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

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Abstract

What makes firms innovate their business models? Why do they engage in innovating how they create, deliver and capture value? And how does such innovation translate into innovation performance? 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's life cycle and levels of industry competition affect firms' business model innovation, and how such innovation 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 industry pressures turn out to be negatively related to the degree of business model innovation. Moreover, we find that the degree of a firm's business model innovation, conditional on it having introduced a new product or process recently, positively influences innovation performance. Our findings contribute to the ongoing dialog on the role of industry structure in business model innovation, and provide implications for the management of business model innovation.

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

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Introduction

Business model innovation has attracted considerable attention in recent strategy literature (e.g., Baden-Fuller & Mangematin, 2013; Casadesus-Masanell & Zhu, 2013; Zott, Amit & Massa, 2011) as well as practitioner discussion (e.g., Pohle & 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 & Bateman, 2013a: 5), business model innovation has been shown to allow both incumbent and entrepreneurial firms to (re-)configure how they operate and increase their performance (e.g., Desyllas & Sako, 2013; Hartmann, Oriani & Bateman, 2013b; Massa & Tucci, 2013). Teece (2007) considered firms' ability to develop, adjust and if necessary replace business models to be central to their dynamic capabilities. Business model innovation differs from other types of innovation in that it deals with the firm's entire activity system, not only a particular product or process (Snihur & Zott, 2013); and is typically harder to protect against imitation than are product and process innovations (Casadesus-Masanell & 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 might lead firms to innovate their business model components: in fact, prior research has emphasized the need for further investigation of the drivers of business model innovation (Chesbrough & Rosenbloom, 2002; George & Bock, 2011; Zott & Amit, 2007). Yet existing evidence seems to be confined to firm-level antecedents, such as organizational inertia (Sosna, Trevinyo-Rodriguez & Velamuri, 2010), inertia at upper management levels (Chesbrough & Rosenbloom, 2002; Tripsas & Gavetti, 2000), cognitive closure of firms (Chesbrough, 2010), and conflicts with existing assets (Amit & Zott, 2001). Little attention has been paid to industry structure, particularly industry life cycle stages and the degree of competitive pressure. This is surprising given Utterback and Abernathy's (1975) seminal contribution on how the focus of innovation on products and processes changes as an industry develops over time. On the one hand, one might assume that emergent industries would provide considerable potential for business model innovation, and there is evidence that start-ups' early experiments with a range of alternative business models, or individual business model components, can lead them to be better able to identify a business model design that can be stabilized and replicated during later exploitation phases (Winter & Szulanski, 2001), and so become profitable over the rest of the firm's life cycle (Murray & Tripsas, 2004). On the other hand, one can also expect that industry maturity is a condition where firms' existing business models become increasingly challenged and so need to be innovated (Sabatier, Craig-Kennard & Mangematin, 2012). Following that logic, business model innovation has been suggested as being more important in later industry life cycle stages, when markets may become commoditized (Johnson, 2010; Massa & Tucci, 2013).

In this paper, we seek to contribute to this debate and incorporate the insights of the model that Utterback and Abernathy (1975) proposed into an analysis of how business model innovation is driven by industry life cycles and competition factors. In particular, as a first step, we are interested in how the specific stage of an industry life cycle influences the degree of innovation in firms' business models. As the second step, we move from the industry level to the firm level to investigate whether the degree of a firm's business model innovation is connected to its innovation performance, defined as its ability to capture value during new product commercialization.

Our research is based on a cross-industry sample of 1,242 Austrian firms which were surveyed in 2010 during 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 the 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 go beyond investigating whether a business model changes or not, but rather focus on the degree of that business model innovation and its relationship with innovation performance. We limit our sample to innovation-active firms - firms that have recently introduced a new product or process - in order to draw valid conclusions regarding the implications of business model innovation for innovation performance. We use data from structural business statistics to classify industry sectors according to their life cycle stages, and compute profit persistence within industry sectors as a measure of competitive pressure.

Our results suggest that, although business model innovation is also discussed as being important in later industry life cycle stages, the degree of business model innovation is greatest in emerging industries. Moreover, we find that – in contrast to what we expected - industry competition negatively influences the degree of business model innovation. Finally, at the firm level we find a positive relationship between the degree of business model innovation and innovation performance, while controlling for industry structure.

Our research makes two main 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. We adapt Utterback and Abernathy's (1975) model to investigate how industry life cycle and competition factors motivate firms to innovate their business models, and how such changes translate into innovation performance. In that sense, our results provide important implications for the management of business model innovation. Second, most business model innovation literature is conceptual in nature or uses single cases to illustrate findings (Schneider & Spieth, 2013), and anecdotal evidence suggests that business model innovation occurs primarily when markets have become mature and commoditized (Johnson, Christensen & Kagermann, 2008; Massa & Tucci, 2013). In contrast, we leverage a large cross-industry database to assess the relationships between industry life cycle stages, industry competition levels and business model innovation, which provides broader empirical evidence.

