

Empirical Paper

Patryk Dziurski*, Agnieszka Sopińska

Does industry matter? Drivers and barriers for open innovation in high-tech and non-high-tech industries—Evidence from Poland

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Abstract: Firms adopt open innovation for different reasons, and they experience various barriers for open innovation. Thus, the paper aims to answer two questions: (1) what type of drivers and barriers for open innovation that are to be identified among innovative firms in Poland and (2) what kind of differences in motives and barriers between high-tech and non-high-tech industries can be identified. The authors analyzed drivers and barriers for open innovation drawn from a survey database of on 122 innovative firms in Poland by means of the CATI method. The study confirms that the concept of open innovation is adopted in high-tech as well as non-high-tech industries. The study also shows that the most important drivers in high-tech and non-high-tech industries are market-driven motives, whereas the most important barriers are related to legal and financial factors. Moreover, the research does not confirm that there are different drivers and barriers between in high-tech and non-high-tech industries.

Keywords: open innovation, drivers for open innovation, barriers for open innovation, high-tech industries, non-high-tech industries

JEL Classification: O31, O32, O36

1 Introduction

Nowadays, many firms search for external partners for their R&D and innovation activities to utilize multiple knowledge sources. The concept of closed innovation is increasingly waning [Hossain, 2016], and the concept of open innovation as a new paradigm for the management of innovation has emerged [Chesbrough, 2003]. Open innovation is defined as “a distributed innovation process based on purposively managed knowledge flows across organizational boundaries” [Chesbrough and Bogers, 2014, p. 17]. It can impact firms positively, as open innovation can enable them to survive in the fast-changing environment by increasing innovation capabilities [Cheng and Chen, 2013]. It can improve the innovation success of many firms [Chesbrough, 2003; Laursen and Salter, 2006; Zobel, 2017] by sharing risk and resources, reducing cost of R&D and product development time, improving competitive advantages and employees’ participation, increasing access to new knowledge, technologies, markets and complementary resources, competences and capabilities [Chesbrough and Crowther, 2006; Chesbrough and Crowther, 2006; Enkel et al., 2009; Krapež et al., 2012]. Open innovation creates new opportunities to growth leading to higher revenues and consequently impacting organizational performance positively [Lindegaard, 2010; Krapež et al., 2012;

*Corresponding author: Patryk Dziurski, Collegium of Management and Finance, SGH Warsaw School of Economics, Warsaw, Poland. E-mail: patryk.dziurski@sgh.waw.pl

Agnieszka Sopińska, Collegium of Management and Finance, SGH Warsaw School of Economics, Warsaw, Poland.

Chesbrough and Brunswicker, 2014; Zhao et al., 2016; Chesbrough, 2020]. Thus, it is not surprising that open innovation has received considerable greater attention from both academic research and industries [Dahlander and Gann, 2010; Huizingh, 2011; Chesbrough and Bogers, 2014; West et al., 2014].

Managers may choose open innovation for different reasons, but the most one of the important motives are acquiring new technological skills or capabilities from partners [Xia and Roper, 2016] and they believe that open innovation is critical to maintain growth [Chesbrough and Crowther, 2006]. Hence, market-driven as well as knowledge-driven motives are ones for open innovation [van de Vrande et al., 2009; Fernandez and Svensson, 2017]. Moreover, firms may not only engage in open innovation to improve organizational performance, but also to overcome various impediments that they are facing [Keupp and Gassmann, 2009; Fu et al., 2014]. However, especially from the practitioners' context, it is shown that the implementation of open innovation is not easy and there are many challenges and constraints that limit organization's ability to use them effectively [Chesbrough and Brunswicker, 2014; Chesbrough, 2020]. Literature identifies various barriers for open innovation indicating that the greatest are internal ones [Enkel et al., 2009; van de Vrande et al., 2009; Bigliardi and Galati, 2016].

The concept of open innovation is widely used in many industries, both high-tech and non-high-tech industries [see e.g. Chesbrough and Crowther, 2006; Martinez et al., 2014; Galati et al., 2016]. Because industries follow different paths to innovation [Lundvall, 1988; Olk and West, 2019], it may be stated that drivers and barriers for open innovation may differ between them. Therefore, drivers and barriers for open innovation may depend on the type of industry [Gassmann and Enkel, 2004; Lichtenthaler, 2008; Keupp and Gassmann, 2009] as well as the state of the industry technology (intensity, turbulence and convergence) [Gassmann and Enkel, 2004; Fortuin and Omta, 2008]. Moreover, it is observed that there may be differences in drivers and barriers between high-tech and non-high-tech industries. However, past studies provided only ambiguous results. On one hand, researchers show that different drivers and barriers for open innovation can be identified for high-tech and non-high-tech industries [Hagedoorn, 1993; Schmidt, 2007; van de Vrande et al., 2009; Garriga et al., 2013; Fu et al., 2014; Verbano et al., 2015; Bigliardi and Galati, 2016; Grimsdottir and Edvardsson, 2018], but on the other hand the study of Chesbrough and Crowther [2006] and Leckel et al. [2020] found out that firms in various industries do not innovate differently. Hence, the mixed results of previous studies indicate that the relationships between the type of industry and drivers as well as barriers for open innovation are understood only partially.

