

## ORIGINAL ARTICLE


**Citation:** Gorączkowska, J. (2020). Enterprise innovation in technology incubators and university business incubators in the context of Polish industry. *Oeconomia Copernicana*, 11(4), 799–817. doi: 10.24136/oc.2020.032

Contact: j.goraczkowska@wez.uz.zgora.pl; University of Zielona Góra, ul. Licealna 9, 65-417 Zielona Góra

Received: 07.07.2020; Revised: 29.10.2020; Accepted: 27.11.2020; Published online: 25.12.2020

**Jadwiga Gorączkowska**

*University of Zielona Góra, Poland*

 [orcid.org/0000-0001-6394-463X](https://orcid.org/0000-0001-6394-463X)

## Enterprise innovation in technology incubators and university business incubators in the context of Polish industry

**JEL Classification:** 030; 032; 038

**Keywords:** *technology business incubator; university business incubator; product innovations; process innovations; R&D activities*

### Abstract

**Research Background:** The development of fledgling enterprises, especially those associated with medium-high and high technology is not easy. They often need to develop from inception a born global strategy, which is a great challenge at the beginning of a new business. Therefore, there is a global phenomenon of incubation, which supports young enterprises in the early stages of development. In Poland, the institutional dimension of incubation (especially for enterprises associated with modern technologies) consists of technology incubators and university business incubators. Yet, scientific research conducted in the area of entrepreneurship incubation gives contradictory results - some assess their activity positively, others negatively.

**Purpose of the article:** Enterprises located in an incubator should allocate funds for R&D activities and create innovations to develop and gain market advantage. With this in mind, the purpose of the article is to check whether technology incubators and university business incubators contribute to an increase in the likelihood of conducting R&D activities and introducing product and process innovations.

**Methods:** The study was conducted on a sample of 1058 industrial enterprises distributed across 2 Polish NUTS level 2 regions: Pomeranian and Kuyavian-Pomeranian Voivodships. It concerned innovative activity that enterprises conducted in 2014–2016. Thanks to the use of probit modeling determination was made for the probability of introducing new products and conducting R&D works in entities that used the services of incubators in relation to those that did not belong to them.

**Findings & Value added:** Econometric modeling revealed that in the studied regions incubators contribute to an increase in the introduction of product innovations by enterprises and in conducting R&D activities. Support for the process of implementing innovation occurred significantly more often only in the case where technology incubators were involved. At the same time, it was noticed that only academic incubators increased the chances of introducing product innovations on a global scale. This means that tenants of technology incubators are more innovative than entities outside them, but their innovations in terms of the level of novelty do not differ from innovations implemented in entities outside incubators. The conducted study indicated that the transfer of systemic solutions related to stimulating innovation from developed countries to catching-up countries may be successful. This is a guideline for local authorities to create incubators that allow for an increase in the level of innovation of the incubated enterprises.

## Introduction

In the modern world, implementation of innovation brings measurable benefits to enterprises. Creating new solutions, such as new products and processes, requires not only research and development, but also the building of a network of connections between enterprises and research centers, and between enterprises themselves. At the same time, it would be difficult for enterprises to create innovations without state involvement. This is due to specific features of innovation, such as difficulties in raising capital for innovative projects from commercial banks or the spread of knowledge created in one enterprise to another due to the openness of the economy (Etzkowitz & Leydesdorff, 2000, pp. 109–123)

The economic conditions for creating innovative solutions can be difficult even for entities with an established position on the market, and the development of young enterprises, especially those associated with medium-high and high manufacturing techniques, is also not easy. Due to the uniqueness of the products offered and the small audience, they often need to develop from inception a born global strategy (Dzikowski, 2018, pp. 281–294; Stayton & Mangematin, 2019, pp. 1163–1187; Blackburne & Buckley, 2019, pp. 32–50). At the beginning of a new business, this is a big challenge. In response to this situation, the development of the phenomenon of incubation arose, i.e., support for young enterprises in the early stages of their activity at both the global and then the Polish levels.

In Poland, the institutional dimension of incubation, especially for enterprises associated with modern technologies, consists of technology business incubators and university business incubators. The purpose of this study is to check whether these institutions contribute to increasing the likelihood of conducting R&D and to implementing product and process innovations. The research hypothesis posits the claim that incubators will contribute to the conducting of innovative activity in the entities engaged in research. The presented research hypothesis seems to be obvious, as stimu-

lating innovation activity is one of the goals of incubators. However, the need to verify the hypothesis results from the ambiguous research on their effectiveness in catching-up countries, including Poland. Research conducted in the Czech Republic showed that enterprises operating in incubators achieved lower results than those located outside them (Dvoulety *et al.*, 2018, pp. 543–563). In studies conducted in Brazil, it was noted that incubators do not achieve the assumed results and do not contribute effectively to local and regional development (Silva & Da Chunha, 2018, pp. 298–313). Some doubts also appeared in the research conducted in China. It turns out that, compared to public incubators, private incubators have a better effect on the economy (Hong *et al.*, 2017, pp. 569–582). In Poland, the activity of incubators is subsidized mainly from public funds, therefore doubts may arise as to their functioning.

