The Role of Business Model Innovation for Product Innovation Performance

Lars Bengtsson (lars.bengtsson@design.lth.se)
Faculty of Engineering, Lund University, Sweden
Sam Tavassoli (sam.tavassoli@rmit.edu.au)
RMIT University, Australia & CIRCLE, Lund University, Sweden

Papers in Innovation Studies
Paper no. 2018/04

This is a pre-print version of paper, which has been submitted to a journal.

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
http://www.circle.lu.se/publications

WP 2018/04

The Role of Business Model Innovation for Product Innovation Performance

Lars Bengtsson, Sam Tavassoli

Abstract: We analyze the effect of Business Model Innovation (BMI) on the product innovation performance of firms, based on a dynamic capabilities theoretical framework. Our empirical study is based on a large-scale representative sample of cross-industry Swedish firms participating in the last three waves of the Community Innovation Survey (CIS) from 2006–2012. Our findings provide support for the dynamics capabilities theoretical framework as well as broad evidence of a significant and positive association between BMI and product innovation performance. Our results imply that BMI in the form of product innovations combined with different complementary innovations will act as isolating mechanisms towards replication by competitors. Therefore, managers should frame product innovations as part of a business model innovation and dynamically adapt the key elements of the firm's business model.

Keywords: Business model innovation; Business models; Dynamic capabilities; product innovation; Innovation performance; Community Innovation Survey

JEL: D22; L20; O31; O32

The Role of Business Model Innovation for Product Innovation Performance

Lars Bengtsson [a] and **Sam Tavassoli** [b,c] *

[a] Faculty of Engineering, Department of Industrial Management and Logistics, Lund University, PO Box 118, 221 00 Lund, Sweden

[b] School of Management, RMIT University, Melbourne, Australia

[c] Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, PO Box 117, 221 00 Lund, Sweden

*Corresponding author, E-mail: sam.tavassoli@rmit.edu.au

Abstract

We analyze the effect of Business Model Innovation (BMI) on the product innovation performance of firms, based on a dynamic capabilities theoretical framework. Our empirical study is based on a large-scale representative sample of cross-industry Swedish firms participating in the last three waves of the Community Innovation Survey (CIS) from 2006–2012. Our findings provide support for the dynamics capabilities theoretical framework as well as broad evidence of a significant and positive association between BMI and product innovation performance. Our results imply that BMI in the form of product innovations combined with different complementary innovations will act as isolating mechanisms towards replication by competitors. Therefore, managers should frame product innovations as part of a business model innovation and dynamically adapt the key elements of the firm's business model.

Keywords: Business model innovation, Business models, Dynamic capabilities, product innovation, Innovation performance, Community Innovation Survey

JEL codes: : D22, L20, O31, O32

1. Introduction

Business model innovation (BMI) have received considerable attention in management research (e.g., Casadesus-Masanell and Zhu, 2013; Demil, *et al*., 2015; Spieth, Schneckenberg, and Ricart, 2014), but few empirical studies have addressed the issue of BMI and firm performance (Foss and Saebi, 2017; Lambert and Davidson, 2013; Schneider and Spieth, 2013). The research-based evidence for the positive effects of BMI on firm performance is primarily based on case studies (e.g., Brea-Solís, Casadesus-Masanell, and Grifell-Tatjé, 2015; Sosna, Trevinyo-Rodriguez, and Velamuri, 2010) and a few large scale empirical studies (e.g. Aspara et al, 2010; Cucculelli and Bettinelli, 2015). Overall there is a dearth of studies derived from a broader evidence-based (Demil *et al.*, 2015; Foss and Saebi, 2017; Lambert and Davidson, 2013; Schneider and Spieth, 2013; Spieth, Schneckenberg and Matzler, 2016).

We define a focal firm's business model (BM) as the "design or architecture of the value creation, delivery, and capture mechanisms" (Teece 2010: 172). In line with this definition, we define BMI as "designed, novel, and nontrivial changes to the key elements of a firm's BM and/or the architecture linking these elements" (Foss and Saebi, 2017:216). Using a dynamic capabilities framework (Teece, 2007; 2010), we expect that firms having the capacity to both introduce product innovations and organize and re-structure complementary and co-specialized assets, both internally and externally, as well as integrating and implementing these assets into a functioning BM, will outperform firms with less such capacity. At the same time, success is not self-evident, BMI can be a difficult and risky process (e.g., Sosna *et al*., 2010; Chesbrough, 2010), requiring for instance, risky boundary-spanning activities (Zott and Amit, 2010) and implementation skills (Brea-Solis et al., 2015). It may also be negatively impacted by technological uncertainties and liabilities of newness (Gerasymenko, De Clercq, and Sapienza, 2015).

In this paper, we aim to contribute to the body of knowledge on BMI and innovation performance. Specifically, we aim to investigate whether firms engaging in BMI will exhibit superior product innovation performance, compared to firms only engaging in product innovation. Our empirical investigation is theoretically guided by the dynamic capabilities framework (Teece, 2006; 2007; 2010; 2017).

A better understanding of the relation between BMI and firm performance is important for three reasons. Firstly, previous research on BMI and firm performance is primarily based on some case-studies of mostly successful business model innovators, such as Walmart (Brea-Solis et al, 2015), hence there is often a positive bias towards BMI in the research literature because of the biased selection of studied cases. A broader based empirical inquiry will give a more systematic view of the relationship between BMI and firm performance. Second, much of earlier BMI research has been mainly conceptual and descriptive rather than theoretical and explanatory (Foss and Saebi, 2017). By grounding our investigation in the dynamic capabilities view of the firm (Teece, 2006; 2007), we aim to provide a more solid base for cumulative BMI research. Third, there are also important implications for strategic and innovation management theory of a strong or weak relationship between BMI and firm performance, such as the relative emphasis on configurations and system models compared to more atomistic models of the firm and how competitive advantage is achieved (Demil et al, 2015; Kim and Min, 2015; Kulins, Leonardy and Weber, 2016; Spieth et al, 2016).

Our findings highlight the superior product innovation performance of BMI-firms compared to firms only introducing product innovations. BMI-firms that simultaneously introduced product, and complementary innovations in processes, marketing and the organization were associated, significantly and positively, with the highest innovation performance, 28 % higher innovation performance than product innovators only in the full

model (R^2 = 0.375). Overall the findings based on one of the few large-scale data study of BMI and innovation performance support the view that is BMI superior to product innovation only (cf. Chesbrough, 2007). The findings are in line with and support the use of dynamic capabilities theoretical framework in BM research (Teece, 2010; 2017). Our findings strengthen the case for further theorizing and empirical studies of BMI and have implications for strategic and innovation management theory and practice.

The remainder of this paper is structured as follows: The second section contains a brief review on prior large-scale empirical studies on BMI and firm performance. The third section develops two hypotheses, based on dynamic capabilities theorizing, in relation to the effect of BMI on innovation performance. The fourth section describes our data and empirical strategy. The fifth section outlines our empirical results, while the sixth section discusses contributions and implications of the results. The final section presents our conclusion, limitations and suggestions for further research.

