affect the results must be considered: institutional, cultural and the domestic markets where the companies work.

Lastly, this study is cross-sectional in nature and therefore does not capture the dynamics of the innovative process where there are more complementary variables. Therefore, it is suggested that future longitudinal studies be carried out to establish relationships between innovation outcomes (their complementarities) and firm performance (economic, social and environmental).

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