Moreover, it may seem that entrepreneurs in academic business incubators, due to the closer access to knowledge resources, may be characterized by greater innovation activity than tenants of technological incubators. A similar thesis with regard to the creation of product innovations was put forward in research conducted in the Sao Paulo region in Brazil. It was negatively verified in the course of the analyzes (Fernandes *et al.*, 2017, pp. 153–170). It remains an open question how this situation will look in Poland in relation to not only product innovations, but also process innovations and R&D.

The analysis is based on the cohort of 1058 enterprises located across 2 Polish NUTS level 2 regions: Pomeranian and Kuyavian-Pomeranian voivodeships. These regions are adjacent to each other and are characterized by an average level of innovation in Poland. On the Polish scale, they are characterized by an average level of innovation, which will not distort the results of analyzes by too large or too small deviations from the national level of innovation. As the research method probit modeling was used, which enables determination of the probability of the occurrence of the studied innovative phenomena.

The article is divided into five parts. The first reviews the literature related to the topic of incubators. The second presents the basic methodological assumptions of the analyses. The third presents the results of the study, and the fourth confronts them with the results of other scientists. The fifth part presents the most important conclusions related to the conducted analyses and also indicates the limitations that impacted on the research work.

## Literature review and empirical research gap indication

The incubation phenomenon contributes to the stimulation of entrepreneurship (Cavallo *et al.*, 2020, pp. 239–262) and brings measurable benefits to the economy (Lamine *et al.*, 2018, pp. 1121–1141). Well-developed incubators have the ability to remove resource gaps or business knowledge gaps (Yusubova *et al.*, 2019, pp. 803–818). They lead to the development of enterprises as well as new products (Breznitz & Zhang, 2019, pp. 885–873). Therefore, it seems important that the range of services that incubators provide should be as wide as possible (Kee *et al.*, 2019, pp. 43–59; Lasrado *et al.*, 2016, pp. 205–219; Stokan *et al.*, 2015, pp. 317–327). Only the proper matching of services to the needs of incubated entities will promote their real development (Kapinga *et al.*, 2018, pp. 1–14, Reyani *et al.*, 2018, pp. 569–573; Vanderstraeten *et al.*, 2016, pp. 45–64). Otherwise, incubators may not fulfill their functions and may not improve regional development (Hong *et al.*, 2017, pp. 569–582). However, extending the protective umbrella too far over the incubated enterprises can cause them to perform worse than enterprises outside the incubator (Lukes *et al.*, 2019, pp. 25–34). Incubators in themselves do not ensure the success of start-ups (Mas-Verdu *et al.*, 2015, pp. 793–796), but they have the opportunity to provide services that will provide assistance for the future development of the entities (Sousa *et al.*, 2018, pp. 823–834).

Nevertheless, determining the success factors of incubators is not an easy task, because incubation of new ventures is a very flexible process aimed at achieving various goals (Franco *et al.* 2018, pp. 239–262). A positive perception of the incubator's work translates into the effectiveness of entrepreneurs and vice versa — i.e., the effectiveness of entrepreneurs has a positive effect on the functioning of the incubators (Martinez *et al.*, 2018, pp. 1–15). For this reason, incubator managers should ensure a good image of the incubator and its brand (Lucic *et al.*, 2018, pp. 1–11).

The location of companies in incubators may be conducive to establishing cooperation in the area of new solutions (Wu *et al.*, 2020; Apa *et al.*, 2017, pp. 198–221). This is especially important for small entities that are just beginning to grow, because it allows the risk associated with creating innovation to be spread over many entities (Zouaghi *et al.*, 2018, pp. 92–104). Creating conditions in which entrepreneurs have the opportunity to build networks increases the chances of establishing contact with other companies in the future (Breznitz *et al.*, 2018, pp. 343–367). Networks of connections can be formed not only between incubated enterprises, but also outside them, which may facilitate the attraction of venture capital (van Rijnssoever, 2020, pp. 1–15). Enabling entrepreneurs to enter the network

brings better results than providing physical infrastructure for companies located in incubators (Fernandes *et al.*, 2017, pp. 153–170).

University business incubators are one of the possibilities for stimulating entrepreneurship among researchers, students and graduates (Guerrero *et al.*, 2020). Nevertheless, to enhance these effects, it is necessary to create entire entrepreneurship-related curricula so that entrepreneurial ecosystems can be created (Allahar & Sookram, 2019, pp. 15–25; Baskaran *et al.*, 2019, pp. 385–400; Stevenson, 2017, pp. 140–144). Such ecosystems, apart from elements of education, are made up of incubators and partnership agreements between universities and external partners who are interested in the commercialization of knowledge (Guerrero & Urbano, 2016, pp. 551–563).

