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Innovation Strategies and Firm Performance

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Abstract: This paper analyzes the effect of various innovation strategies of firms on their future performance, captured by labour productivity. Using five waves of the Community Innovation Survey in Sweden, we have traced the innovative behaviour of firms over a decade, i.e. from 2002 to 2012. We distinguish between sixteen innovation strategies, which compose of Schumpeterian four types of innovations, i.e. process, product, marketing, and organizational (simple innovation strategies) plus various combinations of these four types (complex innovation strategies). The main findings indicate that those firms that choose and afford to have a complex innovation strategy are better off in terms of their future productivity in compare with both those firms that choose not to innovative (base group) and those firms that choose simple innovation strategies. Moreover, not all types of complex innovation strategies affect the future productivity significantly; rather, there are only few of them. This necessitates a purposeful choice of innovation strategy for firms.

Key words: Innovation Strategy, firm performance, productivity, firm level, Community Innovation Survey, Panel

JEL codes: D22, L20, O31, O32

1. Introduction

A right innovation strategy can help firms to overcome the problems they encounter concerning striving for a sustainable competitive advantage (Kuratko, et al., 2005). The firm's innovation process is guided by an explicit or implicit innovation strategy, which provides direction toward specific resources, and help focus the efforts of the entire organization on common innovation goals (Oke, 2007). In this paper, we analyze empirically the relationship between firms' choice of innovation strategy and their performance. According to Schumpeter, firms have an option to choose an innovation strategy involving product, process, market or organizational innovation[1]. This can be termed as "simple" innovation strategy, because firms decide to engage in only one type of innovation. Recent evidence, however, shows that a good portion of innovative firms chooses to combine various types of innovation at the same time, i.e. "complex" innovation strategy (Tavassoli and Karlsson, 2015). Considering both simple and complex innovation strategies, this implies that, in total, firms can choose between sixteen different innovation strategies[2]. However, both theoretical and empirical studies have devoted minor attention to other innovation strategies than those related to technological innovation (Haned, Mothe & Nguyen-Thi, 2014; Oh, Cho & Kim, 2014). This is clearly a serious limitation, because the co-existence and co-evolution of different types of innovation is important for firm performance (Damanpour & Aravind, 2012). Since productivity gains are related to production efficiency and factor saving, it is argued that an analysis of the effects of innovation on productivity that focuses exclusively on product innovation is indeed too restrictive (Polder et al, 2010).

Thus, expanding the scope of analysis of innovation strategies beyond the field of technological innovation is crucial. This will provide a much richer understanding of firms' choices of innovation strategies as well as of the effects of different simple and complex innovation strategies on firm performance (Le Bas, Mothe & Nguyen-Thi, 2015). More complex innovation strategies are more demanding in terms of firm capabilities and we argue that firms that are capable of implementing complex innovation strategies also will achieve a better performance[3] (Gera & Gu, 2004).

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[1] Schumpeter (1934) also described a fifth type of innovation – 'new sources of supply' –, which we exclude here, since we have no data on such innovations.

[2] If we also count being non-innovative as an innovation strategy. This is particularly necessary when it comes to empirical strategy in this paper.

[3] We will elaborate this argument more in detail in Section 2.

Understanding how firms' choices of innovation strategy affect firm performance is of course important from a management and owner perspective. Not least can we assume that in times with increased levels of competition and shortened product cycles the ability of firms to generate innovations may be more important for firms' competitive advantage and performance than ever (Artz, et al., 2010). Thus, innovation can be seen as a requisite objective for all firms that want to improve firm success and performance (Varis & Littunen, 2010). It is also important from a scholarly perspective at least for two reasons. First, most studies of the relationship between innovation strategies and firm performance has focused on simple innovation strategies involving product and process innovations. The effects of complex innovation strategies have seldom been analyzed. Second, even if in those studies that focused merely on simple innovation strategies, not all types of simple innovation is adequately investigated (for instance marketing innovation has been barely considered). Finally, an understanding of the relationship between innovation strategies and firm performance is important from the perspective of public innovation policies. Most such policies seem mainly to focus product and possibly process innovations. The need to support more complex innovation strategies by means of innovation policies is rarely considered.

We employed a panel of five waves of the Community Innovation Survey in Sweden (covers the period 2002 to 2012). We distinguish between sixteen innovation strategies, which compose of Schumpeterian four types of innovations, i.e. process, product, marketing, and organizational (simple innovation strategies) plus various combinations of these four types (complex innovation strategies). Our main finding indicates that those firms that introduce a complex innovation strategy are better off in terms of their future productivity compared with both those firms that choose not to innovative (base group) and those firms that choose simple innovation strategies.

This paper is organized as follows: Section 2 provide a literature review on the relation between innovation strategies of firms and their performance. Section 3 describes our data. Section 4 provides a descriptive of variety of innovation strategies that firms in our dataset actually choose to introduce in a given point in time. Section 5 explains the estimation strategy. Section 6 reports and discusses the empirical results, and Section 7 concludes and provides suggestions for future research.

2. Innovation strategies and firm performance

Researchers have recently increased their efforts to analyze empirically the economic effects of innovation and these efforts have increasingly targeted the effects at the firm level (Evangelista & Vezzani, 2010). There are several motivations to why firm level analyzes are justified in this field. However, the most important motivation is an increased dissatisfaction with aggregated analyzes, which are unable to handle the complexity and randomness of innovation processes, the heterogeneity of firms' innovation behavior and the differing sources of firms' competitiveness. We can also observe more and more attempts to go beyond the R&D-focused version of the innovation process. These studies make analyze the effects of innovation on firm performance using different measures of firms' innovation inputs, activities and outputs. Still most studies disregard that firms have wide options in terms of which innovation strategies to pursue and the effects on firm performance of different innovation strategies.

2.1 Innovation strategies

Innovation is one of the key factors for the success, sustainable competitive advantage and survival of firms (Jimenez & Sanz-Valle, 2011) and consists in principle of a certain knowledge about how to do things better than the existing state of the art (Teece, 1986). Innovation can, from a firm perspective, be conceived as a complex process involving the development, transformation and application of new combinations of ideas, knowledge, technologies, capabilities and resources with the objective to develop a new idea or behavior with the potential to (i) increase the profitability of a firm, (ii) reduce its production and distribution costs, and/or (iii) increasing the willingness of customers to buy and pay for their products (Therrien, Doloreux & Chamberlain, 2011; Jiménez & Sanz-Valle, 2011). The capability to drive innovation processes depends on historical and current investments in several complementary factors including the knowledge and skills of the employees, R&D, management methods, firm culture, and internal & external networks (Feeny & Rogers, 2003). The importance of managing different types of resources and network links in innovation processes has been stressed both in evolutionary economic theory and in the resource-based view of the firm (Nelson & Winter, 1982; Teece, 1988). It is a main assumption in the resources-based view of the firm that only firms with certain resources, network links, and characteristics will achieve competitive advantages through innovation and, therefore achieve superior performance (Camisón & Villar-Lopéz, 2014). Heterogeneity in the internal characteristics of firms contributes to explain their heterogeneity in terms of innovation strategies and performance.