Studies on firms in Poland are rare in the worldwide open innovation literature. However, exploring open innovation in Poland is especially interesting as it is one of the biggest countries in the European Union (EU), but its innovativeness is one of the lowest in the EU [see e.g. European Commission, 2019]. The Statistical Office in Poland showed that innovation active industrial and service firms in 2015 and 2017 accounted to 20.2% and 11.9%, respectively of the total number of such kind of entities. Unfortunately, it seems that open innovation occurs rarely in Poland. Only 28.7% of innovation active industrial firms and 23.6% of service firms applied open innovation between 2015 and 2017 [Statistics Poland, 2018]. It is a poor result, especially when compared to the study of Chesbrough and Brunswicker [2014] that shows that nearly 80 percent of large companies in North America and Europe were engaged in at least some elements of open innovation. Nevertheless, it is in line with the study of Sopińska and Dziurski [2018], which shows that more than 75 percent of innovative firms in Poland implemented at least one open innovation between 2015 and 2017 (it is worth to note that most of them implemented limited number of open innovations).¹ Thus, it seems that Poland is at a transitional phase of catch-up, and innovation capability building and open innovation should be a natural choice for firms therein. Literature suggests that open innovation is used by firms in newcomer countries to overcome internal rigidities and strengthen their innovation capabilities [Fu et al., 2014; Bogers et al., 2019]. But, firms in Poland do not open up their innovation processes widely as a knowledge-poor environment inhibit firms' ability to innovate [van de Vrande et al., 2009; Garriga et al., 2013; Verbano et al., 2015]. Therefore, exploration of drivers and barriers for open innovation in the context of the moderate innovation country (Poland) is interesting as it can allow to better understand

¹ It is worth to note that Sopińska and Dziurski studied only innovative firms in Poland (entities that are active in innovation activities) and study of the Statistical Office focused on all entities in Poland (different sample), thus results are different.

open innovation practices (it follows the most recent call of Chesbrough [2020] for more studies that help to overcome so called the exponential paradox).

The paper aims to answer two important research questions: (1) what type of drivers and barriers for open innovation can be identified among innovative firms in Poland and (2) what type of differences in motives and barriers between high-tech and non-high-tech industries can be identified. According to our knowledge, our study is the first one to investigate drivers and barriers for open innovation in Poland with a broad sample of different industries. On the whole, distinguishing various drivers and barriers for open innovation in different industries appears to be fruitful because it allows more differentiated insights with respect to the importance of factors that remain hidden behind the overall variable “open innovation yes/no”.

2 Literature review

2.1 Drivers for open innovation

The literature has identified various drivers for open innovation. The first distinction is for internal and external ones [Sag et al., 2019; Schroll and Mild, 2011]. Internal motives refer to all factors within the firm, whereas external drivers are those outside the business. External forces are beyond the control of individual company, but they still affect the company directly or indirectly. Similar approach was adopted by Fu et al. [2014] who proposed the “push-pull” framework to analyze drivers for open innovation. They pointed out that pull factors are external to firms and they motivate managers to open up innovation processes. But push factors refer to internal constraints, which encourage companies to adopt open innovation. Another distinction is for offensive (e.g. increasing revenues) and defensive (e.g. decreasing risk) drivers of the open innovation [Huizingh, 2011]. Researchers found that offensive motives are more important than defensive ones [Chesbrough and Crowther, 2006; van de Vrande et al., 2009]. Drivers for open innovation can be also divided into market-driven and knowledge-driven factors [van de Vrande et al., 2009] and Hagedoorn [1993] identified three types of motives for inter-firm technology cooperation: motives related to basic and applied research, motives related to concrete innovation processes, and motives related to market access and search for opportunities.

Different authors have applied various approaches to differentiate drivers for open innovation. In the paper, it is proposed to divide drivers into internal and external ones in which internal motives are further categorized into drivers related to innovation processes and market-driven motives. Factors related to innovation processes aim to improve effectiveness of innovation processes within the firm, and market-driven motives focus on attaining better market position (see Table 1).

The first group of internal drivers for open innovation is related to innovation processes. Firms engage in open innovation to reduce the new product development time as well as the time to market [Jacobs and Waalkens, 2001; Chesbrough and Crowther, 2006; Schmidt, 2007; Krapež et al., 2012]. Another potential driver for open innovation is reducing the cost of innovation processes [Hagedoorn, 1993; Mohr and Spekman, 1994; Hoffmann and Schlosser, 2001; Gassmann and Enkel, 2004; Chesbrough and Crowther, 2006; Huurinainen et al., 2006; Schmidt, 2007; Loren, 2011; Krapež et al., 2012; Martinez, et al., 2014]. The increased complexity and the inter-sectoral nature of new technologies have made projects more expensive resulting in higher risk for firms undertaking them [Sakakibara, 1997], hence cost as well as risk sharing motives are important for open innovation [Hagedoorn, 1993; Mohr and Spekman, 1994; Hoffmann and Schlosser, 2001; Gassmann, 2006; Schmidt, 2007; Martinez, et al., 2014; Oduro, 2020].