The remainder of this article is organized as follows. The next section reviews the literature on business model innovation and outlines our theoretical framework, after which we describe our data and methods. We then present and discuss our results, and finally conclude and outline the limitations of our research.

Literature Review and Hypotheses

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

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

But what drives or blocks business model innovation? While existing research mainly focuses on firm-level antecedents (e.g., Sosna et al., 2010; Chesbrough, 2010; Amit & Zott, 2001; Tripsas & Gavetti, 2000), examining 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 as they traverse through servitization life cycles (Neely, 2008; Visnjic Kastalli & Van Looy, 2013; Visnjic Kastalli, Van Looy & Neely, 2013). Further drivers of business model innovation include market changes, new technology, shifting demographics, or greater regulatory oversight (Baden-Fuller & Haefliger, 2013; Drucker, 1984). In the case of new technology, Baden-Fuller & Haefliger (2013) have described the role of the business model as mediating between technological innovation and firm performance, while Chesbrough (2010) showed that the same technology commercialized in different ways may result in different economic outcomes. In this sense, business models are indeed a subject of innovation in themselves, as firms can compete through their business models (Casadesus-Masanell & Zhu, 2013).

Little research is however available that focuses on the industry level, i.e., on the role of industry structures for business model innovation. While mature industries have been reported as providing a context where existing business models may become challenged and need to be innovated (Sabatier, Craig-Kennard & Mangematin, 2012), the literature still lacks a systematic treatment of how industry life cycles and industry competition affect business model innovation, analogous to Utterback and Abernathy's (1975) model of product and process innovation. In that model, the authors distinguish between three stages. In the 'fluid phase', firms are primarily concerned with product innovation in order to find out which design appeals most to customers and best fulfills their requirements. Over time a dominant design emerges that captures the majority of the market, which they suggest is a 'transition phase' towards product standardization and an increasingly efficient production. In this phase, process innovation becomes firms' dominant focus until - in the final, 'specific phase' - the focus lies on cost minimization with both product and process innovation being of decreasing importance.

In the following, we first present arguments about the industry-level antecedents of business model innovation before outlining the firm-level implications of such innovation for innovation performance.

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 & Zhu, 2013). Incumbents may be forced to adapt to the altered competitive environment and react with business model innovation of their own (Johnson, 2010; Massa & Tucci, 2013; McGrath, 2010; Teece, 2010). However, changing the fundamental components of a running business is risky (Girotra & Netessine, 2011), so knowing when to innovate a business model is a critical challenge for managers (Johnson, 2010). The model proposed by Utterback and Abernathy (1975) provides an understanding of how the focus of innovation changes as an industry matures, when the linkages between product and process are becoming closer and any small changes in either product or process are difficult and expensive (Johnson, 2010; Utterback, 1994).

As a consequence, prior work has suggested that there is a succession of innovation from product to process, and finally to business model innovation (Massa & Tucci, 2013; Boutellier, Eurich & 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 usage; (3) in the relational phase, service provisioning becomes truly outcome-based, and the manufacturer redefines itself as a provider of results (Visnjic Kastalli et al., 2013; Martinez et al., 2011). Martinez et al.'s (2011) study of the truck industry shows that the life cycle of the service offering transforms over time from selling an artefact (a truck) to selling mobility (miles driven).

As services are context specific (Visnjic Kastalli et al., 2013), servitization life cycles can be difficult to generalize and predict: but the anecdotal evidence available suggests that pressures for business model innovation tend to become more intense under real or anticipated competitive pressure, when profit margins are declining and towards the end of industry life cycles (Eggert et al., 2014; Neely, 2008; Visnjic Kastalli et al., 2013). It seems that firms tend to put more effort into business model innovation when their once successful business models lose ground and revenues are dropping. Business model innovation offers them a way to differentiate themselves from their competitors when that is no longer possible based on products or processes alone (Chesbrough, 2010; Johnson, 2010; Matzler et al., 2013). Sabatier et al. (2012) find empirical evidence that when an industry is mature and profitability decreases, existing business models are likely to be challenged by new ones. In his seminal works on disruptive innovation, Christensen (1997; 2006) demonstrates that disruptors enter mature industries primarily with the help of rule-breaking business models.

Nevertheless, there may also be considerable opportunities to innovate business models in emergent industries that are dominated by start-up firms. Start-ups have been shown to experiment frequently with a range of alternative business models or individual model components in order to better identify those that can be stabilized and replicated during later exploitation phases (Winter & Szulanski, 2001; Murray & Tripsas, 2004). Not yet being locked into an established model, start-ups have the choice to tinker around with different business model components and address new business opportunities. Business model innovation flourishes especially when innovative technologies are applied and monetized in different ways (Chesbrough, 2010). Taking these arguments together, our first hypothesis reads:

Hypothesis 1: The degree of business model innovation is highest at the beginning and towards the end of industry life cycles, i.e. at the emergent and the declining stages.

