



Article

# What Shapes Innovation Capability in Micro-Enterprises? New-to-the-Market Product and Process Perspective

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**Abstract:** Innovation is an essential driver of companies' growth and is important in securing and sustaining their competitive advantage and in the implementation of their entire strategies. In this process, a special role is played by companies' capabilities, especially those related to innovation capability (IC). Despite many years of research into identifying the factors that influence IC, there are still many research gaps. One such concerns the IC of micro-enterprises. Only a few studies indicate certain factors that may affect micro-enterprise ICs. Thus, this article aims to analyse the determinants of micro-enterprises' ICs from the perspective of implementing new-to-the-market product and process innovations. The theoretical framework adopted distinguishes between three groups of factors affecting micro-enterprise IC: personal, organizational and external environmental characteristics. The data examined come from an empirical study of a randomly selected representative sample of 1105 Polish micro-enterprises. To analyse these data, a logistic regression model was used. The results indicate that seven factors are common and significant determinants that explain the new-to-the-market product and process dimensions of micro-enterprise IC. Among them, the following have the greatest influence: engagement in initiatives for solving social problems, intensive cooperation with research centers, experience/skills and financial support.

**Keywords:** micro-enterprise; innovation capability; product innovation; process innovation; new-to-the-market; personal characteristics; organizational characteristics; external environment



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## 1. Introduction

The search to find an answer to the question of how to build an enterprise's innovation potential is still ongoing [1–3]. This is especially important in the context of many opinions that a firm's success often depends on its ability to innovate [4]. Despite many years of research into identifying the factors that influence this process, there are still many research gaps. One of these gaps concerns the innovativeness of micro-enterprises. Although such enterprises are usually the most numerous entities in modern economies (EU-28—93% in 2018; Poland—96.4% in 2020) [5,6], they are ignored in most research on innovation, e.g., in the European Union Community Innovation Survey [7]. Only a few studies, such as those by Plotnikova et al. Romero et al., Roper and Hewitt-Dundas, Trinugroho et al. and Raghuvanshi et al., indicate certain factors that may affect their innovativeness [8–13]. The aim of this paper is to shed additional light on this issue.

Since Schumpeter [14] indicated that the individual person, by combining the factors of production to create something new, is a key part of creative destruction—the essential driver of economic development—innovativeness has become a crucial feature of entrepreneurship. Consequently, innovation has become one of the features by means of which we distinguish a true entrepreneur from ordinary business owners [15] or leaders from followers [16]. According to Roper and Hewitt-Dundas, micro- and small entrepreneurial companies, in accordance with Schumpeter's theory of creative destruction, are at the centre of the innovation process [10]. Despite this perspective, studies on micro- and small companies' innovativeness are still limited [17]. Roper and Hewitt-Dundas even

suggest that “micro-enterprises are a neglected part of Schumpeter’s creative army” [10]. In this context, it is worth asking why, today, we are only slightly interested in this “forgotten” group of innovators—micro-enterprises?

The important problem is that innovativeness has many facets, aspects and dimensions. One such interesting aspect is an enterprise’s innovative capability (IC). Usually, from the Resource-Based View, IC is understood as a combination of various types of resources conducive to the emergence of innovation [18,19]. Some studies have suggested, also, that IC allows the organization to adapt to competition, the market and the environment [18,20]. Smith et al. defined a firm’s IC as specific organizational capabilities for managing and creating innovation in the long term [21]. Forsman suggested that IC is composed of internal resources, capabilities and external input gained through networking [22]. In turn, Mendoza-Silva indicated that, due to its intangible nature, IC can be analysed and measured from different perspectives, i.e., dimensions, measurements (input or output) and determinants [23]. This paper concentrates on the determinants of two dimensions of IC in micro-enterprises.

The possible determinants of IC are also examined from different perspectives. For example, Martinez-Roman et al., studying Spanish small and medium-sized enterprises (SMEs), suggested three dimensions of IC determinants—knowledge, organization and the human factor [24]. Roper and Hewitt-Dundas conducted research into Northern Irish micro-companies focused on resources and collaboration [10]. Romero et al., based on a study of Spanish self-employed, indicated three levels of factors: personal, organizational and external environmental characteristics [9]. In turn Mendoza-Silva, on the basis of a systematic literature review, suggested the following main perspectives—managerial, intraorganizational, interorganizational and external [23]. An interesting approach is to look at these determinants from the perspective of the characteristic features of micro-enterprises.

In terms of IC dimensions, it is worth underlining Mendoza-Silva’s opinion that some prior studies conceptualized IC as comprising only product and process innovation [23]. Consequently, some researchers have called for analysing IC as a multidimensional construct [25]. In the field of small business innovativeness, studies have focused mainly on product and process innovation [26,27] and less on organizational and marketing innovation [11,23,28,29]. Considering, as indicated by Schumpeter, five possible combinations of means of production and capital [14], this paper is focused on the following two: (1) introducing a new product previously unknown to customers—a new-to-the-market product; and (2) introducing a new production method, a production technique not used so far—a new-to-the-market process.

Based on one of the quantitative criteria—the number of employees—a micro-enterprise is defined as one which has no more than 9 employees. It is worth underlining that this definition also includes self-employment. This paper is concentrated only on micro-enterprises without self-employment (from 1 to 9 employees).

The main aim of this paper is to analyse the determinants of new-to-the-market product and process dimensions of IC in micro-enterprises based on a survey of a randomly selected representative sample of 1105 micro-enterprises in the Kuyavian–Pomeranian Voivodship, a region in central-northern Poland. From a methodological perspective, the contribution of this study is an attempt to identify the key determinants of the intangible construct, that is, IC, in the context of the specifics of micro-enterprises. To analyse these issues, a logit regression model was used. The conclusion of this analysis can be used in the implementation of effective innovation policies supporting the new-to-the-market product and process innovativeness of micro-enterprises, which, as mentioned by Roper and Hewitt-Dundas, are the neglected part of Schumpeter’s creative army [10].

The paper is structured as follows: Section 2 presents the theoretical underpinnings, focusing on the IC construct and its determinants. A proposed theoretical model is also indicated in this part. Section 3 discusses the conducted empirical research, indicating the method of data acquisition and characterization of the research sample, the included variables and the applied logistic regression models. Section 4 presents the results of the

model estimation. Section 5 discusses these results. The article ends with conclusions in Section 6.

## 2. Literature Review and Conceptual Framework

### 2.1. Innovation Capability

Innovative capability plays an essential role in the research of innovation. What exactly is innovative capability, though? To answer this question, the systematic literature review method was applied. The presented research was focused on renowned journals in the management and innovation field (the journal ranking) and on major works related to the topic (the most cited). To obtain a comprehensive overview of the literature on the topic, a search was carried out using the Scopus databases and covered the period 2000–2021. The “*innovation capa*” term was used in title field to identify relevant studies. The first search returned 1505 results. The following inclusion criteria were applied: (1) subject area: business, management and accounting; (2) document type: article; (3) source type: journal; (4) language: English; (5) source title: Q1/Q2; (6) cited by: more than 20. This resulted in 143 articles for analysis. Table 1 shows the selected recent work related to the concept of innovative capability and the main features, elements or items.

The analysis performed indicated a huge variety of views on IC. In general, it can be indicated that IC is a tacit and non-modifiable special asset [18] that refers to an ability built on organizational learning [30] or knowledge transformation [31], or absorbing, mastering and improving existing technologies [26] to adopt or implement new ideas, processes or products successfully [26,31–34].

The prior studies suggest, also, that IC can be analysed and measured from different perspectives [23].

The first aspect is the dimensions of IC. The vast majority of scientists focus on two dimensions of IC; that is on product and process innovations [24,26,35–39]. These dimensions are also often analysed from the perspective of their radical nature [40]. However, it should be emphasised that important dimensions are also created by organizational and marketing innovations [29,41,42].

The second perspective is connected with the results or output of IC. Research usually points to sales [33,43], share of new products [44,45], patents [26,46–48], a firm’s performance [49] or licences granted [50].

The next aspect relates to IC input. Here, analysis is usually made of R&D expenditure [18,24,46,48,51,52], expenditure on new products [45,53], investments in machinery and external knowledge [54,55] and training expenditure [56,57].

The last perspective shows the possible determinants of IC. The literature indicates different classifications. Russell focused on three major areas: the external environment, macro-organizational characteristics and the individual characteristics of organization managers [58]. The research mentioned earlier by Martinez-Roman et al. also sees three dimensions to IC determinants—knowledge, organization and the human factor [24]. Akman and Yilmaz analysed determinants derived from market orientation, technological orientation and innovation strategy [59]; Eggers et al., in the context of radical innovativeness, focused on the role of networking, customers and technologically turbulent environments [60]; and Mendoza-Silva presented the following main blocks—managerial, intraorganizational, interorganizational and external [23]. Despite the attention that this topic has garnered, it is worth underlining that a better understanding of the impact that open innovation has on a company’s IC is needed [23].

