JMFS
Journal of Management and Financial Sciences

Volume XVI
•
Issue 49
pp. 95–119
SGH Warsaw School of Economics
Collegium of Management and Finance

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# Exploring the drivers of business model innovation and its significance for performance in high-tech sectors

## Abstract

Business model innovation (BMI) has emerged as a vital determinant for the organization's success and survival. This study explores the external (technological turbulence and market dynamism) and internal (knowledge management culture and inbound open innovation) antecedents of BMI and its effect on firm performance on a sample of high-tech companies from Poland (n=160). We find that external antecedents and inbound open innovation are positively related to BMI and that BMI positively affects company performance. This study contributes to the extant literature by emphasizing the role of organizational propensity to conduct open innovation, revealed by building strong ties with external parties and relying on their innovation through proactive search for external ideas, technological knowledge, and products.

**Keywords:** business model innovation, high-tech companies, antecedents, performance
**JEL Classification:** M19

## Introduction

Business model (BM) and business model innovation (BMI) have become important topics for practitioners and academics contributing to a better understanding of the sources of firms' superior performance and survival in the face of rapid technological changes [Futterer et al., 2018]. Business model innovation can be defined as the deliberate reconfiguration of a firm's value generation architecture encompassing both the creation of new business models and the enhancement of existing ones [Foss, Saebi, 2018; Yu et al., 2021]. The BMI phenomenon has attracted increased interest in academic literature leading to theory development on antecedents, drivers, processes, and performance implications [Sabaruddin et al., 2023]. Despite this proliferation of research, scholars still underscore the necessity to resolve fundamental questions related to the mechanisms driving BMI and its performance implications [Foss, Saebi, 2018; Hock-Doepgen et al., 2021]. Consequently, no consensus exists on the circumstances under which BMI emerges, making the body of knowledge inconclusive and noncumulative [Foss, Saebi, 2017]. In particular, the existing body of research does not fully explain the intricate interplay of critical internal and external factors and their combined impact on BMI, particularly in high-tech sectors [White et al., 2023].

Although the key internal and external factors potentially influencing BMI have been widely discussed in the literature, empirical investigation still remains limited. In this regard, scholars argue that although a number of factors exist potentially conditioning BMI and its effect on performance, their interactions and aggregate impact on BMI remain insufficiently explored and understood [Spieth et al. 2014; White et al., 2023]. Among the internal determinants, studies have considered the individual characteristics of decision-makers, the process of decision-making [Loon et al., 2021], organizational design [Christensen et al., 2016], and the contingencies of innovation mode (traditional vs. open) [Monios, Bergqvist, 2015]. In this regard, the combined role of knowledge management culture and the adaptation of the inbound open innovation approach has remained underexplored, although they both are considered to lead to enhancement of BMI [Hock-Doepgen et al., 2021]. The studied external determinants of BMI implementation include institutional and regulatory context [e.g. Dilger et al., 2017]. Interestingly, the effect of industry-level determinants, such as technological turbulence on BMI, indicative of the speed of technological advancements, has been scarcely investigated in the context of unpredictable and ever-changing technological context [Sabaruddin et al., 2023]. Likewise, the relationship between market dynamism, reflecting the rate of change in an organization's business environment, and BMI calls for more rigorous exploration [Hock-Doepgen et al., 2021; Zhou, Wu, 2010]. Taken together, our limited understanding of causal relationships between antecedents of BMI, BMI itself, and its outcomes can be problematic for business decision-makers and prevent them from undertaking BMI activities even in the face of environmental changes [Desyllas et al., 2022]. Because the extant literature on BMI still lacks comprehensive understanding of the linkage between the antecedents of BMI,

BMI, and its performance implications, our objective is to explain this relationship and test a three-step model that accounts for the effects of internal and external factors on BMI and further company performance. Consequently, in the present study, we address these gaps by asking two research questions:
(1) *How do internal and external factors influence BMI of high-tech companies?*
(2) *How does BMI affect high-tech company performance*?

To answer these questions, our study develops a conceptual framework of antecedents and consequences of BMI in the high-tech sector, drawing from the strategic and innovation management literature. We test this framework using regression analysis on a sample of 160 companies operating in high-tech and medium-tech industries. Our findings indicate that while the effect of external antecedents is statistically significant, the effect of internal antecedents is limited. We also find a significant effect of BMI on company performance. Overall, we find partial support for our hypotheses. Our study contributes to the BMI literature by offering a nuanced perspective of its antecedents and consequences in the context of the post-transformational economy of Poland.

The paper proceeds as follows. Firstly, we provide a theoretical overview of the BMI literature and develop hypotheses drawing from the strategic management, innovation, and BMI literature. Secondly, the analytical method and operationalization of variables is presented. Next, we present the results of our statistical analysis. The paper concludes with discussion of our research findings, limitations, and implications for future research.

## Theoretical background

In the dynamic business landscape, particularly within high-tech sectors, business model innovation (BMI) is essential for company competitiveness [Garzella et al., 2021]. A business model reflects a business's 'structural template' [Zott, Amit, 2008] or its configuration [Baden-Fuller, Morgan, 2010]. Business model innovation (BMI) has gained prominence as a way to adapt to a competitive and rapidly changing environment [Foss, Saebi, 2017]. BMI, as defined by Foss and Saebi [2017], involves significant changes to a firm's BM elements and its architecture. This comprehensive approach involves creation of new customer value while capturing value for a firm. Spieth and Schneider [2016] view BMI as an evolution of a firm's value architecture, involving deep-seated changes by creatively recombining elements like value proposition, value creation, and value capture.

BMI represents a multifaceted phenomenon, marked by its ability to assume varying forms along distinct dimensions, a concept gleaned from Foss and Saebi's research [2017]. Their definition characterizes BMI as "designed, novel, and nontrivial changes to the key elements of a firm's BM and/or the architecture linking these elements" [Foss, Saebi, 2017, p. 216]. Firstly, BMI exhibits diversity in terms of the pace or speed at which it transpires, ranging from gradual and slow adaptations to swift and transformative changes. Zott, Amit,

and Massa [2011] contribute to this understanding by emphasizing the various components that make up a business model and how innovation can occur within these components. They stress that the speed of BMI can be influenced by the specific aspects of the business model being modified. Moreover, Mao et al. [2020] and Martins et al. [2015] add valuable insights into the understanding of why BMI is both a planned and adaptive process. They argue that BMI is not a completely emergent process but designed to a certain degree before implementation, highlighting that organizations deliberately shape their business models. Lastly, scholars have debated the novelty of BMI, whether it represents novelty for the firm or the industry, adding an additional layer of complexity to its conceptualization [Foss, Saebi, 2017; Mao et al., 2020]. This multifaceted nature underscores the importance of recognizing that BMI is not a one-size-fits-all concept but rather a dynamic and adaptable phenomenon that can be tailored to an organization's unique needs and goals.