Since the life cycles industries pass through are strongly connected to firms' entries and exits – i.e. there will be high levels of firm entries in the emergent phase, and of exit in the decline stages (McGahan & Silverman, 2001) – the degree of business model innovation has been argued to depend on real or anticipated competitive pressures and associated profit margins (Eggert et al., 2014; Neely, 2008; Visnjic Kastalli et al., 2013). Following 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 (e.g., Aghion & Howitt, 1990; Hashmi, 2013) describe a negative relationship, others (e.g., Carlin, Schaffer & Seabright, 2004; Gorodnichenko, Svejnar & Terrell, 2010; Nickell, 1996) find a positive relationship between competition and innovation. In a seminal article, Aghion et al. (2005) derive an inverse U-shaped relationship between competition and innovation: competitive pressures initially motivate firms to innovate and introduce new products, to attempt to achieve temporary monopolies; but after a certain point when those pressures become too great, incentives to innovate decrease, because firms no longer find their investments in innovation are justified by the returns. These contrasting results seem to depend on the time periods involved, 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 suggest 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, particularly in incumbent firms (Aspara et al., 2013; Sosna et al., 2010). While thoroughly innovating a firm's business model may appear too risky, decision makers' willingness to do so increases with competitive pressures. In fact, anecdotal evidence suggests that most cases of successful business model innovation either involve new market entrants, or incumbent firms that are experiencing severe business problems (Chesbrough, 2007; 2010; Drucker, 1995; Lindgardt, Reeves & 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 pressures (Suarez, Cusumano & Kahl, 2012; Cusumano, Kahl & Suarez, 2014). It seems unlikely that competitive pressure will lead to a decrease in the degree of business model innovation after a certain point - along the lines of an inverse U-shaped relationship - since those firms who resist innovating their business models are anyway likely to be outperformed by their competitors over time. Hence, we propose:

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

Firm-level performance consequences of business model innovation

The link between business models and firm performance is among the dominant themes in the extant business model literature (Lambert & Davidson, 2013). Most of the available evidence is drawn from case study research, but exceptions include Casadesus-Masanell and Zhu (2013), who propose a formal model of business model innovation for a specific business model type - sponsor-based business models - with a focus on the competitive imitation of business models, and Hartmann and colleagues, who use the NK-modelling approach to develop a quantitative model for business model innovation, focusing on the antecedents and performance implications of business model innovation in incumbent firms in established industries (Hartmann et al., 2013a; 2013b).

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

Rather than innovating its whole business model, such innovations may be incremental, i.e., involving only a few components (Massa & Tucci, 2013). Firms that seek to adapt their existing business model to changing markets may only need to innovate a small number of their business model components. But if a business model is sufficiently differentiated and hard to replicate - for incumbents and new entrants alike - it is more likely to give them a head-start over their competitors (Teece, 2010). Changing more business model components (i.e. more radical business model innovation) may increase firm specificity, which will delay imitation by competitors, and thus secure a firm a higher degree of appropriation from its 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 them to benefit from first mover advantages (Lieberman & Montgomery, 1988): In this case, the degree of value capture from new product commercialization, i.e. innovation performance, will be greater. As the first to market with a novel value proposition, a company may have the opportunity to lock-in its customers, e.g. by creating positive network externalities (Katz & Shapiro, 1985), achieving commitment to contracts, personalization of products or services, or by inducing switching costs (Amit & Zott, 2001; Frank, 2007; Harrison et al., 2012; Lieberman & Montgomery, 1988). Lock-in can bind consumers to the new product, create markets for cross-selling opportunities, and eventually gain recurring revenues from the same pool of customers (Amit & Zott, 2001; Farrell & 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 a firm's business model innovation - conditional on it having introduced a new product or process - and its 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 about the structure, employment, activities and performance of Austrian firms broken down according to their economic activities. From this data, we specifically use the number of firms active in three-digit level NACE industries over the period from 2005 to 2011 to classify industries according to their industry life cycle stages. Second, we draw data from the Austrian section of the European Union's Community Innovation Survey (CIS) 2010. The methodology and questionnaire used follow the OECD's Oslo manual (OECD, 2005). The survey asks firms' decision makers, such as CEOs, heads of innovation management units or R&D departments about their innovation activities. Informants provide direct, importance-weighted data for several questions about innovation inputs, processes and outputs (Criscuolo, Haskel & Slaughter, 2005). These surveys have been used in European Union member and associated states for over a decade, and are subject to extensive pre-testing and piloting in various countries, industries and firms to ensure their interpretability, reliability and validity (Laursen & Salter, 2006). CIS data have often been used in recent contributions in the strategy and innovation literature (e.g., Laursen & Salter, 2006; Grimpe & Kaiser, 2010; Leiponen & Helfat, 2011).

