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Innovation versus Imitation: The Role of Distance to Technology Frontier in the Relationship among Innovation, Imitation, and Performance

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Abstract

This paper investigates how new product portfolio –a combination of innovative and imitative products– influences firms' performance. It demonstrates that the relative technology development of a firm determines whether focusing more on imitation is a better strategy, in terms of firm performance. When lagged behind the technology frontier, firms benefit more from introducing new products which are composed mainly by imitative products. This expectation is confirmed by empirical evidence based on Spanish firms. In addition to distinguishing imitation from innovation, the present study recognizes the value of imitation and suggests imitation as an alternative firm strategy.

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This paper investigates how new product portfolio —a combination of innovative and imitative products— influences firms' performance. It demonstrates that the relative technology development of a firm determines whether focusing more on imitation is a better strategy, in terms of firm performance. When lagged behind the technology frontier, firms benefit more from introducing new products which are composed mainly by imitative products. This expectation is confirmed by empirical evidence based on Spanish firms. In addition to distinguishing imitation from innovation, the present study recognizes the value of imitation and suggests imitation as an alternative firm strategy.

1. Introduction

Introducing new products is believed to be one of the drivers of firm performance. Since it is an organizational behavior involving various activities, the relationship between new products and firm performance has been analyzed from different aspects. Focusing on entry order, scholars debate about the performance implication of pioneers (Lieberman and Montgomery, 1988, 1998, 2013) and followers (Ethiraj and Zhu, 2008; Schnaars, 1994). Studies also look at how firm performance is affected by other characteristics of new products, such as incremental and radical innovation (Banbury and Mitchell, 1995; Rubera and Kirca, 2012; Tellis, Prabhu, and Chandy, 2009).

One common limitation can be identified among previous studies. They overlook the possibility that a firm can introduce multiple new products with distinct characteristics and the combination of new products matters for firm performance. In the case of comparing the performance effect of different new products, previous works often use a binary indicator to represent for whether a firm introduces new products with certain characteristics, such as radical vs. incremental innovation, as well as pioneers vs. followers. This approach assumes away the likelihood that the composition of new products can influences firm performance. The same criticism is applied to another frequently used measurement —the share of new product sales. Imaging two firms, both of them have 50% of sales generate from new products. The overall firm performance is likely to be different if one firm's new products are mostly innovative and the other one's are mostly imitative.

Different from previous studies, the present research acknowledges the heterogeneity of new products offered by a single firm. It regards a firm's new products as a portfolio and investigates how the composition of the portfolio influences firm performance. The importance of the composition of new products is not new. Studies on new product development and R&D resource allocation have consensus that a right selection of new product projects is crucial for improving firm performance (Chao and Kavadias, 2008, 2013; Klingebiel and Rammer, 2014). All of these studies support the idea that new product portfolio —the composition of new products with different newness— matters, when it comes to firm performance. Using a portfolio concept, this paper distinguishes imitative from innovative products, and argues that their proportion within a new product portfolio is associated with firm performance. In addition, the association differs depending on a firm's technology development.

The context matters while discussing the relationships among new products and performance. In general, a positive relationship has been found between innovation output and firm performance. Crepon et al. (1998) demonstrate that the larger the share of the sales generated from newly introduced products, the higher the firm's productivity. Using data from Community Innovation Survey (CIS4), Hashi and Stojcic (2013) analyze European firms from mature market and advance transition economics. They find a positive relationship between the share of new product sales and labor productivity for both institutional settings.

In developing and transition countries, the link between new products and firm performance seems to be less robust. Using a sample of Argentina firms, Chudnovsky, López, and Pupato (2006) show that firms with innovation output have higher labor productivity. Masso and Vahter (2008) demonstrate that Estonian firms' labor productivity is influenced by different types of innovation across periods. There is a positive relationship between product innovation and labor productivity during 1998-2000. However, for the period of 2002-2004, they found that labor productivity is only driven by process innovation. They interpret their findings as a result of changes in the macroeconomic conditions. Benavente (2006) find no relationship between firms' productivity and new product sales, in the case of Chili.

The heterogeneous findings among firms in developing countries and the consistent results from studies on advanced economics seem to suggest that the relationship between new products and firm performance might vary depends on the level of development. Aghion and Howitt (2006) point out that Schumpeterian growth model is a suitable framework to explain the variation of performance in different contexts. Therefore, the present study suggests that distance to technology frontier as a potential contingency, which determines the association between new products and firm performance.

