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Antecedents and consequences of business model innovation: The role of industry structure

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Abstract

What makes firms innovate their business model? Why do they engage in innovating the way of creating, delivering and capturing value? Despite the importance of business model innovation for achieving competitive advantage, existing evidence seems to be confined to firm-level antecedents and pays little attention to the impact of industry structure. This study investigates how different stages of an industry life cycle and industry competition affect business model innovation and how such innovation in a firm?s business model translates into innovation performance. Based on a cross-industry sample of 1,242 Austrian firms, we introduce a unique measure for the degree of innovation in a firm?s business model. The results indicate that the degree of business model innovation is highest towards the beginning of an industry life cycle, i.e. in the emergent stage. Competitive pressure in an industry turns out to be negatively related to the degree of business model innovation. Moreover, we find that the degree of business model innovation, conditional on having introduced a new product/process, positively influences innovation performance. Our findings provide implications for the management of business model innovation and contribute to the ongoing dialog on the role of industry structure in business model innovation.

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Keywords: Business Model, Business Model Innovation, Industry Life Cycle, Competition, Strategy

Introduction

Business model innovation has attracted considerable attention in recent strategy literature (e.g., Baden-Fuller and Mangematin, 2013; Casadesus-Masanell and Zhu, 2013; Zott, Amit, and Massa, 2011) as well as practitioner discussion (e.g., Pohle and Chapman, 2006; Chesbrough, 2007). Understood as the "modification or introduction of a new set of key components – internally focused or externally engaging – that enable the firm to create and appropriate value" (Hartmann, Oriani, and Bateman, 2013a: 5), business model innovation has been shown to allow not only entrepreneurial but also incumbent firms to (re-)configure their way of operating and to increase performance (e.g., Desyllas and Sako, 2013; Hartmann, Oriani, and Bateman, 2013b; Massa and Tucci, 2013). The ability to develop, adjust and if necessary replace business models is considered to be central to the dynamic capabilities of a firm (Teece, 2007b). Business model innovation differs from other innovation types in that it deals with the entire activity system, not only a particular product or process (Snihur and Zott, 2013). Moreover, business model innovation is typically harder to protect against imitation compared to product and process innovation (Casadesus-Masanell and Zhu, 2013).

Despite the importance of a business model as a means for achieving competitive advantage (e.g., Teece, 2010), relatively little is known about what may lead particularly incumbent firms to innovate components of their business model. In fact, prior research has emphasized the need for further investigation of the drivers facilitating business model innovation (Chesbrough and Rosenbloom, 2002; George and Bock, 2011; Zott and Amit, 2007). Yet existing evidence seems to be confined to firm-level antecedents, such as organizational inertia (Sosna, Trevinyo-Rodriguez, and Velamuri, 2010), inertia on the upper management level (Chesbrough and Rosenbloom, 2002; Tripsas and Gavetti, 2000), cognitive closure of firms (Chesbrough, 2010), and conflict with existing assets (Amit and Zott, 2001). Little attention has been paid to industry structure, particularly the life cycle stage of the industry and the degree of competitive pressure. This is surprising given the seminal contribution of Utterback and Abernathy (1975) on how the focus of innovation in products and processes changes as an industry develops over time. On the one hand, emergent industries should provide considerable potential for business model innovation. There is also evidence indicating that start-ups' early experimentation with a range of alternative business models or individual business model components may lead to a better identification of the one that can be stabilized and replicated during later phases of exploitation (Winter and Szulanski, 2001) and become profitable over the rest of the life cycle (Murray and Tripsas, 2004). On the other hand, industry maturity is one condition where existing business models may get challenged and need to be innovated (Sabatier, Craig-Kennard, and Mangematin, 2012). Following that logic, business model innovation is suggested to be most important in later stages of the industry life cycle when markets become commoditized (Johnson, 2010; Massa and Tucci, 2013).

Hence in this paper, we seek to contribute to this debate and incorporate the insights of the model proposed by Utterback and Abernathy into an analysis on how business model innovation is driven by the industry life cycle and industry competition. Specifically, we are interested in how the stage of the industry life cycle influences the degree of innovation in a firm's business model. Moreover, we seek to investigate whether the degree of business model innovation is connected to a firm's innovation performance, defined as value capture in new product commercialization.

Our research is based on a cross-industry sample of 1,242 Austrian firms which were surveyed in 2010 in the course of the European Community Innovation Survey (CIS). We adopt the perspective of an innovating firm, i.e. one that has introduced new products or processes to the market, and focus on business model innovation that accompanies such activity. We develop a unique measure for the degree of business model innovation by applying a multi-stage expert rating process to identify CIS questions that are relevant for business model innovation, and assign them to the key business model elements of creating, delivering and capturing value. By doing so we can go beyond investigating whether a business model has changed or not, but rather focus on the degree of business model innovation and its relationship with innovation performance. We condition on actually having introduced a new product or process in order to draw valid conclusions regarding the implications for innovation performance. Using data from structural business statistics we classify industry sectors according to their life cycle stage and compute profit persistence within industry sectors as a measure of competitive pressure.

Our results indicate that, although business model innovation is discussed as also being important in later stages of the industry life cycle, the degree of business model innovation is largest in emerging industries. Moreover, we find that contrary to what we expected industry competition negatively influences the degree of business model innovation. Finally, we find a positive relationship between the degree of business model innovation and innovation performance on the firm level.

Our research makes at least two contributions to the literature on business model innovation. First, we complement existing research by shedding light on the industry-level antecedents of business model innovation. Adapting the model by Utterback and Abernathy (1975) we investigate how industry life cycle and industry competition motivate firms to innovate their business model and how such change translates into innovation performance. In that sense, our results provide important implications for the management of business model innovation processes. Second, most literature on business model innovation is conceptual in nature or uses single cases to illustrate findings (Schneider and Spieth, 2013). Anecdotal evidence suggests business model innovation to primarily occur when markets have become mature and commoditized (Johnson, Christensen, and Kagermann, 2008; Massa and Tucci, 2013). We are able to leverage a large cross-industry database to assess the relationships between industry life cycle stage, industry competition and business model innovation, which provides broad empirical evidence.

The remainder of this article is organized as follows. Section 2 provides a review of the literature on business model innovation and outlines our theoretical framework. Section 3 describes data and methods. Results are presented in section 4 and discussed in section 5. Section 6 concludes and outlines limitations of our research.

Literature Review and Hypotheses

As stated above, our conceptualization of business model innovation rests on the modification or introduction of key components through which firms aim at creating, delivering and capturing value (Hartmann *et al.*, 2013a). The definition we adopt in this paper is thus based on prior work on business models that takes an activity-based perspective (Zott and Amit, 2010), as well as on work on the constitution of the business model concept by identifying its key components (e.g. Amit and Zott, 2001; Chesbrough and Rosenbloom, 2002; Magretta, 2002; Osterwalder, Pigneur, and Tucci, 2005).

In accordance with prior literature, business models are a subject of innovation itself, expanding the traditional dimensions of product and process innovation (Massa and Tucci, 2013; Zott *et al.*, 2011; Mitchell and Coles, 2003). Business model innovation is increasingly recognized as one of the most important sources of creating competitive advantage in rapidly changing environments driven by new technologies, changes in customer preferences, and new regulations (Chesbrough, 2010; Sako, 2012; Teece, 2007a; Teece, 2010; Zott *et al.*, 2011). However, business model innovation is also considered to be a complex and risky process with highly uncertain outcome (e.g., Im and Cho, 2013, Sosna et al., 2010, Chesbrough, 2010), not least because business model innovation requires experimentation (McGrath, 2010), a specific leadership agenda (Smith, Binns, and Tushman, 2010) and boundary-spanning capabilities (Zott and Amit, 2010). Conceptualizing and formalizing the business model by carving out its key components related to creating, delivering and capturing value is discussed as a way to structure, simplify and thus alleviate the process of business model innovation (e.g., Massa and Tucci, 2013; Johnson et al. 2008).

