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# Business model innovation elements and product innovation radicalness: Central European lessons for innovation leaders and followers

**JEL Classification:** *O30; O32; M1; C01*

**Keywords:** *business model innovation; radical innovation; incremental innovation; Central Europe; research and development*

**Abstract**

**Research background:** Despite the increased interest in business model innovation (BMI) in the last 20 years, the current research landscape still lacks empirical efforts aimed at investigating the underexplored link between BMI and innovation performance. This is doubly true in specific contexts like Central European countries, whereas innovation systems are weaker than in Western ones, and firms strongly depend on internal R&D activities and absorptive capacity and technology upgrades via cooperation with other countries.
**Purpose of the article:** This study draws on the BMI theory with the aim of analyzing the effects of each individual BMI element on firms' performance in terms of creation of radical innovations vs incremental ones.
**Methods:** The data used are from the Community Innovation Survey (CIS) 2018 — the latest micro data available to date — focusing on 16,364 firms in Central Europe, namely 5,749 Czech, 7,377 Hungarian, and 3,238 Slovakian firms. As the explained (dependent) variables are dichotomous (binary: 1 indicates the answer is yes, 0 indicates the answer is no) for all estimated models, a binary logistic regression is used in order to focus on the individual elements representing BMI and analyse their separated effects on firms' creation of radical and incremental innovations in Central Europe. Individual BMI elements are: BMI methods, logistics, communication, accounting, external relations, human resource management, and marketing. Moreover, we check for control variables such as tax credits and allowances of R&D, public funding of innovation, cooperation with other organizations on R&D or other activities, in-house R&D activities and contracted out ones, lack of finance, lack of skilled employees and internal financial resources, and size.
**Findings & value added:** For radical innovators, practices for organising procedures and external relations are important. For incremental innovators, methods of organising work responsibility, decision making, and human resource management are significant. Surprisingly, regardless of the innovation radicality, several BMI elements are significant. This study suggests that managers should enhance strategic collaborations with external partners out of Central Europe, exploit their absorptive capacity, and increase the knowledge and experience of their employees, whilst policymakers should keep on providing tax credits and allowances for innovation activities, maintaining a supportive infrastructure and reducing administrative burdens.

## Introduction

Referring to the work of Chesbrough (2010), the same idea or technology brought to the market through different business models (BMs) yields different outcomes. Even when firms make extensive investments in inputs, like exploring new knowledge, ideas, and technologies, their ability to innovate the BM is limited. In fact, BM is the "*the blueprint of how a company does business*" (Osterwalder *et al*., 2005, p. 4), "*the translation of strategic issues, such as strategic positioning and strategic goals into a conceptual model that explicitly states how the business functions*" (Osterwalder *et al*., 2005, p. 4), but this definition describes the BM as a static entity. However, it is necessary for firms to develop their capabilities to innovate their BM because properly implemented business model innovation (BMI) can be a formidable source of competitive advantage (Sorescu, 2017). BMI is the process in which a firm updates its business model and could lead to the: (i) discovery of a fundamentally different BM in an existing business; (ii) search for new firms' business logics; and (iii) providing new ways to create (capture) value for firms' stakeholders (Spieth *et al*., 2014; Kohtamäki *et al*., 2024; J Nair *et al*., 2024; Lu *et al*., 2024).

It is no surprise then that BMI has attracted greater attention from practitioners and researchers in the last 20 years. Previous research can be divided into different (but also complementary) streams (four BMI research streams defined by Foss and Saebi (2017) are presented in Section "Theoretical background and research focus"). For example, Chesbrough (2010) examined BMI opportunities and barriers, Keiningham *et al*. (2020) analysed the way in which BMI and customer experience are related, Sund *et al*. (2021) explored barriers to radical BMI for incumbent firms, and Filser *et al*. (2021) focussed on the general foundation of BMI literature and the main trends.

However, despite various research streams devoted to BMI, Spieth *et al*. (2016) and Bashir and Verma (2018) concluded that empirical research on BMs and BMI is still limited (see also Bamel *et al*., 2024). As a result, we can envisage a call for more generalisable results and greater empirical sophistication (Clauss, 2017). Moreover, we still know little about the effects of BMI elements on firms' activities (Schneckenberg *et al*., 2022) or about the ability of the BMI perspective to discern sources of firms' performance (Spieth *et al*., 2016) and competitiveness due to the difficulty to imitate an activity system as a whole (Schneckenberg *et al*., 2022). It is, though, about

BMI being seen as an important predictor of firm performance (Bashir & Verma, 2018). Moreover, there is a lack of understanding in literature about each component of the BMI and firms' product innovation (Sorescu, 2017; see also Marshall *et al*., 2024; Liu *et al*., 2024; Chesbrough, 2007).

Against this backdrop, we can say, to our knowledge, that there is a research gap concerning the effects of BMI elements on firms' performance (e.g. in terms of introducing new product innovations, Foss & Saebi, 2017; Schneckenberg *et al*., 2022).

As a first motivation, understanding these effects and interdependencies among activities, which create and capture value, appears to be a significant source of competitive advantage. The reason is that it is much more difficult for competitors to "copy" such an activity system than a single activity, product, or process (Schneckenberg *et al*., 2022). Therefore, we focus on the link between BMI and firms' product innovation, which has a rationale in the literature that firms' product innovation can yield insights into the potential adoption and diffusion of BMI (Sorescu, 2017; see also Marshall *et al*., 2024; Liu *et al*., 2024), and because the identification of individual elements of BMI and their effects on selected firms' outputs is necessary for successful BMI (Chesbrough, 2007).

Moreover, innovation activities must be based on and include BMs, rather than just technology and R&D, because technologies are becoming obsolete faster and faster, leading them to become commodities and the need to no longer rely on their ability to generate profit (Chesbrough, 2007). Therefore, it seems warranted to expand current findings regarding BMI into new research categories including new empirical analyses on the elements of BMI and its effects on firms' product innovation.

Given the dearth of empirical research on BMs and BMI (Bashir & Verma, 2018; da Costa Fernandes & Rozenfeld, 2024; Luo, 2024) and the call for empirical analyses of the nexus among BMI and firms' innovation, the aim of this paper is to contribute to the current state of the knowledge by empirically analysing the effects of BMI elements on firms' product innovation.

Moreover, this study categorises the firms in the analysed countries into innovation leaders (creating radical innovations — new to the market) and innovation followers (creating incremental innovations — new to the firm). This perspective of the division of firms appears to be significant within the framework of research on the effects of BMI elements on firm performance, as Laudien and Daxböck (2017) also suggest (see also Han *et al*., 2024; Le &

Mohiuddin, 2024). The authors state that previous research mostly focused on the "success-driven perspective on BMI", in which large established firms were examined, while market players that were average in terms of performance, market position, and size did not receive as much attention.

This research will not only help firms' managers understand the effects of BMI elements on the creation of radical and incremental innovations, but will also give public policymakers a picture of what factors affect innovation leaders and innovation followers in selected European countries. It can, in turn, influence public pro-innovation policymaking and show whether there is a need to provide more targeted financial support in each country, depending on the radicality of innovation.

Finally, the value added of this work lies at the heart of the synergistic recommendations and multi-faceted implications for managers, academicians and policymakers. In detail, the findings advance the theoretical understanding of each BMI element's contribution to the product innovation performance, that is not limited to Central Europe countries, but may be applied to similar national contexts in EU or outside of EU. It also provides differentiated recommendations about the most valuable elements for radical vs incremental innovators (e.g., strengthening strategic partnerships outside of Central Europe vs fostering absorptive capacity) that involve a wider perspective embracing the mutual exchange relationships with innovation partners in other countries worldwide. Policymaking implications are also inherent to tax credits, allowances and supportive infrastructures for innovation activities, that could be deemed as relevant to other developed countries with comparable national contexts (e.g., Central, Eastern, Southern Europe) as well as to cooperating partner countries, globally.

For the purposes of this study, we use data from the Community Innovation Survey (CIS) 2018 — the latest micro data available to date — focusing on firms in Central Europe, namely 5,749 Czech, 7,377 Hungarian, and 3,238 Slovakian firms. A binary logistic regression is used in order to focus on the individual elements representing BMI and analyse their effects on firms' creation of radical and incremental innovations. The analysed countries belong to the same group of so-called "catching-up" Central and Eastern European (CEE) countries, which have several common features and have not received such attention in previous research (concerning firms' innovation and BMI), unlike countries in Western Europe that are generally perceived as innovation leaders and benchmark providers for other European countries (Prokop *et al.*, 2021). However, although CEE countries and firms have examples of good practice from Western countries, innovation models applied in the West do not always work fully in the East. The reality, as supported by empirical results (see examples in Sub-Section "Central European perspective: hypotheses development"), is that CEE countries applied these "best practices" rather late (with a delay compared to Western countries) and to a limited extent, and the CEEs are increasingly benefitting from closure rather than taking full advantage of openness. Moreover, CEE economies do not grow based on research-driven innovation as expected by policymakers in CEE countries (Radošević, 2017); rather, they are more dependent on external (foreign) knowledge and technology flows. Therefore, we believe that it is necessary to provide a picture of the effects of BMI elements on firms' innovation in Central Europe that will be relevant for other CEE firms and countries as well as for public pro-innovation policymakers at the European Union level.

The rest of this paper is structured as follows. The second section provides the theoretical background and hypotheses on which we build this research. The research strategy is presented in the third section. The fourth section is devoted to the empirical results and the fifth section presents the discussion of these results. The implications, limitations, and conclusion are provided in the last section.

## Theoretical background and research focus

### *Business model and Business Model Innovation Theory*

We begin by defining three basic concepts on which we build our arguments and hypotheses (see Sub-Section "Central European perspective: hypotheses development"): innovation, BM and BMI.