2. Prior large scale studies on BMI and firm performance

For a general overview of previous research on BMI we refer to recent papers by Foss and Saebi (2017), Lambert and Davidson, (2013), Schneider and Spieth (2013) and Spieth, Schneckenberg, and Ricart (2014). Here we will focus on prior large-scale empirical studies on BMI and performance. In the recent research reviews the BMI research has been described as limited and mainly exploratory employing various definitions of BMs and BMI (Foss and Saebi, 2017; Lambert and Davidson, 2013; Schneider and Spieth, 2013; Spieth, Schneckenberg, and Ricart, 2014). Research on BMI and firm performance is even more limited and, according to Lambert and Davidson (2013:676) "…in its infancy, so little can be gleaned from the findings" and rarely extend beyond a single case study of a firm (Schneider and Spieth, 2013; Lambert

and Davidson, 2013) or other entities such as alliances (Bouncken and Fredrich, 2016). Moreover, BMI research is generally conceptual and descriptive rather than theoretical and explanatory and only few large-scale studies investigates the innovative acts of BMI with firm performance (Foss and Saebi, 2017). Overall, five larger-scale empirical studies were identified investigating the relation between BMI and various indicators of firm performance (Aspara et al, 2010; Cucculelli and Bettinelli, 2015; Denicolai et al, 2014; Giesen et al, 2007; Kim and Min, 2015). We briefly review these studies.

Aspara *et al*. (2010) measured the act of managers putting a strategic emphasis on novel BMs or on BM replication and its effects on financial performance. They found that firms that placed a high emphasis on both novel forms of BM, as well as BM replication, outperformed those with no strategic emphasis on BMI. Large firms benefited relatively more from BM replication than small firms, while the opposite was true for novel BMs. Cucculelli and Bettinelli (2015) compare various measures of firm performance (sales growth, profitability, productivity) between BMI-firms and non-BMI-firms in the Italian clothing industry during a ten-year period. BMI is here measured as a change in the firms' BM in the study period. BMI-firms show a significantly higher performance than non-BMI-firms especially if they combine BMI with investment in intangibles. Moreover, BMI-firms that changed to more advanced BMs, such as internationalization, branding or introducing high-quality products showed the highest performance levels. Denicolai, Ramirez and Tidd (2014) define BMI as the combination of internal and external knowledge that create and capture value. The aim of the study is to empirically find the optimal combination of external and internal knowledge generating the highest sales growth. They do find an optimal combination but the level of sales growth differs between different types of companies (high-tech, knowledge-intensive and capital-intensive). Giesen et al (2007) describes a framework for BMI identifying three types of BMI; 1) industry

model innovation, i.e., moving into new industries, redefining industries or creating new industries; 2) revenue model innovation study, i.e., reconfiguration of products/services/value-mix and price-models; and 3) enterprise model innovation, i.e., innovating the structure and boundaries of the enterprise. They find no significant differences in financial performance between the three BMI-types and conclude that all three types of BMI may lead to success, but note that the BMI enterprise model is the most used among their 35 case companies. Kim and Lin (2015) compare sales growth of 131 U.S.-based publically traded store-base retailers during a ten-year period whereof 56 retailers added a new business model (e-business) and the rest did not. Just adding a new business model did not significantly increase sales growth, but the retailers that had a strong reputable brand, using that on their e-store, and organized their e-business in a separate organizational unit (separated from the physical store organization) showed a significantly higher sales growth than retailers with a weak brand and operated an integrated organization.

The theorized linkage between BMI and firm performance in these five studies follows three commonly used theorized linkages between strategy and firm performance (Spieth et al, 2016). A first type of linkage is that superior firm performance is a result of coherent strategy planning and execution (Markides, 2004). In analogy, a coherent planning and execution of BMI would result in superior performance as advocated in the studies by Aspara et al (2010) and Giesen et al (2007). A second type of linkage is that BMI, due to its introduction of novelty, will result in temporary monopoly and entrepreneurial rents (Rumelt, 1987) for the novelty-introducing firm, as indicated in the study of Cucculelli and Bettinelli, 2015. The resource-based and dynamic capabilities views of the firm is the foundation of the third type of theorized linkage, due to its social complexity and casual ambiguity (Barney, 1991), and capabilities to dynamically adapt the BM, replication of the BM by the competitors becomes harder (Teece,

2010; 2017). This may benefit the firm, e.g., by leveraging complementary assets (Kim and Lin, 2015).

In summary, the few existing large-scale empirical studies indicated that BMI does matter. Managers in firms with explicit emphasis on BMI (Aspara et al, 2010), engaging in dynamic organizing of complementary (Cucculelli and Bettinelli, 2015; Denicolai et al, 2014) and conflicting assets (Kim and Lin, 2015) are associated with better firm performance than firms without such characteristics. However, all previous large-scale empirical studies employed different methods to conceptualize and measure BMI, as well as different types of performance indicators and used different theories to explain the link between BMI and firm performance (see table 1). These differences in conceptualization and measurement of BMI hinder coordinated research efforts among researchers and accumulation of knowledge in the field (Foss and Saebi, 2017). In order to remedy the situation, we propose that researchers employ large-scale empirical studies where the theorized linkage between BMI and performance is explicit using common strategic and innovation management theories explaining superior performance, such as the dynamic capabilities view, as well as using firm samples with high external validity and refrain from using convenience or best practice samples. Characteristics of the five prior studies and our study are summarized in table 1 below.

/TABLE 1 ABOUT HERE/

3. Theory and hypotheses development – BMI isolating mechanisms

A novel BM is in itself, no matter how much customer value it creates, insufficient to assure the firm competitive advantage (Teece, 2010). Many BMIs are quite transparent and relatively easy to imitate for the competitors, e.g., moving from ownership of product to leasing of the product, thus the innovating BM firm might not be able to capture the value from

innovation. From a strategy perspective, the firm, in order to be successful in its BMI, need to protect their BMI (Teece, 2010) by making them hard to imitate (Barney, 1991) or in a dynamic context continuously "create, adjust, hone, and replace business models" (Teece, 2006:1143). Teece (2010) specifies a number of isolating mechanisms, making the BM harder to replicate, when designing business models, based on the dynamic-capability view of the firm (e.g., Teece, 2007). These are: a) differentiated BM architecture with co-specialized elements, b) complicated process steps, organizational structures, and/or arrangements, c) combinations with (internal or external) complementary assets, d) relationships with external actors, e.g., customers, suppliers, partners, which are unique and/or disturbing to competitors, e) dynamic adaptation of business model elements and architecture, and/or, f) strong intellectual property. In general, apart from the strong intellectual property, innovating individual elements, such as a product or a distribution process, will be a less effective isolating mechanism than changing the whole architecture (Teece, 2010). Overall, BMI with high likelihood of gaining competitive advantage will be achieved through organizing of co-specialized assets and complementary assets, introduction and re-configuration of organizational structures, procedures, and external relationships in a dynamic manner (Bock et al, 2012; Teece, 2010). While many of these organizational changes will be hard to replicate for competitors, due to their social complexity, tacitness, casual ambiguity (Barney, 1991), and strategic flexibility (Bock et al, 2012) they may also receive protection from the disturbances they create for competitors (Teece, 2010).

