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## **To innovate or to imitate: Technology development determines “the” strategy**

**Ching T. Liao**  
**IESE Business School**  
**Strategic Management**  
**ctliao@iese.edu**

### **Abstract**

To innovate or to imitate: Technology development determines “the” strategy. Ching T. Liao. IESE Business School. 2013- 2017. ctliao@iese.edu. Abstract State-of-the-art: Scholars approach the relationship between innovation and imitation differently. Some dichotomizes them, and others consider that firms can do both. A third view focuses on the transition process from imitation to innovation. An associated framework is Schumpeterian growth model. Due to the advantage of backwardness, the farther from the technology frontier, the more improvement it can create from implementing the existing innovation. Thus, when approaching the technology frontier, growth is positively associated with innovation. On the other hand, when lagging behind the technology frontier, implementing innovation developed elsewhere –imitation– becomes the main force of growth. Research gap: Many studies on the relationship between new products and firm performance regard a firm’s new products as homogenous, in terms of their impacts on performance. This paper recognizes the heterogeneity of a firm’s new products. It considers a firm’s new products a portfolio, encompassing imitative and innovative products. Previous studies about firms in developing and transition economics report inconsistent results on the relationship between innovation output and firm performance. This suggests that the level of technology development as a contingency determining the association between new products and performance. Accordingly, I use the framework from Schumpeterian growth model and expect that when a firm is lagged behind the technology frontier, it can benefit from an imitative-focus new product portfolio. Moreover, this paper analyzes large-scale quantitative firm level data, which is different from previous related works that mainly rely on formal models, qualitative case studies, and analyses of national level data. Theoretical arguments: Because firms have limited resources, the efficiency of resource allocation determines the performance. Since technology laggards are at disadvantage in generating innovation, engaging in imitation is more cost-effective. In addition, doing imitation increases the expected return of future investment in innovation. Technology leaders have lower incentive to imitate. First, since few firms own more advanced technology than the leaders, the availability of worthy-imitating spillovers is reduced. Second, competing through innovating is more critical among leaders than laggards. Along with the development of knowledge and capabilities, the net return of investing in innovation increases and the net return of investing in imitation decreases. Thus, I expect that the levels of a firm’s technology development moderate the relationship between new product portfolio and firm performance. Method and data: This study’s data come from Technological

Innovation Panel (PITEC), which is Spanish Community Innovation Survey (CIS). PITEC provides panel data of about 7,910 firms, over a period of 9 years, from 2005 to 2013. Total sales are used to measure firm performance. A binary is created to represent for the focus of a firm's new product portfolio. It takes the value of one when a firm's new product portfolio focuses more on imitation. The distance to technology frontier is used to measure the level of technology development. It is calculated based on the relative labor productivity of an observation to its technology frontier. I control for the share of new product sales, firm types, knowledge stock of a firm, as well as its competitiveness, size, and age. I also control for industry level characteristics such as market structure, the overall spillovers, and appropriability. The analyses are based on firm fixed effects panel data regression, with lag terms in technology development and other control variables. Results: The evidence shows that composition of new product portfolio matters and confirms the moderation role of technology development. A new product portfolio focusing more on imitation benefits more the laggards than the non-laggard firms, in terms of firm performance. This paper provides empirical micro-foundation for Schumpeterian growth model by presenting firm level evidence, as well as rethinks about the pro-innovation argument. Key references Aghion P, Howitt P. 2006. Joseph schumpeter lecture appropriate growth policy: A unifying framework. *Journal of the European Economic Association* 4(2-3): 269-314. Benhabib J, Perla J, Tonetti C. 2014. Catch-up and fall-back through innovation and imitation. *Journal of Economic Growth* 19(1): 1-35. Chang S, Kim H, Song J. 2015. Imitation to innovation: Technological catch-up strategy of late movers in emerging economies. Available at SSRN 2599140. Cohen WM, Levinthal DA. 1989. Innovation and learning: The two faces of R&D. *The Economic Journal* 99(397): 569-596. Gerschenkron A. 1962. Economic backwardness in historical perspective. In *Economic Backwardness in Historical Perspective: A Book of Essays*. Belknap Press of Harvard University Press: Cambridge, Massachusetts: 5-30. Hobday M. 1995. East Asian latecomer firms: Learning the technology of electronics. *World Development* 23(7): 1171-1193. Hobday M, Rush H, Bessant J. 2004. Approaching the innovation frontier in Korea: The transition phase to leadership. *Research Policy* 33(10): 1433-1457. Kim L. 1997. The dynamics of Samsung's technological learning in semiconductors. *California Management Review* 39(3): 86-100. Lee K, Lim C. 2001. Technological regimes, catching-up and leapfrogging: Findings from the Korean industries. *Research Policy* 30(3): 459-483. Lieberman MB, Asaba S. 2006. Why do firms imitate each other? *Academy of Management Review* 31(2): 366-385. Mahmood IP, Rufin C. 2005. Government's dilemma: The role of government in imitation and innovation. *Academy of Management Review* 30(2): 338-360. Nelson RR, Winter SG. 1982. *An Evolutionary Theory of Economic Change*. Belknap Press of Harvard University Press. Schnaars SP. 1994. *Managing Imitation Strategies*. The Free Press: New York.