In this paper, we start from the general definition of innovation as the process of generation of new ideas, products, services, processes *et similia*, endowed with some positive impact and value (European Commission, 2023), but we narrow such a perspective to the dichotomic categorization among radical and incremental innovation, that is developing something far away or just improving something existing (Dahlin & Behrens, 2005).

As for BM, there is no one, generally-accepted definition of BM or BMI that ensures consensus among academicians and practitioners, also considering the emergence of sub-typologies of business models (Laudien & Daxböck, 2017; Bashir & Verma, 2018; Schneckenberg *et al*., 2022; see also Han *et al*., 2024; Le & Mohiuddin, 2024).

From the perspective of BM, we follow the definition provided by Teece (2010), which was subsequently supported by other researchers (e.g., Cortimiglia *et al*., 2016; Tykkyläinen & Ritala, 2021; see also Smol *et al*., 2024; Drupsteen & Wakkee, 2024). The author states that the BM can be seen as the "*design or architecture of the value creation, delivery, and capture mechanisms*" (Teece, 2010, p. 172). More concretely, we can understand BM as a mechanism that fulfils several functions as defined by Chesbrough (2010, p. 355): *(i) articulates the value proposition; (ii) identifies a market segment and specifies the revenue generation mechanism; (iii) defines the structure of the value chain required to create and distribute the offering and complementary assets needed to support position in the chain; (iv) details the revenue mechanism(s) by which the firm will be paid for the offering; (v) estimates the cost structure and profit potential; (vi) describes the position of the firm within the value network linking suppliers and customers; and (vii) formulates the competitive strategy by which the innovating firm will gain and hold an advantage over rivals*.

Meanwhile, BMI is understood in the literature as: (i) "*an opportunity to convert new market opportunities into new BMs, create novel customer value and value delivery methods*" (Bashir & Verma, 2018, p. 263; see also Kohtamäki *et al*., 2024; J Nair *et al*., 2024; Lu *et al*., 2024) and (ii) "*needs to generate a change in the value creation, value appropriation, or value delivery function of a firm that would result in a significant improvement in the firm's value proposition*" (Sorescu, 2017, p. 691; see also Kohtamäki *et al*., 2024; J Nair *et al*., 2024; Lu *et al*., 2024). However, BMI should not only lead to the value creation for other stakeholders, but also be beneficial for the firm that produces and operates these activities. This is critical because a firm that cannot profit from some parts of its activities cannot sustain those activities over time (Chesbrough, 2007). Therefore, we understand BMI as modification of the firm's activity system that involves adding and/or linking novel value activities through integration at different levels in new ways and the (re)design of firms (structures) to gain a competitive opportunity and advantage (Bouncken & Fredrich, 2016; Karayalcin, 2024).

Moreover, we refer to Foss and Saebi (2017) who distinguish among four BMI research streams: (i) conceptualisation of BMI; (ii) BMI as an organisational change process; (iii) BMI as an outcome; and (iv) consequences of BMI. In this study, we focus on the fourth stream, consequences of BMI, specifically on firms' innovativeness (creation of radical and incremental product innovation), which are seen as one of the gaps and challenges in BMI research. It is understandable because the same innovation that is commercialised in two different ways could result in two different returns; more specifically, innovation can successfully employ: (i) a BM already familiar to the firm or (ii) a BM using new innovative practices and processes, although this requires firm managers to expand their knowledge and perspectives to find an appropriate BM (Chesbrough, 2010).

*Business Model Innovation and firms' innovation*

Current research on the link between BMI and firms' innovation as well as on the consequences of BMI has shown that the degree of a firm's BMI, which is conditional on having recently introduced a new product or process, positively influences the firm's innovation performance, as shown with 1,242 Austrian firms (Waldner *et al*., 2015) and, more recently by a comprehensive study on C-level executives by the IBM and Oxford Economics that confirmed the link among BMI and performance (Marshall *et al*., 2024). Tavassoli and Bengtsson (2018) confirmed the positive effects of BMI on product innovation performance in Sweden. In addition, Clauss *et al*. (2019) found the positive effects of BMI on firms' performance (also including product development improvements) by using data from 432 German firms in the electronics industry. Le and Mohiuddin (2024) show that green BMI may enhance firm performance as well as sustainability achievements of SMEs in Vietnam, through a sample of 465 small- and mid-sized firms. BMI impacts on firm performance are confirmed also in China through an analysis of 291 high-tech firms (Han *et al*., 2024), and in the context of smart product systems (Liu *et al*., 2024). However, these studies examined the effect of BMI as a variable consisting of several selected elements representing the BMI.

Unlike previous studies, we examine the effect of each of the elements of BMI separately in this study. Moreover, we follow Souto's (2015) assertion that BMI creates new options for applying and exploiting knowledge (e.g. through knowledge generation, knowledge acquisition, and knowledge application) and technology in different ways to competitors, thereby providing a platform for innovations, both incremental and radical (see also Marshall *et al*., 2024). Souto (2015) analysed the effects of BMI on firms' creation of radical and incremental innovations (similar to the previously mentioned studies, by using the variable consisting of several selected elements representing the BMI) on a sample of 423 Spanish hotel firms.

Finally, understanding the effects of BMI on innovation performance is an important source of competitive advantage, due to the difficulty to replicate an activity system (Schneckenberg *et al*., 2022). Therefore, we focus on the link between each component of the BMI and firms' product innovation, filling in the gap identified in literature (Sorescu, 2017; see also Marshall *et al*., 2024; Liu *et al*., 2024; Chesbrough, 2007).

*Central European perspective: hypotheses development*

CEE countries' long-term economic growth could be positively influenced by their innovation potential, as evidenced by Pece *et al*. (2015) in the case of the Czech Republic, Hungary, and Poland. The authors confirmed a positive relationship between economic growth and innovation, expressed by various variables such as number of patents, number of trademarks, and R&D expenditures. Pece *et al*. (2015) also pointed out an important role of the allocation of resources for R&D activities, the quality of human capital, and foreign direct investment stock. Rok and Kulik (2024) found a link between BMI, innovation performance and circular start-ups in Poland. Kajtazi *et al*. (2023) show that BMI impacts positively on corporate sustainability in Western Balkans (Albania, Kosovo and Macedonia). Velev and Veleva (2021) confirm that BMI leads to higher-than-average economic performance compared to individual innovations in Bulgaria as well as in the ICT context in Romania, according to Foltean and Glovațchi (2021). Similar results are found in Lithuanian SMEs, whereas BMI leads to improved firm performance and innovativeness through strategic and architectural changes (Gatautis *et al*., 2019). The competitiveness of Slovenian SMEs in the context of the digital economy has increased as a result of BMI (Pucihar *et al*., 2019).

Yet, despite innovation activities being confirmed as important in the CEE territory, CEE countries' innovation activity has long been seen to be weaker, especially when compared to their Western neighbours. A clear example is the comparison of countries in terms of their innovation performance, as defined by the European Commission, where the majority of CEE countries fall below the European average (Prokop & Stejskal, 2017), and the Visegrad countries (the Czech Republic, Slovakia, Hungary, and Poland) have long been among the worst performers in innovation and competitiveness in the European Union (Hudec, 2015). Moreover, CEE countries' innovation potential and systems are seen to be weak and CEE firms often lack internal resources for the autonomous development of innovations (Stojčić, 2021).

The reasons for this lower innovation performance, and for the perception that CEE countries and firms as lagging behind in innovation, can be found in the existing literature. For example, Prokop *et al*. (2021) cited two main reasons: (i) lower trust and social capital between cooperating partners and the resulting lock-in of firms, with an aversion to external cooperation; and (ii) lower ability to use public funds efficiently, which is, among other things, caused by the emergence of an innovation paradox; the latter is associated with the discrepancy between the higher need for investment and public support for innovation in lagging regions, compared with their ability to absorb these funds and use them effectively. Odei *et al*.'s (2021) sample from the Czech Republic, Hungary, and Slovakia also pointed to some form of locking-in of firms in CEE countries barring them from the external (foreign) environment and their inability to benefit from globalisation and the advantages of international trade and cooperation. The authors showed that CEE firms participating in international markets are unable to achieve effective and efficient innovations and that locally-owned firms achieved better innovation performance than multinational firms.

Considering these facts, which show that CEE firms are rather heavily dependent on internal activities, such as internal R&D, and have a lower ability to use external resources for innovation effectively (which are crucial for innovation success), the question of examining the effects of BMI on firms' innovation in these countries seems highly relevant. However, few and only explorative qualitative efforts have been done, so far, that take into account BMI, at least in a partial way (Blažková *et al*., 2023; Götz *et al*., 2021). This line of argument is also consistent with the claims of Chesbrough (2007), who pointed out that innovation must include a BM, rather than just technology and R&D, and that the traditional "closed innovation approach", assuming innovation means that firms need to invest in extensive internal R&D laboratories and hire the best people, is obsolete. Chesbrough (2007, p. 12) stated that "*a better business model often will beat a better idea or technology*".

To our knowledge, current research on BMI in CEE countries and Central Europe is quite limited. Indeed, we found only a few studies examining this issue. For example, Mets (2012) conceptualised the BM and general factors of globalising it for hi-tech small and medium-sized enterprises in Estonia but, as the author stated, the study lacked an in-depth analysis. Urbaniec and Żur (2021) analysed corporate benefits and challenges of BMI in the form of accelerator activities and stated that corporate accelerators could serve as a source of innovation, which could be subsequently used to foster entrepreneurial market logic and entrepreneurial learning in Poland. However, as the authors concluded, the study is limited due to the small sample and one country. Additional studies were recently limited to some explorative qualitative studies, which are still not covering the dearth of empirical research (Blažková *et al*., 2023; Götz *et al*., 2021).

On the other side, understanding the effects of BMI on innovation performance is an important source of competitive advantage due to the difficulty to replicate an activity system (Schneckenberg *et al*., 2022). Therefore, we focus on the link between each component of the BMI and firms' product innovation, filling in the gap identified in literature (Sorescu, 2017; see also Marshall *et al*., 2024; Liu *et al*., 2024; Chesbrough, 2007).