Resource based view on the R&D cooperation suggests that firms may use open innovation to better utilize their own internally held immobile resources. Firms identify and select partners with complementary resources that can be combined with their internal resources for innovation processes [Hagedoorn et al., 2000; Tsang, 2000] enabling them to profit and increase number of innovations. Some firms engage in open innovation to better utilize an internal creativity [Jacobs and Waalkens, 2001] and extend skills and competences [Tether, 2002; Miotti and Sachwald, 2003; Huang et al., 2009] as human capabilities

Table 1. Drivers for open innovation**Internal drivers related to innovation processes**

Shortening the innovation processes
 Reducing costs of innovation
 Increasing number of innovations
 Reducing risk of innovations
 Improving research potential
 Earnings from unused inventions
 Acquiring new knowledge and technology

Internal market-driven motives

Possibility to gain new clients
 Improving competitiveness of a firm
 Improving loyalty of existing buyers
 Increasing revenues from innovations

External drivers

Highly turbulent external environment
 Competitive pressure
 Pressure exert by business partners
 Possibility to gain financial support for the open innovation

Source: Own elaboration.

influence the adoption of open innovation [Schroll and Mild, 2011]. Open innovation exposes staff to a new knowledge, a technology, and organizational development processes [Linder, 2004; Calantone and Stanko, 2007] and thus improving the research potential of the firm. Studies show that the firms implement open innovation to acquire a new and missing knowledge, a complementary resources and a finance [Hagedoorn, 1993; Mohr and Spekman, 1994; Hoffmann and Schlosser, 2001; EIRMA, 2003; Koruna, 2004; Gassmann, 2006; Schmidt, 2007; Krapež et al., 2012; Fu et al., 2014; Oduro, 2020] and it enables them to utilize the technological convergence and realize the resource synergy effectively [Loren, 2011]. Firms can benefit from open innovation especially when they experience the high cohesion of skills, experiences, facilities and equipment [Krapež et al., 2012].

Some firms may also engage in open innovation in order to increase the number of innovations and earnings from own unused inventions leading to higher overall revenues [Koruna, 2004]. Thus, the sale of intellectual property and leveraging are seen as important drivers for open innovation [Mohr and Spekman, 1994; Hoffmann and Schlosser, 2001].

The open innovation literature also points out that inherent weaknesses of firms may motivate managers to externalize the innovation processes [Fu et al., 2014]. Studies show that obstacles to innovation increase the breadth and depth of open innovation, whereas firms that do not experience such impediments are more likely to pursue innovation processes alone. Here, open innovation is seen as “an active response to overcome internal rigidities caused by impediments to innovation” [Keupp and Gassmann, 2009, p. 332].

The second group of internal drivers for open innovation is termed as market-driven motives. Chesbrough and Crowther [2006] pointed out that firms implement the open approach to their innovation processes as they believe that it is critical for the profitable growth. Open innovation can help firms to meet customer demands [EIRMA, 2003; Zhao et al., 2016], gain a competitive advantage, and improve a loyalty of existing customers. Innovators are also more likely to cooperate to gain access to new (also foreign) markets [Miotti and Sachwald, 2003; Schmidt, 2007]; motives related to a commercialization of product and process innovations are also important [Schmidt, 2007]. Moreover, managers are interested in open innovation to launch brand-new products and conduct market developments [Hagedoorn, 1993; Zhao et al., 2016], enter new markets, and extend the product range [Hagedoorn, 1993]. All these enable firms to increase revenues from innovations and maintain or increase profit margins [Chesbrough and Crowther, 2006].

Drivers for open innovation can also be externally driven [Radnejad et al., 2017; Sag et al., 2019]. The open innovation literature states that market dynamics as an important external motive for open innovation [Fernandez et al., 2010]. The nature of market environment and competition can motivate managers to implement open innovation as it allows firms to adapt to its local markets and competition [Pervan et al., 2015]. Adoption of open innovation also depends on the level of technology and the level of hostility in an industry [Fernandez et al., 2010; Schroll and Mild, 2011]; shortening product life cycles and the time reduction between innovation and market introduction are also important factors [Hagedoorn, 1993; Gassmann and Enkel, 2004; Huurinainen et al., 2006]. All these mean the environmental change and pressure [Chesbrough, 2003; Belderbos et al., 2004; Radnejad et al., 2017] and the more intense competition from rivals, suppliers, and new entrants [Chesbrough, 2003] drive the externalization of innovation processes. Firms use the open innovation approach to keep up with an increasing technology intensity and fusion [Gassmann, 2006] as well as with competitors [van de Vrande et al., 2009]. The literature on open innovation further suggests that firms open up innovation processes to meet specific industry standards, attempt profit from infringements, realize learning effects and guarantee freedom to operate by establishing cross-licensing agreements with other organizations [Koruna, 2004]. Prior studies point out that a partner advantage may be an important driver for open innovation [Hagedoorn, 2002] as well as availability of external knowledge sources [Garriga et al., 2013]. Thus, firms may be eager to implement open innovation as a response to pressure exerted by business partners.

Past researches emphasized also the importance of government supported developments [Hadjimanolis, 1999] and financial resources in opening up innovation processes [Chesbrough, 2003; Schmidt, 2007; Zhu et al., 2011]. Governments often devote resources not only to encourage firms to conduct open innovation, but they also financially support those processes. The study of Schmidt [2007] shows that innovators are more likely to externalize innovation processes if they receive the public funding than if they do not get it. Thus, possibility to receive the financial support for open innovation is an important motive.

2.2 Barriers for open innovation

Barriers for open innovation are factors that discourage firms from opening innovation processes [Galia et al., 2012; Hjalmarsson et al., 2014; Radziwon and Bogers, 2019]. It is important to differentiate innovation barriers and barriers for open innovation; some types of barriers may overlap, while some may be specific. Innovation barriers inhibit firms from innovation activities, whereas barriers for open innovation are obstacles in opening up those processes.