But what drives or blocks business model innovation, particularly in incumbent firms? While existing research mainly focuses on firm-level antecedents (e.g., Sosna *et al.*, 2010; Chesbrough, 2010; Amit and Zott, 2001; Tripsas and Gavetti, 2000) looking into specific contexts indicates a number of additional sources of business model innovation. In the course of servitization initiatives, for example, it has been shown that firms' business models change when they are traversing through a servitization life cycle (Neely, 2008; Visnjic Kastalli and Van Looy, 2013; Visnjic Kastalli, Van Looy, and Neely, 2013). Further drivers of business model innovation include market changes, new technology, shifting demographics, or greater regulatory oversight (Baden-Fuller and Haefliger, 2013; Drucker, 1984). In the case of new technology, the role of the business model has been described as mediating between technological innovation and firm performance (Baden-Fuller and Haefliger, 2013). The same technology commercialized in different ways may result in different economic outcomes (Chesbrough, 2010). In this sense, business models are indeed a subject of innovation in itself allowing firms to compete through their business models (Casadesus-Masanell and Zhu, 2013).

Little research is however available on the role of industry structure for business model innovation. While a mature industry has been reported to provide a context where existing business models may get challenged and need to be innovated (Sabatier, Craig-Kennard and Mangematin, 2012), a systematic treatment of how industry life cycles and industry competition affect business model innovation – analog to the model by Utterback and Abernathy (1975) for product and process innovation – is absent from the literature. Utterback and Abernathy (1975) distinguish between three stages. In the "fluid phase", firms are primarily concerned with product innovation in order to find out which design most appeals to customers and fulfills their requirements. Over time a dominant design emerges that captures the majority of the market, which is suggested to be in a "transition phase" towards product standardization and an increasingly efficient production. In this phase, process innovation becomes the dominant focus of firms until, in the "specific phase", the focus lies on cost minimization with decreasing importance of both product and process innovation.

In the following, we will first present arguments regarding the industry-level antecedents of business model innovation before we outline the implications of business model innovation for the innovation performance of the firm.

Industry-level antecedents of business model innovation

Prior literature on business model innovation has focused on how incumbents rethink their own business models after a new venture enters their market with a disruptive business model (e.g., Casadesus-Masanell and Zhu, 2013). Incumbents may be forced to adapt to the altered competitive environment and react with business model innovation (Johnson, 2010; Massa and Tucci, 2013; McGrath, 2010; Teece, 2010). However, changing fundamental components of a running business is risky (Girotra and Netessine, 2011). Hence, knowing when to innovate a business model is a critical challenge for managers (Johnson, 2010). The model by Utterback and Abernathy (1975) provides an understanding of how the focus of innovation changes as an industry develops. When an industry matures, it becomes increasingly difficult for firms to differentiate themselves on the basis of products and production processes (Johnson, 2010; Utterback, 1994).

As a consequence, prior work suggests that there is a succession from product to process, and finally to business model innovation (Massa and Tucci, 2013; Boutellier, Eurich, and Hurschler, 2010). Servitization life cycles, for example, often pass through three phases: (1) in the transactional phase the business model is defined by single payments for physical products; (2) in the interactional phase the business model includes considerations about value creation based on adding services to the tangible good with revenue generation typically relying on pay per use; (3) in the relational phase service provisioning becomes truly outcome-based and the manufacturer understands itself as a result provider (Visnjic Kastalli *et al.*, 2013; Martinez *et al.*, 2011). A study in the truck industry shows that the life cycle of the service offering transforms over time from selling an artefact (truck) to selling mobility (miles per gallon) (Martinez *et al.*, 2011). The study also demonstrates that the degree of servitization can be too ambitious in the first place because customers may not be mature enough to receive the service (Martinez *et al.*, 2011). Services are context specific (Visnjic Kastalli *et al.*, 2013) and servitization life cycles are thus difficult to generalize and predict. However, the anecdotal evidence available suggests that business model innovation becomes more intense under real or anticipated competitive pressure, when profit margins are declining and rather towards the end of an industry life cycle (Eggert *et al.*, 2014; Neely, 2008; Visnjic Kastalli *et al.*, 2013).

It seems that firms tend to put much effort into business model innovation when they experience that their once successful business model looses ground and revenues are dropping. Business model innovation offers a way to differentiate from competitors in a situation when differentiation is not possible based on product or process innovation (Chesbrough, 2010; Johnson, 2010; Matzler *et al.*, 2013). Sabatier and Mangematin (2012) find empirical evidence that when an industry is mature and profitability is decreasing, existing business models are likely to be challenged by new business models. In his seminal work on disruptive innovation, Christensen demonstrated that disruptors enter mature industries primarily with the help of rule-breaking business models (Christensen, 1997, 2006).

Nevertheless, there may also be considerable opportunities to innovate the business model in emergent industries which are dominated by start-up firms. Start-ups have been shown to frequently experiment with a range of alternative business models or individual business model components in order to better identify the one that can be stabilized and replicated during later phases of exploitation (Winter and Szulanski, 2001; Murray and Tripsas, 2004). They have the choice to tinker around with different business model components and realize new business opportunities. Business model innovation often flourishes especially when innovative technologies are applied and monetized in different ways (Chesbrough, 2010). Taking the arguments together, our first hypothesis reads:

Hypothesis 1: The degree of business model innovation is highest towards the beginning and the end of an industry life cycle, i.e. in the emergent and the decline stage.

Since the life cycle an industry passes through is strongly connected to the entry and exit of firms – i.e. there will be high entry in the emergent and high exit of firms in the decline stage (McGahan and Silverman, 2001) – the degree of business model innovation has been argued to depend on real or anticipated competitive pressure and associated profit margins (Eggert *et al.*, 2014; Neely, 2008; Visnjic Kastalli *et al.*, 2013). In the Schumpeterian view, where innovation is driven by the expectation of higher profits through temporary monopolies, an increase in competition, which lowers profits, will reduce innovation. However, the results of past studies on competition and innovation have been mixed. While some studies describe a negative relationship (e.g., Aghion and Howitt, 1990; Hashmi, 2013) others find a positive relationship between competition and innovation (e.g., Carlin, Schaffer, and Seabright, 2004; Gorodnichenko, Svejnar, and Terrell, 2010; Nickell, 1996). In a seminal article, Aghion et al. (2005) derive an inverse U-shaped relationship between competition and innovation: some competitive pressure motivates firms to innovate and introduce new products in order to achieve a temporary monopoly but after a certain point when competitive pressure becomes too high incentives to innovate decrease because firms may no longer be able to yield a return from their investments into innovation. Prior contrary results seem to depend on the time period, the definitions of competition and innovation used, and market characteristics (Gilbert, 2006; Hashmi, 2013; Tang, 2006).