Foss and Saebi [2017] underscore the need to resolve fundamental questions related to what determines, facilitates, and hinders business model innovation. In recent years, the BMI literature has made remarkable progress in shedding light on the myriad external factors that influence BMI outcomes [White et al., 2023]. These external drivers encompass a wide range of elements, including environmental conditions and organizational responses [Burns, Stalker, 1961; Chakravarthy, 1982; Teece et al., 1997], the pivotal role played by external stakeholders [Ferreira et al., 2013], and shifts in the competitive environment [De Reuver et al., 2009]. In particular, business model innovation is significantly shaped by changing environmental conditions, competitive landscapes, and technological advancements. From the organizational perspective, several key factors are pivotal in shaping BMI process and outcomes. These include a firm's absorptive capacity, agility, knowledge management culture, and inbound open innovation [Bhatti et al., 2021; Gold et al., 2001; Hock-Doepgen et al., 2021; Lu, Ramamurthy, 2011]. Yan et al.'s [2020] study emphasizes the importance of organizations' strategic orientations. In particular, their work highlights the need for organizations to proactively adapt and innovate, emphasizing the critical role of both internal and external BMI factors in shaping their business trajectories. These internal dynamics serve as the foundation upon which business model innovation is constructed.

Taken together, what remains insufficiently explored is what is the combined effect of external and internal factors on innovation of firms' business model and how BMI itself affects performance [Sabaruddin et al., 2023; White et al., 2023]. Moreover, while the BMI phenomenon in traditional businesses is relatively well explored, the literature remains scarce regarding the antecedents and outcomes of BMI in SMEs in high-tech sectors and in an emerging or post-transition market context [Bhatti et al., 2021; Foss, Saebi, 2018].

## Conceptual model and hypotheses development

Understanding BMI and its antecedents, both internal and external, is pivotal, yet this area has received relatively limited attention in the existing literature. Foss and Saebi [2017] recognize this gap and highlight the need to investigate the factors that lead to BMI, emphasizing that these antecedents can vary in nature, origin, and level, whether internal or external to the firm.

*External antecedents of business model innovation*

Business model innovation is heavily influenced by external factors that drive evolution in a company's business architecture. These external drivers encompass a wide range of factors, including environmental conditions [Burns, Stalker, 1961; Chakravarthy, 1982; Teece et al., 1997], external stakeholders [Ferreira et al., 2013], shifts in the competitive environment [De Reuver et al., 2009], including new technologies [Pateli, Giaglis, 2005; Sabatier et al., 2012; Wirtz et al., 2010]. These factors shape what is referred to as 'evolutionary business model innovation', wherein firms adapt gradually their business models to respond effectively to emerging challenges and opportunities [Foss, Saebi, 2017, p. 217]. This suggests that BMI is often a necessary strategic response to competitive pressures [Johnson et al., 2008], particularly in the context of increasing globalization [Lee et al., 2012] and rapid technological development [Wirtz et al., 2010].

Furthermore, when discussing the external factors within high-tech sectors, the concept of technological turbulence takes precedence, characterized by the rapid and unpredictable pace of technological advancements [Zhou, Wu, 2010]. Given the foundational role of technology in these industries, a comprehensive understanding of how firms navigate this turbulence to drive BMI becomes paramount. Such insights hold the potential to develop valuable strategies for ensuring long-term sustainability and maintaining a competitive edge. Another salient external factor, particularly pronounced in high-tech industries, is the phenomenon of market dynamism, characterized by swiftly changing consumer preferences and market trends [Hock-Doepgen et al., 2021]. In these sectors, firms must continually adapt to remain competitive, making it imperative to explore how they effectively adjust their business models in response to market dynamism. This exploration can shed light on strategies that foster BMI within the context of high-tech industries.

### Technological turbulence and business model innovation

Technological turbulence, characterized by rapid changes, disruptive advances, and a high degree of uncertainty, is undeniably a powerful catalyst for BMI in high-tech sectors [Zhou, Wu, 2010]. High-tech industries, such as information technology and biotechnology, are renowned for their susceptibility to rapid technological advancements that redefine market dynamics. In these sectors, the competitive landscape can shift overnight due to breakthrough innovations, obsolescence of existing technologies, or changes in customer preferences

[Christensen, 1997; Teece, 2018; Zhou & Wu, 2010]. For instance, Christensen's seminal work on disruptive innovation demonstrates how technological turbulence can lead to the emergence of entirely new business models and the displacement of established ones. The case of Apple's disruption of the music industry with the introduction of the iPod and iTunes illustrates how a company can capitalize on technological turbulence to innovate its business model and capture new markets [Christensen, 1997]. Moreover, Teece's [2018] research on profiting from innovation in the digital economy emphasizes the need for firms in high-tech sectors to adapt continuously their business models to changing technological landscapes. Teece [2018] argues that enabling technologies, standards, and licensing models in the wireless world are prime examples of how firms must evolve their business models to seize opportunities presented by technological turbulence. In the realm of high-tech sectors, the importance of strategic flexibility and adaptability within business models cannot be overstated. The ability to experiment with novel value propositions, revenue models, and customer segments becomes a competitive advantage in an environment characterized by technological turbulence [Brynjolfsson, McAfee, 2014]. As firms in high-tech sectors grapple with the continuous impact of technological advancements on market requirements and competitive structures, they are inherently inclined to innovate their business models to maintain their market standing. Therefore, we posit the following hypothesis:

***H1:*** There is a positive relationship between technological turbulence and business model innovation in high-tech firms.