This paper differs from previous studies in a number of ways. First, it acknowledges the heterogeneity of new products offered by a firm and regards new products as a portfolio. Second, it incorporates the concept of distance to technology frontier as a contingent factor to discuss the relationship between new products and performance at firm level. Third, it provides empirical evidence relying firm fixed-effects quantile regression by analyzing a large scale panel data.

2. Previous literature

The argument that innovative and imitative products perform differently is well documented. One of the most discussed scenarios is market entry order. Innovators launching new-to-market products are considered first movers. Later entrants are considered imitators who introduce similar products as the pioneers. Discussion on first mover (Lieberman and Montgomery, 1988, 1998) and fast second (Markides and Geroski, 2004) are examples of this stream of research. Lieberman and Montgomery (1988) argue that pioneer firms enjoy positive economic returns, through the maintenance of technological leadership. Their competitive advantages come from the reduced cost of learning due to cumulative experience and the success in the R&D race. However, pioneers face greater risks during the innovation process. Generating a new product is costly and often time-consuming. When the environmental uncertainty is high and customer demand is unpredictable, being a first mover might not be necessarily a competitive advantage.

On the other hand, the followers often supply similar products at a lower price, sometimes even with improved quality (Ethiraj and Zhu, 2008). The cost associated with improving new products is usually lower than developing a novel product from scratch. Copying existing new products is less risky compared to introducing a new product to the market. Instead of innovation, imitation can also be an optimal competitive strategy (Lieberman and Asaba, 2006). In some cases, followers can even beat the pioneers and become the market leader (Schnaars, 1994).

Another perspective relies on the level of firms' competence in explaining the different performance effect of innovation and imitation. Innovation is more complex and requires higher level of capability than imitation (Knight, 1967). Agénor & Dinh (2013) develop a formal model showing that through reverse engineering and learning-by-doing, unskilled labors in the imitation sectors become familiar with technology and gain cognitive skills, which favors innovation. A transition process from imitation to innovation is observed in newly industrializing economies (NIEs) including Hong Kong, Singapore, South Korea, and Taiwan. These Asian Tigers start from assimilating and adapting foreign technology to innovating (Hobday, 1995). Kim (2001) proposes a three-stage framework —duplicative imitation, creative imitation, and innovation— to account for the industrialization process of developing countries. These studies suggest that imitation is a step stone for innovation (Kim, 1997). The ability to innovate can be learned through doing imitation. Since innovation corresponds to a higher level of competence than imitation, a greater performance effect from innovation than imitation is expected to reflect the improved competence.

However, the overall firm performance depends not only on the characteristics of individual products, but also the composition of its products. This is because a firm's long term performance is more than the sum of individual product. The overall success of a firm is associated with the interaction among different products. An appropriate product portfolio enables a firm to tradeoff between short-term performance and long-term growth (Day, 1977). The cash quadrant proposed by Boston Consultant Group classifies products according to its market share and market growth rate. The idea behind is that a firm needs to have products that generate cash and products that use cash to sustain growth. The concept of ambidextrous organization (Tushman and O'Reilly, 1996) also suggests the importance of simultaneous pursuit of incremental and discontinuous innovation in order to have sustained success.

The importance of product portfolio, especially new product portfolio, is also stressed in studies focusing on resource allocation. Product portfolio reflects firms' ability in exploiting scare resources. An appropriate allocation of R&D resources is critical to firm success so that scholars investigate what constitute an optimal allocation. Analyzing German part of Community Innovation Survey, Klingebiel and Rammer (2014) show that investing R&D resource in a wide range of innovation produces increases performance. The effect is greater when firms intent to develop new products with high novelty. Since uncertain is an inherent characteristics of novel products, investing across a broader range increases the likelihood that at least one project will succeed. Chao and Kavadias (2008) build a formal model to illustrate how the focus of new product portfolio shifts between incremental and radical innovation according to environmental complexity and stability, in order to maximize expected return and reduce risk.