Innovations are a means for firms to differentiate themselves from their competitors. They involve to a varying degree and in varying combinations of scientific, technological, organizational, financial and commercial activities. When implemented they influence the behavior of economic agents, i.e. suppliers, customers and competitors, and lead to the expansion (and contraction) of market segments as well as the introduction of new market segments. It has been suggested that the innovation behavior of firms can be explained by six factors (Cabagnols & Le Bas, 2002):

1. the characteristics of the demand of the firm (price elasticity, evolution and homogeneity),
2. the conditions for the appropriation of the benefits of innovation (patents and models to protect innovation, secrecy in innovative activities, innovation in the efficiency of lead times between products and processes),
3. the sources of technological knowledge (consumers, suppliers and society),
4. the market structure (level of concentration, intensity of technological competition),
5. the characteristics of the firm (size, market share, diversification level, nature of abilities), and
6. the strategy of the firm (quality, marketing, innovation, etc.).

The traditional theory of the firm claims that innovation only can have a transitory effect on a firm's performance in a competitive market, since the information about the new combination will soon be diffused in the market and rapidly imitated by competitors. According to this perspective, all firms in the long run will converge to the steady-state equilibrium (Knight, 1921). However, there exist substantial empirical evidences indicating that there are firms in all kinds of industries that continue to exhibit performance superior to other competing firms in the same industry for considerable periods of time, irrespectively of the institutional setting (Kemp et al., 2003). The findings that some firms, over longer periods, exhibits superior performance than other firms in the same industry is consistent with at least two schools of economic thought: theories of Schumpeterian competition and evolutionary economics. First, Schumpeter (1934) proposed the thesis of creative destruction according to which the launching of new combinations regularly results in the destruction of the current economic structures and to their replacement with new economic structures. For him innovation was not only about "destruction" but also about "creation", which indicates that he also related innovation to growth at the firm and industry level as well as at the macro level (Freeman & Soete, 1997). In Schumpeter (1934), it is the entrepreneur's wish to move boundaries and to change the current organizational forms and methods of doing business that is the main driver of innovation, i.e. the introduction of new combinations (Mark I). Innovation encourages and makes it easier for entrepreneurs to create new firms in order to enter certain industries characterized by an entrepreneurial technological regime (Audretsch, 1995). In Schumpeter (1942), he argued that the main source of innovative activities was large firms operating in concentrated industries (Mark II). Here, he suggested that the development of innovations requires the accumulation of knowledge and financial resources. This implies that the small-scale entrepreneur no longer can be the main driving force of innovation. The entrepreneurial role is relegated to the large firms and their R&D laboratories, which may possess the necessary human and financial capital for innovation. Anyhow, we get explanations of why some firms for extended periods can exhibit superior performance due to innovation compared with other firms in the same industry.

The second explanation of superior firm performance for extended periods is offered by evolutionary economics according to which the behavior of any firm is based on a set of learned principles and routines (Nelson & Winter, 1982). Firms have routines for a number of sub-processes including (i) production, (ii) distribution, (iii) design and construction, (iv) management, administration and commercial activities, (v) innovation, and (vi) renewal of routines. Here, the quality of each firm's routines together with the importance of knowledge inside the firm, organizational structure and R&D affects its position vis-à-vis its competitors. Naturally, firms cannot preserve a superior position permanently based on existing routines. To keep or improve their position firms must develop new and upgrade their routines, i.e. introduce innovations. Of course, this also includes the routines for developing innovations. The continuous renewal of routines drives the changes in different industries as well as in the economic system as a whole.

Researchers for a long time have been aware of the existence of relationships between different types of innovation (Burns & Stalker, 1961). However, it is an open question to what extent different types of innovation are substitutes or complements to each other. Some existing studies seem to indicate that they are complements rather than substitutes (Evangelista & Vezzani, 2010) as well as the coexistence of different innovation strategies in different industries (Tether & Tajar, 2008). Different types of innovation may also drive each other and the causal effect may go in all possible directions[4]. The bottom line here is that whatever types of innovation a firm decides to introduce, it may often find that it is an advantage or even necessary also to introduce innovations in other areas of their operation. Indeed, given prevailing market dynamics it is obvious that many firms optimally need to focus on many types of innovation simultaneously and consider the interrelations between different types of innovation (Lin & Chen, 2007)[5]. We will discuss the effect of such interrelatedness (i.e. complex innovation strategies) on firm performance more in detail in Section 2.2.

2.2 The impact of various innovation strategies on firm performance

A clear link between innovation and performance was introduced by the literature on endogenous economic growth. Accordingly, the growth of an economy is governed by the level of technology. The level of technology is a function of the rate of industrial innovation, which depends on the share of GDP invested in R&D (Aghion & Howitt, 1998). Innovation is here treated as a non-rivalrous input in the production process. The incentives to innovate are a function of the institutional framework of the economy and the degree of competition in the economy, which determines to what extent innovators, can acquire rents from their innovation. The innovation process has its own externalities. The accumulation of technological progress increases the knowledge base and make sequential innovations possible (Stokey, 1995). All firms including rival firms benefit from knowledge flows and technology spillovers across economic agents (Griliches, 1992).

These different theoretical perspectives inspired Klette & Griliches (2000) to create a multi-stage model of firm behavior. In this model, the quality, the price of its own, and its competitors' products determine the growth of a firm whereas the quality of its own products can be improved through innovation. However, the intensity of innovation is assumed independent of the size of the firm but related to the profit margin of the firm, which is a function of the degree to which the firm can differentiate its products from the products of its

[4] There are many examples in earlier research of interrelationships and complementarities between simple innovation strategies. There exist, for example, evidence that organizational restructuring is associated with administrative and structural renewal or improvements, which facilitate other types of innovation. These earlier evidences include: (i) administrative innovations led to technical innovations in public libraries (Damanpour, Szabat & Evan, 1989), (ii) cooperative organizational rearrangements mechanisms enhance technological innovations in the pharmaceuticals industry (Staropoli, 1998), (iii) organizational structural characteristics is associated with process innovations in the logistics sector (Germain, 1999), and (iv) organization, market and product innovations are interrelated in public organizations (Walker, 2008).

[5] These interrelations might go in different directions. It is well known that product innovations might demand not only process innovations but also market and organizational innovations. However, we can equally well imagine that organizational innovations might be needed to spur product innovations.

competitors. The R&D intensity is also assumed a function of the demand for high-quality products and the existence of innovative opportunities. The model by Klette & Griliches has stimulated a stream of literature, which traces the innovation process from a firm's decision to innovate to its performance and which includes aspects such as reverse causality and individual heterogeneity (Lööf & Heshmati, 2006).

Innovation strategies can be simple one, where firms focus to introduce only one type of Schumpeterian innovations (i.e. product, process, market or organization) at a time, or the strategy can be a complex one, where firms combine various types of simple strategies at a time. Whatever innovation strategy a firm chooses, the direct motivation can be a mixture of reasons, such as increased product performance, increased productivity and/or lower production costs, while the underlying motivation is probably to preserve or increase competitive advantage in the existing or new market place. It is beyond the scope of this paper to discuss how different types of innovation relate to each other. Our purpose is to analyze the effects of different innovation strategies on the performance of firms and if there are systemic differences in this respect between the different innovation strategies. We admit that it is difficult to analyze this due to the multiform dimension of firms' "organizations" and the high firm and industry heterogeneity in firms' strategies and resources (Armbruster, et al., 2007).