While such an inverse U-shaped relationship seems sensible in the context of product innovation, we will suggest in the following that there is a positive relationship between competitive pressure and the degree of business model innovation. Previous studies have highlighted competitive pressure and the struggle for survival as important drivers of business model innovation, specifically in incumbent firms (Aspara *et al.*, 2013; Sosna *et al.*, 2010). It may appear too risky to thoroughly innovate a firm's business model, however, decision makers' willingness to do so increases with competitive pressure. In fact, anecdotal evidence suggests that most cases of a successful business model innovation either occurred by new entrants on the market or by incumbent firms that experienced severe business problems (Chesbrough, 2007, 2010; Drucker, 1995; Lindgardt, Reeves, and Stalk, 2009). In the context of servitization, prior research argues that the inflection point when a firm's focus shifts from products to services is often based on current or anticipated future competitive pressure (Suarez, Cusumano, and Kahl, 2012; Cusumano, Kahl, and Suarez, 2014). It seems unlikely that competitive pressure will, along the lines of an inverse U-shaped relationship, after a certain point decrease the degree of business model innovation since firms resisting business model innovation are likely to be outcompeted by their competitors over time. Hence, we propose:

> *Hypothesis 2: There is positive relationship between competitive pressure and the degree of change in business models.*

Performance consequences of business model innovation

The link between business models and firm performance is among the dominant themes in prior business model literature (Lambert and Davidson, 2013). In general, most of the evidence available on the matter is drawn from case study research. An exception here are Casadesus-Masanell and Zhu (2013) with a formal model of business model innovation for a specific type of business models, namely sponsor-based business models, with a focus on the competitive imitation of business models. Hartmann and colleagues developed a quantitative model for business model innovation, using the NK-modelling approach, which focuses on the antecedents and performance implications of business model innovation in incumbent firms within established industries (Hartmann *et al.*, 2013a, 2013b).

In the following, we will outline the mechanisms underlying the relationship between business model innovation and performance. Specifically, we are interested in the implications for innovation performance given that a firm has introduced a (technologically) new product or process. In that sense, we follow prior literature which argues that the full potential of new technologies can often only be realized with innovation in the firm's business model (Baden-Fuller and Haefliger, 2013; Chesbrough and Rosenbloom, 2002). Consistent with the value capture objective of a business model, we adopt the strategy definition of innovation performance, i.e. the value a firm can appropriate from its innovations (e.g., Laursen and Salter, 2006).

Rather than innovating the business model or not, such innovation may be incremental, defined in our context as involving only a few components (Massa and Tucci, 2013). Firms innovating a small number of business model components may only adapt their existing business model to changing markets. If a business model is sufficiently differentiated and hard to replicate, for incumbents and new entrants alike, it may lead to a head-start over competitors (Teece, 2010). Changing a larger number of components of the business model, i.e. more radical business model innovation, may increase firm specificity which retards imitation by competitors and thus secures a higher degree of appropriability of the firm's innovations (Helfat, 1994).

Furthermore, firms introducing a new product which is supported by a high degree of business model innovation may realize a truly innovative value proposition that in turn allows to benefit from first mover advantages (Lieberman and Montgomery, 1988): In this case the value capture in new product commercialization, i.e. innovation performance, is high. As the first one with a novel value proposition, a company may have the opportunity to create a lock-in with the customers, e.g. in terms of creating positive network externalities (Katz and Shapiro, 1985), achieving commitment to a contract, personalization of products or services, or by inducing switching costs (Amit and Zott, 2001; Frank, 2007; Harrison et al., 2012; Lieberman and Montgomery, 1988). Lock-in is considered a means to bind consumers to the business, create a market for cross-selling opportunities, and eventually gain recurring revenues from the same pool of customers (Amit and Zott, 2001; Farrell and Klemperer, 2007). Therefore, the turnover achieved with new products or services, i.e., innovation performance can be assumed to be high. Thus, our third hypothesis reads:

> *Hypothesis 3: There is a positive relationship between the degree of business model innovation, conditional on having introduced a new product or process, and innovation performance.*

Methods

Data

The empirical analyses of our study are based on two data sources. First, we draw data from the Austrian Structural Business Statistics (SBS), a database that provides indicators concerning the structure, employment, activities and performance of Austrian firms in the breakdown by economic activities. From the SBS data, we specifically use the number or firms active in three-digit level NACE industries over the period from 2005 to 2011 to classify industries according to their stage in the industry life cycle. Second, we draw data from the Austrian part of the European Union's Community Innovation Survey (CIS) 2010. The methodology and questionnaire used follow the Oslo manual of the OECD (OECD, 2005). The survey is directed at decision makers for a firm's innovation activities such as CEOs, heads of innovation management units or R&D departments. Informants provide direct, importance-weighted measures for several questions on innovation inputs, processes and outputs (Criscuolo, Haskel, and Slaughter, 2005). The surveys have been used in European Union member and associated states for more than a decade. To ensure interpretability, reliability and validity they are subject to extensive pre-testing and piloting in various countries, industries and firms (Laursen and Salter, 2006). CIS data have often been used in recent contributions in the strategy and innovation literature (e.g., Laursen and Salter, 2006; Grimpe and Kaiser, 2010; Leiponen and Helfat, 2011).

The Austrian CIS data consist of a representative random sample of firms with at least ten employees from the following sectors: mining, manufacturing, energy, water supply, trade, transport, information and communication services, financial intermediation, and professional, scientific and technical service activities. The 2010 survey was sent out to 5409 firms, of which 3172 provided reliable information, which results in a response rate of 59.3 percent (StatisticsAustria, 2012). For the 2010 survey, data refer to the three-year period from 2008 to 2010.

As outlined before, we restrict attention to innovation-active firms in the sample. Innovation-active firms are firms that either had at least one product and/or process innovation, or have not finished yet or failed with product and/or process innovation during the observation period. Restricting the sample to innovation-active firms allows us to identify performance differences for firms that engage in business model innovation in addition to product/process innovation activities as compared to firms whose innovation activities are limited to products and processes. Due to limited numbers of observations in some industry groups we omitted two groups (agriculture and mining) and combined others (information and communication services and financial intermediation). Our effective sample, without missing values, consists of 1,242 observations. Prior studies based on CIS-type data indicate the restriction to innovative firms to be unproblematic in terms of selection bias (Grimpe and Kaiser, 2010). Since the Austrian CIS data are not publicly available, R-scripts have been written for execution by Statistics Austria, which in turn provided us with the data analysis results.

Measurement of the dependent variables

Degree of business model innovation

Although the CIS provides a broad range of information on innovation activities, firms are not directly asked about business model innovation. Since the CIS survey in 2010, innovation activities have been split up into four different types, as suggested by the OECD (2005): product innovation, process innovation, marketing innovation, and organizational innovation. The measure for the degree of business model innovation was thus developed by applying a multi-stage expert rating process in which three independent experts were asked to identify CIS questions relevant for business model innovation and to map them to the key elements of creating, delivering and capturing value. More specifically, we first inspected the entire set of 58 CIS questions and removed those without potential to indicate business model innovation prior to the expert rating process. In total, we removed 16 sub-questions related to two question blocks on employee skills and employee education, as well as on the type of cooperation partners in this preparatory stage. Questions related to cooperation partners furthermore only had to be answered subject to whether or not the firm actually cooperated with other firms and were thus not answered by all firms in the sample.

Second, we selected three independent external experts in business model innovation[1] and individually asked them to rate the remaining 42 questions on whether an answer to these questions may indicate if a firm innovated its business model, i.e. the way it creates, delivers and/or captures value. In line with a procedure for expert rating outlined by Krippendorff (2004), all experts were provided with the business model definition outlined above and informed about the evaluation criteria and the respective rating scales prior to starting the rating process. The aim of this step was to ensure that all experts had a comparable understanding of the task and of the rating standards to be applied. Whether or not an answer to a CIS question contains information on business model innovation was measured using a 5-point rating scale (where 1 = contains no information on business model innovation at all and 5 = contains a high level of information on business model innovation).