# To innovate or to imitate: Technology development determines “the” strategy

Ching T. Liao  
IESE Business School  
ctliao@iese.edu

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## Abstract

This paper acknowledges the heterogeneity of a firm’s new products. It investigates how new product portfolio—a combination of imitative and innovative products— influences performance, according to the relative technology development of a firm. Based on a panel data of Spanish firms, the empirical evidence confirms that being a laggard, a firm can perform better in introducing more imitative than innovative products. It recognizes the value of imitation, suggesting more innovation is not always better. In addition, it provides micro-foundation for the Schumpeterian growth model by analyzing a large firm level dataset.

## 1. Introduction

Introducing new products is one of the important drivers of firm performance. The relationship between new products and performance has been extensively discussed. Many studies implicitly assume that the new products offered by a firm are homogeneous, in terms of the extent of newness. According to the novelty of the products, they categorize firms into different camps and compare their performance. Typical categorizations are radical vs. incremental innovators, first movers vs. followers, as well as innovators vs. imitators. Different from previous studies, the present research acknowledges the heterogeneity of new products. It regards a firm’s new products as a portfolio and investigates how the composition of the portfolio influences performance. Specifically, it distinguishes imitative from innovative products, and argues their proportion within a new product portfolio is associated with firm performance. In addition, the association differs depending on a firm’s technology development.

Previous studies on the impacts of innovation and imitation on performance can be summarized into three approaches. The first view dichotomizes innovation and imitation. A firm can be either an innovator or an imitator. The heterogeneity of firms provides the main theoretical base for this stream of research. Innovation and imitation require different sets of knowledge and capabilities. In some cases, scholars assume that imitation is easy and costless, as if it does not require any knowledge and resources. This is often done in formal modeling (Bessen and Maskin, 2009). Firms either imitate or innovate, depending on the type of knowledge and capabilities they own (Damanpour and Wischnevsky, 2006). The characteristics of the environment are also important factors for firm to decide whether to innovate or to imitate (Shinkle and Mccann, 2014). Scholars with the dichotomy view often juxtapose imitation with innovation, focusing on their market performance implication. The most discussed scenarios are about market entry order (Lieberman and Montgomery, 1988). Later entrants are considered imitators who introduce similar products as the pioneers. The followers often supply similar products at a lower price, sometimes even with improved quality (Ethiraj and Zhu, 2008). They increase the market competition and force the pioneers to share the market with them. In some cases, followers can even beat the pioneers and become the market leader (Schnaars, 1994). Discussion on first-mover (Lieberman and Montgomery, 1988, 1998) and fast second (Markides and Geroski, 2004) are examples of this stream of research. A recent article suggests that not only followers imitate, an incumbent leader also imitates in order to avoid being dethroned (Ross and Sharapov, 2015). Other studies look at the effect of imitation on innovation, focusing on the prevention of the occurrence of imitation in order to protect the innovators, as well as the conditions prolonging innovators' advantages (Teece, 1986). Almost all the innovators need to bear the cost of being imitated. As a result, how to prevent and to delay the occurrence of imitation in order to pursue high performance from innovation is the center of the discussion.