A broad review of the existing literature allows the following groups of possible IC determinants to be indicated: (1) the personal characteristics of a micro-enterprise’s owner or manager, (2) organisational characteristics and (3) external environmental characteristics.

**Table 1.** Summary of the literature on innovative capability.

Author(s)	Innovative Capability—Concept or Definition	Features or Elements
Lawson and Samson, 2001 [31]	Innovation capability is defined as the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of a firm and its stakeholders.	Elements of innovation capability construct: (1) vision and strategy, (2) harnessing the competence base, (3) organizational intelligence, (4) creativity and idea management, (5) organizational structure and systems, (6) culture and climate and (7) management of technology.
Romijn and Albaladejo, 2002 [26]	Innovation capability is defined as the skills and knowledge needed to effectively absorb, master and improve existing technologies, and to create new ones. The innovation capability of a firm accumulates as a result of the various internal and external inputs.	Elements of the conceptual framework: (1) Innovation capability—concerns product innovations and is measured by: product innovation during the last 3 years, number of patents and product innovation index (innovative outputs generated during the 3 years prior to the survey); (2) Internal sources—professional background of founder/manager(s), skills of workforce, internal efforts to improve technology, (3) External sources—intensity of networking, proximity advantages related to networking, receipt of institutional support.
Calantone et al., 2002 [30]	Innovation capability is the most important determinant of firm performance. It is connected with organizational learning and is associated with the development of new knowledge.	Elements of conceptual framework: (1) commitment to learning, (2) shared vision, (3) open-mindedness, (4) intraorganizational knowledge sharing.
Guan and Ma, 2003 [18]	Innovation capability is a special asset of a firm. It is tacit and non-modifiable and is correlated closely with interior experiences and experimental acquirements. Innovation capability consists of core innovation assets—the ability of a firm to translate innovation concepts through R&D, manufacturing and marketing process and supplementary innovation assets—the ability of a firm to support and harmonize core innovation capability to play its role effectively.	The innovation capabilities classified into seven dimensions: (1) learning capability, (2) R&D capability, (3) manufacturing capability, (4) marketing capability, (5) organizational capability, (6) resource-exploitation capability, (7) strategic capability.
Zhao et al., 2005 [33]	Innovation capability relates to the adoption and implementation of useful ideas.	Innovative capability consists of dependent and autonomous innovative capability and is measured by: (1) percent sales of products manufactured according to the design specification of the parent company, (2) percent sales of products using original equipment manufacturing, (3) percent sales of products designed and developed by companies themselves according to buyer's requirements, (4) percent sales of products designed and developed by companies themselves and sold under their own brand.
Yang et al., 2009 [61]	Innovation capability refers to a firm's ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm.	Attributes of innovation capability: (1) service quality management system, (2) entering into newer service routes, (3) regularly improve company's operational systems, (4) exploring best methods to achieve corporate goals, (5) employee reward system for innovative ideas.

Table 1. Cont.

Author(s)	Innovative Capability—Concept or Definition	Features or Elements
Forsman, 2011 [22]	Innovation capacity is composed of internal resources, capabilities and external input gained through networking.	Dimensions of innovation capabilities: (1) knowledge exploitation, (2) entrepreneurial capabilities, (3) risk management capabilities, (4) networking capabilities, (5) development capabilities, (6) change management capabilities, (7) market and customer knowledge.
Martínez-Román et al., 2011 [24]	Innovation capability is an internal ability that conditions the entire organization.	Dimensions of innovative capability: (1) knowledge: incorporation of new members; learning and capacitation; research and development; (2) organization: autonomy; liaison/communication resources; hierarchical power; market focus; (3) human factor: staff training and attitude; criteria for promotion and rewards; risk-taking.
Cheng and Lin, 2012 [62]	Innovation is a dynamic capability, i.e., a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness.	Primary interactive aspects of technological innovation capabilities: (1) planning and commitment of the management capability, (2) marketing capability, (3) innovative capability, (4) R&D capability, (5) operations capability, (6) knowledge and skills capability, (7) information and communication capability and external environmental capability.
Rajapathirana and Hui, 2018 [63]	Innovation capability is considered as a valuable asset for firms to provide and sustain a competitive advantage and in the implementation of overall strategy.	Elements of innovation capability: (1) organizational culture, (2) use knowledge from different sources, (3) involvement of workers, customers, etc.
Zhang and Merchant, 2020 [34]	Innovation capability is the ability to create better or more effective products, processes, services, technologies or ideas that are accepted by markets, governments and society.	Items of innovation capability construct: (1) firm uses knowledge from different sources for product development activities efficiently and rapidly; (2) firm supports and encourages workers to participate in activities, such as product development, innovation process improvement and idea generation; (3) firm continuously evaluates new ideas that come from customers, suppliers, etc., and includes them in product development activities; (4) firm can adapt to environmental changes easily by making suitable improvements and innovations in a short time.
Walter et al., 2021 [64]	Innovation capability in the context of open innovation is the ability of companies to acquire, generate and apply knowledge.	Elements of open innovation capability: (1) patent applications, (2) trademark registrations, (3) intangible asset value indicator.

## 2.2. The Personal Characteristics of a Micro-Enterprise's Owner or Manager

Personal characteristics appear in many studies [65]. Martínez-Roman et al. indicate that when studying the innovativeness of the self-employed, it is worth analysing their general and business education as well as their motivation and previous experience as an employee [9]. Plotnikova et al. point to the same features but in the context of small businesses and the implementation of process innovations [8]. A manager's, business owner's or entrepreneur's educational background was underlined by Koellinger as an important factor explaining innovation in small businesses [66]. In turn, being a university graduate was analysed as a factor in SME innovativeness by Martínez-Roman et al. [24]. Roper et al. analysed the drivers of new-to-market innovations in micro-enterprises and researched the gender (female), background, university education and age of entrepreneurs [10]. In turn, Zastempowski and Cyfert examined the impact of entrepreneur gender on innovation activities from the perspective of small businesses [67]. Dobić et al. examined the gender, age, education and experience in the context of employees' intellectual agility and its influence on SMEs innovativeness [68]. De Martino et al. also indicate the importance of



qualified staff [69]. In turn, from the perspective of open innovation, Naz et al. indicate the role of proactive personalities [70].

In light of the above, and from the perspective of the two analysed IC dimensions, it is possible to formulate the following research question:

RQ 1. Do the personal characteristics of a micro-enterprise owner or manager exert an impact on the new-to-the-market product and process dimensions of innovation capability?

### 2.3. Organisational Characteristics

Organisational characteristics, the second group of IC determinants, appear in many studies devoted to enterprise innovation [23]. The theoretical framework is formed by the following theories: resource-based theory [71–74], absorptive capacity theory [75,76] and dynamic capabilities theory [77].

Organisational characteristics are given various names and consist of various elements. Malik et al. researched them in the context of Quadruple Helix [78]. Adler and Shenhar, analysing the dimensions of an organization's technological capability, describe two internal assets: technological and organizational [79]. Among the important categories of organizational characteristics of the capacity to innovate, Hurley and Hunt indicated structural and process characteristics, as well as cultural characteristics [32]. In turn, Guan and Ma divided interorganizational IC capabilities into the seven following dimensions: learning, R&D, manufacturing, marketing, organizational, resource exploitation and strategic capability [18]. The same approach can be found in research by Yam et al. [43,51] and Yang [52], and a similar approach is presented in research by Wang et al. [80]. In the context of open innovation, Walter et al. suggest the importance of intangible assets [64].

Assink, who analysed disruptive innovation capability, focused on such endogenous determinants as resources, corporate structure and corporate culture [81], while Martinez-Roman et al., in their description of the SME innovative capability-based model, distinguished three IC determinants—knowledge, organization and the human factor [24,57]. Also inspiring is the proposition of Saunila and Ukko, who divided IC factors into external knowledge, work climate and well-being, ideation and organizing structures, regeneration, participatory leadership culture, individual activity and know-how development [55]. Huarng et al. indicated that knowledge is the source of innovation and new knowledge is an antecedent of innovation [82]. Dyduch et al. emphasised the role of dynamic capabilities, value creation and value capture [83], while Cyfert et al. highlighted the role of the developing dynamic capabilities process [84,85]. In turn, Rajapathirana and Hui indicated the following determinants of innovation capability: organizational culture, use of knowledge from different sources, involvement of workers and customers, etc. [63]. Dziallas and Blind, analysing innovation indicators throughout the innovation process, pointed to the following company-specific dimensions: strategy, innovation culture, competence and knowledge, organizational structure, R&D activities and input, and financial performance [86].

It is worth indicating that in this field the different elements of CSR [87–91], social capital [92–94], data-drivenness [95], open innovation [96–99] and social innovation [100–102] are important aspects influencing innovation capability.