In a third step, we informed every expert about the individual ratings of the respective other two experts. Based on this, the experts were allowed – but not required – to individually adapt and refine their ratings if the other experts' ratings convinced them to change their assessment. Interrater reliability was assessed by calculating Krippendorff's alpha. Krippendorff's alpha is a conservative index that measures agreement among multiple raters and is considered a highly rigorous measure for assessing interrater reliability for rating scales such as those employed in this study (values of .67 and greater are generally considered to be satisfactory; Krippendorff

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[1]All three experts have international publications on business model innovation and/or other business model-related topics as well as practical experience in developing business models or consulting business model innovation processes.

2004). The agreement coefficient for our study is 0.84 and thus well above the recommended threshold value.

For further analysis we constructed three versions of the variable representing the degree of business model innovation based on three different thresholds on the 5-point rating scales (>3.0, >3.5, >4.0), i.e. we selected those CIS questions that received expert ratings above 3.0, 3.5 or 4.0. These variables include, depending on the threshold, eighteen, eleven, or seven of the initial 58 CIS questions[2]. The most rigorous selection (threshold value >4.0), for example, resulted in the selection of the following seven CIS items: (1) "Were any of your product innovations (goods or services) during the three years 2008 to 2010 new to your market?", (2) "Were any of your product innovations during the three years 2008 to 2010 a first in Austria, Europe or a world first?", (3) "During the three years 2008 to 2010, did your enterprise introduce new or significantly improved logistics, delivery or distribution methods for your inputs, goods or services?", (4) "During the three years 2008 to 2010, did your enterprise introduce new business practices for organizing procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc.)?", (5) "During the three years 2008 to 2010, did your enterprise introduce new methods of organizing external relations with other firms or public institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc.)?", (6) "During the three years 2008 to 2010, did your enterprise introduce 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.)?", and (7) "During the three years 2008 to 2010, did your enterprise introduce new methods of pricing goods or services (i.e. first time use of variable pricing by demand, discount

[2] Table A5 in the appendix provides the list of selected CIS questions for all three threshold values.

systems, etc.)?”. Data analysis was done using all three versions of the degree of business model innovation variable to provide respective robustness checks.

Innovation performance

We follow prior innovation studies and refer to the market acceptance of a firm’s innovations by using the share of sales achieved with new products (irrespective of whether they were new to the market or only the firm) as our measure for innovation performance as reported in the CIS (e.g., Grimpe and Kaiser, 2010; Klingebiel and Rammer, 2014).

Measurement of the independent variables

Industry life cycle stage classification

Following prior work related to industry life cycles, we classify industries into three life cycle stages: emergent (stage I), maturity (stage II), and decline (stage III) (e.g. Dinlersoz and MacDonald, 2009; Klepper and Graddy, 1990; Utterback and Abernathy, 1975). We apply an approach taken by McGahan and Silverman (2001) to identify the inflection points that characterize the beginning and end of industry life cycle stages by analyzing the number of active firms in industries over time. In this approach the point of industry maturity is detected when the growth rate in the number of firms starts slowing down. Industries move into stage III when the absolute number of firms starts declining. In more detail, life cycle stage II is defined as “the first year in which the number of firms grows during a 3-year period at less than 3% of the growth rate in the prior 3-year period” (McGahan and Silverman, 2001, p. 1144). Life cycle stage III is defined as “the first year in which the number of firms during a 3-year period is less than 97% of the number in the prior 3-year period” (McGahan and Silverman, 2001, p. 1144). We imposed an additional criterion that industries are only classified as being in stage I if the growth rate is strictly positive over the analyzed period. Otherwise, stable industries that contain only very few firms, such as fishing in Austria, would be classified as emergent. To avoid short-term fluctuations, three-year rolling averages are used in all algorithms. We applied this approach since data on gross entry and gross exit rates was not available for this kind of analysis. Otherwise, the classification mechanisms similar to the one reported in Klepper and Graddy (1990) might be preferable. Industries that did not show one of the patterns for the three stages were not used in the analysis, which was the case for five out of 68 three-digit-level NACE codes.

Industry competition

Since profitability or rents are a standard proxy for competition in the empirical innovation literature (e.g., Greenhalgh and Rogers, 2006) we measured sector-based competitive pressure with profitability. Following Aghion et al. (2005) we specifically apply the ratio of net profit to total sales for three-digit-level NACE codes. Other measures such as market share or concentration indices rely more directly on precise definitions of geographic and product markets. This, however, would not be applicable in our study since many Austrian firms highly depend on foreign markets and thus market concentration measures on the basis of Austrian data may be misleading (Aghion *et al.*, 2005). Due to data confidentiality reasons, information on profitability was not available for individual firms and we therefore computed the competition measure using average values for industry sectors.

Control variables

We control for innovation inputs by using the *innovation intensity* measured as innovation expenditures as a share of sales to account for different levels of innovation investments. To control for different technological preconditions concerning business model innovation we include a dummy variable to account for all industries with an above-average *patenting propensity* as measured by Cohen et al. (2000). We furthermore use the number of *employees* in logarithm to account for firm size. Since existing studies often connect business model innovation to the advent of the internet (Amit and Zott, 2001) and postindustrial technologies such as software (Perkmann and Spicer, 2010) we also include a dummy variable that considers whether or not a firm employed *software developers* in-house. Whether firms are engaged in *cooperations* in any innovation activities with other enterprises or institutions is taken into account as well because business model innovation is a boundary-spanning activity in which partners may take a crucial role. Moreover, we control for variation in business model innovation and innovation performance that may be caused by whether or not a firm belongs to a group of companies *(enterprise group)*. Finally, we include a set of dummies to account for different geographic markets the firm sells its goods and/or services to (*local, national, European, other markets*) and apply 15 industry dummy variables representing industry groups as defined in the classification of the OECD (2006).

Model

To assess the sensitivity of our results to differences in measurement of the degree of business model innovation, we present all results for the three different versions of the degree of business model innovation variable. Version (a) of the degree of business model innovation variable takes eighteen, version (b) eleven, and version (c) seven different questions into account. Models with such count measures as dependent variable are commonly modeled with a Poisson estimator. However, a test for overdispersion indicates that the assumption of a Poisson distribution is violated. To correct for overdispersion, we employ negative binomial models to investigate the relationship of the industry life cycle stages and competitive pressure with the degree of business model innovation. As a robustness check we also present findings from Poisson regression models in Appendix A1.

We estimate the models on the relationship between the degree of business model innovation and innovation performance using a Tobit regression model, since the dependent variable is censored between 0 and 100 and has several observations clustered at zero. Moreover, the degree of business model innovation is an endogenous variable which may bias the estimation results if endogeneity remains unaccounted for. As a consequence, we estimate a two-stage least squares instrumental variable regression model to check for consistency of our results. This requires an instrumental variable which should be correlated with the endogenous variable, i.e. the degree of business model innovation, but uncorrelated with the dependent variable, i.e. innovation performance. Unfortunately, the Austrian CIS data do not contain potential instruments, such as information on hampering factors or innovation subsidies. We therefore had to revert to the three-digit NACE industry mean value of the degree of business model innovation variable. Theoretically, it is sensible to assume the industry mean to be related to the firm-specific variable but unrelated to firm innovation performance. In fact, the correlation between the mean and the endogenous variable is quite high 0.38/0.36/0.37 (subject to the respective degree of change variable) while it is quite low between the mean and innovation performance 0.16/0.17/0.16. The F-statistic from the weak instruments test does not indicate the instrument to be weak but since we only have one instrument we cannot perform an overidentification test. Although we acknowledge that our choice of instrument is not optimal, we are bound by the availability of data in the Austrian CIS.