The Austrian CIS data consist of a representative random sample of incumbent and emergent 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 - which gathers data for the three-year period from 2008 to 2010 - was sent out to 5,409 firms, of which 3,172 provided reliable information, a response rate of 59.3 percent (StatisticsAustria, 2012).

Our dataset and method do not allow handling product/process innovation and business model innovation in a fully orthogonal fashion. To keep the effect of the overlap to a minimum, we measure the effect of business model innovation in addition to that of product/process innovations. Hence, as outlined before, we restrict the sample to innovation-active firms (1,792 firms) i.e., those that either introduced at least one product and/or process innovation, or were in the process of so doing, or had tried but failed to do so, during the observation period. 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), which reduced the sample to 1,530 firms. Omitting firms with missing values reduced our effective sample further to 1,242 firms. Prior studies based on CIS-type data indicate restricting a sample to innovative firms would be unproblematic in terms of selection bias (Grimpe & Kaiser, 2010). Since micro-level CIS data about Austrian firms are not publicly available, R-scripts were written for execution by Statistics Austria, which in turn provided us with the data analysis results.

Measurement of dependent variables

Degree of business model innovation

Although the CIS provides a broad range of information on innovation activities, firms are not asked directly 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 which CIS questions applied to business model innovation and to map them to the key elements of creating, delivering and capturing value. The degree of business model innovation was assessed using a count variable that tallied the number of business model relevant questions to which a firm answered ‘yes’. As a preparatory stage before the expert rating process, we first inspected the entire set of 58 CIS questions and removed those that had no potential to indicate business model innovation. In all, we removed 16 sub-questions related to two question blocks on employee skills and employee education, as well as on types of cooperation partners. (Only firms that were actually cooperating with others had to answer these questions about cooperation partners, so they were not answered by all survey respondents.)

Second, we selected three independent external experts in business model innovation[1] and asked them individually to rate the remaining 42 questions as to whether answers to survey questions might indicate that a firm innovated its business model, i.e. changed the way it created, delivered and/or captured value. Before the rating process started, we provided all the experts with the business model definition outlined above and informed them about the evaluation criteria and the respective rating scales, in line with a procedure Krippendorff (2004) outlined for expert rating, to ensure they all had a comparable understanding of the task and of the rating standards to be applied. We asked them to measure whether or not an answer to a CIS question contained information on business model innovation using a 5-point rating scale (where 1 = contains no information at all on business model innovation and 5 = contains a high level of information on business model innovation).

In a third step, we informed each expert about the individual ratings of the other two, based on this, they were allowed (but not required) to adapt and refine their individual ratings if the other experts' ratings convinced them to change their assessments. We assessed inter-rater reliability by calculating Krippendorff's alpha, which is a conservative index that measures agreement between multiple raters and is considered a highly rigorous measure for assessing inter-rater reliability for rating scales such as those employed in this study (values of .67 and greater are generally considered to be satisfactory; Krippendorff, 2004). The agreement coefficient in our study was 0.84, well above the recommended threshold value.

For further analysis we constructed three versions of the variable representing the degree of business model innovation representing more and less inclusive views of the business model construct, based on three different thresholds on the 5-point rating scales (>3.0, >3.5, >4.0), i.e. by selecting those CIS questions that received average expert ratings above 3.0, 3.5 or 4.0, respectively. Depending on the particular threshold, these variables included eighteen, eleven, or seven of the 42 initial CIS questions that we judged might be relevant to business model innovation[2]. The most rigorous selection (threshold value >4.0) led to 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?",

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

[2] Table A5 in the appendix provides the list of selected CIS questions for all three threshold values, and Table A6 reports on how business model innovation-relevant CIS questions were assigned to creating, delivering and capturing value for the eighteen-item selection.

(2) "Were any of your product innovations during the three years 2008 to 2010 a first in Austria, in Europe or the world?",

(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 systems, etc.)?".

We performed data analysis using all three versions of this degree of business model innovation variable to provide 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 by 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 & Kaiser, 2010; Klingebiel & Rammer, 2014).