We, therefore, see the need for an empirical analysis in the CEE area to better understand the potential of BMI for CEE countries and companies. To this end, we have defined the following hypotheses:

*H1: Each BMI element affects positively and significantly radical innovation performance of leaders (radical innovators) and incremental innovation performance of followers (incremental innovators) in Central Europe.*

H2: *BMI elements affect differently the radical innovation performance of leaders (radical innovators) and the incremental innovation performance of followers (incremental innovators) in Central Europe.*

## Research strategy and design

### *Data source and explained variables*

This study employs the most recent wave of Eurostat's Community Innovation Survey (CIS) (https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey) 2018, which provides firm-level survey data about EU Member States and follows the Oslo Manual recommendations on measuring the degree of innovation in firms (Andersson *et al*., 2021).

Hence, it is the reference survey on innovation in enterprises first launched in 1992 and then replicated on a regular basis. It is carried out in EU, EFTA (European Free Trade Association) and candidate countries as a standard questionnaire ensuring a harmonized data collection. As such, CIS data are a reliable and relevant source for cross-country research focused on firms' innovation, providing researchers with information about the innovation activities across a wide range of industries and across Europe (for more information, see Stojčić *et al*., 2020 and Priyadarshini *et al*., 2024; https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey).

However, we focus only on the Czech Republic, Slovakia, and Hungary, which are homogeneous countries under many aspects and constitute the so-called group of "catching-up" countries in Central and Eastern Europe (CEE). Extant literature on firms' innovation and BMI has mostly neglected such countries, especially with regard to empirical research (Prokop *et al*., 2021; Blažková *et al*., 2023; Götz *et al*., 2021), whilst the differences with Western European countries do not make it possible to generalize and apply previous findings to CEE countries (see Section "Introduction").

Our research design is based on the preliminary allocation of firms to the set of either innovation leaders or followers, depending on radicality vs incrementality of their innovation outcomes, coherently with Prokop *et al*. (2023). In detail, innovations are classified as radical if they were the first in Europe and as incremental if they were the first in their home countries. Operatingly, we define radical and incremental product innovations as follows:

– *radical innovations (innovation leaders)* – the firm introduced any new or improved products (goods or services) not previously offered by any of its competitors (not previously available on the market) in the three years 2016 to 2018;
– *incremental innovations (innovation followers)* – the firm introduced products (goods or services) that are identical or very similar to products already offered by its competitors (already previously available on the market) in the three years 2016 to 2018.

We analysed 5,749 Czech, 7,377 Hungarian, and 3,238 Slovakian firms.

*BMI elements: Methods and practices*

Given the dearth of data and empirical research on BMI (Bashir & Verma, 2018) and the fact that a limited number of empirical studies rely on measurement instruments (Clauss, 2017), CIS 2018 was useful as a data source of several proxy variables associated with the BMI elements, especially in the application context of this study (Blažková *et al*., 2023; Götz *et al*., 2021). Such an empirical strategy is coherent with existing studies on CIS data (Waldner *et al*., 2015; Tavassoli & Bengtsson, 2018) aimed at developing aggregate indicators for firm's BMI (Tavassoli & Bengtsson, 2018) or degree of BMI (Waldner *et al*., 2015). However, our work differs from those studies as we focus on each BMI element to analyze its impact on radical and incremental innovations. The selected BMI elements are:

– *BMI-meth*: methods for producing/developing goods or providing services (Waldner *et al*., 2015);
– *BMI-log*: logistics, delivery, and distribution methods because firms' ability to obtain materials as well as ensure the logistics of finished products are seen as a driving force of firms' internationalisation (Abrahamsson *et al*., 2019);
– *BMI-comm*: methods for information processing and communication to ease product and service innovation (Paiola & Gebauer, 2020), and help bridge different communities (suppliers, customers, and other connected organisations; Schwarz & Legner, 2020);
– *BMI-acct*: methods for accounting and other administrative operations to implement appropriate control coherently with the business strategy (Aaltola, 2018);
– *BMI-extrel*: business practices for external relations like building trust with partners, fostering knowledge spill-overs (Prokop *et al*., 2021) and setting more favourable conditions for cooperation;
– *BMI-hrm*: methods of organising work responsibility, decision making, and human resource management to build sufficient human resource capabilities and architecture, increase firm resilience (Loon *et al*., 2020) and employee performance;
– *BMI-mark*: marketing methods for promotion, packaging, pricing, product placement, and after-sales services, to bring value to the market, especially new ones (Robertson, 2017).

To produce a more comprehensive picture of the introduction of BMI elements in the analysed countries, we present Figure 1, in which we merge the countries and present frequencies of introduction of BMI elements in Central Europe (the Czech Republic, Hungary, and Slovakia). In Figure 2, we describe the conceptual model.

The percentage frequencies of the use of BMI elements in the analysed countries are given in Table 1.

*Control variables*

Extant literature identifies some variables as relevant determinants of firms' innovation and radicality (Prokop *et al.*, 2023). Hence, we introduce them in our models as control variables. In detail, we control overall for the public support to innovation activities that represents a key factor in transition CEE economies (Stojčić *et al.*, 2020). Such a factor is operationalized as public funding from national governments (*fungov*), measures for tax credits and allowances supporting either R&D or other innovation efforts (*rdtax*).

Moreover, we control for factors linked to R&D capabilities, another strong determinant of CEE firms' innovation success (Odei *et al.*, 2021). Operatingly, both in-house (*rdevin*) and contracted out R&D activities (*rdevex*) are measured. The latter typology — rdevex — embraces contracted out activities with the same firm group (not just with external public/private organizations) as external R&D is an important source of knowledge spill-overs.

Also, we control for cooperation factors. In fact, the traditional lack of trust of CEE firms towards external partners and the stronger inclination to closedness compared with Western EU competitors, is recently challenged by the favourable impacts of cooperation on innovation in CEE firms' (Stejskal *et al.*, 2016; Stojčić, 2021). This factor is operationalized through the variables measuring the R&D cooperation with other organisations (*rdevco*) as well as on other innovation cooperation activities (*othco*).

Then, we use the barriers of innovation as control variables (D'Este *et al.*, 2012). In operational terms, we use some selected variables hampering firms' decision to start innovation activities like the scarcity of skilled employees (*emphamp*) and internal finance (*finhamp*).

Finally, we use size as a control variable, based on Andersson *et al.* (2021).

The percentage frequencies of each level for used control variables can be found in Table 2.

*Method description*

As the explained (dependent) variables are dichotomous (binary: 1 indicates the answer is yes, 0 indicates the answer is no) for all estimated models, a binary logistic regression is used. Some key advantages and disadvantages for applying the binary logistic regression are that (Fritz & Berger, 2015, pp. 271–272): (1) "*not only [it] allow[s] you to assess how well your set of variables predicts your categorical dependent variable and determine[s] the "goodness-of-fit" of your model as does regular linear regression, but also it provides a summary of the accuracy of the classification of cases, which helps you determine the percent of predictions made from this model/equation that will be correct*". It gives the possibility to test multiple explanatory variables and to obtain their odd ratios; (2) "*it is now routinely used in many fields, including general business and marketing*", thus, allowing to make methodological comparisons with a plethora of studies using it in the same field of study, also in the near future; (3) as for the use of general linear regression models, "*the assumptions that underlie them are violated to too large an extent*", whilst robustness and sensitivity of results are maintained with binary logistics regression, and, "*in addition, some of the theory of binary logistic regression differs from regular linear regression; for example, the best fitting line is not chosen by the criterion of least squares*"; (4) "*if we did find the least-squares regression line when the Y data that yielded the line is 1 and 0, there's a possibility that the resulting Yc can actually be greater than 1 or less than 0. Both of these are theoretically meaningless, since we interpret Yc as the probability of obtaining a 1. Thus is another reason we use logistic regression, which does not allow a Yc outside of the (0,1) range*"; (5) it assumes a linear relationship between predictors and outcome log-odds; (6) it is based on the specification of a link function tha could hinder its flexibility; (7) it may lead to overfitting; (8) it should be applied with large samples (Giglio, 2021; Ranganathan *et al*., 2017; Pepe *et al*., 2004). The general form of the binary logistic model is (Hosmer & Lemeshow, 2000):

$$\ln \frac{\pi_i}{1-\pi_i} = \beta_0 + \sum_{j=1}^{p} \beta_j x_{ij}. \quad (1)$$

The logit member of the Eq. (1) on the left side includes $\pi_i = \text{Prob}[Y_i = 1|\mathbf{x}_i]$. This is the probability that, given the explanatory variables $X_1, \dots, X_p$, the explained variable $Y$ for the $i$-th individual is equal to 1. The probability $\pi_i$ has the expression (Hosmer & Lemeshow, 2000):

$$\pi_i = \frac{\exp\left(\beta_0 + \sum_{j=1}^{p} \beta_j x_{ij}\right)}{1+\exp\left(\beta_0 + \sum_{j=1}^{p} \beta_j x_{ij}\right)}. \quad (2)$$

The following odds ratio $OR$ helps interpreting the impact of $X_k$ on $Y$ (Hosmer & Lemeshow, 2000):

$$OR = \frac{\left(\frac{\text{Prob}[Y=1|X_k=1,X_1,\dots,X_{k-1},X_{k+1},\dots,X_p]}{\text{Prob}[Y=0|X_k=1,X_1,\dots,X_{k-1},X_{k+1},\dots,X_p]}\right)}{\left(\frac{\text{Prob}[Y=1|X_k=0,X_1,\dots,X_{k-1},X_{k+1},\dots,X_p]}{\text{Prob}[Y=0|X_k=0,X_1,\dots,X_{k-1},X_{k+1},\dots,X_p]}\right)} = \exp(\beta_k). \quad (3)$$

whereas, we assume that $X_k$ is dichotomous, without further impositions on the nature of the remaining explanatory variables. Hence, $\exp(\hat{\beta}_k)$ is the estimated odds ratio $\widehat{OR}$ between $Y$ and $X_k$, *ceteris paribus* (Hosmer & Lemeshow, 2000).