Finally, as outlined above, our analyses are based on the sample of innovating firms, i.e. those that have introduced new products or processes. Innovative firms in that sense have made an initial decision whether to innovate or not while other firms are probably not innovative due to path dependency. Within the group of product/process innovators, innovation activities are however very permeable in the sense that many product innovators also perform process innovation and vice versa, if not at the same time then probably in the short run (Grimpe and Kaiser, 2010). Focusing only on product innovators would thus introduce a selection bias. Nevertheless, we also show a consistency check for the sample of product innovators only which yields consistent results.

Results

Table 1 presents descriptive statistics. It turns out that, on average, firms answered 7.82/4.37/2.42 (subject to the respective degree of business model innovation variable) business model relevant questions from the CIS questionnaire with yes. Firms in the sample achieve on average 9.18 percent of their sales with new products. Moreover, 21 percent of firms in the sample are classified as being in lifecycle stage II, 55 percent in lifecycle stage III; leaving 24 percent of the firms classified as being in lifecycle stage I. A mean of 0.89 in competition indicates that on average there is some degree of market power. A value of 1 would indicate perfect competition.

Table 2 presents the pairwise correlations for all measures. All three versions (a), (b) and (c) of the degree of business model innovation variable correlate highly with each other and positively with innovation performance. There are no indications for collinearity problems in our data as evidenced by the rather low mean variance inflation factors of 1.93 in the models predicting the degree of business model innovation and 1.95 in the innovation performance models (Belsley, Kuh, and Welsh, 1980).

Insert Table 1 about here

Insert Table 2 about here

Models 1-3 in Table 3 present the negative binomial results predicting the degree of business model innovation. In all three models the dummy variables for the industry life cycle stages I are positive and significant against the base category life cycle stage II (M1: $\beta=0.131$, $p<0.01$; M2: $\beta=0.147$, $p<0.01$; M3: $\beta=0.216$, $p<0.01$). The coefficients for life cycle stage 1 are all significantly different from the coefficients for life cycle stage III (M1: $p<0.001$, M2: $p<0.01$, M3: $p<0.05$) based on a Wald test. The coefficients for life cycle stage III are however not significantly different zero in any of the models. This indicates that in emergent industries firms exhibit a higher degree of business model innovation than in later industry life cycle stages. Consequently, Hypothesis 1, which predicted a higher degree of business model innovation to occur in early and late stages of the industry life cycle has to be qualified. It turns out that most change occurs in the emergent stage but considerably less in the decline stage.

Competition has a significant negative relationship (M1: $\beta=-0.893$, $p<0.01$; M2: $\beta=-0.922$, $p<0.01$; M3: $\beta=-1.116$, $p<0.01$) with the degree of business model innovation. As a result, we need to reject Hypothesis 2, which argued for a positive relationship between competitive pressure and the degree of business model innovation. Among the control variables innovation intensity, firm size as measured by the number of employees (in log), having software development, being part of an enterprise group and being engaged in innovation cooperation have a positive relationship with the degree of business model innovation. Results for the industry dummies are included in Table A1.

Models 4-6 investigate the influence of the degree of business model innovation on innovation performance, again, using three different versions of the degree of business model innovation variable. It turns out that the degree of business model innovation is positive and significant (M4: $\beta=3.458$, $p<0.001$; M5: $\beta=6.154$, $p<0.001$; M6: $\beta=9.069$, $p<0.001$). This finding provides support for Hypothesis 3.

The coefficients for the industry life cycle stages do not have any significant influence on innovation performance. Among the control variables innovation intensity, selling products in national, European or other markets, and cooperation have a positive effect on innovation performance. In-house software development and the number of employees affect innovation performance negatively.

Insert Table 3 about here

Tables A2 to A4 in the appendix show our consistency checks. We find consistent results when the 2SLS IV regression is used in which the degree of business model innovation is instrumented. Moreover, results are consistent for the sample of product innovators only.

Discussion and Conclusion

How does industry structure affect business model innovation and how does such innovation in the firm's business model translate into innovation performance? Our results indicate that in fact industry structure has an important role to play in affecting business models. First, we find most business model innovation to occur in the emergent life cycle stage, which suggests that firms are experimenting with different configurations of their business model until it becomes stable and is exploited over time. Few changes apparently happen both in the maturity and decline stage. In that sense, our findings challenge prior research that finds business model innovation to be most important in later stages of the industry life cycle when markets become commoditized (Johnson, 2010; Sabatier *et al.*, 2012; Massa and Tucci, 2013). Moreover, our results extend prior literature by not limiting the analysis to start-up firms which typically face a higher likelihood of innovating their business model (Winter and Szulanski, 2001). Instead our analysis includes incumbent firms on which little research is available to date. In fact, our results suggest firm size to be positively related to the degree of business model innovation, indicating such activities more likely to occur in incumbent firms.

Second, we find the competitive pressure in an industry to be negatively related to the degree of business model innovation. While one might have expected competition to force firms to rethink their business model, it seems that competitive pressure rather discourages business model innovation. Firms become reluctant to experiment with a range of alternative business models or individual business model components because they may fear being driven out of the market all too quickly if certain changes in the business model do not turn out to be viable. Another explanation refers to the strength of intellectual property protection which affects incentives to invest in innovation (Gilbert, 2006). Business model innovation is typically harder to protect against imitation compared to product and process innovation (Casadesus-Masanell and Zhu, 2013) which may also explain the negative effect of competition on business model innovation.

In line with prior studies, we provide evidence for a positive relationship between the degree of business model innovation and innovation performance (e.g., Hartmann *et al.*, 2013b; Pohle and Chapman, 2006; Sánchez and Ricart, 2010; Zott and Amit, 2007), given that a firm has introduced a product or process innovation. Apparently, innovating more components of the business model increases firm specificity which retards imitation by competitors and thus secures a higher degree of appropriability of the firm's innovations (Helfat, 1994).

Our results have implications both for the academic literature on business model innovation as well as for practitioner discussion. First, we extend prior literature by focusing on the role played by industry structure. We incorporate the insights of the model proposed by Utterback and Abernathy (1975) into an analysis on how business model innovation is driven by the industry life cycle and industry competition. In that sense, we complement existing research by shedding light on the industry-level antecedents, which we find to be important predictors of business model innovation. An analysis of the drivers of business model innovation without considering the industry-level would thus be incomplete and potentially biased.

Second, our approach shows how innovation survey data may be fruitfully applied towards the identification of business model innovation. By applying a multi-stage expert rating process to identify survey questions that are relevant for business model innovation, we develop a unique measure for the degree of innovation in a firm's business model that can easily be adopted and replicated by scholars working with innovation survey data such as the CIS. In that sense, our research also allows going beyond single cases to illustrate findings (Schneider and Spieth, 2013) and thus provides a broad coverage of industries.

Third, our research provides implications for the management of innovation projects. The combination of new products and processes with business model innovation positively influences innovation performance. If a new technology changes the way value is created and delivered to consumers, a new business model can strengthen the capabilities to capture some of the value created.

Our study clearly also has some limitations. The changing rates of business model innovation over industry life cycles should ideally be measured using longitudinal data derived over a number of years in a single industry. This would also allow to investigate whether firms prefer to exhaust options for – allegedly – lower risk product or process innovation before they move on to innovate the business model. Furthermore, our variable for measuring the degree of innovation in a business model does not incorporate interdependencies between business model components. The developed method is an approximation for the complexities involved in business model innovation efforts of a firm. Additionally, patterns of business models may vary across the industry life cycle. Our setup, however, only allows us to look into the relationship between a certain life cycle stage and the degree of business model innovation. We cannot identify certain communalities of business models depending on the life cycle stage. However, incumbent firms are oftentimes characterized by a high stability of their business model over time. In fact, they may stick to their business model even though the industry is declining due to organizational inertia, lock-in effects, and path dependency (Cavalcante, Kesting, and Ulhøi, 2011; McGrath, 2010; Sosna *et al.*, 2010). Hence, there is reason to assume a certain stability of the business model over time, even though we find that business model innovation occurs. Finally, radical business model innovation often happens across industry boundaries, an aspect that is not captured in the traditional classification of economic activity. Additional empirical analyses using different measures for business model innovation and alternative methods for classifying industry life cycles could help to validate our findings.