Earlier studies of the effect of innovation on firm performance typically reported a positive relationship (Hashi & Stojčić, 2013). In these studies, R&D expenditures were mostly used as the main measure of innovation. Unfortunately, R&D expenditures suffer from many short-comings when used as a measure of innovation activity, since they are an input measure and do not include other critical elements in innovation such as learning-by-doing and investments in physical and human capital. Studies based on R&D expenditures also give very little information about the innovation process per se as well as firms' choices of innovation strategies (Kemp, et al., 2003). Later studies building upon a new generation of models analyzing the effect of innovation on firm performance have shifted the research focus to the complexities of innovation processes and to the channels through which the innovation inputs stimulate a better firm performance (Bessler & Bittelmeyer, 2008). According to these models, the innovation process consists of four stages: (i) the decision to innovate, (ii) the decision on how much to spend on innovation, (iii) the relationship between expenditures on innovation and innovation output, and (iv) the relationship between innovation output and firm performance[6].

We would like to suggest an extension of this description of the innovation process also to include the decision on what innovation strategy to choose[7]. We see the innovation process as consisting of the following five stages: (i) the decision to innovate, (ii) the decision on which of the sixteen innovation strategies to choose[8], (iii), the decision on how much to spend on the chosen strategy, (iv) the innovation performance, i.e. the relationship between investments on the chosen innovation strategy and the output of such investment[9], and (v) the relationship between innovation output and firm performance. Focusing on stage (i) to (iv), Firms are assumed heterogeneous in terms of introducing innovation strategies, since different firms have different knowledge stocks and different innovative capabilities (Barbosa, Faria & Eiriz, 2013). For instance, firms with low innovative capabilities, such as new entrants, might be limited to implement simple innovation strategies[10] (Dasgupta & Stiglitz, 1980). On the other hand, the existing empirical evidences suggest that more complex innovation strategies are associated with a better firm performance (Gera & Gu, 2004). This leads firms to be heterogeneous in the final stage as well, i.e. being different from each other in term of performance.

There exists evidence that a more balanced rate of non-technological and technical innovations is more effective in helping firms to preserve and improve their performance than implementing them alone (Damanpour & Evan, 1984).The innovation literature does not reveal any definitive conclusion whether there is a single best innovation strategy in terms of

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[6] In most of these studies, innovation input is defined as investments in R&D measured either as the total amount invested (Lööf & Heshmati, 2006) or the share of R&D expenditures to total sales turnover, i.e. innovation intensity (Chudnovsky, Lopez & Pupato, 2006). Some studies use a broader definition of innovation expenditures and include expenditures on machinery, organization, markets, etc. The explanatory variables used in these studies include (i) firm size, (ii) export intensity, (iii) human capital, (iv) cooperation with suppliers, customers, universities, research institutes, etc., (v) the existence of public support for R&D and innovation, (vi) previous experiences of R&D and innovation, including persistence in innovation, (vii) the quality of the institutional setting, (viii) country or region specific cultural values, and (ix) access to finance, including public subsidies for innovation activities.

[7] An innovation strategy can be simple or complex, as explained earlier.

[8] These innovation strategies are mutually exclusive and collectively exhaustive choices.

[9] Here the output of such investment refers to "innovation output", which the successful realization (introduction) of the chosen innovation strategy.

[10] Naturally, one have to consider the possibility of reversed causality in the sense that firm performance can influence (i) the decision to innovate or not to innovate, (ii) the choice of innovation strategy, (iii) the decision on how much to spend on innovation and on the distribution over different innovation types, if a complex innovation strategy has been chosen, and (iv) the decision on how much to spend on innovation. Interestingly, innovation can be spurred by both a low and a high firm performance. In the first case the motivation is to improve firm performance and in the second to preserve a good firm performance. The existing empirical evidences suggest that more complex innovation strategies are associated with a better firm performance (Gera & Gu, 2004).

firm performance. However, it seems as if we might conclude that different types of innovation are related to each other and need to be implemented in conjunction (Walker, 2004). Indeed recent evidence shows that firms often choose complex innovation strategies (Tavassoli and Karlsson, 2015). This may indicate that there exist various interrelationships and complementarities between the pure forms of innovation in the sense of Edgeworth: "doing more of one thing increases the return of doing another thing". If innovation strategies are complements, these innovation strategies are mutually reinforcing because increasing the investments in any of them increases the marginal profitability of the others (Milgrom & Roberts, 1990). Complementarity between simple innovation strategies when two or more of them are adopted together implies that their joint adoption leads to a higher firm performance than the sum of the firm performances from their individual adoptions (Mairesse & Mohnen, 2010).[11] This gives us reasons to expect significant positive effects on firm performance from the introduction of complex innovation strategies. Firms that have the capability to implement complex innovation strategies may achieve an extra competitive advantage, in terms of performance, in comparison with competitors that implement simple innovation strategies.

The relationship between firm innovation strategy and firm performance is not straightforward, not least since firm performance is a multi-dimensional concept (Murpy, Trailer & Hill, 1996). However, in empirical studies of firm performance effects of innovation, the most commonly used performance measures are single-dimension measures, such as productivity, employment, sales, exports and profits but also financial measures such as the returns on assets have been used (Bessler & Bittelmeyer, 2008). Most studies report a positive relationship between innovation and firm performance but sometimes with different results for different performance measures (Klomp & Van Leeuwen, 2001). A given problem here is that the effects of innovation on firm performance generally come after a time lag that can vary with industry, firm size, etc. We must also acknowledge that the performance effects of innovations mostly are only temporal, since other firms often can and will imitate the innovations (Cefis & Ciccarelli, 2005). Thus, firm performance might decline, if a firm is not persistent and successful in its long-term innovation efforts. The reason is of course Schumpeter's creative destruction thesis – an innovation generates a competitive advantage for a limited period after which competitors have been able to imitate the innovation and even improve upon it. When improved versions of an innovation are introduced in the market, the

[11] The existence of complementarities between different simple innovation strategies have been tested in several studies using data from innovation surveys. Complementarities exist but they tend to vary between different sectors of the economy (Mairesse & Mohnen, 2010).

competitive advantage of the original innovative firm is reduced and it will suffer losses after some time, and eventually be forced to exit the market, unless it develops an even better innovation.

However, almost all studies focus on the effects of product innovation only. The effects of process, market and organizational innovations are seldom studied in the empirical economics literature. The impact of complex innovation strategies on firm performance is rarely considered.[12] This is very surprising, since the main motivation for firms to pursue innovations is to preserve or increase their competitive advantage (Miller, 2001). Given that different types of innovations are inter-related and complementary with regard to each other it seems natural to assume that whatever type of pure innovation that a firm tries to implement, there will be repercussions and demands for innovation also in one or more of the other fields of innovation.

2.3 The impact of different innovation strategies on firm productivity

Productivity is probably the most important aspect of economies in general at all levels. At the macro level, productivity is critical for the general level and growth of economic welfare. At the firm level, productivity is crucial for the competitiveness of firms and thus for their survival and growth prospects. Highly productive firms tend to have a higher output growth and a lower risk of exit, while low productivity is an indicator of probable future exit (Foster, Haltiwanger & Krizan, 1998). Moreover, the relative productivity between firms tends to be correlated with wages and exports.