As can be seen above, organisational characteristics appear as IC determinants in a number of studies conducted so far. As a consequence, the following research question can be formulated:

RQ 2. Do the organisational characteristics of a micro-enterprise exert an impact on the new-to-the-market product and process dimensions of innovation capability?

### 2.4. External Environmental Characteristics

External environmental characteristics—the last group of IC determinants—are also examined in many studies [23]. A review of the literature shows that in this area there is also a lot of diversity. Jenson et al. suggested four major approaches to the study of innovation systems: national, regional, sectoral and technological [103]. Russell, who

explored innovation in organizations, focused on the phenomenon of environmental uncertainty [58]. The same approach can be found in the research of Özsomer et al. [104]. Adler and Shenbar analysed the relations that a firm establishes with current and potential allies, rivals, suppliers, consumers, political actors and local communities [79]. Romijn et al. and Bessant et al. perceived the important role of the intensity of networking and proximity advantages related to networking [26,105]. In turn, Quintana-Garcia et al. drew attention to the various relations among competitors [44]. Gupta et al. analysed the relation between marketing innovations and competitiveness [28]. Zhao et al., exploring the determinants of IC, suggested that a significant role was played by the competitive environment [33]. In addition, Assink [81] and Martinez-Roman et al. [24] note the role of rivalry and competition dynamics. Xu et al. and De Martino et al. analysed the financial support for SMEs [69,106] and Veronica et al. analysed government support for firms' international growth [107]. Recently, scholars have also suggested the need to focus more on the external determinants of open innovation in order to increase the competitiveness of economies [64,108].

It is worth underlining that many researchers analysing external conditions concentrate, also, on the VUCA environment [109], the different aspects of cooperation [110], environmental and climatic changes [111], ecology [112], sustainable development [113], renewable and green energy [111,114], green innovation [115] and climate neutrality [116]. It is also worth emphasizing the important role of Porter's theory of competitive advantage [117,118].

In light of the above, the following research question can be formulated:

RQ 3. Do external environmental characteristics exert an impact on the new-to-the-market product and process dimensions of innovation capability?

### 2.5. Conceptual Model

Finally, the literature review presented above suggests the following factors within each group of possible IC determinants seen from the perspective of micro-enterprises. The results of this work are shown in Table 2.

**Table 2.** Micro-enterprise innovation capability determinants.

Group	Factors	References
Personal characteristics	Gender	Roper and Hewitt-Dundas, 2017 [10] Ruiz-Jimenez et al., 2016 [119] Horbach and Jacob, 2018 [120] Zastempowski and Cyfert, 2020 [67]
	Age	Foroudi et al., 2016 [121] Lin, 2007 [122]
	Educational background	Foroudi et al., 2016 [121] Lin, 2007 [122]
	Experience/skills	Lin, 2007 [122] Liao, et al., 2007 [54]
Organisational characteristics	Know-how	Guan and Ma, 2003 [18] Yam et al., 2004, 2011 [43,51] Martinez-Roman et al., 2011 [24]
	Work climate	Yam et al., 2004, 2011 [43,51] Martinez-Roman, et al., 2011 [24] Saunila and Ukko, 2014 [55]
	Structure	Guan and Ma, 2003 [18] Yam et al., 2004, 2011 [43,51] Martinez-Roman et al., 2011 [24]

Table 2. Cont.

Group	Factors	References
External environmental characteristics	Technology	Guan and Ma, 2003 [18] Yam et al., 2004, 2011 [43,51] Martinez-Roman et al., 2011 [24]
	Individual activities	Forsman, 2011 [22] Rajapathirana and Hui, 2018 [63] Mazzucchelli et al., 2019 [123]
	Financial support	Martinez-Roman et al., 2011 [24] Wang and Zhang, 2018 [124] Baumann and Kritikos, 2016 [125]
	Cooperation	Adler and Shenhar, 1990 [79] Romijn and Albaladejo, 2002 [26]
	Competition	Quintana-García and Benavides-Velasco, 2004 [44] Assink, 2006 [81] Martinez-Roman et al., 2011 [24]

As a consequence, the following conceptual model was formulated (Figure 1). Its structure was mainly inspired by the models of Russell [58], Hurley and Hult [32], Martinez-Roman et al. [9,24] and Mendoza-Silva [23].

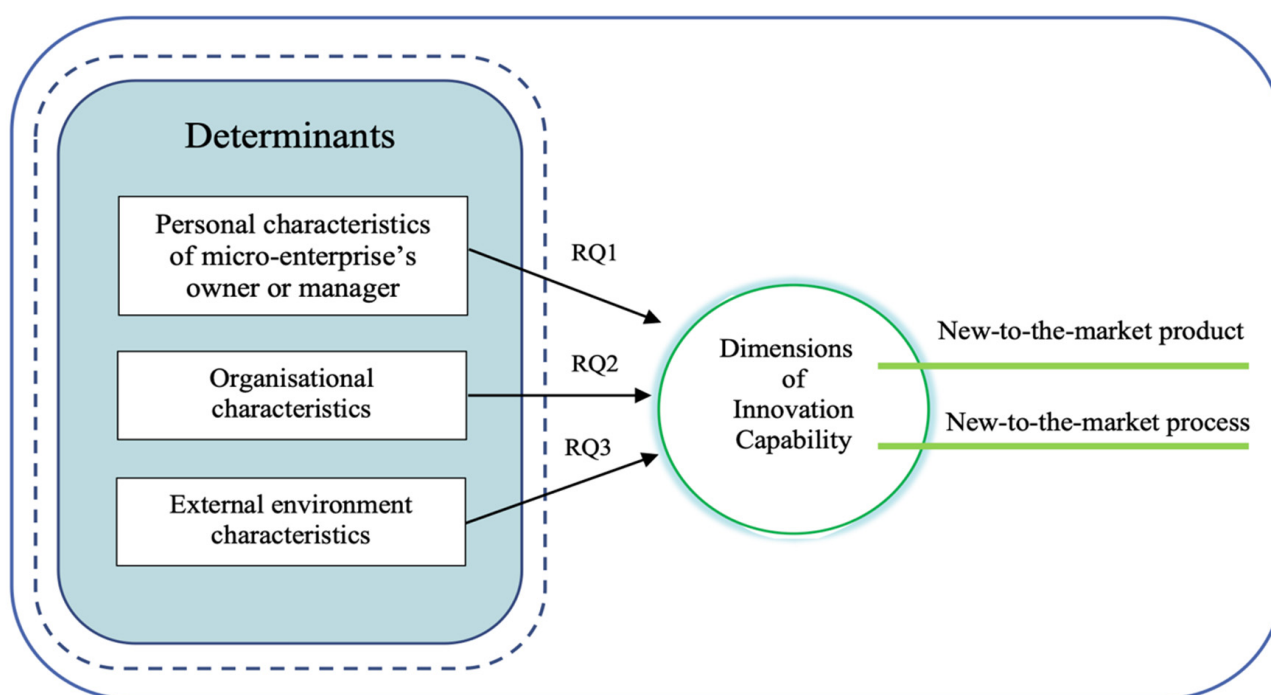


Figure 1. Conceptual model.

### 3. Material and Methods

#### 3.1. Data Collection and Sample

The empirical research was carried out, between June and September 2019, in the Kuyavian–Pomeranian Voivodeship in central-northern Poland. The CAPI method among micro-enterprises was used. The companies participating in the survey were randomly selected by the Kuyavian–Pomeranian Statistical Office, based on the REGON (National Official Register of Economy Entities in Poland) register. The stratified sample—with quotas for sectors, according to PKD 2007 (Code List of Classification of Business Activities in



Poland), subregion (NUTS 3) and county (NUTS 4)—was representative for the population of Kuyavian–Pomeranian micro-enterprises (195,162 micro-enterprises in 2019), with an error of  $\pm 3\%$  at a confidence level of 95%. The final dataset is made up of 1105 observations.

As can be seen in Table 3, the surveyed sample represented all types of economic activity. Only two of these had a higher representation than in the REGON register—manufacturing (22.6%) and wholesale and retail trade (5.85%)—while one had lower representation, namely, transport and storage (4.11%).