The second perspective looks at the dynamic relationship among imitation, innovation, and performance. Innovation is more complex than imitation (Knight, 1967). Scholars with this perspective often focus on the transition process and mechanism from imitation to innovation. 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. Through this mechanism, imitation increases the likelihood of successful 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 capability to innovate can be learned through doing imitation.

The third perspective considers the possibilities that a firm can engage in both innovation and imitation related activities. In addition, they compete for a firm's limited resources. Studies using this approach often discuss factors that influence the intensity of investment in each activity. In their theoretical paper, Benhabib, Perla, and Tonetti (2014) model the optimal choice of an agent as a portfolio of investment in innovation and imitation. The amount of investment in each activity decides the relative return, which leads to various rates of productivity growth. Pérez-Luño, Wiklund, and Cabrera (2011) found that the extent of proactivity and risk taking of a firm positively influences its tendency of doing more innovation than imitation. Using a simulation model, Chang, Kim, and Song (2015) demonstrate that the proportion of R&D expenditure focusing on innovation, relative to imitation, influences the probability that a late comer can overpass the technology level of the frontier. Nelson and Winter (1982) also explicitly point out that a firm's R&D expenditure composes both innovation and imitation.

The context matters while discussing the relationships among innovation, imitation, and performance. Previous studies suggest that the distance to technology frontier is an important factor while considering the relationship among innovation, imitation, and performance. Aghion and Howitt (2006) point out that Schumpeterian growth model is a suitable framework to explain the variation of growth performance in different context. Distance to technology frontier is explicitly incorporated into the growth model. Many previous studies related to distance to technology frontier are theoretical formal models. Empirical works mainly focus on cross-country comparison. Firm level analyses are limited and most of them are qualitative case studies, focusing on the process of technology catch-up. Thus, this paper investigates the impact of innovation and imitation on performance of firms with different level of technology development. It aims to contribute to the research stream by providing some empirical understanding of firm level dynamics, through analyses of large-scale quantitative data, including also non-manufacturing sectors.

This paper rethinks about the pro-innovation argument. It recognizes the value of imitation and suggests that more innovation is not always better. It points out the importance of knowing where a firm stands. The relative technology position to other players in the market is associated with whether focusing more on imitation is an appropriate strategy. From policy perspective, this paper brings up the importance of heterogeneity on recommendation of innovation. Sometimes, encouraging imitation might be a more cost-effect way to improve performance.

## **2. Previous literature**

### **2.1 New products and firm performance**

Introducing new products is a complex process, involving various decision and activities. Therefore, the relationship between new products and firm overall performance is not straightforward. Scholars working on this topic have moved away from using R&D expenditure as a measurement of innovation as in the earlier studies. Many researchers at current time use a four-stage framework to investigate the relationship between new products and firm performance (Kemp et al., 2003). The four stages are the decision to innovate, the decision about the amount of resources invested, the relationship between innovation input and output, and the relationship between innovation output and firm performance. The present study aims to provide an understanding about the relationship between new product portfolio and firm performance, which is an extension of the final stage.

Many previous works use new product related measures to operationize the concept of innovation output, such as new products announcement, the introduction of new products, as well as the share of sales generated by new products. Among these measures, the share of sales from new products seems to be the most adequate because it directly links new products to their commercial value (Kemp et al., 2003). As for firm performance, scholars often use productivity, sales, and profits. Crepon et al. (1998) demonstrate that the larger the share of the sales generated from newly introduced products, the higher the firm's productivity, measured by value added per employee. 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

shares of new product sales and labor productivity for both institutional settings. In general, a positive relationship has been found between innovation output and firm performance.

When using new product related concepts to measure innovation output, researchers usually implicitly assume the homogeneity of new products, in terms of its impacts on firm performance. In the case of using a binary indicator to represent for whether a firm has introduced new products, the different impacts on firm performance due to the quantity and the quality of new products are assumed away. Using the share of new product sales to measure innovation output alleviates this concern to some extent. However, it still overlooks the possibility that the composition of the new products might be influential. 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 all new-to-market and the other one's are all new-to-firm.