Overall, the results of this study indicate that industry structure plays a significant role in business model innovation. Taking industry life cycle stage and competitive pressure into consideration may enable mangers to develop a richer understanding of the performance impact of their business model innovation endeavors. We hope that this study may also serve as a step towards more empirical work on the topic. Future research could clarify the performance implications of business model innovation both in terms of other measures of performance and in the long term, as radical business model innovation may have a detrimental effect in the short run, but generate positive returns in the long run.

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Tables

Table 1. Descriptive statistics (n=1,242)

	Mean	Std. dev.	Min	Max
Degree of BMI (a)	7.82	4.00	0	18
Degree of BMI (b)	4.37	2.50	0	11
Degree of BMI (c)	2.42	1.75	0	7
Innovation performance	9.18	17.56	0	100
Life cycle stage II	0.21	0.41	0	1
Life cycle stage III	0.55	0.5	0	1
Competition	0.89	0.05	0.52	1
Patenting propensity	0.26	0.44	0	1
Innovation intensity	0.04	0.11	0	1
National market	0.37	0.48	0	1
European market	0.33	0.47	0	1
Other market	0.08	0.26	0	1
Employees (log)	4.41	1.41	2.3	9.66
Software development	0.71	0.46	0	1
Enterprise group	0.64	0.48	0	1
Cooperation	0.57	0.5	0	1

(a) Selection of CIS questions on the basis of threshold value >3.0 (18 questions)
(b) Selection of CIS questions on the basis of threshold value >3.5 (11 questions)
(c) Selection of CIS questions on the basis of threshold value >4.0 (7 questions)

Table 2. Correlations (n=1,242)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(1) Degree of BMI (a)															
(2) Degree of BMI (b)	0.95***														
(3) Degree of BMI (c)	0.88***	0.93***													
(4) Innovation performance	0.29***	0.33***	0.34***												
(5) Life cycle stage II	-0.03	-0.03	-0.05	-0.01											
(6) Life cycle stage III	0.02	0.02	0.03	0.01	-0.57***										
(7) Competition	-0.10***	-0.07*	-0.03	-0.08**	0.06*	0.22***									
(8) Patenting propensity	0.07*	0.06*	0.02	0.03	0.02	0.06*	-0.06*								
(9) Innovation intensity	0.14***	0.12***	0.09***	0.23***	-0.03	0.04	-0.12***	0.10***							
(10) National market	-0.05	-0.04	-0.01	-0.03	0.00	-0.01	0.09**	-0.17***	-0.06						
(11) European market	0.15***	0.13***	0.10***	0.10***	0.02	0.06*	0.00	0.21***	0.09**	-0.54***					
(12) Other market	0.09**	0.08**	0.08**	0.07*	0.00	0.06*	0.00	0.16***	0.05	-0.22***	-0.20***				
(13) Employees (log)	0.36***	0.31***	0.27***	-0.06*	0.03	0.01	-0.03	0.16***	-0.10***	-0.09**	0.20***	0.11***			
(14) Software development	0.27***	0.24***	0.22***	0.05	0.02	-0.01	-0.08**	-0.05	0.07*	0.01	0.05	0.03	0.20***		
(15) Enterprise group	0.25***	0.24***	0.24***	0.01	0.07**	-0.02	0.04	0.07*	-0.06*	-0.07*	0.17***	0.09**	0.48***	0.10***	
(16) Cooperation	0.47***	0.37***	0.36***	0.17***	0.02	-0.03	-0.08**	0.08**	0.08**	-0.08**	0.17***	0.09**	0.31***	0.14***	0.25***

*** p<0.001, ** p<0.01, * p<0.05

(a) Selection of CIS questions on the basis of threshold value >3.0 (18 questions)

(b) Selection of CIS questions on the basis of threshold value >3.5 (11 questions)

(c) Selection of CIS questions on the basis of threshold value >4.0 (7 questions)

Table 3. Negative binomial and tobit regression estimates

	Degree of business model innovation			Innovation performance		
	Negative binomial			Tobit		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[a]	Model 5[b]	Model 6[c]
Degree of BMI				3.458***	6.154***	9.069***
				(0.277)	(0.409)	(0.579)
Life-cycle stage I	0.131**	0.147**	0.216**	0.761	0.323	-0.575
	(0.044)	(0.052)	(0.069)	(3.169)	(3.094)	(3.087)
Life-cycle stage III	0.018	0.027	0.072	0.241	-0.01	-0.888
	(0.034)	(0.039)	(0.052)	(2.356)	(2.300)	(2.291)
Competition	-0.893**	-0.922**	-1.116**	-14.451	-12.071	-9.763
	(0.282)	(0.327)	(0.414)	(20.306)	(19.756)	(19.808)
Innovation intensity	0.474***	0.476***	0.493**	28.93***	28.594***	31.844***
	(0.108)	(0.123)	(0.159)	(7.721)	(7.509)	(7.387)
Patenting propensity	-0.03	-0.018	-0.027	-1.732	-2.01	-2.025
	(0.036)	(0.042)	(0.056)	(2.510)	(2.443)	(2.431)
National Market	0.052	0.047	0.091†	6.885**	7.09**	5.969*
	(0.035)	(0.041)	(0.054)	(2.481)	(2.427)	(2.415)
European Market	0.069†	0.071	0.098	9.227***	9.302***	9.072***
	(0.039)	(0.046)	(0.060)	(2.733)	(2.670)	(2.655)
Other markets	0.063	0.068	0.137†	10.695**	10.851**	9.704**
	(0.054)	(0.063)	(0.082)	(3.759)	(3.661)	(3.639)
Employees (log)	0.062***	0.064***	0.06***	-3.573***	-3.685***	-3.244***
	(0.010)	(0.012)	(0.016)	(0.756)	(0.734)	(0.725)
Software development	0.21***	0.218***	0.259***	-4.002*	-4.158*	-3.977*
	(0.029)	(0.035)	(0.046)	(2.007)	(1.949)	(1.935)
Enterprise group	0.076*	0.107**	0.177***	0.514	-0.229	-1.047
	(0.031)	(0.036)	(0.048)	(2.118)	(2.070)	(2.066)
Cooperation	0.394***	0.313***	0.411***	3.399†	5.324**	4.74*
	(0.028)	(0.033)	(0.043)	(2.037)	(1.917)	(1.914)
Industry dummies[d]	YES†	YES	YES	YES	YES	YES
Constant	2.08***	1.524***	0.933*	-9.541	-11.218	-9.006
	(0.264)	(0.306)	(0.389)	(19.026)	(18.506)	(18.515)
Observations	1242	1242	1242	1242	1242	1242
Log Likelihood	-6387.91	-5346.74	-4450.13	-3192	-3151	-3139

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, † < 0.1 (two-sided)
Results for industries dummies see appendix A1
[a] Selection of CIS questions on the basis of threshold value >3.0 (18 questions)
[b] Selection of CIS questions on the basis of threshold value >3.5 (11 questions)
[c] Selection of CIS questions on the basis of threshold value >4.0 (7 questions)
[d] Wald test on joint significance of industry dummies