## Market dynamism and business model innovation

Market dynamism captures the pace and unpredictability of changes in the market. It reflects the complexity and uncertainty shaped by shifting competition and evolving customer preferences. In dynamic environments, firms must adapt and innovate their business models to thrive. Hock-Doepgen et al. [2021] delve into the role of knowledge management capabilities and organizational risk-taking in enabling BMI, emphasizing their importance in navigating market dynamism. Robust knowledge management and willingness to take risks empower firms to sense and respond to rapid changes, essential for success in dynamic contexts [Hock-Doepgen et al., 2021]. Moreover, engaging with customers and non-consumers is pivotal in responding to market dynamism. Firms need to maintain strong customer relationships and continuously adapt their value propositions to meet evolving needs. Learning from non-consumers provides insights into unmet needs and market opportunities [Karimi, Walter, 2016]. Cross-industry learning is another valuable approach, enabling firms to identify emerging trends and apply external knowledge to their industries. This approach can be facilitated through strategic alliances, partnerships, and open innovation platforms that promote collaborative knowledge exchange [Chesbrough, 2007].

In the context of high-tech sectors, the environment is inherently dynamic, fuelled by technological advancements, disruptive innovations, evolving customer needs, and intensified

competition. This dynamic environment drives firm adaptation through innovation of their business models [Foss, Saebi, 2017; Teece, 2007]. Accordingly, high levels of market dynamism can precipitate a shift from static, rigid business models towards more innovative, adaptable models. Therefore, it is hypothesized that market dynamism has a positive impact on BMI, compelling firms in high-tech sectors to innovate their business models in response to their changing ecosystem [Teece, 2018].

***H2:*** There is a positive relationship between market dynamism and business model innovation in high-tech firms.

## Internal antecedents of business model innovation

While previous research has extensively explored external drivers of BMI, such as market competition and technological evolution [Demil, Lecocq, 2010; Johnson et al., 2008; Schneider, Spieth, 2013; Teece, 2017], it is crucial to recognize that internal determinants play an equally significant role in shaping an organization's BMI capabilities. These internal factors encompass organizational elements that not only influence BMI but also lay the foundation for its successful implementation and sustainability. One internal determinant that warrants attention is strategic agility [Bock et al., 2012; Santos et al., 2009; Schneider, Spieth, 2014]. Strategic agility encompasses an organization's ability to swiftly adapt its strategies and operations in response to changing market conditions and emerging opportunities. It allows firms to proactively identify and seize BMI prospects, aligning their business models with evolving customer needs and market dynamics. Moreover, corporate-level strategy, as emphasized by Santos et al. [2009], plays a pivotal role in influencing BMI choices and flexibility at the business unit level. The alignment of corporate strategy with BMI initiatives ensures that the organization's overarching goals and direction are reflected in its innovative endeavors. Delving further into internal determinants, researchers such as Bhatti et al. [2021] have shed light on two crucial factors: organizational absorptive capacity and agility. Organizational absorptive capacity, defined as a firm's adeptness at recognizing and leveraging effectively external information for commercial purposes, stands out as a cornerstone antecedent of BMI [Bhatti et al., 2021]. This capacity enables organizations to assimilate external knowledge, insights, and emerging trends, which can subsequently inform and inspire innovative changes to their business models. It facilitates sensing changes in market demand and customer preferences, coupled with the ability to translate these insights into actionable BMI strategies, positions firms for competitive advantage in rapidly evolving industries.

## Inbound open innovation and business model innovation

Among internal determinants, the impact of inter-organizational collaboration on BMI cannot be understated. Ebel et al. [2016] argue that traditional internal innovation processes are no longer sufficient for driving BMI, as they tend to be slow, linear, and lacking diversity.

Instead, the authors advocate for a more open and collaborative approach to BMI, which involves engaging with external stakeholders such as customers, partners, and even competitors. This approach is referred to as open innovation, and it can involve various forms such as crowdsourcing, co-creation, and open platforms [Chesbrough, Appleyard, 2007]. Researchers also highlight the importance of leveraging virtual tools and technologies to facilitate open innovation processes and support virtual collaboration among stakeholders [Ebel et al., 2016]. Technological changes are potentially the largest for boundary-spanning search approaches [Jeppesen, Lakhani, 2010; Rosenkopf, Nerkar, 2001], and innovation potential is highly disruptive, when partners with large cognitive distance cooperate [Nooteboom et al., 2007]. Cross-industry innovation activities resulted mainly in breakthrough or radical innovation outcomes [Enkel, Gassmann, 2010].

Inbound open innovation is an integral facet of the broader open innovation paradigm and assumes a pivotal role in fostering business model innovation (BMI) by prioritizing the acquisition of external knowledge [Liao et al., 2019]. First, it serves as a proactive approach to identifying emerging opportunities in the external environment. Early recognition of potential market shifts and customer demands enables firms to position themselves strategically in the ever-evolving business landscape, enhancing their adaptability and competitive advantage. Furthermore, inbound open innovation facilitates the establishment of valuable connections with external entities, including other businesses, partners, and customers [Liao et al., 2019]. Spithoven et al. [2013] emphasize that trust is the foundation of successful inter-organizational collaborations are built. The resulting transparency ensures that knowledge flows smoothly between internal and external stakeholders. Collaboration, both within and beyond organizational boundaries, fosters an environment where knowledge exchange thrives, further fuelling the innovation process. Bogers and Horst [2014] shed light on the role of transformational leadership in shaping inbound open innovation by encouraging risk-taking, experimentation, and active knowledge sharing. Leaders who adopt a transformational approach create an organizational climate that is conducive to embracing external knowledge and exploring novel ideas. This, in turn, contributes to a culture of continuous innovation and a higher likelihood of successful BMI. The contemporary shift towards network-driven innovation, as highlighted by Bogers et al. [2017], underscores that in today's interconnected business landscape, innovation is increasingly recognized as a systemic phenomenon that involves multiple actors, including firms, customers, suppliers, and research institutions. By actively participating in networks and ecosystems, organizations can tap into the collective intelligence and creativity of these diverse stakeholders. This collaborative approach enhances the firm's ability to identify and capitalize on new opportunities for business model innovation, leveraging a broader pool of insights and expertise. Therefore, we posit that:

***H3:*** There is a positive relationship between inbound open innovation and business model innovation in high-tech firms.

### Knowledge management and business model innovation

Knowledge management assumes a critical role, particularly in high-tech sectors where proprietary knowledge often forms the bedrock of competitive advantage [Hock-Doepgen et al., 2021]. Investigating the impact of effective knowledge management practices on BMI becomes pivotal, providing practical guidance for firms aspiring to innovate their business models. This underscores the foundational role of knowledge in driving BMI outcomes.