Measurement of independent variables

Industry life cycle stage classification

Following previous work related to industry life cycles (e.g. Dinlersoz & MacDonald, 2009; Klepper & Graddy, 1990; Utterback & Abernathy, 1975), we classify industries into three life cycle stages: emergent (stage I), maturity (stage II), and decline (stage III). We apply the approach taken by McGahan and Silverman (2001) to identify the inflection points that characterize the beginnings and ends 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, and 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 in that we only classified industries as being in stage I if the growth rate was strictly positive over the analyzed period: otherwise, stable industries that contain only very few firms in Austria - such as fishing - would be permanently classified as emergent. We used three-year rolling averages in all algorithms to avoid short-term fluctuations, as data on gross entry and exit rates was not available for this kind of analysis. Otherwise, the classification mechanisms similar to those reported in Klepper and Graddy (1990) might have been preferable. Firms in industries that did not show any one of the three life cycle stage patterns - which was the case for five of the 68 three-digit-level NACE codes - were excluded from the analysis.

Industry competition

Since profitability or rents are used as a standard proxy for measuring competition in the empirical innovation literature (e.g., Greenhalgh & Rogers, 2006), we used profitability to measure sector-based competitive pressure. Specifically, we follow Aghion et al. (2005) in using 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, which would not be appropriate in our study, since many Austrian firms are highly dependent on foreign markets, so that 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, so we compute the competition measure using average industry sector values.

Control variables

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

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 that variable: version (a) takes eighteen different questions into account, version (b) that takes eleven questions, and version (c) seven questions. Models with such count measures as dependent variables are commonly modeled with a Poisson estimator, but an over-dispersion test indicated that the assumption of a Poisson distribution was violated. To correct for over-dispersion, we employed negative binomial models to investigate the relationship between industry life cycle stages and competitive pressures and the degree of business model innovation. (We also present findings from Poisson regression models in Appendix A1 as a robustness check.)

We use a Tobit regression model to estimate the relationship between the degree of business model innovation and innovation performance, since the dependent variable is censored between 0 and 100 and has several observations clustered at zero. Moreover, since the degree of business model innovation is an endogenous variable which might bias the estimation results if endogeneity remained unaccounted for, we follow Rivers and Vuong's (1988) methodology to account for potential endogeneity of the degree of business model innovation in the Tobit models as a consistency check for our results. This requires an instrumental variable (IV) which should be correlated with the endogenous variable (the degree of business model innovation) but uncorrelated with the dependent variable (innovation performance). Unfortunately, the Austrian CIS data do not contain potentially useful instruments, such as information on hampering factors or innovation subsidies, so we had to revert to the three-digit NACE industry mean value of the degree of business model innovation variable. Theoretically, it is reasonable to assume the industry mean will 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), but is quite low between the mean and innovation performance (at 0.16/0.17/0.16 respectively). The F-statistics from the weak instruments test do not indicate the instrument to be weak, but as we only have a single instrument, we cannot perform an over-identification test. Although we acknowledge that our choice of instrument is not optimal, we are bound by the availability of data in the Austrian CIS. Rivers and Vuong (1988) describe a two-stage model. In the first stage, the degree of business model innovation is regressed on the instrument and exogenous regressors, and the fitted values and residuals from this first stage are then both included in the Tobit model estimated in the second stage. We refer to the estimates from this process as IV-Tobit estimates.

Finally, as outlined above, our analyses are based on our sample of innovation-active firms, i.e. those that introduced new products or processes. Firms that are innovative in that sense have made initial decisions as to whether or not to innovate, while others are probably not innovative due to path dependency reasons. However, within the group of product/process innovators, innovation activities are closely interlinked, in the sense that many product innovators also perform process innovations, and vice versa, if not at the same time then probably within the short run (Grimpe & Kaiser, 2010). Thus, focusing only on product innovators risks introducing a selection bias: nevertheless, we also run 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 ‘Yes’ to 7.82/4.37/2.42 questions relevant to business models from the CIS questionnaire, subject to the respective degrees of the business model innovation variable. On average, sample firms achieved 9.18 percent of their sales with new products. 21 percent of them were classified as being in lifecycle stage II and 55 percent in lifecycle stage III; leaving 24 percent being classified as being in lifecycle stage I. A mean of 0.89 in their competition scores suggests that, on average, they face quite strong competition in their markets (a value of 1 would indicate perfect competition and 0 a monopoly).

Table 2 presents the pairwise correlations for all measures. All three versions (a), (b) and (c) of the degree of the business model innovation variables correlate highly with each other, and positively with innovation performance. There are no indications of collinearity problems in our data, as shown 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 & Welsh, 1980).