**Table 3.** Structure of the sample.

Characteristics	REGON (%)	Sample (%)	Difference: REGON—Sample (% Point)
Activities (PKD 2007)			
A—Agriculture, forestry, hunting and fishing	2.02	1.9	0.16
B—Mining and quarrying	0.09	0.1	−0.01
C—Manufacturing	8.79	22.6	−13.82
D—Electricity, gas, steam, hot water and air conditioning	0.30	0.2	0.11
E—Water supply; sewage and waste management and remediation activities	0.38	1.5	−1.09
F—Building construction	13.51	10.7	2.80
G—Wholesale and retail trade; repair of motor vehicles, excluding motorcycles	22.47	28.3	−5.85
H—Transport and storage	6.66	2.6	4.11
I—Activities related to accommodation and catering services	2.40	3.5	−1.14
J—Information and communication	2.63	2.7	−0.02
K—Financial and insurance business	2.98	1.8	1.21
L—Activities related to real estate	5.15	4.6	0.53
M—Professional, scientific and technical activity	8.44	6.3	2.14
N—Administration and support activities	3.15	2.8	0.39
O—Public administration and defence; mandatory social security	0.71	0.5	0.22
P—Education	3.43	0.9	2.54
Q—Health care and social welfare	7.56	4.4	3.14
R—Activities related to culture, entertainment and recreation	2.07	0.6	1.48
S—Other service activities	7.24	4.1	3.14

### 3.2. Variables

Table 4 presents the description, label and scale for all of the variables included in the model. As can be observed, the final model includes: (1) explained variables, labelled from  $y_1$  to  $y_3$ , and (2) explanatory variables, labelled from  $x_1$  to  $x_{19}$  and divided into four groups: personal characteristics of micro-enterprise owners or managers, organizational characteristics, external environmental characteristics and control variables. The descriptive statistics of all variables are presented in Table 5.

**Table 4.** Description of variables.

Label	Description	Reference	Scale
Explained Variables			
$y_1$	New-to-the-market product innovation	Roper and Dundas, 2017 [10]	Dichotomous
$y_2$	New-to-the-market process innovation	Roper and Dundas, 2017 [10]	Dichotomous
$y_3$	New-to-the-market product and process innovations	Roper and Dundas, 2017 [10]	Dichotomous
Explanatory Variables			
Personal characteristics of micro-enterprise owner or manager			
$x_1$	Gender	Horbach and Jacob, 2018 [120]	Dichotomous
$x_2$	Age	Foroudi et al., 2016 [121]	Ordinal (1–5)
$x_3$	Business education	Plotnikova et al., 2016 [8]	Dichotomous
$x_4$	Experience/skills	Romero et al., 2012 [9]	Ordinal (1–4)

**Table 4.** *Cont.*

Label	Description	Reference	Scale
Organizational characteristics			
x <sub>5</sub>	Know-how—We know how to anticipate technological changes	Guan and Ma, 2003 [18]	Ordinal (1–7)
x <sub>6</sub>	Work climate—We support our employees in improving their qualifications	Martinez-Roman et al., 2011 [24]	Ordinal (1–7)
x <sub>7</sub>	Structure_1—We have a research and development unit	Yam et al., 2011 [43]	Ordinal (1–7)
x <sub>8</sub>	Structure_2—We have a marketing unit	Yam et al., 2011 [43]	Ordinal (1–7)
x <sub>9</sub>	Structure_3—We coordinate cooperation between our employees well	Yam et al., 2011 [43]	Ordinal (1–7)
x <sub>10</sub>	Structure_4—Our employees have high decision-making independence	Martinez-Roman et al., 2011 [24]	Ordinal (1–7)
x <sub>11</sub>	Technology—We have modern technologies	Guan and Ma, 2003 [18]	Ordinal (1–7)
x <sub>12</sub>	Individual activities_1—We engage in initiatives for solving social problems	Lee-Ross, 2015 [126]	Ordinal (1–7)
x <sub>13</sub>	Individual activities_2—Our employees take reasonable risks	Martinez-Roman et al., 2011 [24]	Ordinal (1–7)
x <sub>14</sub>	Individual activities_3—Our employees are creative	Martinez-Roman et al., 2011 [24]	Ordinal (1–7)
External environmental characteristics			
x <sub>15</sub>	Financial support	Roper and Dundas, 2017 [10]	Dichotomous
x <sub>16</sub>	Cooperation_1—We cooperate intensively with research centres	Martinez-Roman et al., 2011 [24]	Ordinal (1–7)
x <sub>17</sub>	Cooperation_2—We cooperate intensively with other companies	Plotnikova et al., 2016 [8]	Ordinal (1–7)
x <sub>18</sub>	Competition_1—Level of competitive rivalry in the market	Martinez-Roman et al., 2011 [24]	Ordinal (1–5)
x <sub>19</sub>	Competition_1—Position in the market	Martinez-Roman et al., 2011 [24]	Ordinal (1–4)
Control variables			
x <sub>20</sub>	Age of enterprise	Plotnikova et al., 2016 [8]	Numerical
x <sub>21</sub>	Size	Guan et al., 2006 [19]	Numerical

**Table 5.** Descriptive statistics of variables.

Variables	Mean	Std. Err.	Std. Dev.	Variance	Min.	Max.
y <sub>1</sub>	0.061	0.007	0.239	0.057	0	1
y <sub>2</sub>	0.059	0.007	0.237	0.056	0	1
y <sub>3</sub>	0.045	0.006	0.208	0.043	0	1
x <sub>1</sub>	0.325	0.014	0.469	0.220	0	1
x <sub>2</sub>	2.942	0.023	0.771	0.594	1	5
x <sub>3</sub>	0.250	0.013	0.433	0.188	0	1
x <sub>4</sub>	2.319	0.023	0.767	0.589	1	4
x <sub>5</sub>	3.847	0.047	1.553	2.412	1	7
x <sub>6</sub>	4.357	0.042	1.399	1.958	1	7
x <sub>7</sub>	3.900	0.062	2.056	4.226	1	7
x <sub>8</sub>	3.929	0.057	1.895	3.593	1	7
x <sub>9</sub>	4.184	0.047	1.567	2.454	1	7
x <sub>10</sub>	4.317	0.045	1.482	2.195	1	7
x <sub>11</sub>	3.811	0.048	1.588	2.521	1	7
x <sub>12</sub>	3.793	0.047	1.548	2.396	1	7

Table 5. Cont.

Variables	Mean	Std. Err.	Std. Dev.	Variance	Min.	Max.
x <sub>13</sub>	4.342	0.045	1.487	2.211	1	7
x <sub>14</sub>	4.515	0.043	1.440	2.074	1	7
x <sub>15</sub>	3.254	0.056	1.867	3.487	1	7
x <sub>16</sub>	3.406	0.055	1.831	3.354	1	7
x <sub>17</sub>	3.445	0.053	1.774	3.146	1	7
x <sub>18</sub>	3.315	0.025	0.820	0.672	1	5
x <sub>19</sub>	2.252	0.016	0.537	0.289	1	4
x <sub>20</sub>	2.354	0.023	0.779	0.606	0	4.143
x <sub>21</sub>	1.612	0.016	0.526	0.277	0	2.197

### 3.3. Method

Due to the fact that the explained variables were dichotomous, binary regression was used to estimate the models. The most common binary regression models are the logit model (logistic regression) and the probit model (probit regression). Both of these methods are frequently used to test the influences of the explanatory variables on the dichotomous innovation variables [8,9]. In this study, the logistic regression method was used.

The logistic regression model is of the form:

$$\text{logit}(p_i) = Z_i = x_i' \beta = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} \quad (1)$$

where  $\text{logit}(p_i)$  is denoted  $\ln \frac{p_i}{1-p_i}$ . The subjects of estimation in this model are the parameters  $\beta_0, \beta_1, \beta_2, \dots, \beta_k$ , these being elements of the vector  $\beta$  [127].

To interpret the results of the logit model estimation, odds ratios (ORs) were used. If the likelihood is denoted as:

$$\frac{p_i}{1-p_i} = \exp(x_i' \beta) = \exp(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki}) = \Omega(x_i) \quad (2)$$

then the odds ratios with the variable  $X_{mi}$  increase by a unit and the odds without this increase equal:

$$\frac{\Omega(x_i^m, X_{mi} + 1)}{\Omega(x_i^m, X_{mi})} = \exp(\beta_m) \quad (3)$$

where  $x_i^m$  is the vector  $x_i$  without the variable  $X_{mi}$ . Formula (3) shows that the increase in the value of  $X_{mi}$  by one unit is related, ceteris paribus, to an  $\exp(\beta_m)$ -fold change in the odds ratio. In the case of  $\exp(\beta_m) > 1$ , there is an increase, and, in the case of  $\exp(\beta_m) < 1$ , there is a decrease in the odds ratio.

The maximum likelihood estimation method was used to estimate the models. All analyses were made on the basis of STATA 16.1 software.

## 4. Results

In the first step, using Kendall's tau-b coefficient, the correlation between all the variables was analysed. The results are presented in Table 6.

As can be seen, many correlation coefficients between the explanatory and explained variables are statistically significant. Nevertheless, the coefficients are always below 0.2, so the relationship is very poor. Moreover, the coefficients among the explanatory and control variables are below 0.5, indicating that multicollinearity is not a concern.

Table 6. Correlation matrix.