In recent years, knowledge management (KM) has emerged as a framework encompassing organizational learning, knowledge creation, and acquisition [Castaneda et al., 2018]. KM practices include fostering a knowledge-sharing culture, building knowledge networks, utilizing technology for knowledge capture, and developing knowledge-sharing incentives [Hock-Doepgen et al., 2021]. KM culture (KMC) shapes how information is valued, shared, and used for competitive advantage [Alavi et al., 2005; Santoro et al., 2020]. It interconnects with other KM capabilities and contributes to overall knowledge assets [Hock-Doepgen et al., 2021; Mehta, Bharadwaj, 2015]. Both internal (KM-centric culture, technology, and structure) and external KM capabilities are BMI drivers. Strong KM culture, technology, and organization enable the collection, conversion, and application of external knowledge, enhancing BMI competencies [Hock-Doepgen et al., 2021]. Innovative businesses integrate new skills and knowledge into their processes, systems, and infrastructure, fostering organizational and technical advancement [Karimi, Walter, 2016]. Therefore, we posit the following hypothesis:
***H4:*** There is a positive relationship between knowledge management culture and business model innovation in high-tech firms.

## Business model innovation and company performance

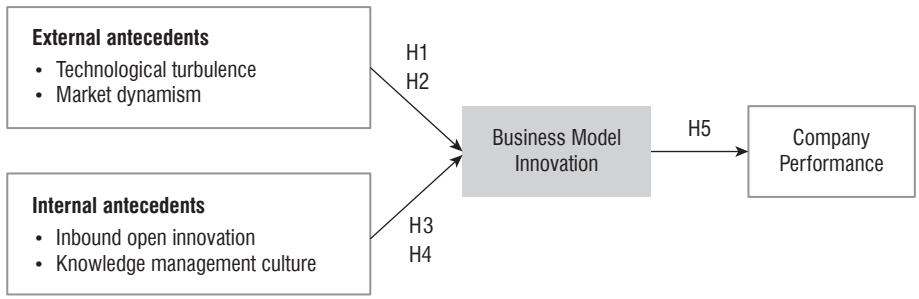
Understanding how BMI influences an organization's performance is essential due to its potential to create value and establish a competitive edge. BMI is considered to significantly enhance a firm's financial and non-financial performance, making firms more competitive [Clauss et al., 2019a; Ferreras-Méndez et al., 2021; Latifi, Bouwman, 2021; Nunes, Do Val Pereira, 2020; Schneider, 2019]. Previous studies suggest a potential positive relationship between BMI and company performance [Bhatti et al., 2021; Xiao et al., 2021]. The underlying premise is that BMI, by enhancing strategic flexibility and responsiveness, can lead to improved performance outcomes. This is because BMI allows firms to adapt their value propositions, restructure operations, and reconsider customer relationships [Foss, Saebi, 2017]. For instance, Teece [2010] highlights that BMI plays a pivotal role in bridging technical innovation and commercial performance. Consistently assessing and refining the BM is crucial for adapting to changing market conditions and evolving customer preferences, ensuring lasting sustainability and growth for the firm. The literature identifies various ways in which BMI contributes to enhanced company performance. One significant aspect is the focus on customer value

creation within BMI. Innovative business models prioritize delivering unique value propositions that effectively meet customer needs, leading to increased customer satisfaction, loyalty, higher revenues, and a larger market share [Osterwalder, Pigneur, 2010]. Furthermore, BMI enables firms to optimize their cost structures and enhance operational efficiency, resulting in improved financial performance with higher profit margins [Teece, 2010]. Overall, BMI enhances a firm's adaptability to external shifts and market disruptions, making it more resilient to external shocks and better equipped to maintain or improve financial performance, particularly in turbulent environments [Casadesus-Masanell, Ricart, 2010].

However, the impact of BMI on performance is not straightforward and varies across industries and markets. First, too quick and too broad BMI may have a detrimental effect on performance, as it may fail to account for internal consistency (alignment of BM elements and dimensions) or to a lack of the fit between existing and novel interdependencies [Desyllas et al., 2022; Leppänen et al., 2023]. Therefore, disruptive BMI is likely to lead to improved performance under the condition of high external volatility rather than during slowly or moderately changing environments [e.g. Gassmann et al., 2014; Karimi, Walter, 2016]. Secondly, higher levels of depth and breadth of BMI contributes more to a firm's performance in less stable political and economic environments than in more stable ones [White et al., 2023]. Thirdly, prior studies found that firms in high-tech industries experience greater performance benefits from BMI than firms in low-tech industries [White et al., 2023]. Therefore, we expect that BMI will contribute to an improved performance of firms in high-tech industries operating in the post-transformational economy of Poland. Consequently, we posit that:
***H5:*** There is a positive relationship between business model innovation and performance of high-tech firms.

Figure 1 presents the model of hypothesized linkages. The constructs developed based on the literature and linkages forming an empirically testable set of hypotheses are presented in the research methodology section.

**Figure 1. Conceptual model of antecedents and effect of business model innovation in high-tech firms**




Source: own elaboration.

# Research methodology

## Data collection

The data for this study come from a survey of Polish-owned companies and form a part of a larger project funded by a grant from the Polish National Science Centre. The hypotheses in the present study (Figure 1) were tested on cross-sectional data collected using computer assisted telephone interviewing (CATI) method in the period between September and December 2022 on a sample of 160 internationally-oriented Polish companies (from the total sample of 400 companies). We applied purposive sampling, as we were interested in established, internationally active high-tech manufacturing Polish companies. The companies included in the research sample were to be established no later than 2019, employ at least ten individuals, and demonstrate an international footprint with a foreign trade share (FSTS) of a minimum of 10% as of 2021. Importantly, Polish majority ownership was a prerequisite, ensuring that at least 51% of the capital was of Polish origin. The informants targeted for this study held senior managerial or ownership roles to ensure that the participants had authority to make key decisions related to business model innovation, digital transformation, and foreign market activities [Myers, 2009]. Details on the characteristics of the sample are presented in Table 1.