The literature very often divides barriers into internal and external ones [Savitskaya et al., 2010; de Faria et al., 2020]. Internal barriers refer to factors within the firm, whereas external barriers to factors outside the company. Barriers for open innovation can be also grouped to specific sets: finance- and risk-related obstacles, market- and institution-related obstacles as well as information- and skill-related obstacles [Baldwin and Lin, 2002; Keupp and Gassmann, 2009].

Different authors have applied various approaches to distinct barriers for open innovation. In the paper, we break down barriers into internal and external ones (see Table 2). The most important internal barriers for open innovation are related to economic and financial issues [Enkel et al., 2009; van de Vrande et al., 2009; Bigliardi and Galati, 2016; Piwoswar-Sulej et al., 2019; Oduro, 2020]. Performing innovation processes openly may be very costly [Galia and Legros, 2004; Knudsen and Mortensen, 2011; D'Este et al., 2012; Teirlinck and Spithoven, 2013; Fu et al., 2014] and firms may lack an internal financial resources [Galia and Legros, 2004; Enkel et al., 2009; D'Este et al., 2012; Galia et al., 2012; Fu et al., 2014; Monteiro et al., 2017]. Some firms may additionally experience administrative and legal barriers [van de Vrande et al., 2009; Bigliardi & Galati, 2016].

The literature on open innovation presents the difficulties addressed by the network theory [Holzmann et al., 2014; Bigliardi and Galati, 2016]. One of the most common barriers is difficulty in finding right partners [Enkel et al., 2009; van de Vrande et al., 2009; Lee et al., 2010; Galia et al., 2012; Holzmann et al., 2014; Fernandez and Svensson, 2017; Oduro, 2020]. Some companies search for partners with complementary resources to have fast access to the new leading knowledge and benefit from learning by networking

Table 2. Barriers for open innovation**Internal barriers**

Negative experience from past cooperation
 Risk of creating new competitor
 Lack of trust
 Legal barriers
 Financial barriers
 Risk of unequal distribution of income from innovation
 Lack of aim alignment
 Cultural differences
 Resources misfit
 Difficulties in finding right partners
 Employees' resistance

External drivers

Market maturity
 Lack of competitive pressure
 Lack of pressure exert by business partners
 Lack of external financial support

Source: Own elaboration.

[Fu et al., 2014]. Thus, barriers may arise due to the insufficient knowledge of partners [van de Vrande et al., 2009] or the lack of resource fit between entities [Oduro, 2020]. Open innovation may be also inhibited due to cultural differences between partners [van de Vrande, et al., 2009; Teirlinck and Spithoven, 2013; Holzmann et al., 2014]; firms with various corporate cultures may not be able to cooperate in innovation together, because they apply different modes of organization, or bureaucratic elements [Leckel et al., 2020; Oduro, 2020]. Besides cultural differences, the lack of strategic fit [Hjalmarsson et al., 2014; Oduro, 2020] and the misalignment of aims [Krapež et al., 2012] are seen as important barriers for open innovation. Some barriers can also be related to the previous negative experience with open innovation [Hoffmann and Schlosser, 2001] and the lack of trust between partners [Krapež et al., 2012]. Opening innovation processes may be associated with the loss or thief of a know-how and ideas [Enkel et al., 2005, 2009; Krapež et al., 2012; Teirlinck and Spithoven, 2013; Leckel et al., 2020], including intended as well as unintended knowledge spillovers, opportunistic behaviors of partners [Enkel et al., 2009; Oduro, 2020], a free-riding behavior [Hjalmarsson et al., 2014], an unclear task distribution, misunderstandings between partners, and an unfair income distribution [Krapež et al., 2012]. Intellectual property rights are perceived as an important obstacle in open innovation, including among others: ineffective or inappropriate legal protection of innovations [Krapež et al., 2012; Fu et al., 2014; Leckel et al., 2020] and problems related to imitation [Lee et al., 2010; Verbano et al., 2015]. Conducting innovation processes with partners is also associated with the threat of emergence of a new competitor.

Adoption of open innovation may be also hindered by human capital; the lack of qualified personnel [D'Este et al., 2012; Galia et al., 2012; Fu et al., 2014; Monteiro et al., 2017; Piwowar-Sulej et al., 2019; Leckel et al., 2020] and the lack of adequate managerial competences [van de Vrande et al., 2009; Lee et al., 2010; Teirlinck and Spithoven, 2013; Verbano et al., 2015; Leckel et al., 2020] are one of the most important barriers for open innovation. Adaption of the open innovation concept is inhibited also by a not-invented-here syndrome [Katz and Allen, 1982; Chesbrough and Crowther, 2006; Burcharth et al., 2014; Aquilani et al., 2017], a lack of internal commitment to open innovation [Chesbrough and Crowther, 2006] and an only-used-here syndrome [Lichtenthaler and Ernst, 2006; Aquilani et al., 2017].

The second group of barriers for open innovation is externally driven. Industry-specific characteristics influence the adoption of open innovation significantly. Moreover, firms may not be interested in opening innovation processes due to an uncertain product demand [Lee et al., 2010; Fu et al., 2014] and a lack of

customer responsiveness to innovations [Galia and Legros, 2004]. A high market competition and saturation [Lee et al., 2010; D'Este et al., 2012], a low profit rate, a dominance of one competitor on the market, and a low innovativeness of competitors are perceived as important barriers for open innovation as well [Fu et al., 2014]. Some barriers are also related to financial constraints. The literature indicates that the low availability of finance and a high cost of external source of finance are the main factors inhibiting open innovation [D'Este et al., 2012; Galia et al., 2012; Fu et al., 2014].