## Results

### *Czechia*

Findings about the Czechia (Table 3) show that three BMI elements affect indifferently both radical and incremental innovations, namely (i) methods for producing goods or providing services (*BMI-meth*); (ii) methods for logistics, delivery, and distribution (*BMI-log*); (iii) marketing methods for promotion, packaging, pricing, product placement, and after-sales services (*BMI-mark*).

As for control variables, the most impactful one, for both radical and incremental innovations, is firms' internal R&D (*rdevin*). External R&D (*rdevex*) and cooperation on other innovation activities (*othco*) are significant in both models, too. Tax credits and allowances for innovation (*rdtax*) are significant for innovation leaders. Significant differences were found for the lack of skilled employees (*emphamp*), whereas innovation leaders envisage a decrease in the creation of radical innovation, whilst followers experience an increase in terms of radical innovations.

### *Hungary*

Findings about Hungary (Table 4) show that there is no significant difference among leaders and followers about the impact of methods for producing goods or providing services (*BMI-meth*), methods for information processing and communication (*BMI-comm*), and marketing methods for promotion, packaging, pricing, product placement, and after-sales services (*BMI-mark*). On the contrary, innovation leaders are affected by business practices for organising procedures and external relations (*BMI-extrel*), whilst followers are affected by logistics, delivery, and distribution methods (*BMI-log*) and methods of organising work responsibility, decision making, and human resource management (*BMI-hrm*).

In-house R&D (*rdevin*) and cooperation on other innovation activities (*othco*) are found to be significantly enhancing both radical and incremental innovations, whilst tax credits and allowances for innovation (*rdtax*) have a significant effect only for leaders, coherently with findings about the Czech Republic. Surprisingly, both innovator profiles are more effective in the creation of product innovations in association with the lack of skilled employees (*emphamp*). Finally, followers are more effective in creating incremental innovations in association with the lack of internal finance (*finhamp*).

*Slovakia*

Findings about Slovakia (Table 5) show that both radical and incremental innovations are fostered by methods for producing goods or providing services (*BMI-meth*), business practices for organising procedures and external relations (*BMI-extrel*), and marketing methods for promotion, packaging, pricing, product placement, and after-sales services (*BMI-mark*). Followers are significantly and positively influenced by logistics, delivery, and distribution methods (*BMI-log*), and methods for information processing and communication (*BMI-comm*), whilst methods for accounting and other administrative operations (*BMI-acct*) are found to be detrimental.

In-house R&D (*rdevin*) has a significant effect in the creation of innovations for both innovation leaders and followers, likewise in Hungary, together with both forms of cooperation (*rdevco* and *othco*). As for leaders, external R&D (*rdevex*) is found to be significant, whilst followers are affected by the scarcity of skilled employees (*emphamp*) and internal finance (*finhamp*).

## Discussion

Before we discuss our results, we provide a summary in Table 6, which shows the innovators in the individual CEE countries for which the BMI elements are significant, thereby leading to an increase in the firms' chance of introducing radical and/or incremental innovations. This helps making a contribution in terms of understanding and differentiating among BMI elements that affect the most firms' innovation performance in the case of innovation leaders and/or followers. It allows us to start with our first hypothesis: *each BMI element affects positively and significantly radical innovation performance of leaders (radical innovators) and incremental innovation performance of followers (incremental innovators) in Central Europe.* Our results presented in Section "Results" and Table 6 show that each BMI element significantly affects innovators in at least one of the selected countries. It confirms our previous argument (based on the findings of Chesbrough (2007)) that focussing on the effects of BMI elements on a firm's product innovation in Central Europe is warranted. However, as this is one of the first empirical studies to examine this issue in Central Europe and, in general, regarding the use of CIS data to measure BMI elements, the empirical support for these arguments is limited.

To have a better picture of the effects of BMI elements and differences between innovation leaders and followers, we focus on the second hypothesis: *BMI elements affect differently the radical innovation performance of leaders (radical innovators) and the incremental innovation performance of followers (incremental innovators) in Central Europe.* Based on our empirical analyses, we can say that differences between innovation leaders and followers exist, although not in all the analysed countries. We find differences primarily in Hungary and Slovakia. In Hungary, innovation leaders, unlike innovation followers, are significantly influenced by business practices for organising procedures or external relations, which are critical for CEE countries. It is because "*these countries are characterised by structurally weak innovation systems and their firms often lack internal resources for the autonomous development of innovations*", whereas it could result in such a situation that firms' R&D, "*rather than driving indigenous innovation efforts, serve as a means of absorption of imported knowledge and technology*" (Stojčić, 2021, p. 533). Building external relationships can help firms overcome such problems and build stronger innovation systems (regional/national/but also global) through spill-over effects, building trust and social capital between partners, providing access to external resources (human, financial, and material), making new contacts, or, for example, profiting from partners' reputation at the beginning of the cooperation.

In contrast, innovation followers in Hungary, compared to radical innovation leaders, are significantly influenced by their methods of organising work responsibility, decision making, and human resource management. Such activities are crucial for firms, especially when they have problems with a lack of skilled employees, which is the case of all analysed incremental innovators, as our results confirmed (see below). This problem also affects innovation leaders in Hungary. Therefore, methods of organising work responsibility, decision making, and human resource management are important because they could lead to the development of employee abilities, motivation, and opportunities to perform and, moreover, could be translated into firms' performance (Zhou *et al*., 2013). In addition, logistics, delivery, and distribution methods significantly increase firms' chance of introducing incremental innovations in Hungary. The same results are found in Slovakia. Finally, Slovakian innovation followers are influenced by methods for information processing and communication, unlike Slovakian radical innovators.

Our results also show that radical innovators in the Czech Republic and Hungary are significantly influenced by the provision of tax credits and allowances for R&D and other innovation activities. Such support has its justification in the literature, as seen in the form of public support that is more neutral and market-oriented and better able to reduce asymmetric information of R&D activities than R&D subsidies (Chen & Yang, 2019). In addition, R&D tax credits can reduce the marginal cost of R&D investments (Castellacci & Lie, 2015).

Regarding BMI elements that significantly increase firms' chance of creating both radical and incremental innovators in the analysed countries, these are: (i) methods for producing goods or providing services (including methods for developing goods or services, *BMI-meth*) and (ii) marketing methods for promotion, packaging, pricing, product placement, and after-sales services (*BMI-mark*). Changes and improvements in the methods for producing goods or providing services, as a significant determinant of firms' innovation (regardless of whether radical or incremental) and R&D within CEE countries, are also confirmed by Radošević (2017). Concerning the positive effects of marketing activities, these findings are in line with Du *et al*. (2014). The authors showed that firms' focus on market needs, together with building market-based partnerships, provides firms with access to diverse types of knowledge and, therefore, plays a significant role in R&D activities.

Considering the effects of our control variables, we confirm the arguments that CEE countries are heavily dependent on their internal R&D and that this determinant is significant across the countries studied. These findings are basically in line with several prior studies (see, for example, Odei *et al*., 2021; Prokop *et al*., 2021). Moreover, we show that successful innovators (radical/incremental) in Central Europe are influenced by cooperation, whose importance within the CEE territory has been confirmed by other authors (e.g. Stejskal *et al*., 2016; Stojčić, 2021); cooperative partners are able to share relevant resources and, therefore, increase employees' competences and capabilities for the creation and commercialisation of innovations (Stojčić, 2021). These findings are also consistent with statements by Radošević (2017) that CEE countries' innovation is dependent on the interaction of domestic R&D with more advanced external technology such as from imported equipment and inputs. It is also in line with our finding that innovation leaders, primarily in the Czech Republic and Slovakia, unlike innovation followers, rely more on external knowledge sources; the former are able to benefit from external cooperation and R&D in the form of contracting out R&D to other enterprises (including enterprises in firms' own group), as well as public and/or private research organisations.

Employees' competences and capabilities seem to be a relevant factor influencing firms' innovation radicalness. We also find that the lack of skilled employees is a significant determinant of firms' creation of incremental innovation in all three analysed countries. Moreover, as we demonstrated, in the case of the Czech Republic, the lack of skilled employees could decrease firms' chance of creating radical innovations. Such a finding is in line with Radošević's (2017) result that innovation performance and R&D are largely determined by the skill of the labour force, whereas the lack of highly skilled workers in the country/region could negatively affect firms' and the country's ability to innovate as it is difficult to commute skilled labour over a large distance (Frenkel, 2003). In addition, we also confirm the significant effects of the second variable representing innovation obstacles — namely, the lack of internal financial sources. More concretely, we show that the lack of internal financial sources significantly influences firms' incremental innovation creation in Hungary and Slovakia.

*Comparisons with non-CEE countries*

Despite the fact that literature depicts a lack of in-depth research about individual contributions of BMI elements to firms' activities at large or to distinguish among performance sources (Schneckenberg *et al*., 2022; Spieth *et al*., 2016), in this sub-section, we provide a comparison between the existing research about the BMI-innovation performance link at large, in CEE vs non-CEE countries.

The first remark is related to the unbalanced amount of research between Western EU countries and CEE countries about BMI and firms' innovation: this leads to the former countries being perceived as innovation leaders and benchmarks for the latter countries (Prokop *et al*., 2021). However, such a comparison may be wrong from the beginning (mainly due to differently developed innovation ecosystems within compared territories), and therefore CEE states may be condemned to a worse rating and the inability to catch up with their Western benchmarks in advance (Kotkova Striteska *et al*., 2024). This gives water to the mill for our intention to compare leaders and followers operating in the same territory.