Overall we argue, based on the dynamic capabilities views of the firm, that product innovations with complementary organizational innovations will not only enable the firm to create value but also to capture value, i.e., to increase firm performance and competitive standing. In the following subsection, we will use the dynamic capabilities framework to develop a hypothesis related to BMI and innovation performance.

3.1. Hypotheses development – BMI and innovation performance

For our purposes, in terms of investigating the relationship between BMI and product innovation performance, the product innovation forms the base case. In order to measure and compare product innovation performance the firm need to introduce at least one new product or service during the studied period. From a dynamic capability perspective, an isolated product innovation, without any other changes, should in a relative sense, be easy to detect and replicate for competitors, hence only giving very short-lived competitive advantage if any.

Viewed from a dynamic capability perspective an even better and competitively stronger form would be to combine the product innovation with other forms of innovations, i.e., in internal and boundary-spanning processes, marketing and organizational structures and arrangements including external relations (Teece, 2010). That would enable the firm to develop even more complex and differentiated co-specialized assets, e.g., in production, distribution and maintenance, and use complementary assets in marketing in the form of co-branding and shared sales channels. Existing research suggests that there are strong complementarities between product and process innovation (Pisano, 1997; Reichstein and Salter, 2006). Combining product innovations with process innovations firms may offer new and complex services such as direct-to-user distribution, overnight delivery of spare parts, e-order systems, real-time tracking of products during transports, and/or customized production systems. Process innovations are mostly internally based processes and may also be specifically user innovated by the innovating firm itself (von Hippel, 2005), thereby being harder to replicate for competitors.

Marketing innovations have generally the aim to maintain, modify or create a customer interface with existing or potential customers, through product design, placement, promotion and/or pricing. Product-related services are easier to replicate than customer-related services

(Visnjic *et al*., 2016). Novel ways of pricing, such as Freemium-pricing for various software and Internet-services has been a marketing innovation that has attracted considerable attention in the BM literature (e.g., Baden-Fuller and Haefliger, 2013), creating new incentives for the customer, but may in itself be easily replicated by competitors (Teece, 2010). Marketing innovations combined with organizational innovations may however offer better protection to competitive replication. Examples are better availability of products or services through franchising or licensing (Teece, 2006), and development of platforms for marketing of related products and services (e.g., Gawer & Henderson, 2007). A new product's performance may be enhanced by simultaneously introducing significant changes in the organization, i.e., organizational innovations. New types of interaction with other external partners, e.g., partnerships and alliances with suppliers and competitors, may create opportunities for larger exposure for the new product and access to new markets (e.g., Cuccelelli and Bettinelli, 2015; Giesen et al, 2007; Larsson et al, 1998). The combination and integration of product, process, marketing and organizational innovations can potentially result in a more complex BM with further co-specialization of assets, combinations with several different complementary assets, more complicated processes and structures and increased number of dynamic adaptations, which all will contribute to a hard-to-replicate BM.

The hypothesis states:

Hypothesis: Firms introducing product innovation which is combined with complementary innovations in processes, marketing and the organization, i.e., BMI firms, will exhibit higher product innovation performance than firms only introducing product innovation.

4. Data and Empirical Strategy

4.1. Data

The data in this study is based on the three waves of the Community Innovation Survey (CIS) in Sweden in 2008, 2010, and 2012. The CIS 2008 encompasses the three-year period 2006−2008, while the CIS 2010 refers to the years 2008−2010, and so on. Hence using the three waves has provided us with information in relation to new innovation activities of firms over a seven-year period, that is, from 2006−2012. The types of questions and method used in CIS are described in the Organization for Economic Co-operation and Development's (OECD) Oslo Manual (OECD, 2005)[1]. In all three waves of the survey, there is information available as to whether a specific firm introduced any new products, services or processes, and the volume of sales that were due to the new product, as well as the amount of inputs (e.g., investments in R&D and in employees' training). In these three waves, there is also information in relation to new marketing and organizational innovation activities. For a description of items surveyed in CIS see Appendix table A1. The survey consists of a representative sample of firms in industrial and service sectors, with 10 or more employees. In this sample, the stratum with 10−249 employees has a stratified random sampling, with optimal allocations, while the stratum with 250 or more employees covers all firms in Sweden. The response rates in the three waves vary between 63−86 percent, with the later CIS waves having higher response rates, as compared to the earlier ones. Overall, the external validity is excellent.

There were 11,218 observations in total, having combined all three waves of the CIS[2]. We also merged the CIS-data with other information reflecting the characteristics of the firms

[1] The reliability, validity, and interpretability of the survey was established by conducting extensive pre-testing and piloting prior to implementation, within different European countries and across firms from a variety of industrial sectors, including manufacturing, construction, and services (Laursen and Salter, 2006).
[2] This is obtained after the usual data cleaning process, namely, excluding observations with zero turnover or zero employees.

(e.g., physical capital, number of employees) based on registered firm-level data maintained by Statistics Sweden (SCB). The descriptive statistics of all variables are presented in Table 2.

/TABLE 2 ABOUT HERE/

The exact variable description is outlined in table 3. Note that log value is shown for all variables in table also for employees. The mean firm size in number of employees are 374. The vector inflation factor (VIF) among the regressors has a mean value of 1.14, and all variables received a VIF score of below 2.4. This implies that multicollinearity is mild and may not bias the subsequent regression analysis.

/TABLE 3 ABOUT HERE/

4.2. The dependent variable

Our dependent variable is the product innovation performance of firms. It is the innovative sales of firms, i.e., volume of sales exclusively due to the introduction of product innovation in the same three-year period as it has been introduced divided by the firm's number of employees (log transformed). Product innovation, in turn, is defined by the Oslo Manual (OECD, 2005) as the introduction to the market of new or significantly improved goods or services in terms of their capabilities, user friendliness, components, or sub-systems[3]. Moreover, the identified product innovation performance provides a direct measure of innovation, arguably superior compared to other commonly used indirect measures of innovation, such as patent application or R&D intensity (Kleinknecht, Van Montfort, and Brouwer, 2002; Smith, 2005). The use of such direct measures to capture a firm's product innovation performance is becoming increasingly used in empirical studies in the fields of management (e.g., Laursen and Salter,

[3] Product innovations (new or improved) must be new to the firm, but they do not need to be new to the market (OECD, 2005). In accordance with extant BMI research we include novelty that are new, reproduced or copied (Zott and Amit, 2007), hence also imitator innovations.

2006; Grimpe and Kaiser, 2010; Klingebiel and Rammer, 2014; Feldman & Tavassoli, 2015; Tavassoli, 2017) as well as in BMI research (Visnjic et al., 2016). BMI could be expected to generate earnings in the long run, thus product innovation performance is a better indicator than measures of profitability such as return on assets or return on investments (Denicoali et al, 2014). Moreover, accounting based measures have their limitations due to heterogeneity of industries (Chakravarty, 1986).