2.3 Drivers and barriers for open innovation in different industries

The critical external factor that impacts open innovation is the industry background as various industries provide relatively more ample opportunities for a competitive advantage [Gassmann, 2006; Sisodiya et al., 2016]. Initially, the concept of open innovation was analyzed based on the context of high-tech industries and industries that focus on emerging technologies [Chesbrough, 2003; Chesbrough and Crowther, 2006; Henkel, 2006; Laursen and Salter, 2006; van de Vrande et al., 2009; Drechsler and Natter, 2012; Sisodiya et al., 2016; Martinez et al., 2014; Galati et al., 2016], where technology pressure is perceived as a key driver for greater openness [Martinez et al., 2014]. Such industries are characterized by a knowledge-rich environment [Porter, 1980] with network spillovers [Meagher and Rogers, 2004] that involve “the leakage or transmission of knowledge from firms such that it can be accessed by other firms in the network” [Sisodiya et al., 2016, p. 837]. High-tech industries highly depend on the science and the technology [Zakrzewska-Bielawska, 2016] and they are characterized by a short product life cycle, a rapid diffusion of innovation, a rising demand for highly qualified staff as well as a close cooperation among firms [NewCronos, 2009]. Thus, firms in high-tech industries need a great deal of relevant knowledge, which they try to find outside their boundaries [Laursen and Salter, 2006]. A high level of R&D intensity and uncertainty, industry modularity, and a wide flow of knowledge motivate firms in high-tech industries to adopt open innovation [Bogers et al., 2017]. Studies show that in-house R&D in a high-technology industry increases the firm's propensity to open innovation [Bayona et al., 2001; Miotti and Sachwald, 2003]. However, the concept of open innovation is adopted by firms operating both in high-tech and non-high-tech industries [Chesbrough, 2003; Chesbrough and Crowther, 2006; Henkel, 2006; Laursen and Salter, 2006; Lecocq and Demil, 2006; van de Vrande et al., 2009; Drechsler and Natter, 2012; Bayona-Sáez et al., 2013; Garriga et al., 2013; Sisodiya et al., 2016; Martinez et al., 2014; Galati et al., 2016] in spite of various differences between them.

Chesbrough and Crowther [2006] found out that firms in non-high-tech industries are not innovating differently from firms in high-tech industries as the main driver for open innovation is to obtaining growth in revenues and in number of new products. However, prior study of Hagedoorn [1993] showed that motives for the R&D cooperation differ significantly across industries. This result was confirmed by Schmidt [2007], who stated that main drivers for the innovation partnership between the firms across science industries are: sharing of costs, an access external knowledge, and commercialization of product innovation, whereas a commercialization motive is crucial for firms of high-intensity industries as they are focused on expending markets in order to benefit from economies of scale. Commercialization motive along with knowledge acquisition, financial and strategic motives were also found to be significant for SMEs of low-tech industries in Ghana [Oduro, 2019]. Different practices are observed between two businesses in open innovation, one in software products (high-tech industry) and the other in agribusiness (non-high-tech industry) according to Grimsdottir and Edvardsson [2018]. The literature on open innovation also indicates that a knowledge-poor environment, which is a characteristic of non-high-tech industries does not motivate, but can inhibit the adoption of open innovation [van de Vrande et al., 2009; Garriga et al., 2013; Verbano et al., 2015].

When analyzed, ambiguous research results are also found in the context of barriers for open innovation. Bigliardi and Galati [2016] found out that there are differences in barriers for open innovation between industries. Knowledge-intense firms indicated that knowledge barriers are the most important ones, while firms from medium-innovative industries pointed out to financial economic and strategic risks and the least innovative industries indicated collaboration and organizational barriers. Fu et al. [2014] showed that firms in high-tech industries adopt open innovation due to constraints in finance and skills, whereas firms in medium- and low-tech industries are more likely to use open innovation to overcome institutional

constrains. However, recent researches among SMEs provides evidence that firms in high-tech industries and traditional manufacturing companies indicate that the main barriers preventing them from adopting open innovation are similar and same [Leckel et al., 2020].

The literature provides more evidences that firms from high-tech and non-high-tech industries may indicate different drivers and barriers for open innovation; however previous studies are not conclusive. Thus, we hypothesize that drivers and barriers for open innovation differ between high-tech and non-high-tech industries:

H1a. Firms operating in high-tech industries point out different drivers for the open innovation than firms operating in non-high-tech industries.

H1b. Firms operating in high-tech industries point out different barriers for the open innovation than firms operating in non-high-tech industries.

3 Methods

3.1 Sample

For analyzing drivers and barriers for open innovation in Poland, we used a survey database of 122 innovative firms in Poland that was drawn from databases of the most innovative firms in Poland according to *Gazeta Prawna* and *Kamerton*. The survey targeted innovative firms in Poland, and it was implemented by means of the computer-assisted telephone interviewing (CATI method). Data collection was done between 12 and 30 January 2019. It was random sampling and the response rate was 69%. The minimum size of the sample for the population was 115 firms. Further, 122 interviews were conducted in the study that ensured the statistical significance of results at the level 0.05.

Moreover, only respondents holding higher managerial positions and representing firms that systematically innovate were selected in the process of identifying drivers and barriers reliably for open innovation. The survey started by asking the screening question. Respondents were asked whether their firm had developed at least one open innovation between 2016 and 2018. The 3-year time perspective was adopted as an innovation is a process and it is important to take into account of time that has lapsed between the moments when an innovation is conceived, implemented, and commercialized.