Variables	y1	y2	y3	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
y1	1.000												
y2	0.736 **	1.000											
y3	0.857 **	0.864 **	1.000										
x1	0.083 **	0.078 **	0.072 *	1.000									
x2	0.003	0.009	−0.010	0.014	1.000								
x3	0.046	0.022	0.035	0.135 **	−0.051	1.000							
x4	−0.069 *	−0.075 **	−0.082 **	0.005	0.417 **	−0.059 *	1.000						
x5	0.053 *	0.079 **	0.057 *	−0.041	0.104 **	0.031	−0.052 *	1.000					
x6	0.069 **	0.108 **	0.073 **	0.088 **	0.096 **	0.072 **	0.010	0.217 **	1.000				
x7	−0.061 *	−0.065 *	−0.059 *	−0.095 **	−0.002	−0.078 **	−0.071 **	0.309 **	−0.066 **	1.000			
x8	0.013	−0.006	0.017	−0.042	0.088 **	−0.069 **	−0.037	0.341 **	0.092 **	0.572 **	1.000		
x9	0.037	0.069 **	0.048	0.008	0.091 **	−0.015	−0.045	0.375 **	0.264 **	0.225 **	0.337 **	1.000	
x10	0.076 **	0.093 **	0.065 *	0.040	0.078 **	0.005	−0.047	0.295 **	0.295 **	0.177 **	0.230 **	0.456 **	1.000
x11	0.041	0.067 *	0.042	−0.042	0.077 **	0.052	−0.017	0.434 **	0.299 **	0.232 **	0.315 **	0.306 **	0.213 **
x12	0.143 **	0.152 **	0.123 **	0.067 *	0.119 **	0.050	−0.057 *	0.429 **	0.164 **	0.330 **	0.314 **	0.273 **	0.249 **
x13	0.102 **	0.092 **	0.084 **	0.035	0.087 **	0.015	−0.039	0.319 **	0.342 **	0.196 **	0.265 **	0.319 **	0.405 **
x14	0.099 **	0.116 **	0.082 **	0.100 **	0.137 **	0.020	−0.001	0.273 **	0.424 **	0.026	0.197 **	0.424 **	0.468 **
x15	−0.102 **	−0.123 **	−0.106 **	−0.065 *	0.017	−0.026	−0.051 *	0.300 **	−0.077 **	0.466 **	0.481 **	0.259 **	0.130 **
x16	0.020	0.018	0.023	−0.032	0.031	−0.038	−0.079 **	0.320 **	−0.007	0.478 **	0.524 **	0.221 **	0.187 **
x17	0.035	−0.001	0.009	−0.054 *	0.003	−0.037	−0.066 **	0.316 **	0.063 **	0.485 **	0.447 **	0.198 **	0.166 **
x18	0.033	0.027	0.009	0.083 **	0.000	0.097 **	−0.002	0.057 *	0.183 **	−0.247 **	−0.103 **	0.076 **	0.058 *
x19	0.024	0.016	0.014	−0.039	0.011	−0.057	−0.010	−0.010	−0.028	0.108 **	0.052 *	0.003	−0.001
x20	0.011	−0.020	−0.015	0.028	0.269 **	0.008	0.434 **	0.002	0.008	−0.012	−0.006	0.007	−0.024
x21	−0.089 **	−0.041	−0.058 *	−0.097 **	−0.041	−0.012	0.069 **	0.068 **	−0.068 **	0.059 *	−0.002	0.013	−0.038
Variables	x11	x12	x13	x14	x15	x16	x17	x18	x19	x20	x21		
x11	1.000												
x12	0.350 **	1.000											
x13	0.269 **	0.261 **	1.000										
x14	0.257 **	0.213 **	0.396 **	1.000									
x15	0.227 **	0.316 **	0.134 **	0.026	1.000								
x16	0.302 **	0.426 **	0.192 **	0.086 **	0.436 **	1.000							
x17	0.383 **	0.406 **	0.203 **	0.106 **	0.410 **	0.439 **	1.000						

**Table 6.** *Cont.*

Variables	x <sub>11</sub>	x <sub>12</sub>	x <sub>13</sub>	x <sub>14</sub>	x <sub>15</sub>	x <sub>16</sub>	x <sub>17</sub>	x <sub>18</sub>	x <sub>19</sub>	x <sub>20</sub>	x <sub>21</sub>
x <sub>18</sub>	0.026	−0.062 *	0.050 *	0.189 **	−0.183 **	−0.177 **	−0.142 **	1.000			
x <sub>19</sub>	0.027	0.027	−0.011	−0.050	0.082 **	0.052 *	0.058 *	−0.123 **	1.000		
x <sub>20</sub>	0.057 **	0.048 *	−0.031	0.009	0.007	−0.003	0.032	0.021	0.014	1.000	
x <sub>21</sub>	0.048 *	−0.033	−0.040	−0.091 **	0.021	−0.009	−0.027	−0.027	0.037	0.056 **	1.000

\*\*  $p$ -value  $\leq 0.01$ . \*  $p$ -value  $\leq 0.05$ .



In the next step, in order to eliminate common method variance (CMV) bias, Harman's single factor test was checked. The results showed that a single factor explained 25.3% of variance, so there is no CMV bias [128].

The results of the estimations for new-to-the-market product innovation ( $y_1$ ) are presented in Table 7, for new-to-the-market process innovation ( $y_2$ ) in Table 8 and for both types of new-to-the-market innovations together ( $y_3$ ) in Table 9. Robust standard errors (S.E.) are presented in the tables.

**Table 7.** Logistic regression for new-to-the-market product innovation ( $y_1$ ).

Variables	Model 1		Model 2		Model 3		Model 4	
	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.
x <sub>1</sub>	0.652 **	0.260	0.372	0.281	0.372	0.299	0.286	0.301
x <sub>2</sub>	0.280	0.178	0.070	0.191	0.046	0.202	0.029	0.210
x <sub>3</sub>	0.287	0.277	0.206	0.301	0.277	0.304	0.244	0.311
x <sub>4</sub>	−0.529 ***	0.176	−0.502 **	0.200	−0.496 **	0.216	−0.685 ***	0.263
x <sub>5</sub>			−0.149	0.110	−0.126	0.116	−0.082	0.112
x <sub>6</sub>			−0.174	0.130	−0.284 **	0.133	−0.291 **	0.125
x <sub>7</sub>			−0.312 ***	0.092	−0.201 *	0.118	−0.151	0.117
x <sub>8</sub>			0.156	0.097	0.157	0.104	0.169	0.103
x <sub>9</sub>			−0.079	0.098	0.058	0.117	0.109	0.117
x <sub>10</sub>			0.071	0.101	0.019	0.124	0.070	0.120
x <sub>11</sub>			−0.038	0.102	−0.016	0.107	0.052	0.110
x <sub>12</sub>			0.476 ***	0.145	0.496 ***	0.150	0.403 ***	0.129
x <sub>13</sub>			0.238 **	0.102	0.225 *	0.130	0.221 *	0.128
x <sub>14</sub>			0.153	0.160	0.193	0.200	0.152	0.181
x <sub>15</sub>					−0.504 ***	0.148	−0.507 ***	0.150
x <sub>16</sub>					0.194	0.134	0.204	0.140
x <sub>17</sub>					−0.016	0.126	−0.116	0.132
x <sub>18</sub>					−0.028	0.185	−0.020	0.186
x <sub>19</sub>					0.447 *	0.262	0.438 *	0.265
x <sub>20</sub>							0.438 **	0.221
x <sub>21</sub>							−0.818 ***	0.246
Constant	−2.733 ***	0.552	−3.794 ***	0.911	−4.520 ***	1.421	−4.028 ***	1.476
Log pseudolikelihood	−244.695		−221.559		−208.233		−200.092	
Wald chi2	19.23		82.69		88.28		108.26	
Prob > chi2	0.0007		0.0000		0.0000		0.0000	
Pseudo-R2	0.0318		0.1233		0.1760		0.2082	
Correct predictions (%)	93.39		93.85		93.94		94.03	

\*\*\*  $p$ -value  $\leq 0.01$ . \*\*  $p$ -value  $\leq 0.05$ . \*  $p$ -value  $\leq 0.1$ . Note: Robust standard error in S.E. column.