Creating university business incubators as a tool through which knowledge can be commercialized brings favorable results (Ng *et al.*, 2019, pp. 465–485). The more so that the Central Statistical Office data indicate that enterprises with no connections with universities do not recognize them as a source of innovation (Krawczyk, 2013, pp. 5–18). Incubators can therefore be a link between business and universities (Bras & Preto, 2019, pp. 147–155). The commercialization of knowledge generated at the university has another positive aspect, i.e., thanks to which it is possible to develop practical solutions that have been developed from public funds (Pohulak-Żołędowska, 2013, pp. 37–52). This means that basic research that has been financed from public funds goes into the market in Poland as applied research on a commercial basis. The effectiveness of incubators at universities with a rich tradition of knowledge commercialization may look slightly different. On the one hand research conducted in Israel and Australia showed that universities played an important role in the creation of new products by incubatees (Rubin *et al.*, 2015, pp. 11–24). On the other hand Kolympiris and Klein (2017, pp. 145–170) indicated, that after the establishment of university business incubators, the quality of university innovations decreased.

The aforementioned literature on incubators raises issues related to the factors responsible for their success or discusses the processes of knowledge transfer that occur in incubators. The issues discussed are treated both from the side of positive impact on incubated enterprises and also indicate some limitations in the process. The positive assessment of the functioning of incubators related mainly to research conducted in countries such as Canada (Brennitz & Zhang, 2019, pp. 885–873), the USA (Lasrado *et al.*, 2016, pp. 205–219), Australia and Israel (Rubin *et al.*, 2015, pp. 11–24). In countries with a slightly lower level of development, e.g. Italy (Cavallo *et al.*, 2020, pp. 239–262; Lukes *et al.*, 2019, pp. 25–34), Spain

(Mas-Verdu *et al.*, 2015, pp. 793–796) and a lower level of development, e.g. Brazil (Vanderstraeten *et al.*, 2016, pp. 45–64; Silva & Da Chunha, 2018, pp. 298–313), the results are not clear. Some of them confirm the effectiveness of the operation of incubators, others indicate problems in their functioning. In this context, it was particularly intriguing that in the Czech Republic, a country similar to Poland in terms of economic development and historical experience, incubator tenants were less productive than enterprises outside incubators (Dvoulety *et al.*, 2018, pp. 543–563). For this reason, there is a gap in the literature related to the assessment of the functioning of incubators in catching-up countries, especially in Central and Eastern European countries, among which Poland belongs. It is reasonable to check how these institutions function in Poland. The conducted analyzes will allow to determine whether entities in incubators are more innovative than outside them. In addition, their functioning will be assessed not only in relation to the introduction of product innovations that appeared in the previously discussed study (e.g. Fernanades *et al.*, 2017, pp. 153–170), but will be extended to process innovations and R&D activities. The analyzes will take into account the level of novelty of implemented innovations, which was not the case in previous studies.

## **Research methodology**

The research on the impact of technology incubators and academic entrepreneurship incubators on innovation activity was designed on the basis of international standards for measuring innovation activity contained in the Oslo Methodology (OECD/Eurostat, 2005, pp. 47–49). The dependent variables were:

- product innovations;
- process innovations together with their types, i.e., new production methods, new production-related systems and new systems supporting the operations of enterprises;
- expenditure on research and development.

In the case of product and process innovations, the scale of implemented novelties was also taken into account. They referred to (OECD/Eurostat, 2005, pp. 57-58):

- new products/process for the enterprise itself which implements them,
- new products/process for the market in which the enterprise operates;
- new products/process for the country of origin;
- new products/process on a global scale.

The independent variables were technology business incubators and university business incubators.

The study was conducted in 2017 and covered the years 2014–2016. The three-year research period is also a standard in the study of innovative activity (cf. Eurostat survey).

Primary data was used to perform the analysis. It was collected using the survey form. This was constructed in such a way that respondents gave an affirmative answer in the event of the occurrence of the analyzed phenomenon in their enterprise. For example, one of the questions was "Did the enterprise in 2014–16 incur expenditure on research and development?". Respondents answered with either a yes or a no. Then, the answers were assigned the value 1 (when the analyzed type of innovative activity occurred in the enterprise or when the services of incubators were used in the entity) or 0 (when the analyzed type of innovative activity did not occur in the enterprise or when the services of the incubators were not used in the entity).

Dichotomous variables allow the use of probability theory in the analysis. In this case, one of three methods can be used: a linear probability model, a logit model or a probit model. The linear probability model can be easily estimated using multiple regression methods. Its use, however, is inadvisable, because the values of such a function may be negative or greater than one, and in the case of this study these values have no interpretative sense (Long, 1997, pp. 38–40). In this situation, it is better to use probit or logit models. Both models are very similar. The main difference between the models is that in the probit model the probability value of the F distribution function of the standard normal distribution is probable, while the logit model uses logistic distribution (Maddala, 1992, pp. 327–328).

Estimation of the parameters of models with a dichotomous variable is carried out using the maximum likelihood method. It gives the highest probability of obtaining the values observed in the sample (Aldrich & Nelson, 1984, pp. 49–54). In the study, the maximization of the likelihood function was performed using techniques used for non-linear estimation. Models were estimated in *Stastica* software using the quasi-Newton method.