Distance to technology frontier measures the relative level of technological development. In Schumpeterian growth model, it is explicitly recognized as an important factor, which influences the growth rate of an economy (Aghion and Howitt, 2006). The Schumpeterian growth comes from quality improving innovations, which encompass two components —generation of leading-edge innovation and implementation of innovation developed elsewhere. This present study refers the former as innovation and the latter as imitation[1]. Innovation directly contributes to performance by Schumpeterian definition. This is because all innovations are improvement over existing leading-edge innovation. On the other hand, the extent of imitation contributes to performance depends on the distance to technology where the imitation occurs. The farther from the technology frontier, the more improvement it can create from implementing the existing leading-edge innovation, given the frequency of imitation (Gerschenkron, 1962).

A general conclusion from the Schumpeterian growth model is that when approaching the technology frontier, performance is positively associated with innovation. On the other hand, when lagging behind the technology frontier, imitation becomes the main force of performance. This is mainly because the laggards' high potential for growth through imitation gradually diminishes along the improvement of their relative technology

[1] A similar concept can be found in literature. Lieberman and Asaba (2006) state that imitation is a common form of organizational behavior. "Firms imitate each other in the introduction of new products and processes…"(p.366). Mahmood and Rufin (2005) explicitly point out that a firm is an imitator when it expands its own existing knowledge set, but not the existing knowledge set of the world. In a brief review of the concept of innovation, Pierce and Delbecq (1997) summarize the different conceptualization of innovation by scholars. Amongst, Mansfield (1963) distinguishes imitation from innovation. He defines innovation as the "first ever use" of an idea and imitation as the "subsequent usage" of the idea. Becker and Whisler (1967) propose defining "innovation as the first or early use of an idea by one of a set of organizations with similar goals" (P.463).

position. Whether innovation or imitation is the optimal choice for performance depends on which activity is more effective in generating quality improvement over the current state. Benhabib et al. (2014) presents a formal model, where an agent can increase its productivity through investing in innovation or imitation. Their model suggests an equilibrium ratio of resource allocation, which is calculated based on the relative productivity of the agent and the frontier.

Empirical evidence also supports the claim that the return of innovation investment varies due to the heterogeneity of firms. Analyzing data of major pharmaceutical firms, Henderson and Cockburn (1994) show that a large variance in research productivity can be attributed to firm fixed effects. According to resource-based view, the difference in the effectiveness of conducting research and introducing innovation is likely to be persistent across firms due to the possession of unique competence and capabilities (Leonard-Barton, 1992). On the other hand, studies also demonstrate that the capability to innovate can be developed by increasing firms' ability in utilizing knowledge. Henderson and Cockburn (1996) show that pharmaceutical firms increase their research productivity by developing capabilities in tapping into knowledge spillover across and within firms. Return of innovation is positively related to the experience of innovation (Helfat and Raubitschek, 2000). In the process of moving toward the frontier, firms accumulate knowledge so that they develop capability in introducing innovative products. Therefore, their return on innovation investment increases while they move toward the frontier.

Studies on newly industrialized economies (NIE) demonstrate that new product strategies change along with the development of technology capability. Hobday, Rush, and Bessant (2004) explore the strategies of leading South Korea firms in various industries. Based on in-depth interviews with directors and managers, they find that the dichotomy between competing as a leader by generating innovative products and continuing being a follower based on improving existing products does not apply to the leading South Korea firms. These companies use a mix strategy, providing a product portfolio including both technological advanced and less advanced products. South Korea's industrialization process suggests that the composition of new product portfolio adjusts along with the progress of technology development, from focusing more on improving existing products to mainly generating their own brand products.

3. Expected results

Given the resource constraints, firms will put more resources in projects with higher expected payoffs, which are calculated based on the likely outcomes —the products of the amount of return and the probability of success. Since laggards are at disadvantage in generating innovation, engaging in imitation-related activities is more cost-effective (Mahmood and Rufin, 2005). In addition, imitation can increase the expected payoffs of future investment in innovation. This is because firms gain knowledge and develop capabilities during the process of imitation. Through case studies, Schnaars (1994) details how firms learn from imitation. These research findings suggest that through engaging in imitation-related activities, firms can develop core knowledge and related capabilities in identifying useful information, in marketing new products, as well as in operating efficiently and effectively. By accumulating knowledge and developing better capabilities during the imitation process, firms can reduce the uncertainty and increase the effectiveness of innovation investments. These together raise the expected payoffs of innovation by offering more favorable outcomes and higher probability of success. Accordingly, firms with larger stock of knowledge and improved capabilities are more likely to invest more resource in innovation.