The argument that products with different degree of newness perform differently is not new. The comparison between radical and incremental innovation, imitators and innovators, as well as pioneers and followers are well documented. The importance of the composition of new products is also stressed by studies on new product development and R&D resource allocation. The consensus is that a right selection of new product projects is crucial in 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. Therefore, the present study introduces the concept of product portfolio into the relationship between new products and overall firm performance.

In the context of developing and transition countries, the link between new products and firm performance seems to be indeterminate. Using a sample of Argentina firms, Chudnovsky, López, and Pupato (2006) show that firms with positive innovation output, either product or/and process innovation, have higher labor productivity. Masso and Vahter (2008) show 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 condition. Benavente (2006) find no relationship between firms' productivity and new product sales, in the case of Chili. The heterogeneity 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. Therefore, the present study introduces the concept of distance to technology frontier as a potential contingency, which determines the association between new products and firm performance.

## 2.2 Distance to technology frontier

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<sup>1</sup>. Innovation directly contributes to growth 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 growth depends on the distance to technology where the imitation occurs. Due to the advantage of backwardness (Gerschenkron, 1962), the farther from the technology frontier, the more improvement it can create from implementing the existing leading-edge innovation, given the frequency of imitation.

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

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<sup>1</sup> 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).

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. The return to innovation is constant and the marginal productivity growth rate of imitation is associated with the distance to technology frontier. Their model suggests an equilibrium ratio calculated based on the relative productivity of the agent and the frontier. At this ratio, an agent simultaneously invests in innovation and imitation. Above this threshold, an agent chooses to invest only in innovation in order to catch-up. When below the ratio, an agent only imitates and optimally falls behind the frontier. In addition to the diminishing advantage of backwardness, the constant return of innovation assumed in the model is associated with the optimal fall back choice. Although some of these agents have relative high productivity, their returns to innovation are not high enough. Therefore, their optimal choice is to do imitation only, and stuck in the middle-income trap (Agénor and Dinh, 2013b).

Unlike assuming constant return to innovation across all agents with different level of productivity under the approach of formal modeling, empirical evidence supports 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. When considering the growth dynamics, the latter view that capability can be developed is more relevant. 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. On the other hand, for agents that are close to frontier, although innovation is the main source of growth, sometimes they also need to imitate innovation developed by the follower in order to update its own technology capability (Ross and Sharapov, 2015).

### **3. Expected results**

When engaging in both innovation and imitation, how to allocate limited resource to optimize the performance becomes an issue of concern. 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. Identifying and understanding the target is the first step of imitation. Then they have to analyze the cause of the success of the target. 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 growth 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<sup>2</sup>. 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. When a firm is lagged behind the technology frontier, a new product portfolio that is mostly imitative enhances firm performance more than a portfolio that focuses more on innovation. That is to say, a new product portfolio focusing more on imitation benefits more the laggards than the non-laggard firms, in terms of firm performance.

#### **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<sup>3</sup>. PITEC is the Spanish

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<sup>2</sup> 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.

<sup>3</sup> PITEC: Panel de Innovación Tecnológica.

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)<sup>4</sup>. 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 Business Register in Spain (DIRCE)<sup>5</sup>. 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. After excluding firms that have merged, shut down, split, or gone through other significant events, I obtain an unbalanced panel of about 7,910 firms (71,202 firm-year observations), over the period from 2005 to 2013. The dataset covers firms from different industry sectors, including agriculture, manufacturing, and services.

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

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<sup>4</sup> INE: Instituto Nacional de Estadística. FECYT: Fundación Española para la Ciencia y la Tecnología. COTEC: Fundación para la Innovación Tecnológica.

<sup>5</sup> DIRCE: Directorio Central de Empresas

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 product 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 order to distinguish these two situations, I classify firms into four types according to their introduction of new products —no new products (the base type), only new-to-firm products (imitators), only new-to-market products (innovators), and both new-to-firm and new-to-market products (hybrid). By controlling for firm types, the estimation of “Moreimi” can be interpreted as the effects due to changing the focus of new product portfolio among hybrid firms.