The model calculations were made at the significance level  $\alpha = 0.01$ ,  $\alpha = 0.05$  and  $\alpha = 0.1$ . The statistical significance of the models is determined on the basis of Wald's chi-square statistics, and the verification of the significance of parameters using Student's t-statistics, based on asymptotic standard errors of assessment.

The estimated models are in the form of a linear function. A positive sign next to a directional coefficient means that the probability of occur-

rence of the type of innovative activity being examined (e.g., creation of product innovation) is greater in the group of entities that used the services of the analyzed incubator. In the case of a negative sign, the situation is opposite — the probability is higher in entities that did not cooperate with incubators.

In the Results section only models that met the requirements of statistical significance were presented. The value of the probability of occurrence of individual types of innovative activity was also estimated, so that it was visible how big the difference in innovation between incubator tenants and entities outside incubators was.

## Results

In total, the survey was completed by 1058 industrial enterprises, whose activities are classified in Section C Polish Classification of Business Activity (Polska Klasyfikacja Działalności). 666 enterprises came from the Pomeranian voivodeship, and 392 from the Kuyavian-Pomeranian voivodeship (Table 1). Nearly half of the surveyed entities were micro and 1/3 small enterprises. Medium-sized enterprises accounted for less than 20% of the surveyed enterprises, and large ones 4%.

Among the surveyed enterprises, only a small number used the services of technology incubators and academic entrepreneurship incubators (Table 2). In the Pomeranian voivodeship there were 12 and 10 entities, respectively, whereas in the Kuyavian-Pomeranian voivodeship there were 8 and 7.

When considering the impact of technology business incubators on the analyzed types of innovative activity, it is noted that they affected activities positively (Table 3). The incubators contributed most to the implementation of new production processes. It can be concluded that the introduction of new processes to enterprises that used incubator services is almost certain, as  $p_1 = 0.95$ . In the opposite case, i.e., in enterprises that did not cooperate with incubators, the level of  $p_2 = 0.61$ . Analyzing the types of process innovations more closely, a significant impact of incubators on the implementation of new production methods and production-related systems is also noticeable. In the first case, the probability of their introduction increases more than 1.5 times from  $p_2 = 0.43$  (in enterprises not using incubator services) to  $p_1 = 0.70$  (among participants of incubators), and in the second more than 3 times, with  $p_2 = 0.21$  to  $p_1 = 0.65$ . Incubators did not have a significant impact on the implementation of new support systems. Due to the activity of technology, business incubators in the surveyed entities, the probability of introducing new products to the market was  $p_1 =$



0.85 and was 1.5 times higher than in entities that did not cooperate with them. The probability of incurring expenditure on R&D in the group of entities using the services of incubators was  $p_1 = 0.75$  and was over 2.5 times higher than in the opposite case of enterprises not using the services. Incubators were characterized by a large and positive impact on innovation activity. Unfortunately, models that illustrated their impact on the degree of novelty of the analyzed products and processes did not meet the conditions of statistical significance.

University business incubators contributed less to the implementation of innovations than technological incubators (demonstrated by fewer models meeting the conditions of statistical significance being estimated), but their impact was positive (Table 4). University incubators have contributed most to the launch of new products. In relation to entities not using incubator services, the probability increased by 1.5 times from  $p_2 = 0.58$  to  $p_1 = 0.88$ . At this stage of consideration, it should be emphasized that in the study of the impact of university incubators on the degree of novelty of implemented product innovations, one model meeting the conditions of statistical significance was estimated. Namely, among the recipients of incubators, innovations on a global scale were more often implemented. On the one hand, this is a positive phenomenon, because the probability increased 5 times, on the other, it remained low,  $p_1 = 0.24$ . This means that every fourth enterprise has implemented novelty on such a large scale. Nevertheless, this is the beginning from which the development of innovative academic entrepreneurship can begin.

Among the process innovations, university incubators only affected the implementation of production-related systems. Entities that used their services implemented this type of innovation almost three times more often. The probability of its implementation was  $p_1 = 0.59$ .

In entities using the services of university business incubators, the probability of incurring expenditure on R&D increased. It amounted to  $p_1 = 0.53$  in this group and was almost 2 times higher than in the opposite case.

## **Discussion**

Undoubtedly, in the surveyed enterprises, incubators contributed to stimulating innovative activity. The importance of incubators in implementing innovative solutions has been confirmed by research conducted in Italy (Sedita *et al.*, 2019, pp. 439–454) and in Brazil (Mansano & Pereira, 2016, pp. 23–32), where enterprises associated with the incubator implemented more product innovations. In the case of university incubators, this result

was confirmed in Australian (Breznitz & Zhang, 2019, pp. 885–873) and Brazilian (Marques *et al.*, 2019, pp. 153–169) studies. This shows that despite the doubts related to the functioning of incubators that arose during the literature review, incubators are a good tool to support the creation of product innovations in developing and developed countries.