Firms included in the study were moderately differentiated. Based on the size class, the sample was dominated by large firms (40.2%) and medium-sized entities (32.8%). Small-sized firms accounted to 24.6% and micro firms accounted to 2.5%. In the sample, firms from high-tech industries accounted to 63.1% and 36.9% entities accounted for non-high-tech industries. Table 3 shows how respondents are distributed across size classes and industries. It seems that firms from high-tech industries are more likely to adopt open innovation compared to entities from non-high-tech industries.

3.2 Variables

The survey proceeded with questions about drivers and barriers for open innovation. After the screening question about implementation of at least one open innovation between 2016 and 2018, respondents were requested to provide drivers as well as barriers for open innovation. Also, a list of drivers and barriers for open innovation is provided to them to choose the factors (respondents may choose more than one factor); respondents had also possibility to add own drivers and barriers, but no one added anything. Respondents were also requested to choose the main area of operations from manufacturing high-tech industries, knowledge-intensive services industries, and non-high-tech industries (definitions of the type of industry were provided on the request).

3.3 Methods

The study performed the critical analysis of academic literature as well as documents analysis (desk research). We conducted the survey among innovative firms in Poland to gather information about drivers

Table 3. Distribution of respondents across industries and size classes

Parameter		No. of firms	Share%
Size class	0–9 employees (micro firm)	3	2.5
	10–49 employees (small-sized firm)	30	24.6
	50–249 employees (medium-sized firm)	40	32.8
	More than 250 employees (large firm)	49	40.2
Industry	High-tech industries	77	63.1
	Non-high-tech industries	45	36.9

Source: Own elaboration.

and barriers for open innovation, and it was implemented by means of the computer-assisted telephone interviewing (CATI method).

Then, statistical inference is also applied, which is the process of drawing conclusions about populations or scientific truths from data. Further, the Pearson's chi-squared test (χ^2) is applied to identify whether there are differences in drivers and barriers for open innovation between high-tech and non-high-tech industries. Pearson's chi-squared test is a statistical test applied to sets of categorical data to evaluate probability and possibility of occurring of any observed difference between the sets by any chance. We used the following formula:

$$\chi^2 = \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i} \quad [1]$$

where O is the value observed and E is the value expected.

In the study, we selected a desired level of confidence (significance level) for the results of the test of $\text{sig} = 0.05$. Statistical analyses were conducted by using SPSS Statistical software.

4 Results and discussions

The most important drivers for open innovation in high-tech and non-high-tech industries in Poland are market-driven motives (to improving competitiveness of a firm, increasing the possibility to gain new clients, increasing revenues from innovations, and improving loyalty of existing buyers). The most important driver for high-tech industries is improving competitiveness, and for non-high-tech industries increasing revenues from innovations. This finding are in agreement with the literature that points that open innovation is mainly motivated by market-driven factors [Gans and Stern, 2003; van de Vrande et al., 2009; Fernandez and Svensson, 2017]. It also supports the studies of Chesbrough and Crowther [2006] as well as van de Vrande et al. [2009] which state that offensive drivers are more important than defensive drivers for open innovation. Besides market-driven motives, respondents often pointed to drivers related to innovation processes with two exceptions: an improving research potential and earnings from unused inventions. Our findings partially supported the results of Bayona et al. [2001], Sakakibara [1997] and Schmidt [2007] who found that a cost-sharing and an uncertainty are motivations for the R&D cooperation. In our study, respondents pointed to those drivers, but they were not the most important. Surprisingly, respondents from Poland did not indicate acquiring new knowledge and technology as important driver for open innovation, which is contrary to conclusions from the literature. Schmidt [2007] stated that access to an external knowledge is the important driver for open innovation in industries related to science. But, in our study, acquiring new knowledge and technology was pointed out more often by firms by non-high-tech rather than high-tech industries. The less indicated driver was related to earnings from unused inventions suggesting that innovative firms from high-tech and non-high-tech industries adopt mainly in-bound, not out-bound open innovation. Interestingly, externally driven motives were the least important for respondents. Respondents from the non-high-tech industries did not point to the competitive pressure

and the pressure exerted by business partners at all, but they were more inclined to adopt open innovation to receive the financial support compared to firms from high-tech industries. Thus, internal drivers for open innovation were more important than external ones in high-tech and non-high-tech industries.

In order to test if there are statistically significant differences between drivers for open innovation in high-tech and non-high-tech industries, the Pearson's chi-squared test is applied. The statistically significant difference was accounted only for the one driver. Respondents from non-high-tech industries more often indicated the raising of revenues from innovation than respondents from high-tech industries ($sig = 0.020$). It is observed that the significant level is above 0.05 for other drivers. Thus, the hypothesis 1a should be rejected as it cannot be asserted that there is difference in drivers for open innovation between high-tech and non-high-tech industries. These results are opposite to those of Hagedoorn [1993], Schmidt [2007], Oduro [2019] as well as Grimsdottir and Edvardsson [2018], who found that driver for open innovation differ significantly across industries, but it supports the study of Chesbrough and Crowther [2006] who founded out no difference in drivers for open innovation between high-tech and non-high-tech industries. Primary driver leading to the adoption of open innovation is a search for growth opportunities.

Table 4 presents comparison of drivers for open innovation between firms from high-tech industries and non-high-tech industries.