Compared to the laggards, firms close to the technology frontier have lower incentive to imitate for several reasons. First, since fewer firms have more advanced technology than the focal firm has, the amount of worthy-imitating spillovers is reduced. Accordingly, in order to take advantage of spillovers, the focal firms need to spend more time and resource in searching for targets. In an extreme case, when the focal firms are at the technology frontier, the searching costs become infinite because no firms own more advanced technology. When the cost of imitation increases, firms are less likely to invest in it. Second, the competitive landscape among the frontier firms is different from the laggards. Innovation is considered a critical factor to enhance performance among technology leaders. The evidence that the level of technology development influences a firm's incentive to innovate is documented in the study of Hölzl and Janger (2014). Using Community Innovation Survey (CIS) over the period from 2002 to 2006, they find that advanced European countries are populated with a highest share of firms that are innovators. Countries that are far from the technology frontier have the highest share of firms that are non-innovators[2]. Once firms become one of the technology leaders, their competitive environment is different from the laggards. They are more likely to find imitation is a less powerful strategy than innovation.

Along with the development of knowledge and capabilities, the return of investing in innovation increases and the return of investing in imitation decreases. Since firms have limited resources, allocating resources to investment projects with higher return increases performance. Therefore, I expect that the levels of a firm's technology development influence the relationship between new product portfolio and firm performance. Compared to a non-laggard, a firm lagged behind the technology frontier can benefit more from introducing an imitation-focused new product portfolio.

4. Data and methodology

The data used in the present study come from the Technological Innovation Panel (PITEC), which covers the innovation activities of firms in Spain[3]. PITEC is the Spanish part of the Community Innovation Survey (CIS). Since 2004 (collecting data of year 2003), an annual survey is carried out by the Spanish National Statistic Institution (INE), in cooperation with the Spanish Foundation of Science and Technology (FECYT) and the Foundation of Technological Innovation (COTEC)[4]. PITEC is a panel data, tracing innovation activities of the same firms over time. It is based on the methodology suggested by the Oslo Manual (see OECD and Eurostat, 2005) so that the results obtained from the analyses can be compared with similar surveys conducted in other OECD member countries. The aim of the survey is to provide direct information on companies' innovation activities in order to advance the understanding of firm level innovation processes in the case of Spain. The structure of the questionnaire consists of eleven sections, including general information of the company, R&D expenditure, purchases of R&D, cooperation, as well as technological and non-technological innovation activities.

The survey started with two samples in 2003. One sample of big firms, which represent for about 73% of all firms with 200 or more employees registered in the Center

[2] Hölzl and Janger define innovators as "firms that introduce a new or significantly improved product or process and/or have ongoing innovation projects." Non-innovators are defined as "firms that do not introduce a new or significantly improved product or process and do not have ongoing innovation projects" (2014:5). Their definition of innovation is different from the present study. They do not distinguish innovation from imitation, based on the novelty of the products.

[3] PITEC: Panel de Innovación Tecnológica.

[4] INE: Instituto Nacional de Estadística. FECYT: Fundación Española para la Ciencia y la Tecnología. COTEC: Fundación para la Innovación Tecnológica.

Business Register in Spain (DIRCE)[5]. The other sample consists of firms with fewer than 200 employees and with intramural R&D expenditure. In 2004, the sample began to include small firms with external R&D expenditure but no intramural R&D expenditure, as well as a representative sample of small firms with no innovation expenditure. About 2,500 firms are incorporated in year 2005 due to further information on firms' R&D activities obtained by INE. Due to the enlargement of the sample, cross-year comparison is only feasible after year 2005.

The present study focuses on small and medium-sized enterprises (SMEs) in the manufacturing sector. According to the definition of European Union (EU recommendation 2003/361), a firm is qualified as a SME when it "employs fewer than 250 persons and have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million". Since PITEC does not provide information on balance sheet, I select firms using the criteria of number of employees and annual turnover. Once a firm is qualified as a SME in the manufacturing sector in 2005, its 9 year observations (from 2005 to 2013) in PITEC are all included in the analysis. After excluding firms that have merged, shut down, split, or gone through other significant events, I obtain a balanced panel of about 3,312 firms (29,808 firm-year observations), over the period of 9 years.