There are many studies analyzing the effect of innovation on firm productivity. A commonly used proxy for innovation is R&D. Most of the results in the literature indicate that the effects of R&D on productivity are positive (Cohen & Klepper, 1996; Lööf & Heshmati, 2002; Parisi, Schiantarelli & Sembenelli, 2006; Van Leeuwen & Klomp, 2006; Hall, Mairesse & Mohnen, 2009). These results are more robust in cross-sectional studies than in time-series studies. Furthermore, a growing number of empirical studies using panel data indicate the presence of a distinct time-invariance in the R&D and innovation strategies of firms (Johansson & Lööf, 2010). Most firms report no R&D, while the R&D performing firms can be separated into one group reporting occasional R&D and another group reporting persistent

[12] There are some empirical studies analyzing the effects on firm performance of both product and process innovations, see, e.g., Ngyen, et al. (2007).

R&D investments. Certainly, this fact affects the statistical association between R&D and productivity growth.

While the empirical results indicate constant returns to R&D across firms, there might be diminishing returns to R&D over time (Klette & Kortum 2004). As more and more researchers are engaged in duplication activities that might lead to diminishing returns to R&D (Aghion & Howitt, 1998). However, for R&D-intensive firms, past experiences can increase the firm's R&D capability so that further R&D investments will be more productive (Henderson & Cockburn, 1996). Empirical studies have produced mixed results concerning the question whether there are increasing or decreasing returns to R&D (Kortum, 1993; Madsen, 2007)[13].

Given the problems related to explaining the productivity effects of innovation using R&D as the main explanatory variable, researchers have turned to various measures of innovation output, such as patents, share of innovative sales, etc as the main explanatory variable of the level or growth of productivity. In this study, we have chosen a different avenue. We try to explain variations in the level of labor productivity among firms with firms' choice of innovation strategy. The level of productivity is among other things a function of the customers' valuation of the characteristics of a firm's products and the costs of producing the firm's value added, which is a function of input costs and the scale of production. All these three factors are in principle affected by the four simple innovation strategies, i.e. product, process, market and organizational innovation.

Product innovation is about introducing new products, which represents a new combination of characteristics in line with the preferences of potential customers or changing the characteristics of current products in a way that increases the potential customers' willingness to pay for this bundle of characteristics. In this manner product, innovation if successful contributes to productivity by increasing the sales value of the firm given that input costs do not increase more. However, product innovation can also contribute to productivity by reducing the input costs by finding and using cheaper materials, components and systems.

Process innovations contribute to productivity by reducing production costs via a more efficient use of inputs and allowing for a larger production scale. However, process

[13] Another issue is that there is considerable heterogeneity across different firms in the effects of R&D. It seems as if the effects of R&D on productivity are higher in science-based (R&D-intensive and/or high-tech) firms (Hall, Mairesse & Mohnen, 2009; Ortega-Argilés, et al., 2010). Interestingly, it seems as if the productivity effect of R&D is higher among firms belonging to the "net users of innovation" (Wakelin, 2001).

innovation can also increase the customers' valuation of the products by increasing the product quality and reducing delivery lead-times.

Turning to market innovations, they can contribute to labour productivity via increased sales values by improving the customers' perception of the firm's products but also by opening up new markets and distribution channels for the firm's products. New markets and distribution channels implies larger sales volumes, which contributes to productivity via increased opportunities to take advantage of scale economies in production.

Finally, organizational innovations can contribute to productivity via a more rational organization of production but it can also contribute to improve the customers' perception of the firm's products for example by the way and where services related to the products are organized.

Hence, we expect all the four basic types of innovation strategies to contribute to the level of labour productivity within firms. However, when it comes to explaining the variation in the level of labour productivity among firms, our hypothesis is that the more complex innovation strategies that are the main explanatory variables. The logic behind this hypothesis is twofold. First, firms that in parallel perform several or all four of the basic innovation strategies simultaneously can naturally benefit more from this than from one of the basic innovation strategies. Second, and perhaps more importantly, there are strong reasons to believe that there are substantial complementarities between the four basic types of innovation strategies (as discussed in Section 2.2).

3. Data

The innovation related data in this study comes from five waves of the Swedish Community Innovation Survey (CIS) in 2004, 2006, 2008, 2010, and 2012. The CIS 2004 covers the period 2002-2004 and CIS 2006 covers the period 2004-2006 and so on, hence using the five ways, provide us with information about innovation activities of firms over a ten years period, i.e. from 2002 to 2012. In all five waves, there is information concerning product and process innovations as well as to innovation inputs (e.g. R&D investments). In the last three waves, there is also information concerning the marketing and organizational innovations. The survey consists of a representative sample of firms in industry and service sectors with 10 and more employees. Among them, the stratum with 10-249 employees has a stratified random sampling with optimal allocations and the stratum with 250 and more employees is fully covered. The response rates in the five waves vary between 63% and 86%, in which the later CIS waves having higher response rates compared with the earlier ones.

There are 21,104 observations in total, after appending all five waves of CIS[14]. Constructing the panel dataset for CIS is not common yet in the literature, while it is frequently called for (Mairesse and Mohnen, 2010). We construct two panel datasets: (i) A balanced dataset consists of 2,870 observations, corresponding to 574 firms who participated in all five waves of CIS and (ii) an unbalanced dataset consists of 16,166 observations, corresponding to 4,958 firms participated in at least two consecutive waves (2,488 firms participated in two waves, 1,534 firms in three waves, and 936 firms in four waves). Finally, we merged the innovation-related data with other firm-characteristics data (e.g. productivity, size, physical capital) coming from registered firm-level data maintained by Statistic Sweden (SCB). Such merging of CIS data with external data (registered data in our case) is argued to be remarkably beneficial to improve the dataset (Mairesse and Mohnen, 2010). We use both balanced and unbalance panel datasets in investigating the various choices of innovation strategies that firms made (Section 4), while we only report unbalanced panel dataset in analyzing the determinants of the various choices, basically since we gain more observations (Section 5). The variable description is presented in the Appendix. The Vector Inflation Factor (VIF) among regressors has the mean value of 3.86 and the maximum value for VIF score was about 5. This implies that multicollinearity is not severe and may not bias the subsequent regression analyses results in Section 5.

4. Variety of innovation strategies

There are four types of innovation and a firms in a given point in time can choose to have any of these four types, any combination of these four types, or non them at all. Therefore, a firm can have any of sixteen possible innovation strategies at a given point in time. Table 1 reports the frequency and percentage of each innovation strategies using balanced and unbalanced panel dataset.

[Table 1 about here]

[14] This is obtained after the usual data cleaning, i.e. dropping observations with zero turnover or zero employees.

Table 1 show that firms choose between wide varieties of innovation strategy. Some firms choose to be a solo-innovator (innovating in only one type of innovation), while others choose to be a complex innovator by combining various types of innovation at the same time. Overall, it is evident that firms choose from "all possible" sixteen strategies and they do not exclude even one possible innovation strategies. There are several worthy points to highlight. First, the balanced and unbalanced panel provide similar patterns and hence for the sake of brevity we choose to discuss only one of them. We will discuss (and further analyze in Section 5) the unbalanced panel, since it provides substantially higher observations. Second, more than half of the innovators (58%) in our sample introduce more than one type of innovation at a given point in time, i.e. complex innovators. This is striking as previous empirical studies rarely investigated the complex innovators. Third, looking at the frequency of all types of innovation strategies, it is clear that different types are innovation strategies are not equally popular among firms. The most popular ones are: (i) only product, (ii) only process, (iii) only marketing, (iv) only organizational, (v) both product and process, and finally (vi) all four types of innovation. These six most popular innovation strategies account for 65% of all choosing innovation strategies (it is even higher in balanced panel: 71%). The next question is which of these innovation strategies (considering all of them and also the most popular ones) are more associated with higher performance of firms.