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)

Models 1-3 in Table 3 present the negative binomial results predicting the degree of business model innovation. We use life cycle stage II as the base category to identify any significant differences between life cycle stages I or III compared to that stage. In all three models the dummy variables for the industry life cycle stage I are positive and significant against life cycle stage II (M1: $\beta=0.131$, $p<0.01$; M2: $\beta=0.147$, $p<0.01$; M3: $\beta=0.216$, $p<0.01$), whereas, the coefficients for life cycle stage III are not significant against life cycle stage II in any of the models. Further Wald tests revealed that the coefficients for life cycle stage I differ significantly from those for life cycle stage III (M1: $p<0.001$, M2: $p<0.01$, M3: $p<0.05$), and the coefficients for life cycle stage III are not significantly different from zero. Hence, there is no evidence for an inverted U-shape relationship between the industry life cycle stage and the degree of business model innovation. These results indicate that firms from life cycle stage I industries exhibit higher degrees of business model innovation than those in industries in later life cycle stages. Consequently, Hypothesis 1, which predicted that higher degrees of business model innovation would occur in firms in early and late stages of industry life cycles, has to be qualified: it turns out that most business model changes occur in the emergent stage, and considerably less in the maturity and decline stages.

Competition has a significant negative relationship with the degree of business model innovation (M1: $\beta=-0.893$, $p<0.01$; M2: $\beta=-0.922$, $p<0.01$; M3: $\beta=-1.116$, $p<0.01$), so that Hypothesis 2 - which argued for a positive relationship between competitive pressure in an industry and the degree of business model innovation - is rejected. Among the control variables, innovation intensity, firm size, having in-house software development, being part of an enterprise group and being engaged in innovation cooperation all have positive relationships with the degree of business model innovation. (Results for the industry dummies are included in Table A1 in the appendix.)

Models 4-6 investigate the relationship between the degree of business model innovation and innovation performance at the firm level, again using the 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: $\beta=9.069$, $p<0.001$) in all three cases, providing support for Hypothesis 3.

The coefficients for the industry life cycle stages show no significant relationships with innovation performance. Among the control variables innovation intensity, selling products in national, European or other markets, and cooperation are positively associated with innovation performance, while in-house software development and firm size relate negatively to innovation performance.

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
Chi^2/Wald F	1275.09	1277.15	1273.08	326.3	391.6	408.5
P-value	0.004	0.001	0.000	0.000	0.000	0.000
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

Tables A2 to A4 in the appendix show our consistency checks. We find consistent results when using IV-Tobit regressions in which the degree of business model innovation is instrumented (Table A3). The results, as shown in Table A4, are also consistent when the sample is restricted to product innovators only (948 firms).

Discussion

How does industry structure affect business model innovation? - and how does such innovation translate into firms' innovation performance? Our results indicate that, in fact, industry structure has an important role to play in effecting business model innovation. We find significant associations between industry life cycle stages, competitive pressures and firms' degree of business model innovation, and a positive association between the degree of business model innovation and firms' innovation performance. As discussed below, our findings shed light on the role of industry structure in business model innovation, and have implications for the management of innovation projects.

First, our research focused on the industry level, and suggested that business model innovation should be seen in the context of the model proposed by Utterback and Abernathy (1975). In that sense, we argued that business model innovation would generally occur at both the beginning and towards the end of an industry life cycle. In fact, we find that most business model innovations occur in the emergent life cycle stage, which suggests that firms experiment with different configurations of their business model until it becomes stable and so can be exploited over time - and that apparently few firms in the maturity and decline stages change their business models. Although a maturing industry should provide fewer opportunities for firms to differentiate themselves based on product or process innovation, we cannot substantiate the idea that, instead, they engage in a higher degree of business model innovation in their later stages. In that sense, our findings challenge prior research that finds business model innovation to be most important in later industry life cycle stages, when markets become commoditized (Johnson, 2010; Sabatier et al., 2012; Massa & Tucci, 2013). Potential explanations for this reluctance of established firms to innovate their business models are higher risk (e.g., losing existing customers), higher barriers to business model innovation in later industry stages, such as organizational inertia (Sosna et al., 2010), and managing conflicts within their existing business models (Christensen, 2006; Chesbrough, 2010). Considering the relatedness of product, process and business model innovation in our measurement of the degree of business model innovation, this leads us to qualify our reasoning regarding including business model innovation as a third dimension to Utterback and Abernathy's model of changing rates of product and process innovation. This finding reflects our conceptualization of business model innovation as relying on product and process innovation, among other components. Nevertheless, we substantiate Utterback's (1994) description of the initial 'fluid phase' as one when a lot of change occurs and in which outcomes are highly uncertain, not just in terms of products and processes, but also in the competitive leadership, the structure and management of firms.

Second, and still at the industry level, we argued that there would be a positive relationship between the degree of competitive pressure in an industry and the degree of business model innovation. We suggested that business model innovation could offer a faster way to cope with intense competition than product innovation based on creating a temporary monopoly which would allow firms to escape price competition. Instead, we find evidence of a negative relationship: it seems that competitive pressures tend to discourage business model innovation. Firms may 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 such changes turn out not to be viable. Another possible explanation could refer to the strength of intellectual property protection that affects incentives to invest in innovation (Gilbert, 2006). Business model innovation is typically harder to protect against imitation than are product or process innovations (Casadesus-Masanell & Zhu, 2013).