Internal barriers were more important for both high-tech and non-high-tech industries compared to external ones. Further, it is observed that legal and financial factors were the most important barriers for all firms. It is in line with the literature which states that barriers related to economic and financial issues are the greatest ones [Enkel et al., 2009; van de Vrande et al., 2009; McCormack et al., 2015; Bigliardi and Galati, 2016], and this is observed in Poland [Piwowar-Sulej et al., 2019]; the rest of barriers were not pointed regularly. One exception is difficulties in finding right partners. However, this barrier was pointed out more often by respondents from non-high-tech industries than by ones from high-tech industries. The employee's resistance was pointed very rarely and it does not support conclusions derived from the literature that open innovation is hindered by human capital. We also do not find support for the conclusion

Table 4. Comparison of drivers for open innovation between high-tech industries and non-high-tech-industries

Drivers for the open innovation	Industry		Pearson's chi-squared; sig
	High-tech	Non-high-tech	
Internal drivers related to innovation processes			
Shortening the innovation processes	24.7%	28.9%	0.610
Reducing costs of innovation	36.4%	46.7%	0.263
Increasing number of innovations	26.0%	28.9%	0.727
Reducing risk of innovations	15.6%	11.1%	0.491
Improving research potential	5.2%	2.2%	0.424
Earnings from unused inventions	3.9%	4.4%	0.883
Acquiring new knowledge and technology	13.0%	24.4%	0.106
Internal market-driven motives			
Possibility to gain new clients	55.8%	53.3%	0.788
Improving competitiveness of a firm	70.1%	71.1%	0.909
Improving loyalty of existing buyers	48.1%	57.8%	0.300
Increasing revenues from innovations	51.9%	73.3%	0.020
External drivers			
Highly turbulent external environment	6.5%	2.2%	0.292
Competitive pressure	7.8%	0.0%	0.055
Pressure exert by business partners	5.2%	0.0%	0.120
Possibility to gain financial support for the open innovation	5.2%	8.9%	0.426

Source: Own elaboration.

that cultural issues are key barriers for open innovation [Chesbrough and Crowther, 2006; van de Vrande et al., 2009]. The insignificant important barrier among internal ones is a negative experience from the past cooperation. It may be explained by limited experience from open innovation as firms in Poland innovative mainly in isolation; however they may have only positive experiences. Findings are also not in line with Fu et al. [2014], who stated that firms from high-tech are more affected by constraints in finance and skills than entities from medium- and low-tech industries (they are more affected by institutional constraints). Surprisingly, external barriers were the least important for innovative firms in Poland. The market maturity and the lack of competitive pressure were selected by single respondent (no one from high-tech industries pointed to the former one) and the lack of pressure exerted by business partners as well as the lack of external financial support was not chosen at all. The last one is interesting as the literature suggests that the low availability of finance and the high cost of external source of finance are the main factors responsible for preventing open innovation [D'Este et al., 2012; Galia et al., 2012; Fu et al., 2014].

Further to test whether there is the statistically significant difference between barriers for open innovation in high-tech and non-high-tech industries, we applied the Pearson's chi-squared test. The statistically significant difference was accounted only for the one barrier. Respondents from non-high-tech industries more often pointed out to the lack of aim alignment than respondents from high-tech industries ($\text{sig} = 0.034$). The significant level is above 0.05 for other barriers. Thus, the hypothesis 1b should be rejected as it cannot be asserted that there is difference in barriers for open innovation between high-tech industries and non-high-tech industries. This result is opposite to those of Bigliardi and Galati [2016] as well as Fu et al. [2014], who found out that firms from different industries experience different barriers for open innovation, but it confirms finding of Leckel et al. [2020] that firms in high-tech industries and traditional manufacturing companies report similar barriers for open innovation.

Table 5 presents comparison of barriers for open innovation between firms from high-tech and non-high-tech industries.

This study brings new insights to our understanding of drivers and barriers for open innovation in different industries in the context of the moderate innovation country (Poland). We believe that a better understanding of drivers and barriers for open innovation provides insights for a better understanding of current business environment and open innovation paradigm. Considering that fact that firms in the moderate innovation country are falling behind their counterparts in countries classified as innovation leaders and strong innovators (in the European Innovation Scoreboard), also in terms of open innovation, and findings of this study provide valuable insight for managers and policymakers in moderate innovation countries.

Many firms adopt open innovation, but without asking themselves what kind of reasons push them to do so and what kind of barriers are associated with it. The study provides the empirical evidence for the most important drivers and barriers for open innovation. Managers therefore can be aware of reasons to adopt open innovation and barrier that they need to overcome to fully benefit from open innovation. Findings of the study can help managers to understand drivers and barriers for open innovation and allow them to develop measurements to fully utilize benefits of open innovation.

The study confirms that firms pursue different motives and experience different barriers when getting engaged in open innovation, which may be more than one driver as well as one barrier at the same time [Arvanitis, 2012]. Initially, open innovation (or broader collaboration in innovation) was adopted mainly by firms in high-tech industries, but more recently it has utility as a paradigm for innovation to non-high-tech industries [Chesbrough and Crowther, 2006]. More and more firms apply the concept of open innovation in various industries, hence drivers and barriers for open innovation homogenize. Firms in various industries are not innovating differently for innovation's sake; the main drivers for open innovation are market-driven motives and the main barriers are legal and financial ones, which can be easily overcome. Manager should remember that advantages related to open innovation processes should be considered as well in order to capture all benefits of open innovation.