**Table 1. Characteristics of the sample companies (N=160)**

| Sample characteristics | Freq. | % | | Freq. | % |
|---|---|---|---|---|---|
| Firm age (years of operation) | | | Degree of Internationalization (FS/TS) | | |
| <10 years | 26 | 16.2 | 10 to 19 | 45 | 28.1 |
| 10–20 years | 38 | 23.7 | 20 to 29 | 30 | 18.8 |
| 21–30 years | 49 | 30.6 | 30 to 49 | 44 | 27.5 |
| >30 years | 47 | 29.4 | 50 and more | 41 | 25.6 |
| Firm size (number of employees) | | | Manufacturing industry | | |
| 10 to 49 | 53 | 33 | Pharmaceutical products and pharmaceutical preparations | 19 | 11.9 |
| 50 to 99 | 19 | 12 | | | |
| 100 to 249 | 34 | 21 | Computer, electronic, and optical products | 12 | 7.5 |
| 250 and more | 54 | 34 | Chemicals and chemical products | 44 | 27.5 |
| | | | Electrical equipment | 37 | 23.1 |
| Ownership | | | Machinery and equipment n.e.c. | 24 | 15.0 |
| 100% of Polish capital | 113 | 70.6 | Motor vehicles, trailers, and semi-trailers | 11 | 6.9 |
| Majority share of Polish capital (51–99%) | 47 | 29.4 | Other transport equipment | 13 | 8.1 |

Source: own elaboration.

The authors were responsible for conceiving the research concept, defining sampling assumptions, and creating the questionnaire. The implementation of the study was entrusted to an external research agency, which specializes in academic projects. The sampling operator was the BISNODE database, the largest database of enterprises operating in Poland.

The interviewers were trained in the research instrument. The interviews began with a set of questions to determine if a company – despite the respondent's initial consent to the interview – could be included in the final sample.

## Measures

The operationalization of variables in this study relies on the scales developed in prior research, with a few relevant adjustments where necessary to ensure reliability and validity. The operationalization of all the constructs is presented in Table 2. In the case of all the variables, factor loadings exceeded the minimum cut-off level, with average factor loading for all the components above 0.7, indicating convergent validity. Composite reliability (CR) above 0.6 and average variance extracted (AVE) above 0.5 for all the variables indicate the reliability of the constructs. Except for one variable, alpha values exceeded 0.7, assuring satisfactory internal consistency. In the case of one variable with alpha value equal to 0.5, CR and AVE thresholds were met, so we kept the variable.

*Firm performance (FP).* We measured firm performance focusing on financial aspects. The respondents were asked to rate the company's financial indicators in 2021 in comparison to 2019 on a seven-point scale, where 1 meant 'a very significant decrease (by over 20%)', 2 – 'a decrease (by 11–20%)', 3 – 'a slight decrease (up to 10%)', 4 – 'no change', 5 – 'a slight increase (up to 10%)'; 6 – 'an increase (by 11% – 20%)'; and 7 – 'a very significant increase (by more than 20%)'. The seven-point scale was adapted from Azar and Drogendijk [2014], while financial indicators (sales volume, sales profitability, and sales revenues from new products/services) are typically included in performance studies [Azar, Drogendijk, 2014; Bhatti et al., 2021; Pedersen et al., 2018; Xiao et al., 2021].

*Business model innovation (BMI).* Following prior research [Pedersen et al. 2018; Yan et al. 2020], BMI was operationalized to denote strategic modifications undertaken by a firm over the preceding three years within nine components of the business model [Osterwalder, Pigneur, 2010]. Nine items embody novel product/service development, market expansion, resource reconfiguration, process innovation, strategic partnership creation, enhancement of customer connectivity through innovative tools and channels, cost structure alteration, and novel revenue generation methods [Pedersen et al. 2018; Yan et al. 2020]. The respondents were asked to rate their firm's strategic focus on each of the nine items, using a seven-point scale ranging from '1 – strongly disagree' to '7 – strongly agree'.

*Technological turbulence (TT).* The measurement of technological turbulence encapsulates the rate and unpredictability of technological changes in an industry. Building on prior studies [Jaworski, Kohli, 1993; Zhou, Wu, 2010], the respondents were asked to rate the technological turbulence of the environment (the pace of technological change, the opportunities presented by these changes, and the emergence of new product ideas through technological breakthroughs), using a seven-point scale ranging from '1 – strongly disagree' to '7 – strongly agree'. During the scale purification, one item from the original scale (difficulty to forecast

where the technology in this area will be in the next few years) was dropped due to the low factor loading.

**Table 2. Construct measures and reliability index**

| Construct and measures | Factor loading | α |
|---|---|---|
| **Business Model Innovation (CR= 0.922, AVE=0.572)** | | |
| *Over the past three years, our focus has been on:* | | |
| 1 Developing radically new products and/or services | 0.726 | 0.900 |
| 2 Identifying and serving new markets and customer segments | 0.529 | |
| 3 Developing and/or acquiring new resources and competences | 0.832 | |
| 4 Developing new core processes and activities | 0.786 | |
| 5 Establishing relationships with new strategic business partners | 0.822 | |
| 6 Developing new tools for building customer relationships | 0.834 | |
| 7 Selling products and/or services through new channels | 0.732 | |
| 8 Making major changes in the combination of costs incurred when operating the company | 0.810 | |
| 9 We have developed new ways of generating revenue | 0.688 | |
| **Firm Performance (CR=0.893, AVE=0.740)** | | |
| 1 Sales volume | 0.951 | 0.810 |
| 2 Sales profitability | 0.925 | |
| 3 Sales revenues from new products/services | 0.678 | |
| **Technological turbulence (CR=0.924, AVE=0.802)** | | |
| 1 The technology in this industry is changing rapidly | 0.945 | 0.874 |
| 2 Technological changes provide substantial opportunities in this industry | 0.882 | |
| 3 A large number of new product ideas have been made possible through technological breakthroughs in this industry | 0.858 | |
| **Market dynamism (CR=0.859, AVE=0.679)** | | |
| 1 The market competitive conditions were highly unpredictable | 0.584 | 0.740 |
| 2 Customers' product preferences changed quite rapidly | 0.906 | |
| 3 Changes in customers' needs were quite unpredictable | 0.935 | |
| **Inbound open innovation (CR=0.933, AVE=0.740)** | | |
| 1 We often acquire technological knowledge from outside for our use | 0.928 | 0.902 |
| 2 We regularly search for external ideas that may create value for us | 0.915 | |
| 3 We have a sound system to search for and acquire external technology and intellectual property | 0.880 | |
| 4 We proactively reach out to external parties for better technological knowledge or products | 0.914 | |
| 5 We tend to build greater ties with external parties and rely on their innovation | 0.626 | |
| **Knowledge management culture (CR=0.749, AVE=0.502)** | | |
| *In our organization….* | | |
| 1 Employees are encouraged to ask others for assistance when needed | 0.615 | 0.500 |
| 2 Our company places high value on taking risks, even if there are occasional mistakes | 0.679 | |
| 3 Employees are encouraged to discuss their work with people in other workgroups | 0.817 | |

Source: own elaboration.