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.

I measure the distance to technology frontier using the 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. Accordingly, a binary variable “Lag” is created to represent for laggard firms. The variable of “Lag” enters regression equation with one-year lag to alleviate the concern of possible reverse causality from new product portfolio to distance to technology frontier. An interaction term between “Lag” and “Moreimi” is used to analyze the moderation effect of distance to technology frontier on the relationship between new product portfolio and firm performance, which is measured by the logarithm of firm sales (“Ln\_sales”).

There are two groups of control variables. The first group includes variables that vary at observation level. The share of sales from new products—including innovative and imitative ones (“Ln\_new”)—is a conventional indicator used to measure innovation output, when estimating firm performance. This variable takes log transformation. Firms’ knowledge is believed to be associated with the market success 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, it is impossible to link the firm with other datasets. 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 (“Ln\_patstock”). Since not all knowledge can be patented, I also apply the same method to calculate the general knowledge stock (“Ln\_rdstock”), using internal R&D expenditure. Both variables enter the regression analysis with one-year lag. Other observation level controls include age (“Ln\_age”) of the firm, the firm size (“Ln\_size”) measured by the number of employees, as well as whether a firm belonging to a group of companies (“Group”). In addition, I also control for the competitiveness of the firm by using a dummy variable (“Export”) to indicate whether a firm engages in exporting.

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 (“Ln\_rdindustry”). 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”). I also control for year effect in all estimations. **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 firm fixed effects regression, with year effect. Due to the use of lag terms and excluding observations with missing values, the number of observations reduced to 63,251 (in total 7,928 firms, over an eight-year period from 2006 to 2013). Model 1 shows the base line. All variables are significant. The share of new products sales (“Ln\_new”) positively contributes to firm performance. This is consistent with previous literature. Model 2 includes also the firm types, which leads the coefficient of the share of new product sales become smaller and less significant.

In Model 5, distance to technology frontier (“Lag”) is negatively associated with firm performance and new product portfolio (“Moreimi”) has no effect. Model 6 is the complete model, including an interaction term between new product portfolio and distance to technology frontier. The interaction term is significant and positive. It demonstrates the moderation effect of being a laggard on the relationship between new product portfolio and performance. By taking into consideration the distance to technology frontier, the effect of new product portfolio is decomposed into direct effect and indirect effect. Compared to Model 5, the effect of an imitation-focus new product portfolio becomes more negative significant. A non-laggard with a new product portfolio focusing more on imitative products is associated with lower firm performance. However, in the case of being a laggard, an imitation-focus new product portfolio has a positive effect on performance. This is consistent with the expectation. According to the estimation, by focusing more on imitation, a laggard can increase its performance by about 0.1%<sup>6</sup>.

## 6. Discussion

This study contributes to the literature of innovation and imitation. It shows that the composition of new product portfolio matters for firm performance. Being a laggard, a firm can improve its performance by focusing more on imitation, rather than on innovation. Moreover, the current present study provides empirical micro-foundation for Schumpeterian growth model by presenting firm level dynamics. Different from previous

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<sup>6</sup> This is calculated by summing up the direct (-0.026) and indirect (0.035) effect.

studies that mainly rely on formal models, qualitative case studies, and analyses of national level data, I analyze large-scale quantitative firm level data. Advancing knowledge in this aspect has its relevance. 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<sup>7</sup>.

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.

## 7. References

- Agénor PR, Dinh HT. 2013a. Public policy and industrial transformation in the process of development. *World Bank Policy Research Paper* (6405).
- Agénor PR, Dinh HT. 2013b. From imitation to innovation: Public policy for industrial transformation. *Economic Premise* (115): 1–8.
- Aghion P, Howitt P. 2006. Joseph schumpeter lecture appropriate growth policy: A unifying framework. *Journal of the European Economic Association* 4(2-3): 269–314.
- Barge-Gil A, López A. 2014. R&D determinants: Accounting for the differences between research and development. *Research Policy* 43(9): 1634–1648.
- Becker SW, Whisler TL. 1967. The innovative organization: A selective view of current theory and research. *The Journal of Business* 40(4): 462–469.
- Benavente JM. 2006. The role of research and innovation in promoting productivity in Chile. *Economics of Innovation and New Technology* 15(4-5): 301–315.
- Benhabib J, Perla J, Tonetti C. 2014. Catch-up and fall-back through innovation and imitation. *Journal of Economic Growth* 19(1): 1–35.
- Bessen J, Maskin E. 2009. Sequential innovation, patents, and imitation. *The RAND Journal of Economics* 40(4): 611–635.
- Cappelli R, Czarnitzki D, Kraft K. 2010. Sources of spillovers for imitation and innovation. *Research Policy* 43(1): 115–120.