The study shows that internal drivers as well as barriers are more important than external ones (they are not significant for respondents in the study). This result is partially surprising for us. As we expected, internal drivers for open innovation are more significant than external ones; the research sample consisted

Table 5. Comparison of barriers for open innovation between high-tech industries and non-high-tech-industries

Barriers for the open innovation	Industry		Pearson's chi-squared; sig
	High-tech	Non-high-tech	
Internal barriers			
Negative experience from past cooperation	1.3%	2.2%	0.698
Risk of creating new competitor	28.6%	20.0%	0.294
Lack of trust	26.0%	17.8%	0.299
Legal barriers	83.1%	91.1%	0.219
Financial barriers	75.3%	80.0%	0.554
Risk of unequal distribution of income from innovation	13.0%	20.0%	0.303
Lack of aim alignment	11.7%	26.7%	0.034
Cultural differences	7.8%	13.3%	0.321
Resources misfit	18.2%	17.8%	0.955
Difficulties in finding right partners	28.6%	40.0%	0.194
Employees' resistance	6.5%	11.1%	0.370
External drivers			
Market maturity	1.3%	2.2%	0.698
Lack of competitive pressure	0.0%	2.2%	0.189
Lack of pressure exert by business partners	0.0%	0.0%	NA
Lack of external financial support	0.0%	0.0%	NA

Source: Own elaboration.

of innovative firms in Poland, thus offensive factors are important as they allow to maintain growth [Chesbrough and Crowther, 2006; van de Vrande et al., 2009]. Because we researched only innovative firms in Poland, we expected that external barriers would be more important than internal ones—firms are actively engaged in innovation activities, hence internal barriers should be limited in order to run smoothly innovation processes and external barriers should be more important. However, our expectation has not found confirmation in the study. Nevertheless, firms in the study implemented only limited number of open innovations; hence they experience internal barriers that constrain their innovation activities.

We believe also that the study provides fresh insights for policymakers as it shows that there is no difference in drivers and barriers between high-tech and non-high-tech industries in moderately innovator country. Findings can be used by policymakers to effectively increase collaboration for innovation among different entities by stimulating open innovation activities and limiting barriers therein. While open innovation has been a great success for at least a few firms, it requires public policy to sustain that success over time, and to drive it throughout the majority of businesses [Chesbrough, 2020]. Therefore, considering the results of the study, policymakers need to refine strategic plans in a way that encourage and facilitate the use of open innovation. On one hand, public policy goals should be stronger oriented toward innovation performance and economic performance of firms as market-driven motives are the most important for innovative firms in Poland. It should facilitate innovation and growth of firms by encouraging them to collaborate with external partners across industries and organizational boundaries. On the other hand, public policy should be also aimed at reducing financial and legal barriers as they are the main obstacles reported by firms in the study. It is worth to highlight that drivers and barriers for innovation differs from drivers and barriers for open innovation, thus there is a need for special-designed programs for open innovation. However, policymakers should remember that a locally bound approach [Leckel et al., 2020] that takes firm- as well as environment-specific factors can offer more advantages than the implementation of “one size fits all” open innovation strategies [Kim and Ahn, 2020].

Totally, we believe that this paper has moved the discussion further and provides a good basis for scholars to advance knowledge on drivers and barriers for open innovation in the moderately innovator country.

5 Conclusions

The paper attempts to answer the demand of van de Vrande et al. [2009] and more recently Salter et al. [2014] to study motives and challenges related to open innovation in a detailed manner using quantitative research methods. The literature review reveals that various drivers as well as barriers for open innovation can be identified. Drivers can be divided into internal and external factors, wherein the former one can be further divided into market-driven motives and drivers related to innovation processes. Barriers can be divided into internal and external factors. The study shows that internal drivers and barriers are more important than external ones for innovative firms in Poland. Firms engage in open innovation mainly due to market-driven motives and the main barriers are related to legal and financial constraints. The literature also suggests that different industries may adopt open innovation for different reasons and there may be differences in barriers for open innovation. Our study does not support this conclusion as for most of drivers and barriers we did not find statistically significant differences between high-tech and non-high-tech industries. The statistically significant difference was accounted only for the one driver and one barrier, respectively: increasing revenues from innovation and a lack of aim alignment; selected driver and barrier were pointed more often by respondents from non-high-tech than high-tech industries.

Although the research has reached its aims, there are some unavoidable limitations. First, conducted research referred only to open innovation in Poland, and thus the generalizability of results to other countries cannot be done as national idiosyncrasies may influence open innovation [Keupp and Gassmann, 2009; Galia et al., 2012; Garriga et al., 2013; Klimas, 2015; Pervan et al., 2015]. Therefore, more cross-national research on open innovation would be desirable. Second, the study compares only high-tech and non-high-tech industries, while it may be interesting to explore differences between manufacturing and services industries as well, especially that manufacturing industries should explored more widely than the service industries [Hossain, 2016; Chesbrough, 2020]. Third, the list of drivers and barriers is probably not complete as the other factors proposed by past studies were not included in the survey. The fourth point is that there are statistical and data limitations. Although our sample is extensive (it ensures the statistical significance of results at the level 0.05), there is a chance that number of micro firms is not sufficient, especially that they are considered as a source of breakthrough innovations. Comparing start-ups to older established SMEs may be also interesting, especially that the most recent study of Gimenez-Fernandez et al. [2020] found that external knowledge sourcing makes a higher contribution to the innovation performance of new compared to older small firms, but only in high-tech settings. Thus, future studies should also include and start-ups at different phases in the life cycle. In addition, our data are subjective in nature as we asked opinions from single representative of a firm. So, in future research data should be obtained from different respondents from a firm.

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