*Market dynamism (MD).* The construct finds its roots in the work of Hock-Doepgen et al. [2021], positing that companies function within a constantly changing context, marked by shifting market and demand conditions. Market dynamism grasps environmental uncertainty, which can bring both difficulties and opportunities, encouraging firms to embrace innovation as a survival tactic and a means of securing competitive advantage in an unstable business landscape. The respondents were asked to rate the market dynamism (unpredictability of market competitive conditions, rapidly evolving customers' product preferences and unpredictability of customers' needs), using a seven-point scale ranging from '1 – strongly disagree' to '7 – strongly agree'.

*Inbound open innovation (IOI)* reflects the intensity and degree to which an organization absorbs and assimilates knowledge from external sources. Following prior research [Chen, Liu, 2018; Liao et al., 2019] we measured inbound open innovation by five items developed by Hung and Chou [2013]. Using a seven-point scale ranging from '1 – strongly disagree' to '7 – strongly agree', the respondents assessed various facets of open innovation practices in their firms, such as the acquisition and utilization of external knowledge, the proactive search for valuable external ideas, a systematic approach towards the acquisition of external technologies and intellectual property, proactive engagement with external entities for technological advancements, and the importance of external collaborations and partnerships in bolstering a firm's innovation.

*Knowledge Management Culture (KMC)* was operationalized by four items, using a seven-point scale ranging from '1 – strongly disagree' to '7 – strongly agree', derived from prior research [Gold et al., 2001; Hock-Doepgen et al., 2021]. As the result of scale purification, one item was dropped, so the final construct of knowledge management culture in this study embraces organizational values and practices that foster knowledge sharing, collaboration, and risk-taking. Considering the construct reliability, the alpha value of 0.5 is below the standard threshold, however, the AVE of the construct is 0.502. The average factor loading above 0.7 and CR of 0.749 suggest adequate convergent validity and composite reliability.

*Control variables.* We employ three control variables relevant for studies concerning innovation and performance. Firstly, the firm's age was quantified by the number of years since its establishment. Secondly, the firm's size was operationalized by the number of employees, which may serve as a proxy of the available resources that may impact firms' innovation activities or performance. Thirdly, we also checked for the firm's international exposure measured as the foreign sales to total sales (FSTS) ratio. Correlations for all of the variables are shown in Table 3.

**Table 3. Correlations**

| | | DV1 | DV2 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|
| DV1 | Firm Performance | 1 | | | | | | | |
| DV2 | Business Model Innovation | 0.527** | 1 | | | | | | |
| 1 | Technological Turbulence | 0.453** | 0.718** | 1 | | | | | |
| 2 | Market Dynamism | 0.279** | 0.318** | 0.262** | 1 | | | | |
| 3 | Inbound Open Innovation | 0.007 | 0.144 | 0.033 | –0.026 | 1 | | | |
| 4 | Knowledge Mng. Culture | –0.052 | 0.065 | 0.082 | 0.132 | –0.131 | 1 | | |
| 5 | Firm Age | –0.142 | –0.056 | –0.055 | –0.104 | 0.076 | –0.009 | 1 | |
| 6 | Firm Size | –0.060 | 0.024 | 0.069 | 0.021 | 0.468** | –0.199* | 0.046 | 1 |
| 7 | FSTS | 0.108 | 0.023 | 0.004 | –0.064 | –0.032 | –0.020 | –0.060 | 0.058 |

Note: * $p < 0.05$; ** $p < 0.01$

Source: own elaboration.

## Analysis and results

We used the sequential multiple regression analysis to test our hypotheses. In this approach, predictor variables are systematically introduced into the regression model to gain better understanding of the variance explained by each variable (or groups of variables) in the outcome variable, whilst accounting for the influence of the preceding variables [Field, 2013]. The results are shown in Table 4. The variance inflation factors (VIF) associated with each regression coefficient (Model 4 and Model 6) did not show significant multicollinearity (VIF < 1.33), suggesting no serious problems with multicollinearity.

**Table 4. Linear regression results for business model innovation and firm performance as dependent variables (DV)**

| Variables | DV: Business Model Innovation | | | | | DV: Firm Performance | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | VIF | Model 5 | Model 6 | VIF |
| Technological Turbulence | | 0.683*** | | 0.681*** | 1.08 | | | |
| Market Dynamism | | 0.143* | | 0.151** | 1.11 | | | |
| Inbound Open Innovation | | | 0.180* | 0.178** | 1.29 | | | |
| Knowledge Mng. Culture | | | 0.081 | –0.009 | 1.07 | | | |
| Business Model Innovation | | | | | | | 0.522*** | 1.00 |
| Firm Age | –0.046 | 0.009 | –0.055 | 0.001 | 1.02 | –0.133† | –0.109 | 1.01 |
| Firm Size | 0.025 | –0.029 | –0.043 | –0.114† | 1.33 | –0.060 | –0.073 | 1.01 |
| FSTS | 0.019 | 0.032 | 0.030 | 0.043 | 1.02 | 0.104 | 0.094 | 1.01 |
| R | 0.056 | 0.732 | 0.183 | 0.749 | | 0.184 | 0.552 | |
| $R^2$ | 0.003 | 0.536 | 0.033 | 0.560 | | 0.034 | 0.305 | |
| Adj. $R^2$ | 0.016 | 0.521 | 0.002 | 0.540 | | 0.015 | 0.287 | |
| F | 0.166 | 35.532*** | 1.062 | 27.692*** | | 1.812 | 17.003*** | |
| Change in $R^2$ | | 0.532 | 0.030 | 0.557 | | | 0.271 | |
| F-change | | 88.303*** | 2.402† | 48.186*** | | | 60.502*** | |

Note: cell entries are standardized regression coefficients. † p < 0.10; * p < 0.05; ** p < 0.01; *** p < 0.001.