4.3. The explanatory variables

Casadesus-Masanell and Zhu (2013: 480) observe that BMI is "a slippery construct to study." It is not realistic to empirically study all the complexities involved in linking BMI and performance (Foss and Saebi, 2017), thus some kind of limitation have to be made. So, in order to operationalize the BMI definition: "designed, novel, and nontrivial changes to the key elements of a firm's BM and/or the architecture linking these elements" (Foss and Saebi, 2017:216) we have, like several other BMI-researchers (e.g., Casadesus-Masanell & Zhu, 2013; Teece, 2006; Zott and Amit, 2007), been inspired by Schumpeter's (1934) notion of innovation as new combinations of resources and Schumpeter's (1942) classification of innovation forms (i.e., product, process, marketing, and organizational innovation). Our conceptualization of BMI focus on the dynamic capabilities of the firm to link product innovations with complementary and dynamic innovations in other innovation forms, i.e., designed, novel, and nontrivial changes in processes, marketing and organization. These innovation forms could be seen as changes in the value creation (products), delivery (processes and organization), and capture (marketing) mechanisms (cf. Teece 2010).

Using CIS, it is possible to identify firms that only innovate products/services and differentiate them from other firms that innovate in several innovation dimensions simultaneously, i.e., introducing several types of innovations in the same three-year period. As

elaborated in the hypothesis development sections we propose one main explanatory variable: *BMI*. It is a dichotomous variable that takes the value of 1 if a given firm *i* introduces production innovation in year t, *and* simultaneously introducing at least one complementary process innovation, *and* at least one complementary marketing innovation *and* at least one complementary organizational innovations, otherwise 0. Moreover, we constructed two other dichotomous explanatory variables that can act as base cases to be compared with *BMI*. The first one relates to those firms that do not introduce any types of innovation in a given period of time (*NO INNOV*). The second one relates to those firms that only introduce a new product in a given period of time (*PROD*). As already stated in the theory section, not only we expect that BMI has higher effect on innovation of firms in compare with NO INNOV, but also it should have higher effect in compare with the *PROD*. Our three explanatory variables are constructed as mutually-exclusive groups (categories). 41 percentages of observations in our sample are non-innovative firms, five percentages introduced only product innovations, while seven percentages introduced all types of innovations simultaneously, i.e., BMI firms[4].

4.4. Control variables

We included a variable that captures the level of innovation inputs by firms, which is measured as the total amount of expenditure in various innovation activities (e.g., R&D investments, employee training, and so on). We also control for the size of firms by including the total number of employees. Moreover, a measure of physical capital per employee is included to control for capital intensity. In order to account for general sector (industry) differences, we used dummies for the NACE[5] single digit categories, which classifies economic sectors into

[4] The remainder of the observations (39 percentages), did not fall into any of the classified six categories in this paper (for instance it could be a firm that introduced only process innovation in a given year).
[5] NACE stands for "Nomenclature générale des Activités économiques dans les Communautés Européennes" and it is the official classification of economic activities developed by OECD.

nine broad sectors. We also included year dummies to control for any unobserved time-specific effects, such as business cycles.

4.5. Model specifications

We used two different estimators to test our hypotheses and check the robustness of our results. Firstly, we used a fixed-effect (FE) estimator in order to control for unobserved time-invariant firm-specific heterogeneity, such as managerial characteristics. Omitted variable bias may have occurred, if we had not controlled for unobserved heterogeneity. Moreover, the main advantage of using a FE estimator is that it allows for a correlation between the explanatory variables and the time-invariant firm-specific term, which is a realistic assumption[6]. Secondly, we utilized a random-effect (RE) estimator. The reason for choosing this estimator is because a FE estimator eliminates all time-invariant regressors from the regression analysis. Therefore, by using a FE estimator, neither heterogeneity between industries (sectors) nor heterogeneity between years in the sample can be controlled for. Conversely, when using an RE estimator it does indeed control for such sectoral and temporal heterogeneity. Controlling for sector-heterogeneity is crucial, because it is a stylized fact that firms have a different propensity to innovate in various industrial sectors, due to particular technological regimes that characterize these sectors (Malerba and Orsenigo, 1997)[7]. Moreover, it is important to control for heterogeneity between years, because this can take into account the macroeconomic effects and business cycles that may affect the volume of innovative sales that firms can succeed in achieving.

[6] For instance, an FE estimator allows for a possible correlation between product innovation (as an explanatory variable) and managerial characteristics in the firm (as a time-invariant firm-specific term).
[7] This implies that sectors do differ from one another, in terms of technology and innovation opportunities, which is inherent in the industrial sector. For instance, firms in the pharmaceutical industry are much more innovative than firms in the pulp and paper industry.

4.6. Endogeneity issues

An important estimation issue relates to the direction of causality in the relationship between BMI and product innovation performance. Our hypotheses implicitly treat the BMI variable as being exogenously determined, which is making a strong assumption. This is because, conceptually, engagement in BMI might also arise from past innovation performance in the form of successful commercialization of innovative products, for example, through the "success breeds success" mechanism. If this is true in our study, the BMI measure would be endogenous and hence it would be difficult to impose a unidirectional relationship, that is, a causal interpretation. In order to (at least partly) deal with this issue, we have further test the robustness of our results by employing an instrumental variable approach and a two-stage least squares (2SLS) estimator. We experimented with various potential instruments that related to some exogenous features of the firm. Firstly, we used sector averages, as a common practice. We also utilized the total number of managers employed within each firm. Both of these variables are conceptually and empirically (correlation) related to BMI, but not necessarily related to sales due to product innovations. Therefore, these variables provide potentially valid instruments. Based on these potential instruments, we used tests on over-identifying restrictions to examine the validity of the instruments, as well as a Durbin-Wu-Hausman (DWH) test to investigate whether there were in fact any endogeneity issues. The main results suggest that endogeneity problems occurred in only a few cases. In this context, it was important that the main results remained fairly robust. Thus, we will present the 2SLS results only in the Appendix (see Table A2).

5. Results

The results of our estimation are presented in Table 4. As described in a previous section, we used two estimators to test the robustness of our results: Models (1) to (4) use FE estimator, while the last model uses a RE estimator. Moreover, first we followed the step-by-step procedure of plug-in main explanatory variables throughout models (1) to (3) and then reported two full models (4) and (5). This would help to rule out possible collinearity issue between main explanatory variables.

TABLE 4 ABOUT HERE/

First of all, our main result shows stable pattern throughout all five models, which roughly speaking, can be an indication of the robustness of our findings. As expected, the introduction of product innovation (*PROD*) has a positive and significant effect on the volume of innovative sales due to the product innovation, both when it entered the regression alone in Model (2) and in the full models (4) and (5). For comparison, the expected negative effect of non-innovators on innovative sales is shown as model (1). In model (3) and the full models (4, 5), when firms choose to engage in BMI the effect on product innovation performance is significantly higher than choosing product innovation only. This result is again robust both when the variable entered the regression alone in Model (3) and in the full models (4) and (5). For example, in the full model (4), *BMI* has 28% (= (453-354)/354) higher impact on product innovation performance than introducing product innovation only[8]. Apart from the magnitude of the effect, the *BMI* effect is stronger than the *PROD* effect based on the relevant t-tests. Thus, hypothesis 1 is supported.

[8] As all of our models are log-level in this paper, the results are interpreted in the form of semi-elasticity.

6. Discussion of contributions and implications

Our study shows that BMI does in fact lead to higher product innovation performance as we found significant positive associations between the configuration of BMI and product innovation performance. The BMI firms exhibited the strongest impact on product innovation performance. Apparently, there is substantial economic value in BMI.