**Table 8.** Logistic regression for new-to-the-market process innovation ( $y_2$ ).

Variables	Model 1		Model 2		Model 3		Model 4	
	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.
x <sub>1</sub>	0.647 **	0.261	0.372	0.277	0.374	0.298	0.319	0.304
x <sub>2</sub>	0.359 **	0.179	0.121	0.192	0.028	0.203	0.015	0.212
x <sub>3</sub>	0.082	0.288	−0.137	0.328	−0.068	0.331	−0.089	0.342
x <sub>4</sub>	−0.599 ***	0.175	−0.538 ***	0.183	−0.520 **	0.202	−0.609 ***	0.230
x <sub>5</sub>			−0.093	0.116	−0.096	0.124	−0.055	0.126
x <sub>6</sub>			0.027	0.135	−0.087	0.151	−0.118	0.148
x <sub>7</sub>			−0.252 ***	0.093	−0.124	0.106	−0.090	0.103
x <sub>8</sub>			0.017	0.104	0.060	0.095	0.066	0.094
x <sub>9</sub>			0.013	0.085	0.167	0.102	0.211 **	0.105
x <sub>10</sub>			0.125	0.096	0.025	0.104	0.060	0.103
x <sub>11</sub>			0.020	0.099	0.092	0.107	0.144	0.109
x <sub>12</sub>			0.436 ***	0.144	0.529 ***	0.155	0.453 ***	0.141

Table 8. Cont.

	Model 1		Model 2		Model 3		Model 4	
Variables	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.
x <sub>13</sub>			0.080	0.097	0.071	0.113	0.077	0.116
x <sub>14</sub>			0.112	0.165	0.197	0.205	0.188	0.193
x <sub>15</sub>					−0.658 ***	0.139	−0.662 ***	0.140
x <sub>16</sub>					0.399 ***	0.115	0.403 ***	0.121
x <sub>17</sub>					−0.264 **	0.118	−0.336 ***	0.124
x <sub>18</sub>					−0.227	0.189	−0.225	0.186
x <sub>19</sub>					0.287	0.261	0.285	0.263
x <sub>20</sub>							0.214	0.207
x <sub>21</sub>							−0.660 **	0.262
Constant	−2.768 ***	0.594	−4.383 ***	0.936	−4.093 ***	1.484	−3.511 **	1.548
Log pseudolikelihood	−241.782		−218.822		−196.681		−192.386	
Wald chi2	22.72		90.63		109.80		130.40	
Prob > chi2	0.0001		0.0000		0.0000		0.0000	
Pseudo-R2	0.0328		0.1246		0.2132		0.2304	
Correct predictions (%)	93.85		94.03		94.12		94.21	

\*\*\*  $p$ -value  $\leq 0.01$ . \*\*  $p$ -value  $\leq 0.05$ . Note: Robust standard error in S.E. column.Table 9. Logistic regression for both types of new-to-the-market innovations together ( $y_3$ ).

	Model 1		Model 2		Model 3		Model 4	
Variables	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.	$\beta$	S.E.
x <sub>1</sub>	0.659 **	0.298	0.368	0.321	0.313	0.359	0.234	0.363
x <sub>2</sub>	0.237	0.200	0.027	0.214	−0.057	0.219	−0.075	0.232
x <sub>3</sub>	0.220	0.317	0.113	0.347	0.175	0.362	0.150	0.369
x <sub>4</sub>	−0.669 ***	0.204	−0.629 ***	0.222	−0.609 **	0.246	−0.771 ***	0.281
x <sub>5</sub>			−0.107	0.117	−0.086	0.129	−0.038	0.124
x <sub>6</sub>			−0.097	0.142	−0.225	0.155	−0.255 *	0.146
x <sub>7</sub>			−0.347 ***	0.088	−0.233 **	0.117	−0.195 *	0.117
x <sub>8</sub>			0.179 *	0.103	0.194 *	0.107	0.206 **	0.103
x <sub>9</sub>			0.002	0.096	0.179	0.114	0.234 **	0.116
x <sub>10</sub>			0.076	0.105	−0.020	0.121	0.027	0.116
x <sub>11</sub>			−0.066	0.106	0.001	0.110	0.066	0.114
x <sub>12</sub>			0.439 ***	0.166	0.505 ***	0.180	0.411 ***	0.154
x <sub>13</sub>			0.203 **	0.094	0.203	0.128	0.206	0.129
x <sub>14</sub>			0.061	0.189	0.128	0.256	0.108	0.236
x <sub>15</sub>					−0.656 ***	0.168	−0.663 ***	0.171
x <sub>16</sub>					0.392 ***	0.136	0.404 ***	0.145
x <sub>17</sub>					−0.217	0.140	−0.310 **	0.151
x <sub>18</sub>					−0.273	0.198	−0.265	0.195
x <sub>19</sub>					0.328	0.308	0.307	0.311
x <sub>20</sub>							0.338	0.238
x <sub>21</sub>							−0.780 ***	0.294
Constant	−2.611 ***	0.632	−3.684 ***	1.069	−3.312 ***	1.780	−2.687	1.833
Log pseudolikelihood	−195.980		−179.233		−162.194		−156.850	
Wald chi2	17.87		17.93		98.05		120.61	
Prob > chi2	0.0013		0.0000		0.0000		0.0000	
Pseudo-R2	0.0376		0.1198		0.2035		0.2297	
Correct predictions (%)	95.26		95.29		95.38		95.66	

\*\*\*  $p$ -value  $\leq 0.01$ . \*\*  $p$ -value  $\leq 0.05$ . \*  $p$ -value  $\leq 0.1$ . Note: Robust standard error in S.E. column.

Firstly, the basic model is presented in each case, which is built on variables related to personal characteristics (Model 1). Next, a second estimation is put forward which includes organizational characteristics as regressors (Model 2). In the third step, the estimated model also contains external environmental characteristics (Model 3). After this, in the final model, the control variables were also included (Model 4). As the percentages of correct

predictions (94.03% for  $y_1$ , 94.21% for  $y_2$  and 95.66% for  $y_3$ ) and pseudo-R2 vales (0.2082 for  $y_1$ , 0.2304 for  $y_2$  and 0.2297 for  $y_3$ ) show, all these additions improved the goodness of fit of the estimations.

The significance of all the estimated models was assessed by the pseudolikelihood ratio test. The obtained results show that each of the estimated models ( $y_1$ ,  $y_2$ ,  $y_3$ ) was significant. The goodness of fit between the estimated models and the data was also analysed. Consequently, the accuracy of forecasting on their basis was checked. Such prediction is based on the estimated probability  $\hat{p}_i$ , which is a function of  $F(x_i'\hat{\beta})$ . It is usually assumed that if  $F(x_i'\hat{\beta}) \geq 0.5$ , then the prediction equals  $\hat{y}_i = 1$ . If  $F(x_i'\hat{\beta}) < 0.5$ , then the forecast from the model is equal to  $\hat{y}_i = 0$ . The results are shown in Tables 7–9.

For the final model 4, the ROC curve was also used. The area under the ROC curve for the  $y_1$  model 4 was 0.8422, 0.8497 for  $y_2$  and 0.8633 for  $y_3$ . The results are shown in Figure 2.

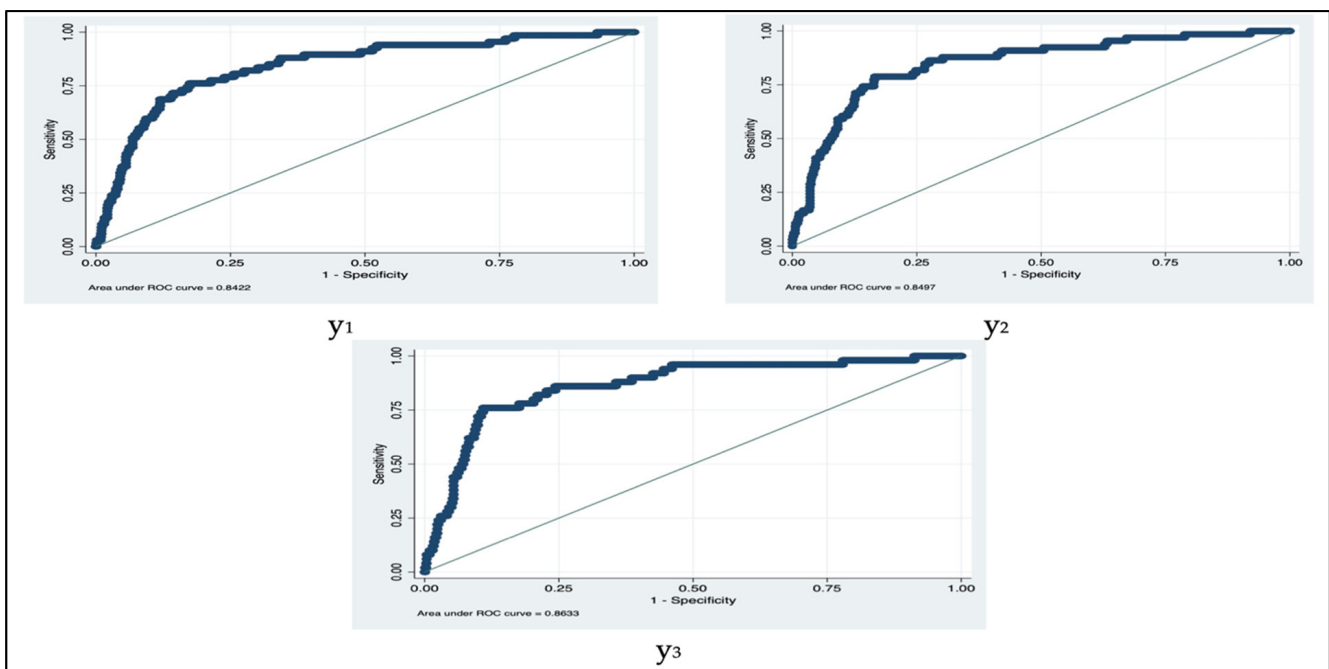


Figure 2. ROC curve for  $y_1$ ,  $y_2$  and  $y_3$  (model 4).