Source: own elaboration.

In the sequential regression analysis for BMI as the dependent variable, presented in Table 4 (Models 1–4), Model 1 incorporated the control variables only: firm size, firm age and FSTS. By introducing these variables at the outset, subsequent analyses were adjusted for their influence, focusing on the impact of the primary predictors. Model 1 is, however, statistically insignificant ($F = 0.166$, $p > 0.1$) and reveals that none of the control variables provides explanation for BMI.

In Model 2, the external antecedents of BMI (i.e. technological turbulence and market dynamism) were introduced, aligning with H1 and H2, respectively. This provided an assessment of the additional variance in BMI that these variables explain, building upon the

baseline model established by the control variables. In comparison with Model 1, Model 2 is statistically significant ($F$=35.532, $p$<0.001) and reveals greater explanatory power (the change in *R-squared* = 0.532, $p$<0.001). H1 predicts that technological turbulence is positively associated with BMI. Model 2 in Table 4 confirms the result ($\beta$=0.68, $p < 0.001$). Thus, H1 is supported. H2 predicts that market dynamism has a positive effect on BMI. Model 2 also confirms the result ($\beta$=0.14, $p < 0.05$). Therefore, H2 is also supported.

Regression results for the hypotheses examining the significance of internal antecedents for BMI, i.e. inbound open innovation (H3), and knowledge management culture (H4) are presented in Model 3 (Table 4). However, Model 3 is statistically insignificant ($F$=1.062, $p$>0.1), revealing that the examined internal antecedents alone do not significantly contribute to the explanation of variance in the dependent variable (i.e. BMI).

Finally, Model 4 (Table 5) incorporates both internal and external antecedents. The model is significant and in comparison with Model 1 its explanatory power increased significantly (change in *R-squared* = 0.557, $p$<0.001). This model highlights the simultaneous effect of both internal and external factors on BMI. Comparing Models 1 to 4, it is evident that Model 4 has the greatest explanatory power (the highest *R-squared*, equal to 0.56). Model 4 renders support for H1, H2, and it also provides support for H3 that predicts that inbound open innovation has a positive effect on BMI ($\beta$=0.18, $p < 0.01$). There is no support for H4 that assumes the positive relationship between knowledge management culture and BMI ($\beta$=–0.009, $p > 0.1$). The results presented in Model 4 allow for the conclusion that BMI is triggered by both external (H1, H2) and internal (H3) antecedents, although among analysed antecedents, external antecedents are greater predictors of BMI, as their significance as predictors was supported with and without the inclusion of internal antecedents.

**Table 5. Summary results of hypotheses testing**

| Hypothesis | Relationship | Finding |
|---|---|---|
| H1 | Technological turbulence → BMI | Supported |
| H2 | Market dynamism → BMI | Supported |
| H3 | Inbound open innovation → BMI | Supported |
| H4 | Knowledge management culture → BMI | n.s. |
| H5 | BMI → Firm performance | Supported |

Source: own elaboration.

In order to test H5 that predicts that BMI has a positive effect on high-tech firms' performance we run two models – Model 5 (baseline, control variables only) and Model 6 (main effects) (Table 4). The inclusion of BMI as a predictor of firm performance in Model 6 significantly increased the explanatory power of the model (change in *R-squared* = 0.271, $p < 0.001$), providing strong and significant support for H5 ($\beta = 0.52$, $p < 0.001$). Therefore, our findings underscore the substantial role BMI plays in influencing a firm's performance in technologically advanced manufacturing industries. Overall, the regression results robustly support

the positive impact of Business Model Innovation on firm performance in high-tech sectors, reemphasizing the significance of BMI as a strategic lever for performance enhancement. Table 5 summarizes the results of the hypotheses testing.

## Summary

Our study aims to provide comprehensive insights into the intricate interplay between internal and external factors influencing BMI within high-tech companies and confirms a robust positive relationship between external factors and BMI in high-tech sectors. Technological turbulence (TT), in line with prior research [Guo et al., 2017; Zhou, Wu, 2010], was found to compel firms to continually innovate, seize emerging opportunities, and adapt to rapid environmental changes. Additionally, our findings indicate that market dynamism (MD) plays a pivotal role, prompting firms to adopt innovative business models capable of managing risk and adjusting value propositions in response to evolving customer preferences and competitive forces [Bolton, Hannon, 2016; Ferreira et al., 2013; Hock-Doepgen et al., 2021; Klein et al., 2021]. These findings underscore that high-tech firms operating in turbulent or dynamic contexts are more inclined to engage in BMI, emphasizing the indispensable nature of strategic adaptability as a fundamental survival trait in high-tech sectors when faced with external pressures.

Our findings revealed lower level of confirmation of internal drivers of BMI. Specifically, we found that fostering inbound open innovation practices leads to increased BMI within high-tech firms. This result aligns with the expectations, as the concept of open innovation implies the infusion of external knowledge and ideas into an organization [Hock-Doepgen et al., 2021]. Nonetheless, these study findings prompt us to delve deeper into the nuances of open innovation in high-tech contexts.

In turn, the results of our study did not show a positive relationship between knowledge management culture (KMC) and BMI in high-tech firms. This finding may appear counterintuitive given the long-standing emphasis on the significance of KMC in fostering innovation within organizations. To reconcile this result, we must consider the multifaceted nature of KMC and its potential interactions with other internal and external factors. While KMC emphasizes the value of knowledge sharing, storage, and utilization within a firm, its impact on BMI may be contingent upon several variables, including the receptiveness of the organizational culture to change, the alignment of knowledge management practices with strategic goals, and the capacity to translate internal knowledge into innovative business models [Hock-Doepgen et al., 2021]. Taken together, our examination of internal factors reveals a nuanced landscape where the influence of inbound open innovation and knowledge management culture on BMI in high-tech firms may not be as straightforward as initially conceived.

Finally, we found support in our empirical results for the positive and significant relationship between BMI of high-tech firms and their enhanced firm performance, which aligns

with prior studies [see White et al., 2023]. This underscores the strategic significance of BMI in high-tech sectors as a primary driver of competitive advantage.