5. Empirical Strategy

The basic model in our empirical analysis is a standard Cobb–Douglas production function augmented with various innovation strategies of firms. The standard Cobb–Douglas production function is given as follows:

$$Q_{it} = AK_{it}^{\beta 1} L_{it}^{\beta 2} \tag{1}$$

Where Q_{it} is the value-added (as a performance measure) of firm *i* in the time point of *t*, K_{it} is the physical capital input, L_{it} is the ordinary labour input, and A is the knowledge input. By dividing Q_{it} with ordinary labor we may express (1) as a labour productivity function:

$$q_{it} \equiv \frac{Q_{it}}{L_{it}} = AK_{it}^{\beta 1} L_{it}^{\beta 2-1} \tag{2}$$

Let us now turn to our assumption about knowledge input, *A*. Pioneered by Romer's model of endogenous growth (Romer, 1990); several recent empirical studies attempt to operationalize

A as the innovation output of firms. Most of these studies used product innovation alone or in the best case product and process innovation as the two separate innovation output (Griffith et al, 2006; Mairesse and Robin, 2009; Polder et al, 2010). We extend this stream of literature by incorporating sixteen innovation strategies (IS), discussed in Section 4. Therefore, we operationalize *A* as follows:

$$A = IS^j \quad j=0, 1, 2, \ldots, 15 \tag{3}$$

Hence $A = IS^j$ is a categorical variable with sixteen mutually exclusive and collectively exhaustive alternatives. We will consider *J=0* (being non-innovative) as the reference (base) category and hence the interpretation of each remaining alternative categories need to be stated in refer to this base category. Combining (2), and (3), and transform it to be a linear function, the full model can be expressed follows:

$$\text{Ln } q_{it} = \beta_1 \text{ Ln } K_{it} + (\beta_2 - 1) \text{ Ln } L_{it} + \alpha_j IS_{it}^j + M_i + T_t + u_i + \varepsilon_{it} \tag{4}$$

Where, q_{it} is the labor productivity of firm *i* in year *t*, which is measured as value added per employee. K_{it} is the physical capital input measured as the value of machines, inventory, building, and land. L_{it} is the ordinary labour input, measured as number of employees with less than three years of education. M_i is industry-specific component that captures the heterogeneity between industries by indicating whether firm *i* belong to a manufacturing sector not. T_t is time-specific component that takes into account macroeconomic effects and business cycles that may affect the export decision and intensity. u_i is a firm-specific effect, which captures unobserved time-invariant firm heterogeneity (such as managerial ability or organizational culture) that may affect the productivity of firms. ε_{it} is an idiosyncratic error term. All time-variant explanatory variables are lagged one period in time (2 years) in order to reduce the simultaneous bias.

There are four technical points that should be discussed. First, as noted by previous studies[15], IS^j can be possibly endogenous in Equation (4). This is because it seems likely that characteristics of firms unobservable to us (and thus omitted) can make them both increase their innovation output (reflected in IS^j) and their productivity. This means that the α_j

[15] Griffith et al (2006), Mairesse and Robin (2009), and Polder et al (2010) are example of these studies, albeit using different measures for innovation output.

parameters in (4) would be biased upward. In order to deal with such issue, we follow the suggestion of previous studies and use the predicted probabilities of IS^j rather than the actual value of IS^j. The predicted probabilities of IS^j are obtained from modelling the determinant of IS^j. This means the estimation in this paper is actually attributed to a two-step procedure: (i) in the first step, we estimated the determinants of all innovation strategies with an extensive set of explanatory variables, employing a Multinomial Logit model. (ii) We obtain the predicted probabilities of each innovation strategies from the first step and then will use these predicted probabilities in the second step of the procedure in order to estimate the Equation (4). In other words, we are adopting the instrumental variable approach[16] to deal with the potential endogeneity of innovation strategy in the Equation (4). The result of the estimation of first step is reported in Appendix 2 and a detailed discussion is available in Tavassoli and Karlsson (2015)[17]. We mainly focus on presenting and discussing the second step of the procedure in this paper (in Section 6), which is the estimation of Equation (4).

Second, we used panel estimators in order to further account for the endogeneity, by controlling for some unobserved time-invariant heterogeneity in the model, i.e. an omitted variable bias in the relation between innovation and productivity. There are two common choices of panel estimator, i.e. Fixe Effect (FE) and Random Effect (RE). The Hausman test speaks in favor of FE estimator. However, as discussed by Baltagi (2008), one should not automatically interpret a rejection of the null hypothesis in a Hausman test as a rejection of the RE-model, since there are quite strong assumptions underlying this test. We indeed prefer not to use FE because of two reasons. First, all of our innovation strategy variables have considerably lower within variation compared to their overall and between variations. They are predicted values bounded between 0 and 1 and they change slowly within firms. In addition, considering that FE operates through within transformation, it is expected that FE does not work well in our case (Wixe, 2014). Second, it is not recommended to use FE if the dataset is characterized by the "small T, large N", which is particularly the case in our dataset (Nickell, 1981). This is because the demeaning process, which subtracts the individual's mean value of each explanatory variable, creates a correlation between regressor and error.

[16] in particular Two Stage Least Squares (2SLS)

[17] Perhaps a worthy not here is that some previous studies employed multivariate probit model when it comes to modelling of the determinants of various innovation strategies. The main motivation for such estimation strategy was to accommodate the possible interrelation between various types of innovation (e.g. product process, and organizational innovation). We are not worry about such potential interrelation in our study, since we have sixteen innovation strategies that are collectively exhaustive and mutually exclusive choices. That means in each period, a given firm can pick only one of these sixteen choices, and hence the issue of interrelatedness should not be an issue in our study. Details can be found in Tavassoli and Karlsson (2015).

Therefore, we have reported RE results. However, the main drawback of RE estimator is that it does not allow for correlation between the regressors and the time-invariant firm-specific term (u_i in Equation 4), which is a strict assumption. In order to (partly) remedy this, we also employed Hausman-Taylor estimator (RE-HT), allowing for correlation between all of innovation strategies variable with time-invariant firm-specific term (Hausman and Taylor, 1981). This way, we are further accounting for possible endogeneity of innovation strategies in Equation 4. Results are reported and discussed in Section 6.

Third, as noted earlier, we follow Cobb–Douglas production function as our modelling framework. This model is inherently parsimonious when it comes to adding control variables, such as ownership structure of firm or amount of import and export. Nevertheless, an extensive set of control variables are indeed controlled for in our two-step procedure, when they already entered the first step in form of explanatory variables. Since, in the second step, we are using the predicted value of IS^j in Equation (4), adding explanatory variables (who actually formed the predicted values) would lead to serious multicollinearity issues in the estimation of the Equation (4). Such an estimation strategy of having a parsimonious model in the second step, while having extensive explanatory variables in the first step is also performed in previous similar studies (Griffith et al, 2006; Mairesse and Robin, 2009; Polder et al, 2010).

And finally, forth, the sixteen innovation strategies might be correlated with each other and that can makes it difficult to isolate the effect of each innovations strategy from each other on productivity. Nevertheless, we do not think this is an issue in our analysis for four reasons: (i) the sixteen innovation strategies are mutually-exclusive choices, hence, data-wise, firms can choose only one of the these innovation strategies at the given time, (ii) there is a low correlation between RHS variables, which is reflected in VIF score (discussed in Section 3), (iii) the assumption of Independence for Irrelevant Alternative (IIA) is not violated in our data (see Tavassoli and Karlsson, 2015), and finally (iv) we performed a robustness check in the 1st stage of estimation by using multivariate probit estimation, which allows for the interrelation between all innovation strategies with each other [18].