Appendix

Table A1. Estimation results for industry dummies

	Degree of business model innovation			Innovation Performance		
	Negative binomial			Tobit		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[a]	Model 5[b]	Model 6[c]
Textiles and leather	-0.049	-0.089	-0.042	6.288	7.286	5.935
	(0.099)	(0.119)	(0.152)	(6.611)	(6.441)	(6.412)
Wood, paper, printing	-0.006	-0.042	-0.17	-5.728	-5.089	-2.444
	(0.070)	(0.083)	(0.111)	(4.949)	(4.837)	(4.817)
Chemicals and pharmaceuticals	-0.036	-0.033	-0.039	1.828	1.655	1.698
	(0.069)	(0.081)	(0.104)	(4.818)	(4.696)	(4.683)
Non-metallic mineral products	-0.138	-0.126	-0.115	4.783	4.998	4.387
	(0.091)	(0.108)	(0.140)	(6.128)	(5.955)	(5.923)
Basic metals and fabricated metal	-0.159*	-0.161*	-0.278**	-1.245	-1.208	0.779
	(0.067)	(0.079)	(0.104)	(4.659)	(4.543)	(4.528)
Computers, electronic and optical	-0.034	-0.048	-0.107	5.229	6.014	7.161
	(0.070)	(0.082)	(0.107)	(4.845)	(4.716)	(4.701)
Machinery and equipment	-0.03	-0.008	-0.045	8.06†	7.47†	8.195†
	(0.068)	(0.080)	(0.104)	(4.645)	(4.524)	(4.506)
Transport equipment	0.187*	0.225*	0.201	3.381	1.993	4.131
	(0.091)	(0.105)	(0.136)	(6.406)	(6.228)	(6.175)
Manufacturing n.e.c.	-0.12	-0.157	-0.226†	1.916	3.066	3.617
	(0.081)	(0.096)	(0.125)	(5.560)	(5.412)	(5.405)
Electricity, water supply, waste collection	-0.251**	-0.188†	-0.215	-9.77	-11.26†	-11.078
	(0.093)	(0.108)	(0.138)	(7.021)	(6.822)	(6.783)
Trade	0.017	0.064	0.127	-2.547	-4.084	-5.111
	(0.060)	(0.070)	(0.091)	(4.130)	(4.032)	(4.027)
Transportation and storage services	-0.31***	-0.299***	-0.319**	-13.007*	-13.15*	-14.061**
	(0.071)	(0.084)	(0.109)	(5.343)	(5.227)	(5.212)
Information and communication services	-0.054	-0.007	-0.028	5.208	3.738	4.691
+ financial intermediation	(0.074)	(0.086)	(0.112)	(5.109)	(4.983)	(4.957)
Scientific and technical services	-0.203*	-0.23*	-0.361**	3.255	3.635	5.349
	(0.079)	(0.094)	(0.124)	(5.555)	(5.427)	(5.429)

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, † < 0.1 (two-sided)
[a] Selection of CIS questions on the basis of threshold value >3.0 (18 questions)
[b] Selection of CIS questions on the basis of threshold value >3.5 (11 questions)
[c] Selection of CIS questions on the basis of threshold value >4.0 (7 questions)

Table A2. Poisson and 2SLS IV regression estimates

	Degree of business model innovation			Innovation performance		
	Poisson			2SLS IV		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[a]	Model 5[b]	Model 6[c]
Degree of BMI				0.824	2.297*	2.514*
				(0.732)	(0.931)	(1.157)
Life-cycle stage I	0.132***	0.148**	0.216**	-1.01	-0.436	-0.535
	(0.038)	(0.051)	(0.069)	(1.800)	(1.721)	(1.729)
Life-cycle stage III	0.017	0.026	0.072	-1.663	-1.231	-1.529
	(0.029)	(0.038)	(0.052)	(1.666)	(1.584)	(1.563)
Competition	-0.9***	-0.925**	-1.116**	-5.531	-2.092	-4.448
	(0.238)	(0.315)	(0.414)	(12.251)	(11.538)	(11.356)
Innovation intensity	0.453***	0.472***	0.493**	23.901***	21.835***	23.854***
	(0.089)	(0.118)	(0.159)	(5.451)	(4.966)	(4.716)
Patenting propensity	-0.031	-0.019	-0.027	-1.398	-1.451	-1.468
	(0.030)	(0.041)	(0.056)	(1.448)	(1.411)	(1.410)
National Market	0.048	0.046	0.091†	2.528†	2.425†	2.34†
	(0.030)	(0.040)	(0.054)	(1.298)	(1.260)	(1.267)
European Market	0.064	0.07	0.098	4.072**	3.836**	3.95**
	(0.033)	(0.044)	(0.060)	(1.486)	(1.440)	(1.436)
Other markets	0.062	0.068	0.137†	4.806*	4.521*	4.386*
	(0.046)	(0.061)	(0.082)	(2.145)	(2.086)	(2.101)
Employees (log)	0.063***	0.064***	0.06***	-2.229***	-2.485***	-2.184***
	(0.009)	(0.012)	(0.016)	(0.572)	(0.496)	(0.447)
Software development	0.209***	0.217***	0.259***	-0.196	-0.946	-0.387
	(0.025)	(0.034)	(0.046)	(1.505)	(1.307)	(1.221)
Enterprise group	0.077**	0.107**	0.177***	0.582	0.066	0.064
	(0.026)	(0.035)	(0.048)	(1.213)	(1.192)	(1.209)
Cooperation	0.393***	0.313***	0.411***	2.997	2.412	3.043*
	(0.024)	(0.032)	(0.043)	(2.317)	(1.553)	(1.456)
Industry dummies[d]	YES†	YES	YES	YES	YES	YES
Constant	2.087***	1.526***	0.933*	11.984	7.344	11.473
	(0.223)	(0.295)	(0.389)	(12.400)	(11.280)	(10.785)
Observations	1242	1242	1242	1242	1242	1242

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, † < 0.1 (two-sided)
Results for industries dummies see appendix A1
[a] Selection of CIS questions on the basis of threshold value >3.0 (18 questions)
[b] Selection of CIS questions on the basis of threshold value >3.5 (11 questions)
[c] Selection of CIS questions on the basis of threshold value >4.0 (7 questions)
[d] Wald test on joint significance of industry dummies