## Theoretical contributions

Our study contributes to research on business model innovation in three ways. Firstly, it sheds additional light on the theoretical and empirical relationships between internal and external factors on BMI. Specifically, while previous studies considered the effect of either internal or external factors separately [see Bhatti et al., 2021; Foss, Saebi, 2017; Yan et al., 2020], we highlight the consideration of the effects of these two groups of factors simultaneously. We argue that such an approach helps to understand better the interplay between them. In particular, given that knowledge management culture was found as not significant, but inbound open innovation as significant for enhanced BMI, our findings suggest that opening up to external sources of knowledge and creating solutions to BMI-related challenges does not necessarily require well established culture of absorbing this knowledge. However, it is enough to perform 'on-the-go' interventions by collaborating with external stakeholders [see Hock-Doepgen et al., 2021]. Moreover, our findings suggest that environmental pressures act as a dominant factor for BMI – stronger than internal factors, at least in the short term. The fact that market dynamism and technological turbulence strongly affect BMI, against limited effect of internal factors resonates with behavioural arguments for organizational change [Osiyevskyy, Dewald, 2015]. In other words, high-tech firms are more likely to engage in BMI when forced by environmental volatility than they are motivated by internal factors.

Secondly, our study adds to the debate on the effectiveness of BMI and the context in which it is introduced. Previous studies discussed the importance of the external environment at large [Leppänen et al., 2023; Schneider, 2019; Spieth et al., 2014]. However, large-scale empirical research in other-than-developed economies are scarce. As an exception, a study by Bhatti et al. [2021] conducted on a sample of 172 Pakistani firms in the IT industry revealed a positive effect of Internal factors (knowledge absorptive capacity, organizational agility, and top management mindfulness) on BMI and its positive effect on firm performance. Our findings advance our understanding of BMI antecedents and outcomes, by empirically testing the linkages between internal and external drivers of BMI, BMI and its performance implications in the context of post-transformational economy of Poland. To the best of our knowledge, our study is the first in empirically exploring these relationships.

Thirdly, our work contributes to the BMI literature by providing additional insights into the relationship between BMI and both financial and non-financial performance in technologically advanced manufacturing industries. By revealing the positive link, we suggest that BMI is a more appropriate response in the long term than technological or product innovation with dynamically changing technologies, customer preferences, market structures, and blurring industrial boundaries. BMI in these contexts seems to be an efficient response and a reflection of strategic renewal [see Ciszewska-Mlinarič, Wójcik, 2023]. From this perspective,

in technological markets, BMI offers a more stable long-term growth as compared to product innovation. However, when coupled with product innovation, it may help to achieve sustained above-average performance. For instance, Apple introduced BMI by linking hardware (iPod) with software (iTunes). This combination of product and content turned out to have had a more positive effect on performance in the long term than the sole product innovation. While other smartphone manufacturers such as HTC faced deteriorating performance, Apple's net income and stock price after 2010 grew exponentially and helped it to achieve competitive advantage for more than a decade [Amit, Zott, 2020, pp. 103–105]. Indeed, research findings revealed a substitution effect between product and business model innovation in the short term. In technological manufacturing industries servitization competes with product innovation for the same resources in the short term. Only when employed jointly, they may produce positive performance effects in the long term [Visnjic et al., 2016].

## Practical implications

From a practical perspective, the findings are significant as they show that managers need to focus on interorganizational collaboration and open innovation efforts in stimulating BMI. Our findings suggest that transcending the organizational boundaries may – to some extent – serve as a substitute to (replace) absorptive capacity and knowledge management culture. Any changes in the business model cannot be achieved unless the organization opens up for external stakeholders. It is plausible that while open innovation practices are commonplace, their direct influence on BMI might be more intricate than a straightforward cause-and-effect relationship. It is essential to recognize that not all external knowledge or partnerships automatically translate into business model innovation. Factors such as the absorptive capacity of the firm, the alignment of external knowledge with internal strategic objectives, and the ability to effectively integrate external insights can all play crucial roles. To elucidate this further, future research could consider examining the specific mechanisms through which inbound open innovation impacts BMI within high-tech firms. Qualitative investigations or case studies might unveil the subtleties of how these firms harness external knowledge and convert it into innovative business models. At the same time, managers should be aware of the dark side of open innovation and interorganizational collaboration, as it may also involve misappropriation of intellectual property rights and other challenges [Chesbrough, 2010]. In this sense, our findings underscore the need for high-tech firms to go beyond the establishment of KMC principles and delve into the practical implementation of these practices within the context of BMI. In-depth qualitative research or case studies could illuminate how firms with successful BMI strategies effectively leverage their knowledge management cultures to drive innovation.

### Study limitations and directions for future research

Although our study helps to understand better the antecedents and outcomes of BMI, it also presents some limitations which open directions for future research. Firstly, the model that was empirically verified in this study adopted the cross-sectional approach. Given that BMI is a process, we postulate that future studies adopt longitudinal research design. Secondly, we did not account for the indirect effect of BMI on performance and the boundary conditions, such as industry, organizational maturity, and other, internal (behavioural and cognitive) factors. Thus, future studies may consider other potential antecedents to BMI. Against the backdrop of our findings, it is promising to investigate empirically the relative importance of the effect of threat versus opportunity recognition in pursuing BMI efforts. Also, considering prior firm performance seems to be important, as it likely affects the resource slack necessary for further investments in BMI endeavours. Taken together, the model needs further testing and elaboration in different contexts and different set of variables, testing for mediation and moderation effects. Thirdly, the BMI scale we adopted can be considered a limitation since it may affect the results of our study. Therefore, it should be subject to further revisions. In other words, we did not account for how BMI is performed. Therefore, the findings of our study may be extended by considering how BM dimensions and elements are innovated (simultaneously vs. sequentially; degree of frequency; in terms of BM structure and internal consistency, BMI breadth) [see Desyllas et al., 2022; Leppänen et al., 2023].

In conclusion, despite its limitations, our study sheds light on the intricate dynamics within high-tech companies concerning BMI, encompassing both internal and external influences. Our findings underscore the paramount importance of strategic renewal and adaptation through BMI in the face of external pressures. We highlight the need for future research to explore the underlying mechanisms and contextual factors that shape the relationship between these internal factors and BMI. By doing so, we can gain a deeper understanding of how high-tech firms can effectively harness their internal resources to drive business model innovation.

## Funding

This work was supported by the National Science Centre of Poland [grant number: 2019/33/B/HS4/03140].

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