6. Result

[18] In particular, using the multivariate probit estimation (instead of multinomial logit) in the first stage of estimation and then using predicted value in the second stage did not change the main results.

Table 2 reports the estimation of Equation (4), where we estimate the effect of various innovation strategies (IS) on firm performances, measured as labor productivity (value added per employee) using a panel of firms from 2002 to 2012 (employing five waves of CIS in Sweden). Three estimators are employed: Model (1) pools the data uses ordinary least square (OLS), Model (2) employs panel estimator of generalized least Square (GLS) by using Random Effect (RE) in order to account for time-invariant firm-level heterogeneity, and finally Model (3) employs Hausman-Taylor estimator (HTRE), in order to relax an assumption of model (2), by allowing for correlation between the innovation strategy variables and the time-invariant firm-specific term.

[Table 2 about here]

There are fifteen innovation strategies as explanatory variables for productivity of firms in Table 2. These are the predicted values coming from the first stage of the estimation procedure reported in Appendix 2 (details in Tavassoli and Karlsson (2015)). The peculiar innovation strategy of deciding not to innovative ($j=0$) is the base (reference) group and hence the interpretation of the estimated parameters of all reported fifteen strategies should be done in refer to this base group. As noted earlier, these fifteen strategies can be grouped to be either "simple" strategies or "complex" strategies. The simple ones are when firm decide to engage in only one type of innovation at the given point in time. The first four innovations strategies in the table are the simple ones, i.e. when firms introduce only product, or process, or marketing, or organizational innovations. The rest of innovation strategies in the table are complex one where firms introduce ore and one type of innovation at the same time while employing various combination of simple innovation strategies.

Looking at the simple innovation strategies, product innovation positively and significantly affects the future productivity level of firms in Model (1) and Mode (2). However, the significance disappears in the last model when we allowed a correlation between the innovation strategy variables and the time-invariant firm-specific term. Marketing innovation appears to be significant in only last model, hence does not give us a signal of robust behavior. To sum up, we did not find a robust behavior in any of single innovation strategies, although product innovation seems in relative terms to be the most stable innovation strategy that positively and significantly can affect the future productivity of firms.

There are results that are more robust as soon as we move to complex innovation strategies. The complex innovation strategies that show the robust results in all the three models are: (i) introducing product and process innovation at the same time, (ii) introducing product and organizational innovation at the same time, and (iii) introducing all types of innovation at the same time. This shows that those firms that choose and afford to have the complex innovation strategies are better off in terms of their future productivity in compare with those firms that choose not to innovative (base group) and those firms that choose simple innovation strategies. Looking again to complex innovators, two choices of innovation strategies shows some degree of significance. First, introducing product, process and marketing innovation actually seems to have negative effect in future productivity, although the significance of the effect is vanished in the last model. Second, introducing market and organizational innovation at the same time seems to have positive and significant effect on productivity, although once again the significance is vanished in the last model.

7. Conclusion

Firms may gain a sustainable competitive advantage, if they choose the right innovation strategy (Kuratko et al., 2005). However, what is the right innovation strategy that enhances a superior firm performance? Although not a new question, nevertheless, the ligature has provided very limited insights so far both from theoretical and empirical perspectives on this topic. Most prior studies have focused on technological innovations (product and process). However, we know already from Schumpeter that there exists also non-technological innovation (organizational and marketing). Moreover, any combination of these four Schumpeterian types of innovation can form complex innovation strategies, which we have limited knowledge about their effect on firm performances.

The purpose of this paper was to analyze the effect of various innovation strategies of firms on their future performance, measured by labor productivity. We employed five waves of the Community Innovation Survey (CIS) in Sweden, which enabled us to trace the innovative behavior of a representative sample of Swedish firms over a decade, i.e. between 2002 and 2012. We distinguish between sixteen innovation strategies, which compose of Schumpeterian four types of innovations, i.e. process, product, marketing, and organizational (simple innovation strategies) plus various combinations of these four types (complex innovation strategies). The main findings indicate that those firms that choose and afford to have a complex innovation strategy perform better in terms of their future productivity in compare with both those firms that choose not to innovative (base group) and those firms that choose simple innovation strategies. Moreover, not all types of complex innovation strategies affect the future productivity significantly; rather, there are only few of them. This necessitates a purposeful choice of innovation strategy for firms. Moreover, the results may trigger the attention of innovation policy toward more complex strategies, rather than commonly pursued simple ones.

This study is the first step that incorporates a wide range of simple as well as complex innovation strategies in a common empirical setting. Now we have initial insight that complex innovation strategies perform superior. Qualitative investigations of these specific strategies are needed in future research to shed further light on the process of transformation of these complex strategies into the future performance of firm. Moreover, exactly which complex innovation strategies affect future productivity significantly can be country-specific. Future research is needed in other countries to improve the understanding.

Table 1-Innovation strategies: various combination of innovation types

		Balanced Panel			Unbalanced Panel		
#	**Innovation Strategy**	Frequency	Percentage (Total)	Percentage (Innovative)	Frequency	Percentage (Total)	Percentage (Innovative)
1	NON-INNO	1089	38%	-	9718	46%	-
2	PROD	269	9%	15%	1512	7%	13%
3	PROC	288	10%	16%	1799	9%	16%
4	MAR	96	3%	5%	826	4%	7%
5	ORG	88	3%	5%	746	4%	7%
6	PROD PROC	369	13%	21%	1580	7%	14%
7	PROD MAR	51	2%	3%	453	2%	4%
8	PROD ORG	44	2%	2%	220	1%	2%
9	PROC MAR	39	1%	2%	305	1%	3%
10	PROC ORG	69	2%	4%	508	2%	4%
11	MAR ORG	63	2%	4%	630	3%	6%
12	PROD PROC MAR	70	2%	4%	381	2%	3%
13	PROD PROC ORG	63	2%	4%	347	2%	3%
14	PROD MAR ORG	48	2%	3%	351	2%	3%
15	PROC MAR ORG	61	2%	3%	774	4%	7%
16	PROD PROC MAR ORG	163	6%	9%	955	5%	8%
	Total	2870	100%	100%	21105	100%	100%

Source: Tavassoli and Karlsson (2015)

Notes: The table shows the 16 possible combinations of innovation strategies that firms make considering four types of innovation. NON-INNO: non-innovative, PROD: doing only product innovation in year *t*, PROC: doing only process innovation in year *t*, MAR: doing only marketing innovation in year *t*, ORG: only organizational innovation in year *t*, PROD PROC: doing product and process innovations in year *t*, PROD PROC MAR doing product, process and marketing innovations in year *t* and so on. Time period is from 2002 to 2012.