Second, despite CEE countries look at Western ones as best practices, innovation models and systems working in those areas are not automatically transferable into CEE regions. In fact, CEE countries applied Western models very late and to a limited extent, finding much more benefits from closedness than from openness or research-driven efforts (Radošević, 2017). Hence, any policy or managerial recommendations based on the traditional motto that "one fits all" could be wrong and risks to waste governmental resources, as it would target drivers that are valid only in the Western EU countries.

Third, as for CEE similarities and differences towards other countries, the analysis of literature from Western and non-EU countries suggests that the innovativeness of a BM influences innovation performance (Waldner *et al*., 2015; Marshall *et al*., 2024; Clauss *et al*., 2019; Le & Mohiuddin, 2024; Han *et al*., 2024; Liu *et al*., 2024), and, more specifically, product innovation (Tavassoli & Bengtsson, 2018), whilst Souto (2015), in a study focusing on Spanish firms, is the only one to fill the gap on the relationship between BMI and incremental vs radical innovation.

In CEE countries, a first difference is about the way innovation is traditionally investigated, as Pece *et al*. (2015) do not mention radicalness, but focus on other variables related, for instance, to patents, trademarks and

R&D expenditures. However, more recent analyses from Rok and Kulik (2024) in Poland, report the same findings as in Western EU and non-EU countries, apparently confirming the lateness and closedness of CEE countries (Radošević, 2017). Similar conclusions can be drawn based on Velev and Veleva's (2021) study in Bulgaria, Foltean and Glovațchi's one (2021) in Romania, Gatautis *et al*.'s analysis (2019) in Lithuania, Pucihar *et al*.'s paper (2019) in Slovenia. However, the comparison of the country-level studies and their timeline shows that the majority of CEE countries falls below the European average (Prokop & Stejskal, 2017), and the Visegrad countries (the Czech Republic, Slovakia, Hungary, and Poland) are classified as some of the worst performers in innovation and competitiveness in the European Union (Hudec, 2015). Finally, few and only explorative qualitative efforts have been done, so far, that take into account BMI, at least in a partial way (Blažková *et al*., 2023; Götz *et al*., 2021), whilst researchers in Western EU countries realized more and more specific studies (Souto, 2015) compared to CEE countries (Mets, 2012; Urbaniec & Żur, 2021).

## Conclusions

Business model innovation has been increasingly investigated in the last 20 years, but empirical research is still underexplored. Even lower attention has been paid to the link between BMI and innovation performance. This is doubly true in CEE countries, characterized by weaker innovation systems compared with Western ones, and by firms' dependency on internal R&D, absorptive capacity and technology upgrades, and foreign cooperations. Hence, the main contribution of this research is threefold. First, this study draws on the BMI theory and recent call for additional empirical analyses of the consequences of BMI on firms' performance (Foss & Saebi, 2017; Bashir & Verma, 2018; Schneckenberg *et al*., 2022; Bamel *et al*., 2024; da Costa Fernandes & Rozenfeld, 2024; Luo, 2024) and analyses the effects of various BMI elements on firms' product innovation. Moreover, in line with Laudien and Daxböck (2017) who suggest focussing also on "average players" in the market, we link current BMI research with the research on the determinants of firms' radical and incremental innovation and reveal the effects of BMI elements on the radicality of firms' innovation.

Second, this study contributes to the ongoing empirical research on the link between BMI and innovation creation in transitioning CEE countries

(Stejskal *et al*., 2016; Radošević, 2017; Prokop *et al*., 2021; Stojčić, 2021). More accurately, this study helps to better understand the factors influencing innovation leaders and followers in Central Europe, with a focus on the elements of BMI (Schneckenberg *et al*., 2022; Han *et al*., 2024; Le & Mohiuddin, 2024). We point out the importance of BMI within these countries, but we also show that many BMI elements are important for both innovation leaders and followers, thereby highlighting the need for further research on this issue and for a more detailed analysis that examines the importance of these BMI elements.

Third, this study offers several practical implications for firm managers and for public policymakers at the country and EU levels. In fact, the findings show that innovation leaders are positively affected by practices for organising procedures and external relations, whilst followers are influenced by methods of organising work responsibility, decision making, and human resource management. Interestingly, many BMI elements are significant in both radical and incremental innovation contexts.

*Managerial implications*

From the perspective of managerial implications, to support the creation of radical innovations, we highly recommend that innovation leaders within the CEE territory carry out and support activities that will lead to building and strengthening relationships with external partners, which will lead to the creation of strategic partnerships. It could help break the reluctance of (foreign) partners to reveal strategically important resources, which have historically been seen as one of the reasons for the limited success of (foreign) collaborations in CEE countries (Stojčić, 2021). However, firms could also benefit from short-term collaborations to solve specific research tasks and gain the experience and knowledge necessary to build their own research capacity. They could, thus, increase the knowledge and experience of their own employees (to avoid problems with a shortage of skilled workers) and, ultimately, increase firms' absorption capacity and knowledge base. These implications are also relevant for innovation followers, considering the fact that they are significantly influenced by human resource management and, at the same time, burdened by problems stemming from a shortage of skilled workers. Moreover, increased absorptive capacity of incremental innovators can simplify and speed up the exchange of existing knowledge and learning (Ritala & Hurmelinna-Laukkanen, 2013). Hence, collaborative relationships with external institutions and the utilisation of external human capital that contribute to innovation performance seem to be fruitful for these innovators (Zhou *et al*., 2013). According to Zhou *et al*. (2013), firms can have access to such practices, such as participating in strategic alliances, joint ventures, joint technical committees, and industrial districts, which could lead to knowledge exchanges while also obtaining valuable resources for innovation. The authors propose partners such as customers, suppliers, investors, government institutions, and consultants to obtain useful information and resources from external human capital. For innovation followers who create incremental innovations within the CEE area, we also recommend focussing on efficiency and the method of implementation of activities, such as logistics, delivery, and distribution, as well as information processing and communication. Based on our results, these activities could significantly influence firms' chance of creating incremental innovations within the analysed states.

In general, for innovative firms in Central Europe as well as in the CEE area, we recommend focussing on support for internal R&D and research capacities in the form of the activities as listed herein. Moreover, we recommend that firms focus on: *"a) identifying and recognizing value of externally generated knowledge (e.g. through probing, informal interactions with industry actors, studying patent literature); b) learning from and with external partners including for example suppliers, customers, and competitors (e.g. through cooperation, co-invention, and networking); c) transferring knowledge back to the organization (e.g. through pacing the partners)"* (Prokop *et al*., 2021, pp. 16–17).

*Policy implications*

From the perspective of recommendations for public policymakers, they should continue with the provision of tax credits and allowances for R&D and other innovation activities that are found to be significant for radical innovators. To avoid the emergence of the innovation paradox, it is necessary to support the building of the necessary (supportive) infrastructure in CEE countries and to focus on the efficiency of the provision of public financial funds that are found to be insignificant. Consequently, it is necessary to actively create an environment for cooperation, even between different partners who often pursue different interests and are motivated to cooperate in order to achieve diametrically different outputs (an example is university–company cooperation where universities can follow publications as a significant output, while companies want to keep their know-how secret and increase their sales). Therefore, it is appropriate to seek to reconcile the interests of the cooperating partners as well as reduce the administrative burden that may discourage partners from this form of co-operation and only lead to cooperation based on contract research. Moreover, referring to Radošević (2017), policymakers must reflect on the fact that CEE firms rely on the interaction of domestic R&D with more advanced technology from imported equipment and inputs; therefore, greater attention should be paid to helping CEE innovators improve their productivity such as by targeting public support for their actual technology upgrade needs. In order to support firms' foreign cooperation, it is necessary to help firms face a realistic risk of failure due to several factors influencing foreign cooperation such as the social, cultural, and institutional distance between partners (Stojčić, 2021).

*Limitations and future research*

The main limitation of this research is that we do not use primary data, but rather the CIS questionnaire, which admittedly was not designed to measure BMI (Tavassoli & Bengtsson, 2018). Moreover, due to the nature of the CIS questionnaire, we are not able to discern some of the longer-term effects, which are hard to find in the short run, as provided by CIS (Stojčić *et al.*, 2020). In contrast, these results can serve as a pilot analysis; based on this, it will be possible to develop our findings using primary data within the CEE territory, considering several avenues that are important for future research such as characteristics of firms' managers (e.g. skills, gender, personal preferences, and experiences). In addition, since we tested the effects of BMI elements on the innovations of various market players, follow-up research could also consider other factors that play a role; for example, various resource (e.g. knowledge, financial, and other) constraints (Laudien & Daxböck, 2017). Finally, it would be interesting and beneficial to focus on the response of firms to multiple crises such as the Covid-19 pandemic, war crisis, or energy crisis. Such crisis situations can lead to the introduction of a temporary BM (Clauss *et al.*, 2022) whose effects on firm performance have not yet been fully explored.

**References**

Aaltola, P. (2018). Investing in strategic development: Management control of business model and managerial innovations. *Qualitative Research in Accounting & Management*, *15*(2), 206–230. https://doi.org/10.1108/QRAM-05-2017-0044.

Abrahamsson, J., Boter, H., & Vanyushyn, V. (2019). Business model innovation of international new ventures: An empirical study in a Swedish context. *Journal of International Entrepreneurship*, *17*(1), 75–102. https://doi.org/10.1007/s10843-018-0238-3.

Andersson, M., Kusetogullari, A., & Wernberg, J. (2021). Software development and innovation: Exploring the software shift in innovation in Swedish firms. *Technological Forecasting and Social Change*, *167*, 120695. https://doi.org/10.1016/j.techfore.2021.120695.

Bamel, N., Kumar, S., Bamel, U., Lim, W. M., & Sureka, R. (2024). The state of the art of innovation management: Insights from a retrospective review of the European Journal of Innovation Management. *European Journal of Innovation Management*, *27*(3), 825–850. https://doi.org/10.1108/EJIM-07-2022-0361.

Bashir, M., & Verma, R. (2018). Internal factors & consequences of business model innovation. *Management Decision*, *57*(1), 262–290. https://doi.org/10.1108/MD-11-2016-0784.