At the same time, it is noticeable that technology business incubators were characterized by greater efficiency than university business incubators. For the former, more models meeting the conditions of statistical significance were estimated, and except creating product innovations the probability of the occurrence of the analyzed innovative phenomena was higher. This is surprising, because the proximity of the university should provide incubatees greater access to knowledge resources. It is difficult to give an unambiguous reason for this condition, however, Italian studies indicate that providing too friendly an environment for incubated entities may reduce their effectiveness (Lukes *et al.*, 2019, pp. 25–34). In the case of the studied region, it may turn out that the university community protects entities in the incubator to a greater extent than in the case of technological incubators, therefore they do not have to be as innovative as entities in technological incubators. However, explicit confirmation of this thesis requires additional analysis.

At this stage, it should be emphasized that university business incubators have contributed to the implementation of innovations worldwide. This means that entities residing in incubators most likely use the potential of the close vicinity of the university. This is a very positive phenomenon, because while innovations are implemented in the Polish industry, they are at a low level (Sachpazidu-Wójcicka, 2017, pp. 287–299). The number of entities that used university business incubators' services in the scale of the regions studied was small, but this phenomenon is the beginning from which a more intensive development of the region may begin.

Entities located in technology business incubators more often implemented process innovations than entities situated outside of them. This concerned new production and production-related systems. In the case of university incubators, the impact was noticed only for production-related systems. This phenomenon may be associated with the implementation of product innovations, because one of the factors that forces enterprises in incubators to implement new processes is the need to improve the product and increase production (Adelowo *et al.*, 2015, pp. 72–89).

In the surveyed enterprises, incubators contributed to the expenditure on R&D. This is a positive phenomenon, because R&D is one of the most important variables influencing patenting by incubatees (Lofsten, 2015, pp. 1–32).

A small number of enterprises that used the services of technology business incubators and university business incubators might suggest that the impact of these institutions on the economy of the regions is small. However, statistical analysis provides evidence to note their significant impact. It turns out that incubator tenants are more innovative than companies located outside of them.

## **Conclusions**

The analysis of the impact of technology business incubators and university business incubators has confirmed their systemic, positive impact on the innovation of the surveyed entities. Both types of incubators contributed to expenditure on R&D, creation of new products and implementation of new processes. The research hypothesis has been confirmed and the aim of the study achieved. Nevertheless, it should be emphasized that the analyzes showed a weak relationship between enterprises — tenants of technology incubators, and the degree of novelty of the implemented product and process innovations. In the case of university business incubators, a positive correlation was noticed for new product worldwide. Taking into account the fact that incubators should significantly increase the level of incubatees' innovation, it can be assumed that university incubators filled this gap, while technological incubators did not.

At the same time, the research has some limitations. On the one hand, it can be concluded that incubators positively influenced the innovation activity of incubatees, on the other hand, it is difficult to quantify exactly the influence of the incubators' contribution to the development of participants. Therefore, research should be deepened and the functioning of the incubators themselves and their tenant entities should be assessed. There should be an examination of the availability and nature of services provided by these institutions and an assessment of how entrepreneurs evaluate them. In addition, the study is limited to analyzing two regions in Poland. It is, therefore, difficult to generalize from them to the entire population — all the more so because in the economy some incubators are more effective, others less (M'Chirgui *et al.*, 2018, pp. 1142–11).

Despite the denoted limitations, the conducted analyzes filled the research gap indicated at the beginning of the paper. From the point of view of enriching the literature, it was indicated that in Poland, a country located in Central and Eastern Europe, incubators contribute to increasing the level of innovation of tenant companies. The study shows that transferring of system solutions related to stimulating innovation (including incubators)

from developed countries to catching up countries may be successful. The strength of the study was that this thesis was confirmed using econometric modeling. Although only a few companies have used the services of incubators, the impact on such companies is high. If only simple statistical analyses had been made, this fact would not be visible. From the perspective of practical implications, the analysis carried out gives a signal to local government authorities. It indicates that the phenomenon of incubation allows the development of enterprises by creating new products and implementing new processes. Considering the fact that in the period under consideration only a small number of entities used the services of incubators, one should consider how to increase their number. This could have a positive impact on the development of the region.