Table A3. Estimation results for industry dummies

	Degree of business model innovation			Innovation Performance		
	Poisson			IV		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[a]	Model 5[b]	Model 6[c]
Textiles and leather	-0.038	-0.086	-0.042	4.022	4.641	4.032
	(0.085)	(0.116)	(0.152)	(3.795)	(3.723)	(3.706)
Wood, paper, printing	-0.007	-0.041	-0.17	0.009	0.433	0.955
	(0.060)	(0.080)	(0.111)	(2.656)	(2.606)	(2.640)
Chemicals and pharmaceuticals	-0.033	-0.032	-0.039	1.403	1.506	1.41
	(0.058)	(0.078)	(0.104)	(2.717)	(2.656)	(2.653)
Non-metallic mineral products	-0.122	-0.122	-0.115	2.19	2.622	2.077
	(0.078)	(0.104)	(0.140)	(3.458)	(3.353)	(3.329)
Basic metals and fabricated metal	-0.151**	-0.159*	-0.278**	0.201	0.86	0.905
	(0.057)	(0.076)	(0.104)	(2.716)	(2.601)	(2.630)
Computers, electronic and optical	-0.026	-0.046	-0.107	6.363*	6.695*	6.927*
	(0.059)	(0.079)	(0.107)	(2.745)	(2.690)	(2.699)
Machinery and equipment	-0.023	-0.006	-0.045	4.88†	4.815†	5.016†
	(0.058)	(0.077)	(0.104)	(2.633)	(2.571)	(2.573)
Transport equipment	0.188*	0.227*	0.201	4.8	3.475	4.708
	(0.076)	(0.101)	(0.136)	(3.983)	(3.851)	(3.747)
Manufacturing n.e.c.	-0.117†	-0.156†	-0.226†	1.092	1.902	1.728
	(0.069)	(0.093)	(0.125)	(3.177)	(3.109)	(3.107)
Electricity, water supply, waste collection	-0.254**	-0.189†	-0.215	-4.067	-3.848	-4.424
	(0.079)	(0.105)	(0.138)	(3.906)	(3.632)	(3.600)
Trade	0.019	0.066	0.127	-0.27	-0.739	-0.864
	(0.051)	(0.068)	(0.091)	(2.239)	(2.201)	(2.209)
Transportation and storage services	-0.304***	-0.298***	-0.319**	-2.624	-1.751	-2.685
	(0.061)	(0.082)	(0.109)	(3.014)	(2.762)	(2.665)
Information and communication services	-0.055	-0.007	-0.028	4.319	4.055	4.155
+ financial intermediation	(0.063)	(0.083)	(0.112)	(2.870)	(2.785)	(2.785)
Scientific and technical services	-0.203**	-0.23*	-0.361**	3.61	4.598	4.498
	(0.067)	(0.091)	(0.124)	(3.255)	(3.119)	(3.142)

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, † < 0.1 (two-sided)
[a] CIS questions threshold value >3.0 (18 questions)
[b] CIS questions threshold value >3.5 (11 questions)
[c] CIS questions threshold value >4.0 (7 questions)

Table A4. Negative binomial and tobit regression estimates based on the product innovator sample

	Degree of business model innovation			Innovation performance		
	Negative binomial			Tobit		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[a]	Model 5[b]	Model 6[c]
Degree of BMI				1.876***	4.161***	6.834***
				(0.290)	(0.422)	(0.579)
Life-cycle stage I	0,094*	0,092†	0,166*	0.34	-0.087	-1.206
	(0,042)	(0,055)	(0,075)	(3.238)	(3.173)	(3.149)
Life-cycle stage III	0,024	0,03	0,078	0.816	0.593	-0.217
	(0,031)	(0,041)	(0,055)	(2.381)	(2.334)	(2.313)
Competition	-0,498†	-0,458	-0,676	-11.677	-9.411	-5.224
	(0,260)	(0,345)	(0,452)	(20.765)	(20.345)	(20.236)
Innovation intensity	0,415***	0,47***	0,452**	36.162***	33.32***	35.468***
	(0,098)	(0,129)	(0,175)	(8.286)	(8.081)	(7.926)
Patenting propensity	-0,015	-0,004	-0,012	-1.929	-2.028	-1.994
	(0,032)	(0,043)	(0,058)	(2.499)	(2.446)	(2.418)
National Market	-0,003	-0,018	0,036	5.309*	5.678*	4.591†
	(0,033)	(0,044)	(0,060)	(2.564)	(2.518)	(2.493)
European Market	-0,007	-0,013	0,02	7.904**	8.226**	7.798**
	(0,037)	(0,049)	(0,066)	(2.823)	(2.769)	(2.739)
Other markets	-0,005	-0,013	0,065	9.424*	9.799**	8.593*
	(0,049)	(0,066)	(0,088)	(3.802)	(3.724)	(3.676)
Employees (log)	0,05***	0,053***	0,044**	-3.447***	-3.753***	-3.534***
	(0,009)	(0,012)	(0,016)	(0.752)	(0.734)	(0.721)
Software development	0,196***	0,2***	0,234***	-1.759	-2.606	-2.847
	(0,027)	(0,036)	(0,049)	(2.059)	(2.005)	(1.976)
Enterprise group	0,052†	0,069†	0,127*	-0.087	-0.662	-1.49
	(0,028)	(0,038)	(0,051)	(2.159)	(2.119)	(2.102)
Cooperation	0,335†***	0,265***	0,388***	4.847*	4.944*	3.454†
	(0,026)	(0,035)	(0,047)	(2.095)	(1.971)	(1.961)
Industry dummies[d]	YES	YES	YES	YES	YES	YES
Constant	1,952***	1,351***	0,801†	3.455	-0.221	-1.083
	(0,243)	(0,323)	(0,424)	(19.431)	(19.025)	(18.886)
Observations	948	948	948	948	948	948
Log Likelihood	-4699	-4000	-3436	-3079	-3050	-3027

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, † < 0.1 (two-sided)
Results for industries dummies see appendix A1
[a] CIS questions threshold value >3.0 (18 questions)
[b] CIS questions threshold value >3.5 (11 questions)
[c] CIS questions threshold value >4.0 (7 questions)
[d] Wald test on joint significance of industry dummies

Table A5. CIS questions indicating innovation in a firm's business model

	Degree of business model innovation version:	**(a)**[a]	**(b)**[b]	**(c)**[c]
1	During the three years 2008 to 2010, did your enterprise introduce: New or significantly improved goods (exclude the simple resale of new goods and changes of a solely aesthetic nature)	x	x	
2	During the three years 2008 to 2010, did your enterprise introduce: New or significantly improved services	x	x	
3	Were any of your product innovations (goods or services) during the three years 2008 to 2010 new to your market?	x	x	x
4	Were any of your product innovations (goods or services) during the three years 2008 to 2010 new to your firm?	x		
5	Were any of your product innovations during the three years 2008 to 2010 a first in Austria, Europe or a world first?	x	x	x
6	During the three years 2008 to 2010, did your enterprise introduce new or significantly improved methods of manufacturing or producing goods or services	x	x	
7	During the three years 2008 to 2010, did your enterprise introduce new or significantly improved logistics, delivery or distribution methods for your inputs, goods or services?	x	x	x
8	During the three years 2008 to 2010, did your enterprise introduce new or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing	x	x	
9	During the three years 2008 to 2010, did your enterprise engage in the following innovation activities: Acquisition of advanced machinery, equipment or software to produce new or significantly improved products and processes	x		
10	During the three years 2008 to 2010, did your enterprise engage in the following innovation activities: Activities for the market introduction of your new or significantly improved goods or services, including market research and launch advertising	x		
11	During the three years 2008 to 2010, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?	x		
12	During the three years 2008 to 2010, did your enterprise introduce new business practices for organizing procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc.)?	x	x	x
13	During the three years 2008 to 2010, did your enterprise introduce: New business practices for organizing procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc.)	x		
14	During the three years 2008 to 2010, did your enterprise introduce new methods of organizing external relations with other firms or public institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc.)?	x	x	x
15	How important were each of the following objectives for your enterprise's organizational innovations introduced during the three years 2008 to 2010 inclusive: Improve ability to develop new products or processes? (HIGH)	x		
16	During the three years 2008 to 2010, did your enterprise introduce 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.)?	x	x	x
17	During the three years 2008 to 2010, did your enterprise introduce new methods of pricing goods or services (i.e. first time use of variable pricing by demand, discount systems, etc.)?	x	x	x
18	How important were each of the following objectives for your enterprise's marketing innovations introduced during the three years 2008 to 2010 inclusive: Introduce products to new customer groups? (HIGH)	x		

[a] Selection of CIS questions on the basis of threshold value >3.0 (18 questions)
[b] Selection of CIS questions on the basis of threshold value >3.5 (11 questions)
[c] Selection of CIS questions on the basis of threshold value >4.0 (7 questions)