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<sup>7</sup> Compared to innovation, imitation is more economical because it often costs less, takes shorter time, and involves less risk.

- Chang S, Kim H, Song J. 2015. Imitation to innovation: Technological catch-up strategy of late movers in emerging economies.
- Chao RO, Kavadias S. 2008. A theoretical framework for managing the new product development portfolio: When and how to use strategic buckets. *Management Science* **54**(5): 907–921.
- Chao RO, Kavadias S. 2013. R&D intensity and the new product development portfolio. *IEEE Transactions on Engineering Management* **60**(4): 664–675.
- Chudnovsky D, López A, Pupato G. 2006. Innovation and productivity in developing countries: A study of Argentine manufacturing firms' behavior (1992–2001). *Research Policy* **35**(2): 266–288.
- Crepon B, Duguet E, Mairessec J. 1998. Research, innovation and productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology* **7**(2): 115–158.
- Damanpour F, Wischnevsky DJ. 2006. Research on innovation in organizations: Distinguishing innovation-generating from innovation-adopting organizations. *Journal of Engineering and Technology Management* **23**(4): 269–291.
- Ethiraj SK, Zhu DH. 2008. Performance effects of imitative entry. *Strategic Management Journal* **29**(8): 797–817.
- Gerschenkron A. 1962. Economic backwardness in historical perspective. In *Economic Backwardness in Historical Perspective: A Book of Essays*. Belknap Press of Harvard University Press: Cambridge, Massachusetts: 5–30.
- Hashi I, Stojic N. 2013. The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4. *Research Policy* **42**(2): 353–366.
- Helfat CE, Raubitschek RS. 2000. Product sequencing: Co-evolution of knowledge, capabilities and products. *Strategic Management Journal* **21**: 961–979.
- Helpman E, Grossman GM. 1991. *Innovation and Growth in the Global Economy*. MIT Press: Cambridge, Massachusetts.
- Henderson R, Cockburn I. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal* **15**(Winter): 63–84.
- Henderson R, Cockburn I. 1996. Scale, scope, and spillovers: The determinants of research productivity in drug discovery. *The Rand journal of economics* **27**(1): 32–59.
- Hobday M. 1995. East Asian latecomer firms: Learning the technology of electronics. *World Development* **23**(7): 1171–1193.
- Hobday M, Rush H, Bessant J. 2004. Approaching the innovation frontier in Korea: The transition phase to leadership. *Research Policy* **33**(10): 1433–1457.
- Hölzl W, Janger J. 2014. Distance to the frontier and the perception of innovation barriers across European countries. *Research Policy* **43**(4): 707–725.
- Kemp RGM, Folkerling M, de Jong JPJ, Wubben EFM. 2003. Innovation and firm performance. Research Report H200207. Zoetermeer.
- Kim L. 1997. The dynamics of Samsung's technological learning in semiconductors. *California Management Review* **39**(3): 86–100.
- Kim L. 2001. The dynamics of technological learning in industrialisation. *International Social Science Journal* **53**(168): 297–308.
- Klingebiel R, Rammer C. 2014. Resource allocation strategy for innovation portfolio management. *Strategic Management Journal* **35**: 246–268.
- Knight KE. 1967. A descriptive model of the intra-firm innovation process. *The Journal of Business* **40**(4): 478–496.
- Leonard-Barton D. 1992. Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal* **13**(summer): 111–125.