The analysis is mainly based on firm fixed-effects quantile regression. Compared to ordinary least square (OLS), the benefit of using quantile regression is that it enables the estimation of coefficients to vary according to selected quantiles, which fits the need of the present study. Coad and Rao (2008) also use the approach of quantile regression to investigate the relationship between innovation and firm growth in high-tech sector. Labor productivity (sales per employee, in log) is used as a measure for firm performance ("Ln_labprodt"). Using labor productivity as a dependent variable in the quantile regression enables the comparison among firms with different level of technology development. In order to consider the influences of the heterogeneity of firm specific characteristics, I use firm fixed-effects quantile regression, which is introduce by Canay (2011).

As a benchmark, the present study also provides OLS results by splitting the sample into two sub-samples —laggard and non-laggard— according to an observation's distance to technology frontier. I measure the distance to technology frontier using the

[5] DIRCE: Directorio Central de Empresas

relative labor productivity of the frontier firm to that of the observation. Then, I define a firm as a laggard when its distance to technology frontier is larger than the median distance to technology frontier of firms in its industry-year group[6].

The technology frontier is conceptualized as the most advanced technology available in the world. It can produce the same amount of output as the current technology but with the least amount of input (Helpman and Grossman, 1991). Total factor productivity is an indicator of the technology development (Mahmood and Rufin, 2005). Therefore, the technology frontier firm can be identified as the firm with the highest level of total factor productivity in the world. However, PITEC covers only Spanish enterprises and the information is insufficient to calculate total factor productivity. Thus, I use labor productivity (sales per employee) as a proxy for the total factor productivity. In the group of firms belonging to the same industry at a given year, the firm with the highest labor productivity is regarded as the technology frontier firm.

The empirical measurement of the concept of imitation and innovation relies on the extent of newness of the new products. The data provide a direct measure of the proportion of sales due to new-to-market and new-to-firm products that are introduced in the last two years prior to the survey year. Knight (1967) proposes the concept of "new to an organization and to the relevant environment" as a requisite to define innovation. Based on this criterion, a new-to-firm product is considered an imitative product and a new-to-market product is an innovative product. Since the questionnaire asks for the breakdown of the annual sales into three categories: new-to-market, new-to-firm, and old products, the two categories of innovative and imitative products are mutually excluded.

A binary variable ("Moreimi") is created to represent for the composition of new products portfolio, in terms of imitation and innovation. "Moreimi" takes the value of one when a firm has higher sales from imitative products than from innovative products. There are two scenarios where "Moreimi" equals to one. In the first situation, a firm has only sales from imitative products and no sales from innovative products. The second possibility is that a firm has both imitative and innovative products; and its imitative products generate higher sales than innovative products. In this paper, firms with either scenario are regarded as firms with an imitation-focused new product portfolio. The variable of "Moreimi" enters regression with one year lag to alleviate the concern of reverse causality. Since this paper is interested in the effects of new product portfolio on

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[6] It is possible that a firm is defined as a laggard in certain years, but as a non-laggard in the rest of period.

firm performance, observations without neither new-to-firm nor new-to-market products are excluded.

There are two groups of control variables. All of them enter the regression equation with one year lag. The first group includes variables that vary at observation level. Previous literature has shown that process innovation has effects on firm performance. Therefore, I control for whether a firm has process innovation by using a binary variable ("Innproc"). Firms' knowledge is believed to be associated with the performance of new products. Cappelli, Czarnitzki, and Kraft (2010) demonstrate that the internal knowledge stock of a firm influences its innovative and imitative sales differently. Following their study, I use perpetual inventory method with a constant depreciation rate of 15% to construct the knowledge stock. Since PITEC is an anonymous dataset, linking it with other datasets is infeasible. I can only rely on PITEC data and start to account for the knowledge stock using the earliest data available on patent application (year 2005). I use it as a proxy for the patentable knowledge stock of a firm ("Patstock"). Since not all knowledge can be patented, I also apply the same method to calculate the general knowledge stock ("Rdstock), using internal R&D expenditure. Other observation level controls include age ("Age") of the firm, whether a firm belonging to a group of companies ("Group"), and whether a firm engages in exporting ("Export").