Our findings support previous large-scale empirical research (Aspara et al, 2010; Cucculelli and Bettinelli, 2015; Denicolai et al, 2014; Giesen et al, 2007; Kim and Min, 2015) in the sense that they overall point to a positive relationship between BMI and firm performance. In comparison to Aspara et als (2010) who observed performance differences between large and small firms we found no such differences when dividing our sample into small and large firms.

Compared to previous studies our empirical investigation is more systematic in three ways. Firstly, our study provides a clear theoretical rationale why BMI will lead to competitive advantage and thus to higher levels of firm performance. Following Teece's (2010) reasoning that product or service innovations by themselves may create value but not necessarily value capture for the firm, we hypothesized that complementary innovations in several of the business model elements including innovations in processes; marketing and organizational arrangements will act as isolating mechanisms towards replication by competitors. The results of empirical inquiry are in line with this hypothesis and thus support the theoretical framework. Thus, our first and main contribution of this paper is to provide systematic evidence on the relationship between BMI and firm performance than previously reported studies. Secondly, our study also provides a novel method on how to use available CIS data, in order to develop a unique measure of BMI, using the items in CIS and combine it with simultaneous (within the same three-year period) innovation activities in product/service, process, marketing and organization. In terms

of accumulation of research knowledge on BMI (Foss and Saebi, 2017) our method provides an opportunity to further investigate performance effects in all EU-countries as well as several other OECD-countries performing similar nationwide surveys. Thirdly, the empirical evidence in this study pinpoints the superior contribution from innovating the BMI compared to only innovating the product and with much broader and representative empirical base than previous studies.

6.1. Implications for theory

In accordance with prior research on BMI (Foss and Saebi, 2017) our research suggests the merits of theorizing and analyzing value creation and delivery on the business model level and how this value is captured at the focal firm level. The business model level has generally attracted much less research attention than the firm level or network level (Amit and Zott, 2015). In a world where common success factors can explain less of new product success (Evanschitzky et al, 2012), more industries and firms are experiencing network effects due to increased digitalization, and transactions costs generally are reduced, due to cost reductions in external search, contracting and control, we find it pertinent to increase the research attention to the business model level. Our study has on a general level shown the added product innovation performance by innovating the BM. Our results imply that innovating the BM creates an amplified effect on innovation performance as a measure of a firm's performance, in line with recent findings from Tavassoli and Karlsson (2016), where such an amplified effect was found using another measure of firm performance, i.e., productivity. To theoretically define

the boundaries for the effective use of isolating mechanisms in BMI is an important way forward for further research.

6.2. Implications for management

On the subject of how firms do business at the business level model our results indicate that managers should put product innovations in a BMI context, i.e., to make appropriate changes in the organizational architecture of the product and changes to supporting key activities in processes and marketing in order to create and capture more value from the product innovation. Our research does not explicitly specify in which order to innovate; it merely stresses the importance of framing the product innovation in a BMI context in order to create and capture more value (cf. Aspara et al., 2010; Pynnönen, Hallikas and Ritala, 2012), as well as to implement the innovation activities simultaneously, i.e., in a limited time frame. The business model level indicates the need for a corresponding strategic and innovation management level. Even if the management of BMI can adopt practices and learn from product innovation management there are important differences in terms of more widespread effects on the organization (Bucherer, Eisert, and Gassmann, 2012) and more boundary-spanning activities (Amit and Zott, 2015). As an example of such BMI management many managers of industrial companies are trying to respond to the threats and opportunities of digitalization, for instance in the automotive industry (KPMG, 2016). These responses may include the development of various ICT-capabilities in-house as well as in their supplier and dealer networks, to cease collaboration with suppliers and dealers that are not able to upgrade their ICT-capabilities, and connect with more ICT-firms as complementors and partners in order to develop more ICT-based services connected to the car. At the same time, the car manufacturers must safeguard, i.e., to design isolating mechanisms, against competitive attacks from major

ICT-firms to take over the car customer relationship possibly dispatching them to metalsmiths (KPMG, 2016) with possible diminishing market power and value capture potential.

7. Conclusion

There have been few previous studies of large-scale empirical research that have attempted to investigate the link between BMI and performance (Demil *et al*., 2015; Foss & Saebi, 2017; Lambert and Davidson, 2013; Schneider and Spieth, 2013; Spieth et al, 2016). Firstly, we provide a theoretical framework, based on the dynamic capabilities view of the firm (Teece, 2006; 2007) and specifically Teece's (2010; 2017) reasoning that product or service innovations by themselves may create value but not necessarily value capture for the firm. Thus, we hypothesize that complementary innovations in processes, marketing and the organization may act as isolating mechanism towards competitive imitation. The results from the empirical inquiry is in line with the theoretical framework. Secondly, we provide a new method to empirically investigate BMI using CIS data. As this data is regularly collected in the EU member and other OECD countries, our research may be replicated and extended. Our third contribution to the body of knowledge on BMI and firm performance is to provide broad evidence of a significant and positive association between BMI and product innovation performance, based on a representative sample of industry and service firms in Sweden in the period of 2006-2012. BMI firms capture up to 28 % higher product innovation sales than product innovators only. This is a remarkably strong effect. Overall the findings based on this large-scale data study of BMI and innovation performance support the view that BMI is superior to firms only introducing product innovations. Lastly, our results imply the importance of further research attention, theorizing and empirical investigation, to the business model level.

The study clearly has some limitations. Firstly, the CIS is admittedly not designed from the outset to measure BMI. A specific design of survey items of BMI for established firms would be preferable. The CIS does measure product innovations and complementary innovations but it does not measure the alignment (Giesen et al, 2007) of these innovation forms. We have inferred this alignment of innovations by measuring the combination of product innovation with other forms of innovation during the same three-year period (simultaneous introduction). Secondly, our BMI concept assumes that the firm has one BM and that all innovations in the business model elements are reconfigurations of or incremental innovations to the existing BM. However, firms may have more than one BM (Casadesus-Masanell and Tarzijan, 2012). Consequently, we are not able to determine with certainty that all innovations are linked to the same BM in question. However, most firms in our sample are limited in size, with an average of 374 employees, which usually implies a limited number of products and BMs. Thirdly, we have used product innovation performance or innovative sales as our dependent variable which is common practice in innovation research (e.g., Laursen and Salter, 2006; Grimpe and Kaiser, 2010; Klingebiel and Rammer, 2014; Tavassoli, 2015; 2017). In the long run firms need to show more than increasing innovative sales from new products, they need obviously to show profits and return on investments. However, this usually takes longer than three years, which is the period surveyed in each CIS-wave, and requires a more longitudinal research design than available here. Fourth, as our data consist of an unbalanced panel we can only determine an association and not a causal relationship between BMI and product innovation performance. Fifth, information about intellectual property such as patents have not been available to us. Hence, our empirical inquiry has not been able to consider performance effects from this type of isolating mechanism (Teece, 2010). Future empirical studies, as mentioned above, could apply our BMI measure to other national CIS samples or

similar surveys in other parts of the world, in order to replicate and extend our results to other national or industry-specific settings. A final suggestion is to study samples of entrepreneurial firms (Zott and Amit, 2007), small firms (Aspara et al, 2010) or service firms (Cheng, Shiu and Dawson, 2014) in order to determine if the performance effects are similar to our results.