- Lieberman MB, Asaba S. 2006. Why do firms imitate each other? *Academy of Management Review* **31**(2): 366–385.
- Lieberman MB, Montgomery DB. 1988. First-mover advantages. *Strategic management journal* **9**: 41–58.
- Lieberman MB, Montgomery DB. 1998. First-mover (dis)advantages: Retrospective and link with the resource-based view. *Strategic management journal* **19**(12): 1111–1125.
- Mahmood IP, Rufin C. 2005. Government's dilemma: The role of government in imitation and innovation. *Academy of Management Review* **30**(2): 338–360.
- Mansfield E. 1963. Size of firm, market structure, and innovation. *Journal of Political Economy* **71**(6): 556–576.
- Markides CC, Geroski PA. 2004. *Fast Second: How Smart Companies Bypass Radical Innovation to Enter and Dominate New Markets*. John Wiley & Sons: San Francisco, CA.
- Masso J, Vahter P. 2008. Technological innovation and productivity in late-transition Estonia: Econometric evidence from innovation surveys. *The European Journal of Development Research* **20**(2): 240–261.
- Nelson RR, Winter SG. 1982. *An Evolutionary Theory of Economic Change*. Belknap Press of Harvard University Press.
- OECD, Eurostat. 2005. *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. OECD: Paris.
- Pérez-Luño A, Wiklund J, Cabrera RV. 2011. The dual nature of innovative activity: How entrepreneurial orientation influences innovation generation and adoption. *Journal of Business Venturing* **26**(5): 555–571.
- Pierce JL, Delbecq AL. 1997. Organization structure, individual attitudes and innovation. *Academy of Management Review* **2**(1): 27–37.
- Ross J, Sharapov D. 2015. When the leader follows: Avoiding dethronement through imitation. *The Academy of Management Journal* **58**(3): 658–679.
- Schnaars SP. 1994. *Managing Imitation Strategies*. The Free Press: New York.
- Shinkle GA, Mccann BT. 2014. New product development: The moderating influence of economic institutional context. *Strategic Management Journal* **35**: 1090–1101.
- Teece DJ. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research policy* **15**: 285–305.
- Veugelers R, Cassiman B. 2005. R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization* **23**(5-6): 355–379.
- Wheelwright SC, Clark KB. 1992. Creating project plans to focus. *Harvard Business Review* (March-April): 70–82.

Table 1  
Descriptive statistics

Variable	Mean	Std. dev.	Min	Max	Note
<u>Variables at observation level:</u>					
Ln_sales	15.85	2.05	5.44	23.39	Total sales of a firm, in log.
Moreimi	.26	.44	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.
Lag <sub>t-1</sub>	.50	.50	0	1	Binary identifies the laggard.
Type	1.89	1.07	1	4	Firm types. A categorical variable: 1 for firms with no new products (the base type); 2 for imitators; 3 for hybrid; 4 for innovators.
Ln_new	1.50	1.79	0	4.62	The share of sales from new products, including imitative and innovative products, in log.
Ln_rdstock <sub>t-1</sub>	8.89	6.07	0	20.78	Knowledge stock, in log.
Ln_patstock <sub>t-1</sub>	.29	.72	0	7.06	Patent stock, in log.
Ln_size	.16	.31	0	3.75	No. of employees (in thousands), in log.
Ln_age	3.30	.53	0.69	6.32	No. of years since foundation, in log.
Export	.41	.49	0	1	Binary identifies firms that export.
Group	.40	.49	0	1	Binary takes value one when firms belong to a group of companies.
<u>Variables at industry level:</u>					
HHI	452	401	91.70	10000 <sup>a</sup>	Herfindahl-Hirschman index.
Ln_rdindustry	18.20	1.36	11.51	20.90	Log of R&D expenditure.
Approp	.10	.08	0	.46	The proportion of firms having applied patents.

N=63,251

Sources: Technological Innovation Panel (PITEC) (Madrid: INE, 2015).

Note: a. Only one firm in the coke industry.