At the industry level, I control for market structure, the extent of spillovers, and appropriability. Market structure ("HHI") is measured by the Herfindahl-Hirschman index. PITEC does not provide a direct measure of market share. I aggregate the sales of firms in the same industry as the market size. Accordingly, market share of a firm is the ratio of the sales of the firm over the market size of the industry. The R&D spillovers from other firms are associated with the easiness of imitations, as well as the rents innovators can generate from the market. Following previous studies (Cappelli et al., 2010), I aggregate the R&D spending of all firms within the same industry as a proxy for the R&D spillover at the industry level ("Spillover"). Appropriability means the extent that innovators can benefit from their own innovation. An environment with high appropriability favors more the innovators than the imitators. Under such an environment, imitators are less likely to profit. As previous studies (Barge-Gil and López, 2014), I use the proportion of firms that have applied patents in a given year to measure the extent of appropriability ("Approp"). When discussing the different effects of imitation and innovation on productivity, the importance of the relative technology development is stressed in the literature. Accordingly, I also control for the labor productivity of the frontier firms ("Frontier"). It enters the regression with log transformation. The inclusion of "Frontier" also enables me to interpret the results as the extent of catching up. In all estimations, I control for year and industry effects. **Table 1** and **Table 2** present descriptive statistics and correlation coefficients of variables.

5. Analyses of results

The regression results are presented in **Table 3**. All models are with year and industry effects. Due to the exclusion of observations without new products and the use of lag variables, the number of observations reduced to 15,607. The first two models are OLS pooled regression on sub-samples. For laggards, the coefficient of "Moreimi" is positive and significant, but not for the non-laggards. This seems to suggest that laggards benefit from introducing imitation-focused new product portfolio, but not the non-laggards. Model (3) to (9) are firm fixed-effects quantile regression at selected quantiles. Most of the control variables are significant. The estimated coefficients of "Innproc" suggest that for firms that located at the lower quantile, investing in process innovation has positive effects on firm performance. The magnitude of the positive effect decreases along the increasing of the quantile. This is consist with the previous literature that laggards are suggested to relying more on process innovation, rather than product innovation, to improve its performance.

The sign of estimated coefficients of "Moreimi" change from positive to negative. It suggests that focusing on imitative new products has different effects, depending on the level of firms' labor productivity. For firms that located at the lower quantile, the coefficient of "Moreimi" is positive and significant. However, for firms that are close to the frontier (e.g. 95 quantile), the coefficient of "Moreimi" is negative and significant. This seems to suggest that for firms that lagged behind the technology frontier, introducing an imitation-focused new product portfolio is associated with higher firm performance. However, for firms that are close to technology frontier, focusing more on imitation is associated with lower performance. The magnitude of the effect of an imitation-focused new product portfolio on firm performance changes over the quantiles as well. The positive effect estimated at 10% quantile is larger than the one estimated at 25% and 50%. Since performance is measured as labor productivity and the models control also the labor productivity of the frontier firm, the results can also be interpreted as laggards who focus more on imitation will have a higher chance to catch up or to shorten its distance to technology frontier.

6. Discussion

This study contributes to the literature of the relationship between new products and firm performance. It recognizes the heterogeneity of new products, showing that he composition of new product portfolio matters for firm performance. In addition, it rethinks about the pro-innovation argument and recognizes the value of imitation. More innovation is not always better. It is important to know where a firm stands. The relative technology position to other players in the market is associated with whether focusing more on imitation is a better. Being a laggard, a firm can improve its performance by focusing more on imitation. Finally, from policy perspective, if distance to technology frontier does influence the relationship among innovation, imitation, and performance, it might be more effective to encourage firms that are lagged behind the technology frontier to imitate, rather than to innovate. Therefore, their performance can be improved by a more economical manner[7].

Due to the limitation of the data, the present study cannot claim causality; neither demonstrates the mechanism through which distance to technology affects the relationship among innovation, imitation, and performance. Future works are needed to explore this topic. For example, the extent that distance to technology frontier moderates the relationship between new product portfolio and performance probably varies across industries. Comparing the magnitude of the moderation effect across industries might be interesting. Studies could use a finer measure of product portfolio in order to account for other characteristics of new products, in addition to novelty. Examining the difference in firm characteristics, in terms of innovators or imitators, is also fundamental in understanding the different ways of organizing resources within firms. Finally, uncovering the key that drives the transition from imitation to innovation is intriguing.

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[7] Compared to innovation, imitation is more economical because it often costs less, takes shorter time, and involves less risk.