## References

- Adelowo, C. M., Ilori, M. O., Siyanbola, W. O., & Oluwale, B. A. (2015). Technological learning mechanisms in Nigeria's technology incubation centre. *African Journal of Economic and Management Studies*, 6(1). doi: 10.1108/AJEMS-10-2014-0071.
- Aldrich, J. H., & Nelson, F. D. (1984). Linear probability, logit, and probit models. *Quantitative Applications in the Social Sciences*, 45.
- Allahar, H., & Sookram, R. (2019). A university business school as an entrepreneurial ecosystem hub. *Technology Innovation Management Review*, 9(11). doi: 10.22215/timreview/1280.
- Apa, R., Grandinetti, R., & Sedita, S. R. (2017). The social and business dimensions of a networked business incubator: the case of H-Farm. *Journal of Small Business and Enterprise Development*, 24(2). doi: 10.1108/JSBED-07-2016-0103.
- Baskaran, A., Chandran, V. G. R., & Ng, B. K. (2019). Inclusive entrepreneurship, innovation and sustainable growth: role of business incubators, academia and social enterprises in Asia. *Science Technology and Society*, 24(3). doi: 10.1177/0971721819873178.
- Blackburne, G. D., & Buckley, P. J. (2019). The international business incubator as a foreign market entry mode. *Long Range Planning*, 52(1). doi: 10.1016/j.lrp.2017.10.005.
- Breznitz, S. M., & Zhang, Q. T. (2019). Fostering the growth of student start-ups from university accelerators: an entrepreneurial ecosystem perspective. *Industrial and Corporate Change*, 28(4). doi: 10.1093/icc/dtz033.
- Breznitz, S. M., Clayton, P. A., Defazio, D., & Isett, K. R. (2018). Have you been served? The impact of university entrepreneurial support on start-ups' network formation. *Journal of Technology Transfer*, 43(2). doi: 10.1007/s10961-017-9565-0.

- Bras, G. R., & Preto, M. T. (2019). The geographical distribution of Portuguese business incubators: an empirical approach. *Economics and Business Letters*, 8(3). doi: 10.17811/eb1.8.3.2019.147-155.
- Dzikowski, P. (2018). A bibliometric analysis of born global firms. *Journal of Business Research*, 85. doi: 10.1016/j.jbusres.2017.12.054.
- Dvoulety, O., Longo, M. C., Blazkova, I., Lukes, M., & Andera, M. (2018). Are publicly funded Czech incubators effective? The comparison of performance of supported and non-supported firms. *European Journal of Innovation Management*, 21(4). doi: 10.1108/EJIM-02-2018-0043.
- Cavallo, A., Ghezzi, A., Colombelli, A., & Casali G.L. (2020). Agglomeration dynamics of innovative start-ups in Italy beyond the industrial district era. *International Entrepreneurship and Management Journal*, 16. Advance online publication. doi: 10.1007/s11365-018-0521-8.
- Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2). doi: 10.1016/S0048-7333(99)00055-4.
- Fernandes, C. C., Oliveira, M. D., Sbragia, R., & Borini, F. M. (2017). Strategic assets in technology-based incubators in Brazil. *European Journal of Innovation Management*, 20(1). doi: 10.1007/10.1108/EJIM-04-2016-0043.
- Franco, M., Haase, H., & Correia, S. (2018). Exploring factors in the success of creative incubators: a cultural entrepreneurship perspective. *Journal of the Knowledge Economy*, 9(1). doi: 10.1007/s13132-015-0338-4.
- Guerrero, M., & Urbano, D. (2016). Entrepreneurial universities: emerging models in the new social and economic landscape. *Small Business Economics*, 47(3). doi: 10.1007/s11187-016-97554.
- Guerrero, M., Urbano, D., & Gajón, E. (2020). Entrepreneurial university ecosystems and graduates' career patterns: do entrepreneurship education programmes and university business incubators matter? *Journal of Management Development*. Advance online publication. doi: 10.1108/JMD-10-2019-0439.
- Hong, J., Chen, M., Zhu, Y.H., & Song, G. (2017). Technology business incubators and regional economic convergence in China. *Technology Analysis & Strategic Management*, 29(6). doi: 10.1080/09537325.2016.1216096.
- Kapinga, A. F., Suero Montero, C., Mwandosya, G. I., & Mbise, E. R. (2018). Exploring the contribution of business and technology incubators to women entrepreneurs' business development in Dar es Salaam, Tanzania. *Journal of Global Entrepreneurship Research*, 8(23). doi: 10.1186/s40497-018-0111-9.
- Kee, D. M. H., Yusoff, Y. M., & Khin, S. (2019). The role of support on start-up success: a PLS-SEM approach. *Asian Academy of Management Journal*, 24(1). doi: 10.21315/aamj2019.24.s1.4.
- Kolympiris, C., & Klein, P.G. (2017). The effects of academic incubators on university innovation. *Strategic Entrepreneurship Journal*, 11(2). doi: 10.1002/sej.1242.