Blažková, I., Svatošová, V., Chmelíková, G., Tamáš, V., Svobodová, E., Grega, L., Miškolci, S., Piecuch, J., Ujj, A., Hupková, D., Puchała, J, Bazsik, I., Jancsovszka, P., Nagyné Pércsi, K., Dobošová, Ľ. (2023). The effects of COVID-19 crisis on small family farms: Empirical evidence from Visegrad countries. *Agricultural Economics*, *69*(9), 366–374. https://doi.org/10.17221/217/2023-AGRICECON.

Bouncken, R. B., & Fredrich, V. (2016). Business model innovation in alliances: Successful configurations. *Journal of Business Research*, *69*(9), 3584–3590. https://doi.org/10.1016/j.jbusres.2016.01.004.

Castellacci, F., & Lie, C. M. (2015). Do the effects of R&D tax credits vary across industries? A meta-regression analysis. *Research Policy*, *44*(4), 819–832. https://doi.org/10.1016/j.respol.2015.01.010.

Chen, L., & Yang, W. (2019). R&D tax credits and firm innovation: Evidence from China. *Technological Forecasting and Social Change*, *146*, 233–241. https://doi.org/10.1016/j.techfore.2019.05.018.

Chesbrough, H. (2007). Business model innovation: It's not just about technology anymore. *Strategy & Leadership*, *35*(6), 12–17. https://doi.org/10.1108/10878570710833714.

Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning*, *43*(2-3), 354–363. https://doi.org/10.1016/j.lrp.2009.07.010.

Clauss, T. (2017). Measuring business model innovation: conceptualization, scale development, and proof of performance. *R&D Management*, *47*(3), 385–403. https://doi.org/10.1111/radm.12186.

Clauss, T., Abebe, M., Tangpong, C., & Hock, M. (2019). Strategic agility, business model innovation, and firm performance: An empirical investigation. *IEEE Transactions on Engineering Management*, *68*(3), 767–784. https://doi.org/10.1109/TEM.2019.2910381.

Clauss, T., Breier, M., Kraus, S., Durst, S., & Mahto, R. V. (2022). Temporary business model innovation–SMEs' innovation response to the Covid-19 crisis. *R&D Management*, *52*(2), 294–312. https://doi.org/10.1111/radm.12498.

Cortimiglia, M. N., Ghezzi, A., & Frank, A. G. (2016). Business model innovation and strategy making nexus: Evidence from a cross-industry mixed-methods study. *R&D Management*, *46*(3), 414–432. https://doi.org/10.1111/radm.12113.

da Costa Fernandes, S., & Rozenfeld, H. (2024). Business model innovation through the design of circular product-service system value propositions: A method proposal. *Business Strategy and the Environment*. https://doi.org/10.1002/bse.3759.

Dahlin, K. B., & Behrens, D. M. (2005). When is an invention really radical? Defining and measuring technological radicalness. *Research Policy*, *34*, 717–37. https://doi.org/10.1016/j.respol.2005.03.009.

D'Este, P., Iammarino, S., Savona, M., & von Tunzelmann, N. (2012). What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy*, *41*(2), 482–488. https://doi.org/10.1016/j.respol.2011.09.008.

Drupsteen, L., & Wakkee, I. (2024). Exploring characteristics of regenerative business models through a Delphi-inspired approach. *Sustainability*, *16*(7), 3062. https://doi.org/10.3390/su16073062.

Du, J., Leten, B., & Vanhaverbeke, W. (2014). Managing open innovation projects with science-based and market-based partners. *Research Policy*, *43*(5), 828–840. https://doi.org/10.1016/j.respol.2013.12.008.

European Commission (2023). Glossary:Innovation. March 27th, 2023. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Innovation.

Filser, M., Kraus, S., Breier, M., Nenova, I., & Puumalainen, K. (2021). Business model innovation: Identifying foundations and trajectories. *Business Strategy and the Environment*, *30*(2), 891–907. https://doi.org/10.1002/bse.2660.

Foltean, F. S., & Glovațchi, B. (2021). Business model innovation for Iot solutions: An exploratory study of strategic factors and expected outcomes. *Amfiteatru Economic*, 23(57), 392–411. https://doi.org/10.24818/EA/2021/57/392.

Foss, N. J., & Saebi, T. (2017). Fifteen years of research on business model innovation: How far have we come, and where should we go? *Journal of Management*, *43*(1), 200–227. https://doi.org/10.1177/0149206316675927.

Frenkel, A. (2003). Barriers and limitations in the development of industrial innovation in the region. *European Planning Studies*, *11*(2), 115–137. https://doi.org/10.1080/0965431032000072837

Fritz, M., & Berger, P. D. (2015). Will anybody buy? Logistic regression. In M. Fritz & P. D. Berger (Eds.). *Improving the user experience through practical data analytics* (pp. 271–304). Waltham, MA: Morgan Kaufmann. https://doi.org/10.1016/B978-0-12-800635-1.00011-2.

Gatautis, R., Vaiciukynaite, E., & Tarute, A. (2019). Impact of business model innovations on SME's innovativeness and performance. *Baltic Journal of Management*, *14*(4), 521–539. https://doi.org/10.1108/BJM-01-2018-0035.

Giglio, C. (2021). Cross-country creativity and knowledge flows of patent acquisitions: Drivers and implications for managers and policy-makers. *Journal of Engineering and Technology Management - JET-M*, *59*, 101617. https://doi.org/10.1016/j.jengtecman.2021.101617.

Götz, M., Sass, M., & Élteto, A. (2021). Perceptions of Industry 4.0 in Visegrad Firms. *Danube*, *12*(4), 239–255. https://doi.org/10.2478/danb-2021-0016.

Han, W., Li, X., Zhu, W., Lu, R., & Zu, X. (2024). Knowledge digitization and high-tech firm performance: A moderated mediation model incorporating business model innovation and entrepreneurial orientation. *Technology in Society*, 77, 102536. https://doi.org/10.1016/j.techsoc.2024.102536.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression*. Wiley. https://doi.org/10.1002/0471722146.

Hudec, O. (2015). Visegrad countries and regions: Innovation performance and efficiency. *Quality Innovation Prosperity*, *19*(2), 55–72. https://doi.org/10.12776/qip.v19i2.593.

J Nair, A., Manohar, S., Mittal, A. (2024). Reconfiguration and transformation for resilience: Building service organizations towards sustainability. *Journal of Services Marketing*, *38*(4), 404–425. https://doi.org/10.1108/JSM-04-2023-0144.

Kajtazi, K., Rexhepi, G., Sharif, A., & Ozturk, I. (2023). Business model innovation and its impact on corporate sustainability. *Journal of Business Research*, *166*, 114082. https://doi.org/10.1016/j.jbusres.2023.114082.

Karayalcin, I. S. (2024). Intrapreneurship, competitiveness and business model innovation. In A. Pauceanu & M. Porada-Rochoń (Eds.). *Innovating from within: Intrapreneurship and innovation within the organization* (pp. 86–92). London: Routledge. https://doi.org/10.4324/9781003348825.

Keiningham, T., Aksoy, L., Bruce, H. L., Cadet, F., Clennell, N., Hodgkinson, I. R., & Kearney, T. (2020). Customer experience driven business model innovation. *Journal of Business Research*, *116*, 431–440. https://doi.org/10.1016/j.jbusres.2019.08.003.

Kohtamäki, M., Leminen, S., & Parida, V. (2024). Conceptualizing digital business models (DBM): Framing the interplay between digitalization and business models. *Technovation*, *133*, 103013. https://doi.org/10.1016/j.technovation.2024.103013.

Kotkova Striteska, M., Myslivcova, K., Prokop, V., & Zapletalova, L. (2024). Employees' engagement, family ownership, or gender diversity? Searching for determinants of SMEs' green behaviors in CEE countries. *Corporate Social Responsibility and Environmental Management*. https://doi.org/10.1002/csr.2736.

Laudien, S. M., & Daxböck, B. (2017). Business model innovation processes of average market players: A qualitative-empirical analysis. *R&D Management*, *47*(3), 420–430. https://doi.org/10.1111/radm.12208.

Le, T. T., & Mohiuddin, M. (2024). Organizational inertia and firm performance: mediating role of green business model, and open innovation in manufacturing SMEs of emerging markets. *Global Journal of Flexible Systems Management*, *25*(2), 325–341. https://doi.org/10.1007/s40171-024-00384-1.

Liu, W., Liu, Y., Liu, L., & Peng, Q. (2024). A MBSE-based approach for architecting concepts for business model innovation of smart product systems. *Computer-Aided Design and Applications*, *21*(1), 155–170. https://doi.org/10.14733/cadaps.2024.155-170.

Loon, M., Otaye-Ebede, L., & Stewart, J. (2020). Thriving in the new normal: The HR microfoundations of capabilities for business model innovation. An integrated literature review. *Journal of Management Studies*, *57*(3), 698–726. https://doi.org/10.1111/joms.12564.

Lu, C., Qi, Y., Hao, S., & Yu, B. (2024). How and when domestic and international collaboration networks influence innovation performance of SMEs: Evidence from China. *Business Process Management Journal*, *30*(2), 435–462. https://doi.org/10.1108/BPMJ-05-2023-0336.

Luo, X. (2024). Exploring entrepreneurial learning, digital business management, and business model innovation in internet new ventures: An empirical study. *Journal of System and Management Sciences*, *14*(2), 35–54. https://doi.org/10.33168/JSMS.2024.0203.

Marshall, A., Bieck, C., Dencik, J., Goehring, B. C., & Warrick, R. (2024). How generative AI will drive enterprise innovation. *Strategy and Leadership*, *52*(1), 23–28. https://doi.org/10.1108/SL-12-2023-0126.

Mets, T. (2012). Creative business model innovation for globalizing SMEs. In *Entrepreneurship – creativity and innovative business models* (pp. 169–187). IntechOpen. https://doi.org/10.5772/37915.