References

Amit R, Zott, C. 2015. Crafting Business Architecture: the Antecedents of Business Model Design. *Strategic Entrepreneurship Journal,* **9**: 331–350.

Aspara J, Hietanen J, Tikkanen H. 2010. Business model innovation vs. replication: financial performance implications of strategic emphases. *Journal of Strategic Marketing* **18**(1): 39–56.

Baden-Fuller C, Haefliger S. 2013. Business models and technological innovation. *Long Range Planning* **46**: 419–426.

Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of Management* **17**(1): 99–120.

Bouncken, R. B., Fredrich, V. 2016. Business model innovation in alliances: Successful configurations, *Journal of Business Research*, 69, 3584-3590.

Brea-Solís H, Casadesus-Masanell R, Grifell-Tatjé E. 2015. Business model evaluation: quantifying Walmart's sources of advantage. *Strategic Entrepreneurship Journal* **9**: 12–33.

Bucherer, E., Eisert, U., & Gassmann, O. 2012. Towards systematic business model innovation: lessons from product innovation management. *Creativity and Innovation Management*, ***21***(2), 183-198.

Casadesus-Masanell R, Tarzijan J. 2012. When one business model isn't enough. *Harvard Business Review* **90**(1–2): 132−137.

Casadesus-Masanell R, Zhu F. 2013. Business model innovation and competitive imitation: the case of sponsor-based business models. *Strategic Management Journal* **34**(4): 464–482.

Chesbrough, H. 2007. Business model innovation: it's not just about technology anymore. *Strategy and Leadership* **35**(6): 12–17.

Chesbrough, H. 2010. Business model innovation: opportunities and barriers. *Long Range Planning* **43**(2−3): 354–363.

Cucculelli, M., Bettinelli, C. 2015. Business models, intangibles and firm performance: evidence on corporate entrepreneurship from Italian manufacturing SMEs. *Small Business Economics,* **45**(2), 329-350.

Damanpour, F. Gopalakrishnan S. 2001. The dynamics of the adoption of product and process innovations in organizations, *Journal of Management Studies,* **38**(1):45–66.

Demil B, Lecocq X. 2010. Business model evolution: in search of dynamic consistency. *Long Range Planning* **43**: 227–246.

Demil B, Lecocq X, Ricart JE, Zott C. 2015. Introduction to the *SEJ* special issue on business models: business models within the domain of strategic entrepreneurship. *Strategic Entrepreneurship Journal* **9**: 1–11.

Denicolai, S., Ramirez, M., Tidd, J. 2014. Creating and capturing value from external knowledge: the moderating role of knowledge intensity. *R&D Management,* **44**(3), 248-264.

Evanschitzky, H., Eisend, M., Calantone, R. J. and Jiang, Y. 2012. Success Factors of Product Innovation: An Updated Meta-Analysis. Journal of Product Innovation Management, **29**: 21–37

Feldman, M. P.; Tavassoli, S. 2015. Where do New Industries Come from? In D. Audretsch, A. Link, Oxford Handbook of Local Competitiveness, (p.125-141) Oxford University Press.

Foss, N. J., & Saebi, T. (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? Journal of Management, 43(1), 200-227.

Gambardella A, McGahan AM. 2010. Business-model innovation: general purpose technologies and their implications for industry structure. *Long Range Planning* **43**(2–3): 262–71.

Gawer, A. and Henderson, R. 2007, Platform Owner Entry and Innovation in Complementary Markets: Evidence from Intel. *Journal of Economics & Management Strategy*, 16: 1–34.

Gerasymenko V, De Clercq D, Sapienza HJ. 2015. Changing the business model: effects of venture capital firms and outside CEOs on portfolio company performance. *Strategic Entrepreneurship Journal*, **9**: 79–98.

Giesen, E., Berman, S. J., Bell, R., Blitz, A. 2007. Three ways to successfully innovate your business model. *Strategy & leadership*, **35**(6), 27-33.

Giesen E, Riddleberger E, Christner R, Bell R. 2010. When and how to innovate your business model. *Strategy and Leadership* **38**(4), 17–26.

Haeussler, C. and Higgins, M. J. (2014), Strategic Alliances: Trading Ownership for Capabilities. Journal of Economics & Management Strategy, 23: 178–203.

Hamel, G. 1991, Competition for competence and interpartner learning within international strategic alliances, *Strategic Management Journal*, vol. 12, pp. 83-103.

Jonsson, S., Regnér, P. 2009. Normative barriers to imitation: social complexity of core competences in a mutual fund industry. *Strategic Management Journal*, **30**(5), 517-536.

Kim, S. K., Min, S. (2015), Business Model Innovation Performance: When does Adding a New Business Model Benefit an Incumbent?. *Strategic Entrepreneurship Journal,* **9**: 34–57.

Kleinknecht A, Van Montfort K, Brouwer E. 2002. The non-trivial choice between innovation indicators. *Economics of Innovation and New Technology* **11**(2): 109–121.

Klingebiel, R, Rammer C. 2014. Resource allocation strategy for innovation portfolio management. *Strategic Management Journal*, **35**(2):246-268.

KMPG. 2016. KPMG's global executive survey 2016, available at: https://home.kpmg.com/xx/en/home/insights/2015/12/kpmg-global-automotive-executive-survey-2016.html

Lagerstedt Wadin, J., Ahlgren, K., Bengtsson, L. (2017) Joint business model innovation for sustainable transformation of industries – A large multinational utility in alliance with a small solar energy company, *Journal of Cleaner Production*, forthcoming.

Lambert SC, Davidson RA. 2013. Applications of the business model in studies of enterprise success, innovation and classification: an analysis of empirical research from 1996 to 2010. *European Management Journal* **31**(6): 668–681.

Larsson R, Bengtsson L, Henriksson K, Sparks J. 1998. The interorganizational learning dilemma: Collective knowledge development in strategic alliances. *Organization Science*, **9**(3): 285-305.

Laursen K, Salter A. 2006. Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal* **27:** 131–150.

Malerba F, Orsenigo L. 1997. Technological regimes and sectoral patterns of innovative activities. *Industrial and Corporate Change* **6**(1): 83–117.

Markides, C. 2006. Disruptive Innovation: In Need of Better Theory. Journal of Product Innovation Management, **23**: 19–25.

Massa L, Tucci CL. 2013. Business model innovation. In *The Oxford Handbook of Innovation,* Dodgson M, Gann DM, Phillips N (eds). Oxford University Press: Oxford, U.K.: 420–441.

Organisation for Economic Co-operation and Development (OECD). 2005. Oslo manual: guidelines for collecting and interpreting innovation data (3rd ed). Organisation for Economic Co-operation and Development: Paris, France.

Pisano, G. 1997, *The Development Factory: Unlocking the Potential of Process Innovation*. Harvard Business School Press: Boston.

Pohle G, Chapman M. 2006. IBM's global CEO report 2006: business model innovation matters. *Strategy and Leadership* **34**(5): 34–40.

Reichstein T, Salter A 2006. Investigating the sources of process innovation among UK manufacturing firms, *Industrial and Corporate Change* **15**(4):653-682.