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Table 1
Descriptive statistics

Variable	Mean	Std. dev.	Min	Max	Note
Variables at observation level:					
$Labprodt_t$	5.05	.68	.84	8.85	Labor productivity (sales per employee), in log.
$Moreimi_{t-1}$	.57	.49	0	1	New product portfolio. It takes value of one when a firm has more sales from imitative new products than from innovative new products.
$Innproc_{t-1}$	.69	.46	0	1	Binary identifies firms with process innovation.
$Rdstock_{t-1}$	11.77	3.64	0	18.94	Knowledge stock, in log.
$Patstock_{t-1}$	.46	.83	0	6.75	Patent stock, in log.
Age_{t-1}	3.32	.52	1.10	4.88	No. of years since foundation, in log.
$Export_{t-1}$	.66	.47	0	1	Binary identifies firms that export.
$Group_{t-1}$	.30	.46	0	1	Binary takes value one when firms belong to a group of companies.
Variables at industry level:					
HHI_{t-1}	196.85	385.56	47.22	8124.63	Herfindahl-Hirschman index.
$Spillover_{t-1}$	17.47	.93	14.20	18.46	Log of R&D expenditure.
$Approp_{t-1}$	.13	.06	0	.36	The proportion of firms having applied patents.
$Frontier_{t-1}$	7.14	.59	5.24	9.77	Labor productivity (sales per employee) of the frontier firm, in log [a].

N=15,607

Sources: Technological Innovation Panel (PITEC) (Madrid: INE, 2015).
Note: a. The frontier firm is the firm with the highest labor productivity in an industry of a given year.

Table 2
Correlation coefficients

	Labprodt	Moreimi	Innproc	Rdstock	Patstock	Age	Export	Group	HHI	Spillover	Approp
Moreimi	.05										
Innproc	.06	-.01									
Rdstock	.12	-.07	.07								
Patstock	-.01	-.13	.01	.17							
Age	.10	.04	.04	.09	.01						
Export	.17	-.01	.03	.15	.11	.18					
Group	.23	.03	.06	.14	.09	.03	.06				
HHI	-.05	-.01	.00	.04	-.01	-.01	-.03	-.01			
Spillover	.05	-.02	-.07	.16	.01	.00	.07	.01	-.27		
Approp	-.10	-.05	-.10	-.01	.14	-.10	.09	-.03	-.03	.24	
Frontier	.11	.02	.00	.12	.04	.06	.00	.00	.07	.38	-.01

N=15,607

Table 3
Regression results

Dependent variable: Labprodt									
	OLS		Fixed-effects quantile regression						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Model:	Laggard[a]	Non-laggard	q5	q10	q25	q50	q75	q90	q95
Independent variable:									
Moreimi	0.019 *	-0.003	0.017	0.015 +	0.008 +	0.006 *	0.000	-0.011	-0.022 +
Innproc	0.029 **	0.003	0.032 **	0.029 **	0.012 **	0.007 *	-0.005	-0.009	-0.025 *
Rdstock	0.004 **	0.002	0.003 *	0.003 *	0.003 ***	0.004 ***	0.005 ***	0.006 ***	0.005 **
Patstock	-0.006	-0.019 **	0.009	0.007	0.007 **	0.005 **	0.003	0.005	0.010
Age	0.121 ***	-0.057 ***	0.260 ***	0.228 ***	0.201 ***	0.179 ***	0.160 ***	0.130 ***	0.089 ***
Export	0.133 ***	0.022 *	0.020 +	0.027 **	0.010 *	0.006 +	-0.006	-0.019 *	-0.011
Group	0.101 ***	0.116 ***	0.000	0.012	0.021 ***	0.021 ***	0.018 ***	0.010	0.030 *
HHI	0.000	0.000 **	0.000	0.000 *	0.000 **	0.000 ***	0.000 ***	0.000 **	0.000 **
Spillover	0.047 +	0.043	0.091 **	0.064 **	0.023 +	0.039 ***	0.021 +	0.049 *	0.015
Approp	0.759 **	0.653 *	1.478 ***	1.211 ***	1.082 ***	1.069 ***	0.950 ***	0.804 ***	0.866 **
Frontier	0.016	0.061 ***	0.054 ***	0.044 ***	0.036 ***	0.040 ***	0.042 ***	0.038 ***	0.058 ***
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	7,177	8,430	15,607	15,607	15,607	15,607	15,607	15,607	15,607
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.26	0.27	0.16	0.17	0.2	0.2	0.16	0.12	0.09

***P<0.001;** P<0.01;*P<0.05; +P<0.1

Note: a. Laggards are observations whose labor productivity is below the medium observation in its industry at a given year.