Third, our research moves to the firm level, and introduces the industry structure into estimating the relationship between the degree of business model innovation and innovation performance (e.g., Hartmann et al., 2013b; Pohle & Chapman, 2006; Sánchez & Ricart, 2010; Zott & Amit, 2007) in firms that have introduced product or process innovations. Our findings provide support for the hypothesis that there is a positive relationship when controlling for industry structure. Apparently, innovating more components of the business model increases firm specificity, which tends to deter imitation by competitors and thus allows a firm to secure a higher degree of appropriation from its innovations (Helfat, 1994).

Besides the three relationships we have hypothesized, it is interesting to note the relationship between firm size and the degree of business model innovation and innovation performance, respectively. Our results indicate a positive relationship in the former case, demonstrating that larger firms are more inclined to innovate their business models. In that regard, we extend prior literature by not limiting the analysis to start-up firms which are typically more likely to engage in such innovations (Winter & Szulanski, 2001). Instead, our analysis includes large, medium and small-sized firms, and indicates that business model innovation is more likely to occur in larger firms. However, our results show a negative relationship of firm size with innovation performance: potential explanations include organizational inertia and the higher levels of firm bureaucracy associated with greater size.

Our results have implications both for the academic literature on business model innovation and for practitioners. 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 of how business model innovation is driven by industry life cycles and competition. In that sense, we complement existing research by shedding light on the industry-level antecedents of business model innovation, which we find to be important predictors for such changes. Our results suggest that an analysis of the drivers of business model innovation that does not consider industry-level factors would be incomplete and potentially biased.

Second, our approach shows how innovation survey data may be applied fruitfully towards identifying 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. Applying the measure to CIS data, however, requires careful consideration of the (minor) differences in the implementation of the survey across European countries and over time. We believe that adding a question regarding changes in the basic "units of business" (c.f. McGrath, 2010) to innovation surveys could help to improve the identification and analysis of business models in innovation survey data. In that sense, our research also allows going beyond single cases to illustrate a wider range of findings (Schneider & Spieth, 2013) and thus provide a broad coverage of industries. Moreover, our measure of business model innovation based on CIS data offers three different conceptualizations, and thus allows for future experimentation with more or less conservative measurements and their effects.

Third, our research offers implications for the management of innovation projects. Business model innovation that accompanies the introduction of new products and processes 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 firm's capabilities to capture some of the value thus created. While our approach does not necessarily identify explicitly the concrete business model components that should be innovated in connection with product or process innovation, our results can encourage managers to focus not only on developing new technologies. And they may also emphasize potential avenues for improving the models so as to allow them to exploit the potential of product and process innovation more fully.

Conclusions

Our research is one of the first attempts to consider the role of industry structure in business model innovation, and we hope it will inspire future discussions on the drivers of business model innovation beyond the firm level, and thus contribute to developing a better understanding of when during an industry's life cycle it would be most beneficial for firms to consider innovating their business models.

However, our study clearly also has some limitations that we need to acknowledge. First, they concern the empirical approach to testing our hypotheses. 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, which would also allow us to investigate whether firms prefer to exhaust options for – supposedly – lower risk product or process innovations before moving on to innovate their business models. Further, our variable for measuring the degree of innovation in a business model does not incorporate interdependencies between different model components. For example, one could assume that process innovations would necessarily involve changes in firms' organizational structures. The method presented here can only give an approximate picture of the complexities involved in firms' business model innovation efforts.

What is more, business model patterns may vary across industry life cycle stages: our setup, however, only allows us to look into the relationships between specific life cycle stages and degrees of business model innovation. We cannot identify certain communalities of business models depending on the life cycle stage. Incumbent firms are often characterized by the high stability of their business models over time - in fact, they may stick to their models due to organizational inertia, lock-in effects, and path dependency even when their industry is in decline (Cavalcante, Kesting & Ulhøi, 2011; McGrath, 2010; Sosna et al., 2010). Hence, it is reasonable to assume a certain basic stability of firms' business models over time, even if we find evidence of some degree of business model innovation. Finally, radical business model innovation often happens across industry boundaries, an aspect that cannot be 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 therefore help to validate our findings.

Overall, the results of this study indicate that industry structure plays a significant role in business model innovation. Taking their industry's life cycle stage and competitive pressures into consideration may enable managers to develop a richer understanding of the likely performance impact of their business model innovation endeavors. We hope that this study may also serve to encourage more empirical work on this topic. While it has measured the performance consequences of different degrees of business model innovation, it has not investigated the consequences of particular types or patterns of such innovations, i.e., configurations of business model components. Future studies could investigate in more depth how particular patterns of business model innovation perform over industry life cycles. The relationships between different types of business model innovation - especially the interdependencies between technological innovations and business models - could also be investigated in more detail. And future research could attempt to clarify the performance implications of business model innovation, both in terms of other measures of performance and over the long term, as radical business model innovation may have detrimental effects in the short run, but generate positive returns in the long run.