- Krawczyk, M. (2013). Sources of information for innovative activity of enterprises. types, importance, measurement. *Oeconomia Copernicana*, 4(1). doi: 10.12775/OeC.2013.001.
- Lasrado, V. Sivo, S., Ford, C., O'Neal, T., & Garibay, I. (2016). Do graduated university incubator firms benefit from their relationship with university incubators? *Journal of Technology Transfer*, 41(2). doi: 10.1007/s10961-015-9412-0.
- Lamine, W., Mian, S., Fayolle, A., Wright, M., Klofsten, M., & Etzkowitz, H. (2018). Technology business incubation mechanisms and sustainable regional development. *Journal of Technology Transfer*, 43(5). doi: 10.1007/s10961-016-9537-9.
- Lofsten, H. (2015). Critical resource dimensions for development of patents—an analysis of 131 new technology-based firms localised in incubators. *International Journal of Innovation Management*, 19(1). doi: 10.1142/S1363919615500061.
- Long J. S. (1997). *Regression models for categorical and limited dependent variables*. Newbury Park: Sage Publishing.
- Lucic, A., Dabic, M., & Busic, S. (2018). Brand management practices in technology parks and incubators - an exploratory study. In K. S. Soliman (Eds.). *Innovation management and education excellence through vision 2020, Vols I-XI*. Milan: International Business Information Management Association.
- Lukes, M., Longo, M. C., & Zouhar, J. (2019). Do business incubators really enhance entrepreneurial growth? Evidence from a large sample of innovative Italian start-ups. *Technovation*, 82(83). doi: 10.1016/j.technovation.2018.07.008.
- Maddala, G. S. (1992). *Introduction to econometrics*. New York: Macmillan Publishing Company.
- Mansano, F. H., & Pereira, M. F. (2016). Business incubators as support mechanisms for the economic development: case of Maringa's technology incubator. *International Journal of Innovation*, 4(1). doi: 10.5585/iji.v4i1.51.
- Martinez, K. R. G., Fernandez-Laviada, A., & Crespo, A. H. (2018). Influence of business incubators performance on entrepreneurial intentions and its antecedents during the pre-incubation stage. *Entrepreneurship Research Journal*, 8(2). doi: 10.1515/erj-2016-0095.
- Marques, N. D., Sbragia, R., Oliveira, M. D., & Borini, F. (2019). Entrepreneur's background and product innovation Evidences from technology-based incubated firms. *Management Research - The Journal of The Iberoamerican Academy of Management*, 18(2). doi: 10.1108/MRJAM-11-2018-087.
- Mas-Verdu, F., Ribeiro-Soriano, D., & Roig-Tierno, N. (2015). Firm survival: the role of incubators and business characteristics. *Journal of Business Research*, 68(4), doi: 10.1016/j.jbusres.2014.11.030.
- M'Chirgui, Z., Lamine, W., Mian, S., & Fayolle, A. (2018). University technology commercialization through new venture projects: an assessment of the French regional incubator program. *Journal of Technology Transfer*, 43(5). doi: 10.1007/s10961-016-9535-y.

- Ng, B. K., Chen, S. H., Wong, C. Y., & Chandran, V. (2019). University incubation system for research commercialisation: the case of Taiwan and Malaysia. *Science Technology and Society*, 24(3). doi: 10.1177/0971721819873184.
- OECD/Eurostat (2005). *Oslo manual: guidelines for collecting and interpreting innovation data*. The measurement of scientific, technological and innovation activities. Paris, Luxembourg: OECD/ Eurostat. doi: 10.1787/9789264013100-en.
- Pohulak-Żołędowska, E. (2013). Property rights of scientific knowledge in terms of creating innovation. *Oeconomia Copernicana*, 4(1). doi: 10.12775/OeC.2013.003.
- Reyani, S., Muralidharan, C., Selvi, R. P., & Sakthirama, V. (2018). The impact of technology business incubators in entrepreneurial development of start-ups. *Indian Journal of Economics and Development*, 14(3). doi: 10.5958/2322-0430.2018.00173.7.
- van Rijnsoever, F. J. (2020). Meeting, mating, and intermediating: how incubators can overcome weak network problems in entrepreneurial ecosystems. *Research Policy*, 49(1). doi: 10.1016/j.respol.2019.103884.
- Rubin, T. H., Aas, T. H., & Stead, A. (2015). Knowledge flow in technological business incubators: evidence from Australia and Israel. *Technovation*, 41(42). doi: 10.1016/j.technovation.2015.03.002.
- Sachpazidu-Wójcicka, K. (2017). Innovation as a determinant of the competitiveness of Polish enterprises. *Oeconomia Copernicana*, 8(2). doi: 10.24136/oc.v8i2.18.
- Sedita, S. R., Apa, R., Bassetti, T., & Grandinetti, R. (2019). Incubation matters: measuring the effect of business incubators on the innovation performance of start-ups. *R&D Management*, 49(4). doi: 10.1111/radm.12321.
- Silva, A. Q., & Da Cunha, J. C. (2018). Are technology business incubators fulfilling their objectives? A study of the Tbi's performance located in Brazil. *International Journal of Innovation*, 6(3). doi: 10.5585/ijj.v6i3.313.
- Stayton, J., & Mangematin, V. (2019). Seed accelerators and the speed of new venture creation. *Journal of Technology Transfer*, 44(4). doi: 10.1007/s10961-017-9646-0.
- Stevenson, B. (2017). Oulu Edulab: university-managed, interdisciplinary Edtech incubator program from Finland. In K. A. Aziz (Ed.). *Proceedings of the 5th international conference on innovation and entrepreneurship (ICIE 2017)*. Kuala Lumpur.
- Stokan, E., Thompson, L., & Mahu, R. J. (2015). Testing the differential effect of business incubators on firm growth. *Economic Development Quarterly*, 29(4). doi: 10.1177/0891242415597065.
- Sousa, J., Meneses, R., Ribeiro, H., & Alves, S. R. (2018). The symbiotic relationship between startups and incubator. In R. Veselica, G. Dukic, & K. Hammes (Eds.). *36th international scientific conference in economic and social development - "Building resilient society"*. Book Series: International Scientific Conference on Economic and Social Development Zagreb.