Odei, S. A., Stejskal, J., & Prokop, V. (2021). Revisiting the factors driving firms' innovation performances: The case of Visegrad countries. *Journal of the Knowledge Economy*, *12*(3), 1331–1344. https://doi.org/10.1007/s13132-020-00669-7.

Osterwalder, A., Pigneur, Y., & Tucci, C. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems*, *16*, 1–25. https://doi.org/10.17705/1CAIS.01601.

Paiola, M., & Gebauer, H. (2020). Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. *Industrial Marketing Management*, *89*, 245–264. https://doi.org/10.1016/j.indmarman.2020.03.009.

Pece, A. M., Simona, O. E. O., & Salisteanu, F. (2015). Innovation and economic growth: An empirical analysis for CEE countries. *Procedia Economics and Finance*, *26*, 461–467. https://doi.org/10.1016/S2212-5671(15)00874-6.

Pepe, M. S., Cai, T., & Zhang, Z. (2004). Combining predictors for classification using the area under the ROC curve. *UW Biostatistics Working Paper Series*, *198*.

Priyadarshini, A., Gao, Y., & O'Gorman, C. (2024). Firm specific determinants of open innovation in European SMEs. *Journal of Small Business & Entrepreneurship*, *36*(1), 130–157 https://doi.org/10.1080/08276331.2021.1907698.

Prokop, V., & Stejskal, J. (2017). Different approaches to managing innovation activities: An analysis of strong, moderate, and modest innovators. *Engineering Economics*, *28*(1), 47–55. https://doi.org/10.5755/j01.ee.28.1.16111.

Prokop, V., Stejskal, J., Klimova, V., & Zitek, V. (2021). The role of foreign technologies and R&D in innovation processes within catching-up CEE countries. *PLoS ONE*, *16*(4), e0250307. https://doi.org/10.1371/journal.pone.0250307.

Prokop, V., Stejskal, J., Mikusova Merickova, B., & Odei, S. A. (2023). Revealing the importance of international and domestic cooperation by using artificial neural networks: Case of European radical and incremental innovators. *European Journal of Innovation Management*, *26*(2), 531–563. https://doi.org/10.1108/EJIM-02-2021-0104.

Pucihar, A., Lenart, G., Borštnar, M. K., Vidmar, D., & Marolt, M. (2019). Drivers and outcomes of business model innovation-micro, small and medium-sized enterprises perspective. *Sustainability*, *11*(2), 344. https://doi.org/10.3390/su11020344.

Radošević, S. (2017). Upgrading technology in Central and Eastern European Economies. *IZA World of Labor*, *338*, 1–11. https://doi.org/10.15185/izawol.338.

Ranganathan, P., Pramesh, C. S., & Aggarwal, R. (2017). Common pitfalls in statistical analysis: Logistic regression. *Perspectives in Clinical Research*, *8*, 148–151. https://doi.org/10.4103/picr.PICR_87_17.

Ritala, P., & Hurmelinna-Laukkanen, P. (2013). Incremental and radical innovation in coopetition—The role of absorptive capacity and appropriability. *Journal of Product Innovation Management*, *30*(1), 154–169. https://doi.org/10.1111/j.1540-5885.2012.00956.x.

Robertson, T. S. (2017). Business model innovation: A marketing ecosystem view. *AMS Review*, *7*(3), 90–100. https://doi.org/10.1007/s13162-017-0101-z.

Rok, B., & Kulik, M. (2024). Circular start-up development: The case of positive impact entrepreneurship in Poland. *Corporate Governance (Bingley), 21*(2), 339–358. https://doi.org/10.1108/CG-01-2020-0043.

Schneckenberg, D., Matzler, K., & Spieth, P. (2022). Theorizing business model innovation: An organizing framework of research dimensions and future perspectives. *R&D Management*, *52*(3), 593–609. https://doi.org/10.1111/radm.12506.

Schwarz, J. S., & Legner, C. (2020). Business model tools at the boundary: Exploring communities of practice and knowledge boundaries in business model innovation. *Electronic Markets*, *30*(3), 421–445. https://doi.org/10.1007/s12525-019-00379-2.

Smol, M., Marcinek, P., & Duda, J. (2024). Circular business models (CBMs) in environmental management—Analysis of definitions, typologies and methods of creation in organizations. *Sustainability*, *16*(3), 1209. https://doi.org/10.3390/su16031209.

Sorescu, A. (2017). Data-driven business model innovation. *Journal of Product Innovation Management*, *34*(5), 691–696. https://doi.org/10.1111/jpim.12398.

Souto, J. E. (2015). Business model innovation and business concept innovation as the context of incremental innovation and radical innovation. *Tourism Management*, *51*, 142–155. https://doi.org/10.1016/j.tourman.2015.05.017.

Spieth, P., Schneckenberg, D., & Matzler, K. (2016). Exploring the linkage between business model (&) innovation and the strategy of the firm. *R&D Management*, *46*(3), 403–413. https://doi.org/10.1111/radm.12218.

Spieth, P., Schneckenberg, D., & Ricart, J. E. (2014). Business model innovation–state of the art and future challenges for the field. *R&D Management*, *44*(3), 237–247. https://doi.org/10.1111/radm.12071.

Stejskal, J., Mikušová Meričková, B., & Prokop, V. (2016). The cooperation between enterprises: Significant part of the innovation process - a case study of the Czech machinery industry. *E&M Ekonomie a Management*, *19*(3), 110–122. https://doi.org/10.15240/tul/001/2016-3-008.

Stojčić, N. (2021). Collaborative innovation in emerging innovation systems: Evidence from Central and Eastern Europe. *Journal of Technology Transfer*, *46*(2), 531–562. https://doi.org/10.1007/s10961-020-09792-8.

Stojčić, N., Srhoj, S., & Coad, A. (2020). Innovation procurement as capability-building: Evaluating innovation policies in eight Central and Eastern European countries. *European Economic Review*, *121*, 103330. https://doi.org/10.1016/j.euroecorev.2019.103330.

Sund, K. J., Bogers, M. L., & Sahramaa, M. (2021). Managing business model exploration in incumbent firms: A case study of innovation labs in European banks. *Journal of Business Research*, *128*, 11–19. https://doi.org/10.1016/j.jbusres.2021.01.059.

Tavassoli, S., & Bengtsson, L. (2018). The role of business model innovation for product innovation performance. *International Journal of Innovation Management*, *22*(07), 1850061. https://doi.org/10.1142/S1363919618500615.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2-3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003.

Tykkyläinen, S., & Ritala, P. (2021). Business model innovation in social enterprises: An activity system perspective. *Journal of Business Research*, *125*, 684–697. https://doi.org/10.1016/j.jbusres.2020.01.045.

Urbaniec, M., & Żur, A. (2021). Business model innovation in corporate entrepreneurship: Exploratory insights from corporate accelerators. *International Entrepreneurship and Management Journal*, *17*(2), 865–888. https://doi.org/10.1007/s11365-020-00646-1.

Velev, M., & Veleva, S. (2021). Research of the influence of the innovations of the business models on the economic results of the enterprises. *Economic Altern*atives, *27*(4), 567–579. https://doi.org/10.37075/EA.2021.4.05.

Waldner, F., Poetz, M. K., Grimpe, C., & Eurich, M. (2015). Antecedents and consequences of business model innovation: The role of industry structure. In *Business models and modelling*. Emerald Group Publishing Limited. https://doi.org/10.1108/S0742-332220150000033009.

Zhou, Y., Hong, Y., & Liu, J. (2013). Internal commitment or external collaboration? The impact of human resource management systems on firm innovation and performance. *Human Resource Management*, *52*(2), 263–288. https://doi.org/10.1002/hrm.21527.

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## Annex

**Table 1.** Frequencies of introduction of BMI elements in the analysed countries (in %)

| | Czech Republic | | Hungary | | Slovakia | |
|---|---|---|---|---|---|---|
| **Variable** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** |
| *BMI-meth* | 25.54 | 74.46 | 13.13 | 86.87 | 12.42 | 87.58 |
| *BMI-log* | 13.4 | 86.6 | 7.57 | 92.43 | 7.51 | 92.49 |
| *BMI-comm* | 21.7 | 78.3 | 12.76 | 87.24 | 12.61 | 87.39 |
| *BMI-acct* | 16.79 | 83.21 | 9.62 | 90.38 | 9.12 | 90.88 |
| *BMI-extrel* | 15.57 | 84.43 | 6.8 | 93.2 | 10.44 | 89.56 |
| *BMI-hrm* | 23.49 | 76.51 | 9.09 | 90.91 | 9.52 | 90.48 |
| *BMI-mark* | 25.14 | 74.86 | 8.84 | 91.16 | 8.34 | 91.66 |

**Table 2.** Frequencies of each level for the control variables in analysed countries (in %)

| | Czech Republic | | Hungary | | Slovakia | |
|---|---|---|---|---|---|---|
| **Variable** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** |
| *emphamp* | 42.86 | 57.14 | 38.38 | 61.62 | 52.19 | 47.81 |
| *finhamp* | 41.75 | 58.25 | 29.38 | 70.62 | 57.29 | 42.71 |
| *fungov* | 6.91 | 93.09 | 8.76 | 91.24 | 2.22 | 97.78 |
| *othco* | 13.03 | 86.97 | 8.01 | 91.99 | 7.23 | 92.77 |
| *rdevco* | 14.23 | 85.77 | 8.36 | 91.64 | 6.98 | 93.02 |
| *rdevex* | 18.19 | 81.81 | 3.48 | 96.52 | 5.03 | 94.97 |
| *rdevin* | 29.97 | 70.03 | 13.12 | 86.88 | 11.15 | 88.85 |
| *rdtax* | 9.58 | 90.42 | 4.55 | 95.45 | 2.22 | 97.78 |
| *size* | **under 250** | **250 and more** | **under 250** | **250 and more** | **under 250** | **250 and more** |
| | 78.69 | 21.31 | 90.55 | 9.45 | 86.53 | 13.47 |