Sanchez P, Ricart JE. 2010. Business model innovation and sources of value creation in low-income markets. *European Management Review* **7**(3): 138–154.

Schneider S, Spieth P. 2013. Business model innovation: towards an integrated future research agenda. *International Journal of Innovation Management* **17**(1): 1–34.

Schumpeter JA. 1934. *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle* (Vol. 55). Transaction publishers.

Schumpeter JA. 1942. *Capitalism, Socialism and Democracy,* Harper & Row, New York.

Smith K. 2005. Measuring innovation. In *The Oxford Handbook of Innovation,* Fagerberg J, Mowery DC, Nelson RR (eds). Oxford University Press: Oxford, U.K.: 148–179.

Sosna M, Trevinyo-Rodriguez RN, Velamuri SR. 2010. Business model innovation through trial-and-error learning: the Naturhouse case. *Long Range Planning* **43**(2–3): 383–407.

Spieth P, Schneckenberg D, Ricart JE. 2014. Business model innovation—state of the art and future challenges for the field. *R&D Management* **44**(3): 237–247.

Spieth, P., Schneckenberg, D.; Matzler, K. 2016. Exploring the linkage between business model (&) innovation and the strategy of the firm. *R&D Management*, *46*(3), 403-413.

Tavassoli, S. 2015. Innovation determinants over industry life cycle. *Technological Forecasting and Social Change* **91**: 18–32.

Tavassoli, S., Karlsson, C. 2016. Innovation strategies and firm performance: Simple or complex strategies?. *Economics of Innovation and New Technology*, **25**(7), 631-650.

Tavassoli S. 2017. The Role of Product Innovation on Export Behavior of Firms: Is It Innovation Input or Innovation Output That Matters, *European Journal of Innovation Management*, DOI:10.1108/EJIM-12-2016-0124

Teece, D. J. 2006. Reflections on "profiting from innovation". *Research Policy*, 35(8), 1131-1146.

Teece, D. J. 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic management journal*, 28(13), 1319-1350.

Teece, DJ. 2010. Business models, business strategy and innovation. *Long Range Planning*, **43**(2−3), 172–194.

Teece, D. J. (2017). Business models and dynamic capabilities. Long Range Planning, forthcoming.

Visnjic I, Weingarten F, Neely A. 2016. Only the brave: product innovation, service business model innovation, and their impact on performance**.** *Journal of Product Innovation Management* **33**(1): 36-52.

von Hippel, E. (2005). *Democratizing Innovation.* Cambridge: MIT Press.

Zott C, Amit R. 2007. Business model design and the performance of entrepreneurial firms. *Organization Science* **18**(2): 181–199.

Zott C, Amit R. 2010. Business model design: an activity system perspective. *Long Range Planning* **43**(23): 216–226.

Table 1. Summary of prior and present BMI and firm performance large-scale studies.

Study	Research question	BMI concept	Method and Sample	Explicit theory	Results
Aspara et al 2010	What are the financial performance implications of a firm's strategic emphases with respect to BMI vs replication?	BMI as strategic emphasis on creating new value through new BMs or emphasis on replicating successful BMs into new markets	Survey (questionnaire) of 545 CEOs at small and large Finnish firms in different industries (convenience sample) Firm performance variable: Change in sales growth and operating income	Conscious and consistent strategic emphasis from firm managers lead to superior performance	Firms with a high strategic emphasis on both business model innovation and replication exhibit a higher profitable growth than firms that do not strategically emphasize either dimension.
Cucculelli and Bettinelli, 2015	How does BMI affect firm performance and how it is moderated by investment in intangibles?	BMI as changes on three levels; low only design changes in current products, medium entry current products into new markets, high higher quality products and new markets.	Survey (questionnaire) of 376 Italian firms in the clothing industry and accounting data in years 2000-2010. Sample representative of Italian clothing industry. Firm performance variables: sales growth, returns on sales and productivity.	Strategic entrepreneur-ship: firms need to be simultaneously strategic and entrepreneurial (Ireland et al. 2001). Intangible assets are key resources for firms' competitiveness (Arrighetti et al. 2014).	Modifications of the business model had a positive effect on firm performance and a positive complementary positive performance effect of business model change and investment in intangibles.
Denicolai et al, 2014	Under what conditions can the combination of internal and external assets contribute to BMI?	Only the value creation architecture of BMI, the optimal combination of external and internal knowledge.	Survey (annual reports) of 310 European firms in four countries sample representative of population. Firm performance variables: sales growth 2008-2010.	Dynamic capabilities view (Teece, 2010), optimal proportions of externally acquired and internal knowledge may exist (e.g., Grimpe and Kaiser, 2010).	Firms increasing external knowledge have better performance, but only up to a threshold, after which the firm encounters decreasing performance.
Giesen et al, 2007	Which is the best type of BMI?	Three types of BMI: innovations in industry models, in revenue models and in enterprise models.	Case analysis of 35 best practice firms from publically available sources (e.g., Business Week) and financial analysis of 24 of these cases (convenience sample). Firm perfor-	N/A	All three types of BMI can lead to successful financial results. No significant variation in financial performance.

			mance variables: operating profit margin annual growth rate 2001-2006 and stock price annual growth rate from 1996-2006.		
Kim and Min, 2015	When does adding a new BM benefit an incumbent?	Incumbent imitative BMI as physical retail stores adding online store.	Survey of annual reports of 131 publicly traded store-based retailers in 1996 whereof 56 added online store by 2004. Firm performance: Increase in sales revenue before and after online store.	Both complementary assets (e.g., Teece, 1986) and conflicting assets (e.g., Chandy and Tellis, 1998) affect BMI and firm performance.	Incumbent performance after BMI improves when it aligns complementary assets with earlier BMIs as well as organizes conflicting assets in autonomous business unit.
This study	What is the role of BMI for product innovation performance?	BMI as product innovation plus complementary innovations in processes, marketing and organization.	Survey (questionnaire) of Swedish 5.046 firms with 11.218 observations in 2008, 2010 and 2012. Sample representative of entire Swedish firm population above 10 employees. Firm performance variable: Innovative sales, fraction of total sales from new products introduced the last three years.	Dynamic capabilities view (e.g., Teece, 2010)	Support for the dynamics capabilities theoretical framework as well as broad evidence of a significant and positive association between BMI and product innovation performance

Table 2: Descriptive statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
PRODUCT INNOVATION PERFORMANCE	11,218	3.82	6.67	0	22.97
NO INNOVATION	11,218	0.41	0.49	0	1
PROD	11,218	0.05	0.23	0	1
BMI	11,218	0.07	0.26	0	1
INNOVATION INPUTS	11,218	6.71	6.54	0	24.18
PHYSICAL CAPITAL	11,218	14.29	5.17	0	23.95
EMPLOYEES	11,218	3.92	1.35	2.30	10.32

Notes for Table 2: The log value is shown for all continuous variables.