VARIABLES	(1) OLS	(2) GLS (RE)	(3) HTRE

PROD	1.032***	0.566***	0.037
	(0.174)	(0.143)	(0.139)
PROC	-0.251	-0.128	-0.112
	(0.203)	(0.131)	(0.140)
MAR	-0.090	0.770	1.257**
	(0.667)	(0.521)	(0.554)
ORG	-0.214	-0.314	-0.414
	(0.618)	(0.490)	(0.447)
PROD PROC	0.343***	0.263***	0.153**
	(0.093)	(0.070)	(0.075)
PROD MAR	0.022	-0.147	-0.608**
	(0.380)	(0.301)	(0.269)
PROD ORG	1.502**	1.496***	0.976**
	(0.734)	(0.474)	(0.465)
PROC MAR	0.056	0.116	0.368
	(0.648)	(0.476)	(0.575)
PROC ORG	-0.314	0.140	0.172
	(0.601)	(0.362)	(0.320)
MAR ORG	2.476***	1.135**	0.501
	(0.749)	(0.510)	(0.572)
PROD PROC MAR	-1.841***	-0.943***	-0.324
	(0.463)	(0.358)	(0.307)
PROD PROC ORG	0.842*	-0.164	-0.451
	(0.489)	(0.248)	(0.237)
PROD MAR ORG	-0.024	-0.048	-0.005
	(0.652)	(0.569)	(0.462)
PROC MAR ORG	-0.081	-0.049	-0.007
	(0.315)	(0.199)	(0.247)
PROD PROC MAR ORG	1.074***	0.792***	0.439***
	(0.275)	(0.203)	(0.165)
PHYSICAL CAPITAL	0.055***	0.032***	0.029***
	(0.005)	(0.003)	(0.003)
SIZE	-0.039***	0.003	0.016*
	(0.011)	(0.009)	(0.009)
MANUF	-0.343***	-0.258***	-0.213***
	(0.026)	(0.021)	(0.024)
TIME DUMMIES	YES	YES	YES
Number of Firms	4,201	4,201	4,201
Observations	8,298	8,298	8,298

Table 2- The effect of various innovation strategies (IS) on firm performances

Notes for Table 2: The table reports the estimated parameters with bootstrapped standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is labour productivity (value added per employee) in all models. For fifteen innovation strategies, the predicted values are used in the regressions (as instruments) in order to reduce the possible endogeneity. Model 1 uses Ordinary Least Square (OLS), Model 2 uses Generalized Least Square (GLS) with random effect (RE), and model 3 is Hausman-Taylor Random Effect estimator (HTRE). In Model 3, the possible endogeneity of all fifteen innovation strategies are further taken into accounted (i.e. they are explicitly allowed to be correlated with firm-level random effect). The table uses unbalanced panel data of firms in CIS 2004, 2006, 2008, 2010, 2012. The main result of using balanced panel is similar to the above table. All explanatory variables are lagged one period in time (2 years).

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Appendix 1-Variable description

Variables	Type*	Definitions
q_{it}	C	Productivity of firm *i* year *t*, measures as value added per employee (log)
$PROD_{it}$	0/1	1 if firm *i* introduces only product innovation into the market in year *t*, 0 otherwise. A product innovation is the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems. Product innovations (new or improved) must be new to the enterprise, but they do not need to be new to the market.
$PROC_{it}$	0/1	1 if firm *i* introduces only process innovation in year *t*, 0 otherwise. A process innovation is the implementation of a new or significantly improved production process, distribution method, or support activity for goods or services, such as maintenance systems or operations for purchasing, accounting, or computing (exclude purely organizational innovation). Process innovations must be new to the enterprise, but they do not need to be new to your market.
MAR_{it}	0/1	1 if firm *i* introduces only marketing innovation in year *t*, 0 otherwise. A marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from the enterprise's existing marketing methods and which has not been used before. It requires significant changes in product design or packaging, product placement, product promotion or pricing. It exclude seasonal, regular and other routine changes in marketing methods.
ORG_{it}	0/1	1 if firm *i* introduces only organizational innovation in year *t*, 0 otherwise. An organizational innovation is a new organizational method in the enterprise's business practices (including knowledge management), workplace organization and decision making, or external relations that has not been previously used by the enterprise. It must be the result of strategic decisions taken by management. It exclude mergers or acquisitions, even if for the first time.
L_{it}	C	Number of employees in firm *i* year *t* (log)
K_{it}	C	Physical capital of firm *i* in year *t*, measured as the sum of investments in Buildings and Machines at year's end for (log)
$MANUF_i$	0/1	1 if firm belongs to manufacturing sector, 0 otherwise captured by forty two sector dummies
$Time\ Dummies$	0/1	Time-specific component captured by five time dummies