**Table 3.** The effects of BMI elements on firms' radical and incremental innovations in the Czech Republic

| **Independent Variables** | **Radical innovations – leaders** | | | **Incremental innovations – followers** | | |
|---|---|---|---|---|---|---|
| | **Coeff.** | **OR** | **p-value** | **Coeff.** | **OR** | **p-value** |
| (Intercept) | -3.227 | 0.040 | < 2.2e-16 *** | -2.888 | 0.056 | < 2.2e-16 *** |
| *BMI-meth* | 0.684 | 1.981 | 1.673e-12 *** | 0.694 | 2.001 | 1.897e-14 *** |
| *BMI-log* | 0.489 | 1.631 | 1.020e-05 *** | 0.375 | 1.456 | 0.0006112 *** |
| *BMI-comm* | 0.109 | 1.115 | 0.3322481 | 0.162 | 1.176 | 0.1319145 |

**Table 3.** Continued

| Independent Variables | Radical innovations – leaders | | | Incremental innovations – followers | | |
|---|---|---|---|---|---|---|
| | Coeff. | OR | p-value | Coeff. | OR | p-value |
| *BMI-acct* | 0.059 | 1.061 | 0.6128288 | 0.031 | 1.031 | 0.7849369 |
| *BMI-extrel* | -0.110 | 0.896 | 0.3223889 | 0.067 | 1.069 | 0.5308586 |
| *BMI-hrm* | 0.095 | 1.100 | 0.3619604 | -0.016 | 0.984 | 0.8700361 |
| *BMI-mark* | 0.956 | 2.601 | < 2.2e-16 *** | 0.986 | 2.681 | < 2.2e-16 *** |
| rdevin | 1.675 | 5.339 | < 2.2e-16 *** | 1.625 | 5.078 | < 2.2e-16 *** |
| rdevex | 0.419 | 1.520 | 3.665e-05 *** | 0.209 | 1.232 | 0.0374774 * |
| othco | 0.451 | 1.571 | 2.641e-05 *** | 0.473 | 1.605 | 1.131e-05 *** |
| fungov | 0.231 | 1.260 | 0.0782112 + | 0.231 | 1.260 | 0.0824570 + |
| rdtax | 0.446 | 1.562 | 0.0001459 *** | - | - | - |
| emphamp | -0.172 | 0.842 | 0.0455159 * | 0.417 | 1.518 | 6.601e-08 *** |
| size (250 and more) | - | - | - | 0.520 | 1.682 | 6.603e-09 *** |

Note: Signif. codes: *** = 0.001; ** = 0.01; * = 0.05; + = 0.1; during the analyses, some control variables were discarded (due to their statistical insignificance) in order to obtain more accurate model results
Note: Signif. codes: *** = 0.001; ** = 0.01; * = 0.05; + = 0.1; during the analyses, some control variables were discarded (due to their statistical insignificance) in order to obtain more accurate model results.

**Table 4.** The effects of BMI elements on firms' radical and incremental innovations in Hungary

| Independent Variables | Radical innovations – leaders | | | Incremental innovations – followers | | |
|---|---|---|---|---|---|---|
| | Coeff. | OR | p-value | Coeff. | OR | p-value |
| (Intercept) | -3.156 | 0.043 | < 2.2e-16 *** | -2.777 | 0.062 | < 2.2e-16 *** |
| *BMI-meth* | 1.494 | 4.457 | < 2.2e-16 *** | 1.434 | 4.195 | < 2.2e-16 *** |
| *BMI-log* | 0.185 | 1.204 | 0.1654546 | 0.515 | 1.674 | 0.0001222 *** |
| *BMI-comm* | 0.542 | 1.719 | 3.835e-05 *** | 0.790 | 2.203 | 2.937e-10 *** |
| *BMI-acct* | -0.011 | 0.989 | 0.937144 | 0.098 | 1.103 | 0.4558814 |
| *BMI-extrel* | 0.489 | 1.631 | 0.0007869 *** | -0.184 | 0.832 | 0.2297849 |
| *BMI-hrm* | -0.113 | 0.893 | 0.4162323 | 0.447 | 1.564 | 0.0010530 ** |
| *BMI-mark* | 0.859 | 2.360 | 2.202e-11 *** | 0.843 | 2.323 | 1.151e-10 *** |
| rdevin | 1.353 | 3.870 | < 2.2e-16 *** | 1.326 | 3.765 | < 2.2e-16 *** |
| othco | 0.428 | 1.535 | 0.0004342 *** | 1.109 | 3.033 | < 2.2e-16 *** |

**Table 4.** Continued

| Independent Variables | Radical innovations – leaders | | | Incremental innovations – followers | | |
|---|---|---|---|---|---|---|
| | **Coeff.** | **OR** | **p-value** | **Coeff.** | **OR** | **p-value** |
| fungov | - | - | - | 0.189 | 1.208 | 0.1209894 |
| rdtax | 0.460 | 1.584 | 0.0032670 ** | - | - | - |
| emphamp | 0.226 | 1.253 | 0.0088199 ** | 0.228 | 1.256 | 0.0061395 ** |
| finhamp | - | - | - | 0.206 | 1.229 | 0.0168828 * |
| size (250 and more) | - | - | - | 0.341 | 1.406 | 0.0043165 ** |

Note: Signif. codes: *** = 0.001; ** = 0.01; * = 0.05; + = 0.1; during the analyses, some control variables were discarded (due to their statistical insignificance) in order to obtain more accurate model results.

**Table 5.** The effects of BMI elements on firms' radical and incremental innovations in Slovakia

| Independent Variables | Radical innovations – leaders | | | Incremental innovations – followers | | |
|---|---|---|---|---|---|---|
| | **Coeff.** | **OR** | **p-value** | **Coeff.** | **OR** | **p-value** |
| (Intercept) | -3.578 | 0.028 | < 2.2e-16 *** | -3.833 | 0.022 | < 2.2e-16 *** |
| *BMI-meth* | 0.972 | 2.643 | 1.229e-07 *** | 1.129 | 3.093 | 7.148e-11 *** |
| *BMI-log* | 0.308 | 1.361 | 0.184381 | 0.572 | 1.772 | 0.009795 ** |
| *BMI-comm* | 0.336 | 1.399 | 0.1447176 | 0.698 | 2.01 | 0.001442 ** |
| *BMI-acct* | -0.313 | 0.731 | 0.1731294 | -0.439 | 0.645 | 0.051453 + |
| *BMI-extrel* | 0.486 | 1.625 | 0.0462662 * | 0.454 | 1.575 | 0.055439 + |
| *BMI-hrm* | -0.017 | 0.983 | 0.945337 | -0.176 | 0.839 | 0.462864 |
| *BMI-mark* | 0.891 | 2.438 | 2.180e-05 *** | 0.633 | 1.884 | 0.002034 ** |
| rdevin | 1.673 | 5.33 | < 2.2e-16 *** | 1.669 | 5.305 | < 2.2e-16 *** |
| rdevex | 0.585 | 1.795 | 0.0126086 * | - | - | - |
| rdevco | 0.544 | 1.723 | 0.0119143 * | 0.387 | 1.473 | 0.069327 + |
| othco | 0.792 | 2.207 | 0.0001513 *** | 0.817 | 2.264 | 5.876e-05 *** |
| emphamp | - | - | - | 0.484 | 1.622 | 0.001877 ** |
| finhamp | - | - | - | 0.277 | 1.32 | 0.083042 + |
| size (250 and more) | 0.392 | 1.48 | 0.0281277 * | - | - | - |

Note: Signif. codes: *** = 0.001; ** = 0.01; * = 0.05; + = 0.1; during the analyses, some control variables were discarded (due to their statistical insignificance) in order to obtain more accurate model results.

**Table 6.** Summary of the significance of BMI elements in the processes of creating radical and incremental innovations

| | *BMI-meth* | *BMI-log* | *BMI-mark* | *BMI-comm* | *BMI-extrel* | *BMI-hrm* | *BMI-acct* |
|---|---|---|---|---|---|---|---|
| **Czech Republic** | Radical<br>Incremental | Radical<br>Incremental | Radical<br>Incremental | - | - | - | - |
| **Hungary** | Radical<br>Incremental | Incremental | Radical<br>Incremental | Radical<br>Incremental | Radical | Incremental | |
| **Slovakia** | Radical<br>Incremental | Incremental | Radical<br>Incremental | Incremental | Radical<br>Incremental | - | Incremental<br>(-) |

Note: *BMI-acct* has negative effects on firms' incremental innovation in Slovakia.

**Figure 1.** Frequencies of introduction of BMI elements in Central Europe (in %)

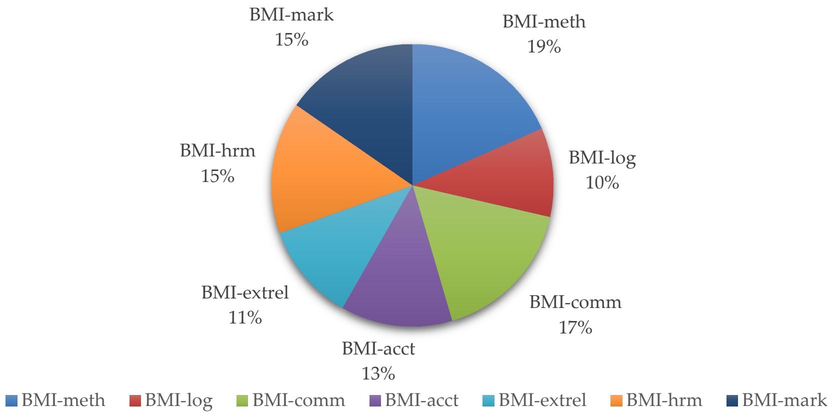


**Figure 2.** Conceptual model