The odds ratios for the regression coefficients for each of the final model 4 results are presented in Table 10.

Table 10. Odds ratios for model 4 ( $y_1$ ,  $y_2$  and  $y_3$ ).

Variables	$y_1$	$y_2$	$y_3$
$x_1$	1.331	1.375	1.263
$x_2$	1.030	1.015	0.927
$x_3$	1.276	0.915	1.162
$x_4$	0.504 ***	0.544 ***	0.463 ***
$x_5$	0.921	0.947	0.963
$x_6$	0.747 **	0.889	0.775 *
$x_7$	0.859	0.914	0.823 *
$x_8$	1.184	1.069	1.229 **
$x_9$	1.115	1.235 **	1.264 **
$x_{10}$	1.072	1.062	1.028
$x_{11}$	1.054	1.154	1.068

Table 10. Cont.

Variables	y <sub>1</sub>	y <sub>2</sub>	y <sub>3</sub>
x <sub>12</sub>	1.497 ***	1.573 ***	1.509 ***
x <sub>13</sub>	1.247 *	1.080	1.229
x <sub>14</sub>	1.165	1.206	1.114
x <sub>15</sub>	0.602 ***	0.516 ***	0.515 ***
x <sub>16</sub>	1.226	1.497 ***	1.498 ***
x <sub>17</sub>	0.890	0.715 ***	0.734 **
x <sub>18</sub>	0.981	0.798	0.767
x <sub>19</sub>	1.550 *	1.330	1.359
x <sub>20</sub>	1.550 **	1.239	1.402
x <sub>21</sub>	0.441 ***	0.517 **	0.459 ***
Constant	0.018 ***	0.030 **	0.068

\*\*\*  $p$ -value  $\leq 0.01$ . \*\*  $p$ -value  $\leq 0.05$ . \*  $p$ -value  $\leq 0.1$ .

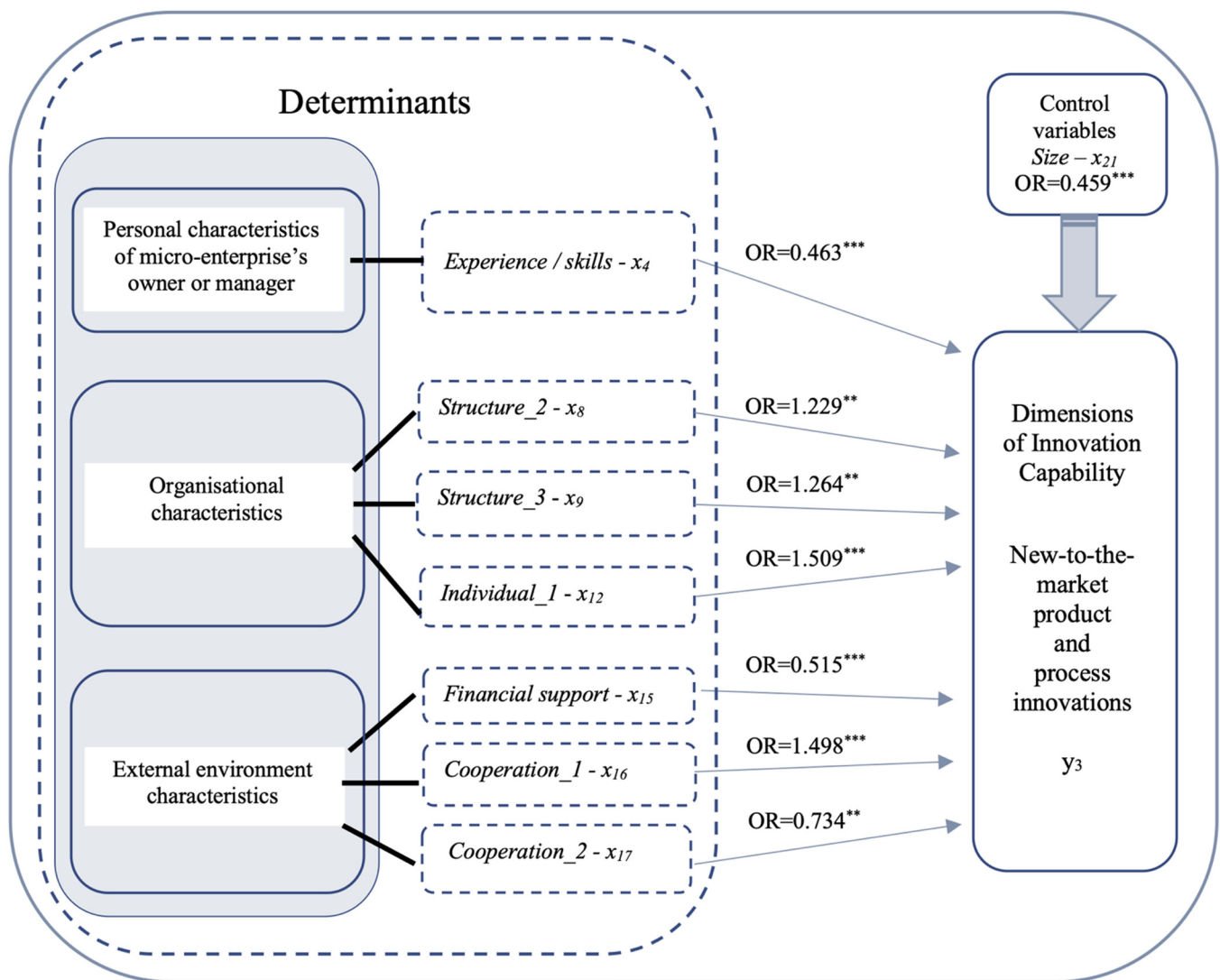
The results in Tables 7–9 show that three variables are common, statistically significant factors, at a confidence level of either 0.05 or 0.01, explaining both the new-to-the-market product and process innovations (y<sub>3</sub>) in model 4: experience/skills (x<sub>4</sub>), engagement in initiatives for solving social problems (x<sub>12</sub>) and financial support (x<sub>15</sub>). It is worth underlining that, in the case of x<sub>4</sub> and x<sub>15</sub>, the value is negative.

However, some differences can be found between the determinants of new-to-the-market product and process innovations. Thus, the variable concerning work climate (x<sub>6</sub>) is significant for new-to-the-market product innovation but not for new-to-the-market process innovation. In turn, good coordination of cooperation between employees (x<sub>9</sub>) and intensive cooperation with research centres (x<sub>16</sub>) and other companies (x<sub>17</sub>) are significant variables for new-to-the-market process innovation but not for product innovation.

It is worth underlining that one of the control variables, size (x<sub>21</sub>), turned out to be a statistically significant factor for both analysed IC dimensions. Interestingly, it showed a negative impact. Thus, each additional employee in a micro-enterprise reduces its chance for new-to-the-market product and process innovation. In turn, the second control variable, age of enterprise (x<sub>20</sub>), is statistically significant in the case of new-to-the-market product innovation (with a positive sign).

Next, let us concentrate on those micro-enterprises that introduced both new-to-the-market product and process innovations (Table 9). In this case the statistically significant variables, at the confidence level of either 0.05 or 0.01, are the following: experience/skills (x<sub>4</sub>), with a negative sign; having a marketing unit (x<sub>8</sub>); good coordination of cooperation between employees (x<sub>9</sub>); engagement in initiatives for solving social problems (x<sub>12</sub>); financial support (x<sub>15</sub>), with a negative sign; intensive cooperation with research centres (x<sub>16</sub>) and with other companies (x<sub>17</sub>), with a negative sign. As indicated earlier, one control variable—size (x<sub>21</sub>)—is significant here. Additionally, supporting employees in improving their qualifications (x<sub>6</sub>) and having a research and development unit (x<sub>7</sub>), both with negative signs, are marginally significant factors influencing the introduction of both new-to-the-market product and process innovations (with a confidence level of 0.10).

As shown in Figure 3, among them, the largest odds ratios have, with increasing chances, engagement in initiatives for solving social problems (x<sub>12</sub>) and intensive cooperation with research centres (x<sub>16</sub>), and, with decreasing chances, experience/skills (x<sub>4</sub>) and financial support (x<sub>15</sub>).