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Appendix

Table A1. Estimation results for industry dummies

	Degree of business model innovation Negative binomial			Innovation Performance 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 IV-Tobit regression estimates

	Degree of business model innovation Poisson			Innovation performance IV-Tobit		
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[a]	Model 5[b]	Model 6[c]
Degree of BMI				3.646**	6.651***	8.164***
				(1.180)	(1.523)	(1.873)
Life-cycle stage I	0.132***	0.148**	0.216**	-0.326	0.161	0.42
	(0.038)	(0.051)	(0.069)	(3.207)	(3.090)	(3.098)
Life-cycle stage III	0.017	0.026	0.072	0.033	0.229	-0.219
	(0.029)	(0.038)	(0.052)	(2.901)	(2.782)	(2.750)
Competition	-0.9***	-0.925**	-1.116**	-10.86	-7.529	-10.263
	(0.238)	(0.315)	(0.414)	(20.742)	(19.817)	(19.606)
Innovation intensity	0.453***	0.472***	0.493**	26.977**	26.352**	31.924***
	(0.089)	(0.118)	(0.159)	(8.792)	(8.051)	(7.558)
Patenting propensity	-0.031	-0.019	-0.027	-1.72	-2.03	-2.05
	(0.030)	(0.041)	(0.056)	(2.460)	(2.390)	(2.376)
National Market	0.048	0.046	0.091†	6.807**	6.928**	6.039*
	(0.030)	(0.040)	(0.054)	(2.438)	(2.372)	(2.372)
European Market	0.064	0.07	0.098	8.933***	8.851***	9.033***
	(0.033)	(0.044)	(0.060)	(2.707)	(2.632)	(2.609)
Other markets	0.062	0.068	0.137†	10.498**	10.513**	9.875**
	(0.046)	(0.061)	(0.082)	(3.719)	(3.607)	(3.607)
Employees (log)	0.063***	0.064***	0.06***	-3.653***	-3.81***	-3.082***
	(0.009)	(0.012)	(0.016)	(0.967)	(0.848)	(0.763)
Software development	0.209***	0.217***	0.259***	-4.125	-4.448†	-3.328
	(0.025)	(0.034)	(0.046)	(2.572)	(2.274)	(2.127)
Enterprise group	0.077**	0.107**	0.177***	0.528	-0.321	-0.641
	(0.026)	(0.035)	(0.048)	(2.118)	(2.081)	(2.100)
Cooperation	0.393***	0.313***	0.411***	2.734	4.553†	5.428*
	(0.024)	(0.032)	(0.043)	(3.824)	(2.649)	(2.482)
Industry dummies[d]	YES†	YES	YES	YES	YES	YES
Constant	2.087***	1.526***	0.933*	-13.404	-16.632	-8.994
	(0.223)	(0.295)	(0.389)	(20.357)	(19.028)	(18.391)
Observations	1242	1242	1242	1242	1242	1242
Chi^2 / Wald F	1720.61	1359.71	1273.26	330.9	396.8	414.5
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Log Likelihood	-6439.9	-5352.9	-4454.1	-3230	-3188	-3175

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 Poisson			Innovation Performance IV-Tobit		
	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] 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 A4. Negative binomial and Tobit regression estimates based on the product innovator sample

	Degree of business model innovation Negative binomial			Innovation performance 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] 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 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: improved 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)

Table A6. Business model operationalization

		Business model element[a]
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)	Value creation
2	During the three years 2008 to 2010, did your enterprise introduce new or significantly improved services	Value creation
3	Were any of your product innovations (goods or services) during the three years 2008 to 2010 new to your market?	Value creation Value delivery
4	Were any of your product innovations (goods or services) during the three years 2008 to 2010 new to your firm?	Value creation
5	Were any of your product innovations during the three years 2008 to 2010 a first in Austria, Europe or a world first?	Value creation
6	During the three years 2008 to 2010, did your enterprise introduce new or significantly improved methods of manufacturing or producing goods or services	Value creation
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?	Value delivery
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	Value creation Value delivery Value capture
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	Value creation
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	Value delivery
11	During the three years 2008 to 2010, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?	Value creation Value delivery
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.)?	Value creation
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.)	Value creation Value delivery
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.)?	Value creation Value delivery Value capture
15	How important were each of the following objectives for your enterprise's organizational innovations introduced during the three years 2008 to 2010 inclusive: improved ability to develop new products or processes? (HIGH)	Value creation Value delivery
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.)?	Value delivery Value capture
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.)?	Value capture
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)	Value creation Value delivery Value capture

[a] Two or more experts indicated that the question relates to either value creation, value delivery, or value creation