- Vanderstraeten, J., van Witteloostuijn, A., Matthyssens, P., & Andreassi, T. (2016). Being flexible through customization - the impact of incubator focus and customization strategies on incubatee survival and growth. *Journal of Engineering and Technology Management*, 41. doi: 10.1016/j.jengtecman.2016.06.003.
- Wu, W., Wang, H., & Tsai, F.-S. (2020). Incubator networks and new venture performance: the roles of entrepreneurial orientation and environmental dynamism. *Journal of Small Business and Enterprise Development*. Advance online publication. doi: 10.1108/JSBED-10-2019-0325.
- Yusubova, A., Andries, P., & Clarysse, B. (2019). The role of incubators in overcoming technology ventures' resource gaps at different development stages. *R&D Management*, 49(5). doi: 10.1111/radm.12378.
- Zouaghi, F., Sanchez, M., & Martinez, M. G. (2018). Did the global financial crisis impact firms' innovation performance? The role of internal and external knowledge capabilities in high and low tech industries. *Technological Forecasting and Social Change*, 132. doi: 10.1016/j.techfore.2018.01.011.



## Annex

**Table 1.** Structure of the surveyed industrial enterprises in the Pomeranian and Kuyavian-Pomeranian voivodeships in 2017

Voivodeships	Micro		Small		Medium-sized		Large	
	Quantity of companies	Percentage	Quantity of companies	Percentage	Quantity of companies	Percentage	Quantity of companies	Percentage
Pomeranian	321	48%	210	31%	111	17%	24	4%
Kuyavian-Pomeranian	164	42%	130	33%	80	20%	18	5%
Sum	485	46%	340	32%	191	18%	42	4%

**Table 2.** Number of enterprises using the services of technology business incubators and university business incubators in the surveyed voivodeships in 2014–2016

Voivodeships	Number of enterprises	
	technology business incubators	university business incubators
Pomeranian	12	10
Kuyavian-Pomeranian	8	7
Sum	20	17

**Table 3.** The influence of technology business incubators on innovation activity of industrial companies in Pomerania and Kuyavian-Pomerania voivodeships in 2014–2016

Innovation Attributes	Models	$p_1$	$p_2$	$\sigma$	$t$	$\chi^2$	$p$
Expenditure on R&D	$y = 1.22x - 0.54$	0.75	0.29	0.31	3.98	17.52	0.000
Implementation of new products	$y = 0.85x + 0.19$	0.85	0.57	0.34	2.46	6.92	0.009
Implementation of new processes, including	$y = 1.35x + 0.29$	0.95	0.61	0.47	2.85	12.28	0.000
a) manufacturing methods	$y = 0.71x - 0.18$	0.70	0.43	0.30	2.39	6.01	0.014
b) production-related systems	$y = 1.19x - 0.80$	0.65	0.21	0.29	4.08	17.44	0.000
c) support systems							

Note:

$p_1$  – probability of occurrence of the examined type of innovation activity in the group of enterprises that used the services of technology business incubators  
 $p_2$  – probability of occurrence of the examined type of innovative activity in the group of enterprises that did not use the services of technology business incubators

$\sigma$  – asymptotic standard error of the independent variable parameter estimator (technology business incubator)

$T$  – Student  $t$ -distribution value of the independent variable parameter estimator (technology business incubator)

$\chi^2$  – chi-square test value of the estimated model

$p$  –  $p$ -value

**Table 4.** The influence of university business incubators on innovation activity of industrial companies in Pomerania and Kuyavian-Pomerania voivodeships in 2014–2016

Innovation Attributes	Models	$p_1$	$p_2$	$\sigma$	$t$	$\chi^2$	$p$
Expenditure on R&D	$y = 0.61x - 0.53$	0.53	0.30	0.31	1.98	3.92	0.048
Implementation of new products	$y = 1.00x + 0.19$	0.88	0.58	0.40	2.50	7.59	0.005
New products on a global scale	$y = 0.94x - 1.66$	0.24	0.05	0.34	2.76	6.81	0.009
Implementation of new processes, including							
a) manufacturing methods							
b) production-related systems	$y = 1.02x - 0.80$	0.59	0.21	0.31	3.29	11.00	0.001
c) support systems							

Note:

$p_1$  – probability of occurrence of the examined type of innovation activity in the group of enterprises that used the services of university business incubators

$p_2$  – probability of occurrence of the examined type of innovative activity in the group of enterprises that did not use the services of university business incubators

$\sigma$  – asymptotic standard error of the independent variable parameter estimator (university business incubator)

$t$  – Student t-distribution value of the independent variable parameter estimator (university business incubator)

$\chi^2$  – chi-square test value of the estimated model

$p$  –  $p$ -value