**Figure 3.** The determinants of innovation capability in micro-enterprises for new-to-the-market product and process innovations. \*\*\*  $p$ -value  $\leq 0.01$ . \*\*  $p$ -value  $\leq 0.05$ .

## 5. Discussion

The main objective of this paper was to analyse the determinants of two dimensions of innovation capability—new-to-the-market product and process innovation—among micro-enterprises. The proposed conceptual model divided the possible determinants into three groups: personal, organisational and external environmental characteristics of micro-enterprises.

Looking at the obtained results from the perspective of the first research question, it should be noted that it is difficult to give an unambiguous answer for several reasons.

Only one of the analysed personal characteristics of micro-enterprise owners and managers had an impact on the new-to-the-market product and process dimensions of micro-enterprise innovation capability, i.e., experience/skills ( $x_4$ ). However, the impact turned out to be negative. There is a lower likelihood of owners or managers with more experience introducing new-to-the-market product and process innovations in micro-enterprises. This is probably due to the fact that more experienced micro-enterprise owners or managers are attached to more traditional business models. Hurley and Hunt suggest, also, that this may be related to the fact that, the older the organization, the more bureaucratic and the less receptive it is to innovation [32]. Perhaps it is also the result of a decline in creativity



and a growing reluctance to change. This type of relationship is indicated by Berkeley psychologists, who suggest that creativity generally tends to decline as we age [129].

Another interesting result is the lack of impact on the introduction of new-to-the-market product and process innovation exerted by business education, as research in the field of self-employed innovativeness, e.g., by Martinez-Roman et al., shows that there is such a relationship [9].

It is also worth noting that, in the case of model 1 ( $y_1$ – $y_3$ ), gender ( $x_1$ ) also turned out to be a statistically significant factor. These results may suggest that women are more involved in creating an appropriate working atmosphere in micro-enterprises. Only a few studies seem to confirm the important role of women as entrepreneurs, owners or managers in the process of creating innovation [130,131]. Unfortunately, gender lost its statistical significance in further estimates (models 2, 3 and 4).

Analysing the obtained results from the point of view of the second research question, it is again impossible to give an unambiguous answer. Only three of the possible characteristics assessed were found to have a statistically significant impact on the analysed dimensions of IC, i.e., having a marketing unit ( $x_8$ ), good coordination of cooperation between employees ( $x_9$ ) and engagement in initiatives for solving social problems ( $x_{12}$ ). The obtained results indicate that, among organizational characteristics, the most important, from the perspective of introducing new-to-the-market product and process innovation, is involvement in initiatives for solving social problems. This suggests an important role for micro-enterprises in creating social innovations [132] and corresponds to their willingness to create a good working atmosphere and direct relations between employees [133–136]. It also indicates the closeness of relations with the nearest environment in which micro-companies operate.

It is also worth underlining that it is surprising that employees' creativity ( $x_{14}$ ) has no impact. After all, many studies show the relationship between creativity and innovation [137–139], e.g., Martinez-Roman et al. suggested the impact of managers' creativity on SME innovations [24]. On the other hand, this may be the result of the use of only one item to describe employee creativity. Anderson et al. indicated that creativity is a nuanced concept that incorporates a number of distinct but closely related processes which result in distinct but often closely related outcomes [140]. Given the complex and dynamic nature of creativity as a construct [140–142], it is perhaps unsurprising that it has proven difficult to define and measure. A number of previous studies in the field of personality traits and their influence on innovativeness or entrepreneurship showed the need to use more extensive scales [143–145] based on creativity-relevant skills (e.g., intrinsic motivation to perform a task, skills in the task domain, creative thinking skills [146] or having a proactive personality, intrinsic motivation and creative self-efficacy [147]). The observed lack of influence of creativity may also be a result of the innovations introduced to the market that have been studied, while prior research into creativity has typically examined the stage of idea generation [140]. This also creates an interesting area for further possible research.

The last research question concerned the possible impact on micro-enterprise new-to-the-market product and process innovation exerted by characteristics of the external environment. Three of the five characteristics studied proved to be statistically significant for all IC dimensions, i.e., external financial support from public administration ( $x_{15}$ ) and intensive cooperation with research centres ( $x_{16}$ ) and with other companies ( $x_{17}$ ). The first and third results were surprising because they indicated a negative impact.

In the first case ( $x_{15}$ ), the obtained result is in contradiction with other studies, e.g., Martinez-Roman et al.'s. In their results, backing received for SMEs from public administration positively influenced product and process innovativeness [24]. This may have been a result of the differences between the surveyed enterprises (micro- versus SME) and of the fact that, in these models, only financial support was included. In turn, the positive impact of cooperation with research centres ( $x_{16}$ ) confirms the results of previous research [18,148–150], e.g., Roper et al. [10]. On the other hand, the negative impact of cooperation with other enterprises ( $x_{17}$ ) seems puzzling. This is probably due to the fact

that a specific kind of innovation—only new-to-the-market innovation—was studied. The innovations of this type, which may be radical [40] or disruptive [151], arise within the company rather than in cooperation with other entities.

## 6. Conclusions

In this paper, the determinants of two dimensions of the intangible construct that is innovation capability have been studied from the perspective of micro-enterprise characteristics. From the theoretical perspective, the division of IC determinants into three groups was indicated: personal, organisational and external environmental characteristics.

The proposed model is original in the following aspects: (a) it explains new-to-the-market product and process dimensions of a micro-enterprise's innovation capability, (b) it includes a wide spectrum of factors specific to micro-enterprises that have not been sufficiently researched so far and (c) it gives the possibility of a new look at micro-enterprise innovativeness and predicts some possible new aspects of their functioning, important from a management and support policy point of view.

The results indicate that seven factors are common and significant determinants that explain the new-to-the-market product and process dimensions of micro-enterprise IC. These are experience/skills (personal characteristics), having a marketing unit, good coordination of cooperation between employees, engagement in initiatives for solving social problems (organizational characteristic), financial support and intensive cooperation with research centres and with other companies (external environmental characteristics)

### 6.1. Practical Implications

This research has direct managerial and policy implications. Firstly, an important role is demonstrated for micro-enterprises' engagement in initiatives for solving social problems. If we wish to increase the new-to-the-market innovativeness of a given region, micro-enterprises should be encouraged to become more involved in local social initiatives. Possible activities include practical policies and educational programmes and financial support for local social initiatives.

Secondly, micro-enterprises should be encouraged to cooperate with research centres. Stimulating this kind of cooperation directly increases micro-enterprises' new-to-the-market product and process innovation and thus the level of innovation in a given region. Therefore, it is worth taking various actions in the field of regional policy to support the exchange of information between micro-enterprises and research centres.

### 6.2. Limitations and Future Directions

This study has certain limitations which point to possible avenues for future research.

Firstly, this research is based on cross-sectional data. Therefore, it should be noted that, between different sectors (e.g., trade, production, services), the determinants of micro-enterprises' ICs could be different. Future research could concentrate on the investigation of a specific sector.

Secondly, the study concentrated on micro-enterprises that did not include the self-employed. Future research could be focused squarely on the self-employed. Taking into account their characteristics, such research could offer interesting and valuable insights into the determinants of IC for the theory of entrepreneurship and innovation.

Thirdly, the presented research was based on the single-respondent interview method. It should be emphasised that such an approach could have deformed the results due to the variety of the surveyed areas and to subjectivity.

Fourthly, this research was based only on new-to-the-market product and process innovations. Considering the important role of open innovation, it would be worth analysing micro-enterprise innovation capability in this context too.

Fifthly, this study was geographically limited. The results of the research may be applied to the Kuyavian–Pomeranian Voivodeship and, to a certain extent, to similar regions in Poland.

Lastly, the research shows the determinants of micro-enterprise IC at a specific moment. It would be valuable to examine whether the determinants change over time. Therefore, the conduction of a longitudinal survey is suggested.

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**Institutional Review Board Statement:** In this research I examined the group of micro-enterprises, however my research involved human participants, since I asked entrepreneurs or managers to answer the survey questions. The research was carried out by a specialized marketing research agency - Soma Social and Marketing Research Laboratory, in accordance with ICC / ESOMAR International Code on Market and Social Research (<https://iccwbo.org/publication/icesomar-international-code-on-market-and-social-research/> (accessed on 17 March 2022)). All participants were informed that the survey is anonymous. I also analysed data anonymously, and I did not ask about any personal information. Therefore, my research, in accordance with the recommendations of the Polish National Science Centre (based on document in polish: <https://www.ncn.gov.pl/aktualnosci/2016-03-24-zalecenia-dot-etyki-badan> (accessed on 17 March 2022)) which are the basis for drawing up guidelines for conducting research at Nicolaus Copernicus University (based on document in polish: <https://dokumenty.umk.pl/d/5665/5/> (accessed on 17 March 2022)) did not require approval of the ethics committees.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

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