Table 2  
Correlation coefficients

	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Ln_sales	.07	-.37	.05	.02	.00	.08	.61	.37	.22	.52	-.02	.00	-.10
2 Moreimi		-.05	.19	.49	.24	.06	-.02	.04	.15	.04	-.04	.08	.11
3 Lag			-.08	-.06	-.11	-.07	-.05	-.09	-.15	-.23	.00	.00	.00
4 Type				.75	.43	.24	-.01	-.02	.20	.04	-.01	.17	.21
5 Ln_new					.42	.21	-.04	-.05	.20	.02	-.02	.16	.22
6 Ln_rdstock						.30	-.08	-.02	.27	.05	-.01	.25	.30
7 Ln_patstock							.05	.04	.20	.08	-.03	.12	.28
8 Ln_size								.20	-.02	.32	.08	-.07	-.15
9 Ln_age									.18	.12	-.07	-.08	-.07
10 Export										.12	-.13	.12	.21
11 Group											.03	.05	-.03
12 HHI												-.24	-.09
13 Ln_rdindustry													.40
14 Approp													

N=63,251

Table 3  
Firm fixed effects regression analysis

Dependent variable: Ln_sales						
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variable:						
Moreimi			-.011		-.011	-.026 <sup>*</sup>
Lag				-.225 <sup>***</sup>	-.225 <sup>***</sup>	-.235 <sup>***</sup>
Moreimi*Lag						.035 <sup>***</sup>
Type						
Imitator		.040 <sup>***</sup>	.051 <sup>***</sup>	.042 <sup>***</sup>	.052 <sup>***</sup>	.050 <sup>***</sup>
Hybrid		.042 <sup>***</sup>	.045 <sup>***</sup>	.046 <sup>***</sup>	.049 <sup>***</sup>	.048 <sup>***</sup>
Innovator		.041 <sup>***</sup>	.041 <sup>***</sup>	.042 <sup>***</sup>	.042 <sup>***</sup>	.042 <sup>***</sup>
Ln_new	.013 <sup>***</sup>	.004 <sup>+</sup>	.004 <sup>+</sup>	.004	.004	.004
Ln_rdstock	.007 <sup>***</sup>					
Ln_patstock	.057 <sup>***</sup>	.057 <sup>***</sup>	.056 <sup>***</sup>	.056 <sup>***</sup>	.056 <sup>***</sup>	.056 <sup>***</sup>
Ln_size	1.366 <sup>***</sup>	1.366 <sup>***</sup>	1.366 <sup>***</sup>	1.385 <sup>***</sup>	1.385 <sup>***</sup>	1.384 <sup>***</sup>
Ln_age	.457 <sup>***</sup>	.453 <sup>***</sup>	.453 <sup>***</sup>	.423 <sup>***</sup>	.424 <sup>***</sup>	.425 <sup>***</sup>
Export	.083 <sup>***</sup>	.083 <sup>***</sup>	.083 <sup>***</sup>	.080 <sup>***</sup>	.080 <sup>***</sup>	.080 <sup>***</sup>
Group	.048 <sup>***</sup>	.047 <sup>***</sup>	.047 <sup>***</sup>	.046 <sup>***</sup>	.046 <sup>***</sup>	.047 <sup>***</sup>
HHI	-.000 <sup>**</sup>					
Ln_rdindustry	.018 <sup>**</sup>					
Approp	.832 <sup>***</sup>	.825 <sup>***</sup>	.826 <sup>***</sup>	.835 <sup>***</sup>	.835 <sup>***</sup>	.837 <sup>***</sup>
Constant	13.693 <sup>***</sup>	13.701 <sup>***</sup>	13.700 <sup>***</sup>	13.903 <sup>***</sup>	13.902 <sup>***</sup>	13.902 <sup>***</sup>
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	63,251	63,251	63,251	63,251	63,251	63,251
No. of firms	7,928	7,928	7,928	7,928	7,928	7,928
F-value	335.81 <sup>***</sup>	286.52 <sup>***</sup>	272.92 <sup>***</sup>	336.2 <sup>***</sup>	320.96 <sup>***</sup>	307.64 <sup>***</sup>
R <sup>2</sup> (between)	.48	.48	.48	.55	.55	.55
R <sup>2</sup> (within)	.09	.09	.09	.11	.11	.11

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