* 0/1 corresponds to dichotomous variable, C corresponds to continuous variable

Appendix 2- Determinants of various Innovation Strategies (IS) in year *t*

VAR	(1) PROD	(2) PROC	(3) MAR	(4) ORG	(5) PROD PROC	(6) PROD MAR	(7) PROD ORG	(8) PROC MAR	(9) PROC ORG	(10) MAR ORG	(11) PROD PROC MAR	(12) PROD PROC ORG	(13) PROD MAR ORG	(14) PROC MAR ORG	(15) PROD PROC MAR ORG
$RDIN_{it-1}$	2.414***	1.361**	1.429**	1.096	1.841***	2.227***	2.119**	1.437	1.378*	1.632***	2.000***	2.121***	1.569*	1.228	1.780***
	(0.153)	(0.145)	(0.158)	(0.177)	(0.175)	(0.223)	(0.332)	(0.223)	(0.186)	(0.183)	(0.215)	(0.229)	(0.269)	(0.177)	(0.161)
$RDEX_{it-1}$	1.292*	0.837	1.032	1.404*	1.259	1.094	1.079	1.143	0.955	1.175	1.522**	1.301	1.487**	1.219	1.193
	(0.148)	(0.157)	(0.182)	(0.188)	(0.152)	(0.198)	(0.224)	(0.250)	(0.195)	(0.205)	(0.192)	(0.211)	(0.200)	(0.174)	(0.145)
$CONT.RD_{it-1}$	1.721***	1.033	1.177	1.104	1.930***	2.353***	2.894***	0.720	0.882	0.786	2.215***	1.554**	2.350***	1.286	1.784***
	(0.152)	(0.156)	(0.199)	(0.218)	(0.160)	(0.197)	(0.279)	(0.275)	(0.223)	(0.230)	(0.206)	(0.213)	(0.231)	(0.187)	(0.158)
$MACH_{it-1}$	0.947	1.795***	1.343**	1.192	1.913***	1.556**	1.549*	1.925***	1.635***	0.972	1.776***	2.208***	1.216	1.965***	1.375**
	(0.132)	(0.131)	(0.144)	(0.148)	(0.150)	(0.184)	(0.249)	(0.198)	(0.175)	(0.160)	(0.188)	(0.196)	(0.218)	(0.161)	(0.137)
$EXKN_{it-1}$	0.984	1.189	1.219	1.273	1.232	1.204	1.452	1.527*	1.253	1.404*	1.168	1.196	1.176	1.659***	1.527***
	(0.133)	(0.133)	(0.157)	(0.171)	(0.139)	(0.190)	(0.245)	(0.223)	(0.181)	(0.176)	(0.179)	(0.187)	(0.199)	(0.166)	(0.133)
$TRAINING_{it-1}$	1.064	1.446***	0.898	1.408**	1.420**	0.485***	0.964	0.560**	1.513**	0.990	0.701*	1.706***	0.978	1.270	1.101
	(0.139)	(0.132)	(0.172)	(0.167)	(0.148)	(0.196)	(0.254)	(0.236)	(0.172)	(0.187)	(0.185)	(0.185)	(0.209)	(0.154)	(0.135)
$MARK_{it-1}$	1.858***	0.680***	1.300	0.889	1.557***	3.058***	1.369	1.711**	0.754	1.364*	2.715***	1.366*	3.224***	1.037	2.432***
	(0.133)	(0.145)	(0.171)	(0.189)	(0.145)	(0.183)	(0.239)	(0.215)	(0.212)	(0.181)	(0.184)	(0.187)	(0.207)	(0.162)	(0.133)
COS_{it-1}	1.355*	1.350*	1.301	1.269	1.081	1.547**	1.497	1.398	1.208	1.574**	1.185	1.417*	1.611**	1.274	1.806***
	(0.159)	(0.162)	(0.199)	(0.215)	(0.164)	(0.206)	(0.263)	(0.269)	(0.252)	(0.226)	(0.208)	(0.207)	(0.221)	(0.193)	(0.153)
$COCL_{it-1}$	0.896	0.947	0.699	0.522**	1.176	0.801	1.466	0.890	1.116	0.700	1.396	1.054	1.196	1.294	0.763
	(0.172)	(0.192)	(0.244)	(0.271)	(0.189)	(0.249)	(0.297)	(0.331)	(0.257)	(0.285)	(0.236)	(0.225)	(0.271)	(0.216)	(0.179)
$COCOM_{it-1}$	0.959	1.397	1.330	1.090	0.642**	1.155	0.773	1.897**	0.957	0.974	1.175	0.771	0.862	1.182	0.845
	(0.201)	(0.204)	(0.236)	(0.263)	(0.223)	(0.261)	(0.327)	(0.289)	(0.267)	(0.278)	(0.244)	(0.272)	(0.276)	(0.216)	(0.194)
$COUNIV_{it-1}$	0.877	0.873	0.755	0.880	1.040	0.838	0.923	0.824	1.359*	0.956	0.988	1.007	1.020	0.875	1.141
	(0.124)	(0.130)	(0.182)	(0.169)	(0.123)	(0.172)	(0.210)	(0.240)	(0.167)	(0.201)	(0.152)	(0.154)	(0.155)	(0.149)	(0.117)
$COINST_{it-1}$	0.901	1.075	1.280	1.060	1.091	0.693	1.125	0.864	0.733	0.767	0.610**	1.147	0.776	0.772	0.749*
	(0.162)	(0.163)	(0.199)	(0.207)	(0.141)	(0.245)	(0.221)	(0.340)	(0.221)	(0.314)	(0.221)	(0.176)	(0.243)	(0.224)	(0.162)
$SIZE_{it-1}$	0.948	1.160***	1.110**	1.319***	1.187***	0.930	1.121	1.319***	1.530***	1.276***	1.376***	1.526***	1.049	1.541***	1.548***
	(0.049)	(0.043)	(0.048)	(0.047)	(0.054)	(0.068)	(0.073)	(0.074)	(0.054)	(0.053)	(0.063)	(0.071)	(0.075)	(0.045)	(0.047)
$PHYCAP_{it-1}$	1.026*	1.015	0.998	1.003	1.045**	0.995	1.055***	0.971**	1.021	0.976**	1.045**	1.034	1.030*	0.974***	0.997
	(0.013)	(0.013)	(0.011)	(0.011)	(0.022)	(0.017)	(0.020)	(0.015)	(0.015)	(0.011)	(0.022)	(0.029)	(0.016)	(0.010)	(0.012)
$HUMCAP_{it-1}$	4.455***	1.273	1.556	1.339	2.995***	3.889***	5.256***	1.206	2.274**	1.658	2.413*	6.948***	3.050***	2.557***	6.721***
	(0.303)	(0.290)	(0.290)	(0.321)	(0.353)	(0.387)	(0.567)	(0.457)	(0.370)	(0.332)	(0.482)	(0.499)	(0.416)	(0.305)	(0.313)
$IMPORT_{it-1}$	5.075***	1.013	0.758	1.164	2.423***	4.650***	5.632***	1.280	1.768	0.926	4.503***	3.968***	1.515	0.833	3.571***
	(0.278)	(0.342)	(0.403)	(0.385)	(0.342)	(0.350)	(0.423)	(0.628)	(0.402)	(0.471)	(0.405)	(0.369)	(0.468)	(0.541)	(0.306)
$EXPORT_{it-1}$	1.956***	1.249	1.293	1.027	1.544**	2.647***	2.218**	0.682	1.315	0.710	1.113	2.313***	2.460***	0.493*	1.976***
	(0.201)	(0.231)	(0.254)	(0.277)	(0.214)	(0.260)	(0.310)	(0.529)	(0.287)	(0.347)	(0.273)	(0.278)	(0.309)	(0.395)	(0.209)
$UNINAT_i$	1.131	1.144	1.438**	0.997	1.213	0.945	0.845	1.517**	1.314	1.760***	1.039	1.584	0.990	1.558**	1.043
	(0.146)	(0.129)	(0.142)	(0.148)	(0.169)	(0.209)	(0.360)	(0.205)	(0.189)	(0.180)	(0.225)	(0.308)	(0.271)	(0.172)	(0.177)
$DOM\ MNE_i$	1.133	1.240	1.214	1.085	1.054	1.151	1.565	1.035	1.079	1.714***	0.923	1.299	1.504	1.431*	1.233
	(0.166)	(0.154)	(0.179)	(0.185)	(0.188)	(0.226)	(0.338)	(0.277)	(0.227)	(0.209)	(0.247)	(0.308)	(0.280)	(0.195)	(0.185)
$FOR\ MNE_i$	1.313	1.124	0.950	0.918	1.032	1.027	1.579	0.734	0.825	1.202	0.785	1.016	1.364	0.824	0.830
	(0.168)	(0.160)	(0.200)	(0.194)	(0.201)	(0.236)	(0.343)	(0.302)	(0.245)	(0.229)	(0.246)	(0.327)	(0.297)	(0.215)	(0.192)
$MANUF_i$	3.203***	1.153	0.664***	0.817	4.592***	1.991***	2.249***	0.894	1.001	0.707**	2.583***	4.024***	1.478*	0.623***	2.396***
	(0.143)	(0.115)	(0.130)	(0.134)	(0.173)	(0.190)	(0.286)	(0.197)	(0.161)	(0.153)	(0.193)	(0.247)	(0.204)	(0.154)	(0.151)

Source of Appendix 2: Tavassoli and Karlsson (2015). Please see the reference for the details and analyses.

Notes for Appendix 2: The table reports Relative Risk Ratio (RRR) with clustered standard errors in parentheses. ***,** and * indicate significance on a 1%, 5% and 10% level. Multinomial Logit model is used for estimating the sixteen innovation strategies of all firms with being non-innovative as the base model (strategy). RRR is calculated as in Equation 2. RRR>1 means one unit increase in the corresponding regressor is associated with higher probability that firms chooses the corresponding innovation strategy in compare with the base model (being a non-innovative firm) by RRR times. Conversely, RRR< 1 implies a negative effect. PROD: only product innovators, PROC: only process innovators, only MAR: marketing innovators, ORG: only organizational innovators, "PROD PROC": both product and process innovators, and so on. Observations are pooled over t=2004, 2006, 2008, 2010, 2012. All time-variant explanatory variables are lagged one period in time (2 years). Both Hausman tests and suest-based Hausman tests of IIA assumption point that IIA assumption is not violated in the estimation. Time dummies are included in the regression model. The estimation is based on unbalanced panel data with 9,061 observations. Balanced panel data reveals similar results.