Table 3: Variable definitions

Variables	**Type***	**Definitions**
$PROD\ INNOVATION\ PERFORMANCE_{it}$	C	The volume of sales exclusively due to the introduction of production innovation per employee for firm *i,* in year *t* (log).
$PROD_{it}$	0/1	1 if firm *i* introduces product innovation into the market in year *t,* otherwise 0 (*NO INNOV*). A product innovation is the market introduction of new or significantly improved goods or services, with respect to its capabilities, user friendliness, components, or sub-systems.
BMI_{it}	0/1	1 if firm *i* introduces production innovation in year *t,* AND simultaneously introducing at least one complementary process innovation, AND at least one complementary marketing innovation, AND at least one complementary organizational innovations, otherwise 0.
$Innovation\ inputs_{it}$	C	The log amount of the sum of expenditure in the following six innovation activities (per employee) for firm *i* in year *t*: internal R&D, external R&D, training of employees, acquisition of machinery, market introduction of innovation, and acquisition of external knowledge.
$Employees_{it}$	C	Total number of employees in firm *i,* year *t* (log).
$Physical\ capital_{it}$	C	Sum of investments in buildings and machines at year end for firm *i,* in year *t* (log).
Industry dummies	0/1	Industry-specific component captured by nine industry dummies in a single digit Nomenclature générale des Activités économiques dans les Communautés Européennes'(NACE) code (statistical classification of economic activities developed in the European Community).
Time dummies	0/1	Time-specific component captured by five time dummies.

* 0/1 corresponds to a dichotomous variable, and C corresponds to a continuous variable.

Table 4: Effect of Business Model Innovation (BMI) on product innovation performance

Variables	(1) FE	(2) FE	(3) FE	(4) FE	(5) RE
NO INNOV	-0.960***			-0.191***	-0.561***
	(0.169)			(0.160)	(0.110)
PROD		2.276***		3.549***	4.604***
		(0.416)		(0.426)	(0.280)
BMI			3.537***	4.532***	5.334***
			(0.343)	(0.360)	(0.257)
Innovation inputs	0.752***	0.777***	0.760***	0.715***	0.490***
	(0.021)	(0.019)	(0.020)	(0.021)	(0.013)
Physical capital	0.106***	0.107***	0.096***	0.097***	-0.010
	(0.035)	(0.035)	(0.034)	(0.034)	(0.012)
Employees	-1.623***	-1.571***	-1.590***	-1.592***	-0.125***
	(0.304)	(0.306)	(0.299)	(0.299)	(0.043)
Industry dummies	NO	NO	NO	NO	YES
Number of firms	5,046	5,046	5,046	5,046	5,046
Observations	11,218	11,218	11,218	11,218	11,218
R^2	0.316	0.318	0.334	0.375	0.442

Notes for Table 2: The table reports the estimated coefficients, with clustered standard errors over 574 firms in the parentheses. ***, **, and * indicate a significance level of 1%, 5%, and 10% respectively. The dependent variable in all models is product innovation performance, measured as the amount of sales due to innovative products per employee (log). Models (1) to (4) employ the fixed effect (FE) estimator and Model (5) employs the random effect (RE) estimator. The results are based on the unbalanced panel of three waves of the CIS with t=2008, 2010, 2012.

Appendix Table A1. CIS-items for main explanatory variables (BMI-firms) and dependent variable (with the period 2010-2012 as an example)

Innovation form	CIS-item
Product innovation (*PROD*)	During the three years 2010 to 2012, did your enterprise introduce: **Product innovations** **ITEM 1:** Goods innovations: New or significantly improved goods (exclude the simple resale of new goods and changes of a solely aesthetic nature)? Y/N **ITEM 2:** Service innovations: New or significantly improved services? Y/N
Business Model Innovation (*BMI*)	During the three years 2010 to 2012, did your enterprise introduce: **Product innovations** **ITEM 1:** Goods innovations: New or significantly improved goods (exclude the simple resale of new goods and changes of a solely aesthetic nature)? Y/N **ITEM 2:** Service innovations: New or significantly improved services? Y/N **Complementary process innovations** **ITEM 1:** New or significantly improved methods of manufacturing or producing goods or services Y/N **ITEM 2** New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services Y/N **ITEM 3:** New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing Y/N **Complementary marketing innovations** **ITEM 1:** Significant changes to the aesthetic design or packaging of a good or service (*exclude changes that alter the product's functional or user characteristics – these are product innovations*) **ITEM 2** New media or techniques for product promotion *(i.e. the first time use of a new advertising media, a new brand image, introduction of loyalty cards, etc.*) Y/N **ITEM 3:** New methods for product placement or sales channels *(i.e. first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc.) Y/N* **ITEM 4:** New methods of pricing goods or services *(i.e. first time use of variable pricing by demand, discount systems, etc.) Y/N* **Complementary organizational innovations** **ITEM 1:** New methods of organizing external relations with other firms or public institutions (*i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc*.) Y/N **ITEM 2:** New business practices for organizing procedures *(i.e. supply chain management, business reengineering, knowledge management, lean production, quality management, etc*.) Y/N **ITEM 3:** New methods of organizing work responsibilities and decision making (*i.e. first use of a new system of employee responsibilities, teamwork, decentralization, integration or de-integration of departments, education/training systems, etc*.) Y/N
Product innovation performance	**Please give the percentage of your total turnover in 2012 from:** **ITEM 1:** New or significantly improved products introduced during the three years 2010 to 2012 that were new to your market **ITEM 2:** New or significantly improved products introduced during the three years 2010 to 2012 that were only new to your firm

Notes: This table reports the 'raw' items in the CIS survey. We used these raw items and construct our dependent and independent variables, inspired by previous studies, in the later stage, which are reported in the Table 3.

Appendix- Table A2: Effect of BMI on product innovation performance: an instrumental variable approach

Variables	(6) 2SLS	(7) 2SLS
NO INNOV	-0.240*	-0.316*
	(0.214)	(0.169)
PROD	7.525***	5.097***
	(1.736)	(0.389)
BMI	5.734***	8.298***
	(0.351)	(1.672)
Innovation inputs	0.481***	0.465***
	(0.014)	(0.020)
Physical capital	-0.009	-0.011
	(0.012)	(0.012)
Employees	-0.088*	-0.157***
	(0.048)	(0.047)
Industry dummies	Yes	Yes
Time dummies	Yes	Yes
Sargan test	0.037	1.532
	(0.847)	(0.182)
DWH test	7.436	3.533
	(0.006)	(0.061)
Number of firms	5,046	5,046
Observations	11,218	11,218
R^2	0.434	0.431

Notes for Table A2: The table reports the estimated coefficients, with clustered standard errors over 5,046 firms in the parentheses for the second stage of a two-stage least square (2SLS) estimation. ***, **, and * indicate a significance level of 1%, 5%, and 10% respectively. The dependent variable in all models is innovation performance, measured as the log amount of sales due to innovative products per employee. In model (6), product innovation (*PROD*) is instrumented by all explanatory variables, plus its average industry value and the number of managers. In model (7), *BMI* is instrumented by all the explanatory variables, plus its average industry value and the number of managers. The Sargan test is an over-identification test, with its p-value in parentheses. The null hypothesis is not rejected in any of the models, which means that there is no evidence of over-identification in the specification. The Durbin-Wu-Hausman (DWH) test of endogeneity has its p-value in parentheses. The null hypothesis is strongly rejected in only Model (5), indicating that the endogeneity does not exist in most of the cases. The results are based on the unbalanced panel of three waves of the CIS with t=2008, 2010, 2012.