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Entrepreneurial Orientation of Academic Spin-Offs: Statistical Correlations

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The main goal of this article is to present statistical correlations as regards the impact of certain determinants on entrepreneurial orientation of academic spin-off companies. The first part presents the definition of academic spin-offs and the most important elements of entrepreneurial orientation of such companies. The second, empirical, part reports the results regarding statistical correlations of entrepreneurial orientation of academic spin-offs. The research was conducted among 141 academic spin-offs. The test of independence and Cramér's V coefficient were used to diagnose the correlation.

Keywords: entrepreneurship, academic spin-off companies, commercialisation, innovation.

Orientacja przedsiębiorcza uczelnianych firm spin-off – zależności statystyczne

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Podstawowym celem artykułu jest przedstawienie zależności statystycznych dotyczących oddziaływania poszczególnych determinant na orientację przedsiębiorczą akademickich przedsiębiorstw spin off. W pierwszej części przedstawiono istotę uczelnianych firm spin off oraz zaprezentowano najważniejsze elementy orientacji przedsiębiorczej przedsiębiorstw. W drugiej części empirycznej dokonano analizy wyników badań dotyczących zależności statystycznych orientacji przedsiębiorczej uczelnianych firm. Badania zostały przeprowadzone wśród 141 akademickich podmiotów funkcjonujących w Polsce. Do ustalenia związków korelacyjnych wykorzystano test niezależności oraz dla istotnie statystycznych korelacji wskaźnik V-Cramera.

Słowa kluczowe: przedsiębiorczość, akademickie przedsiębiorstwa spin off, komercjalizacja, innowacyjność.

JEL: L21, L26, L29

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1. Introduction

Contemporary literature defines entrepreneurial orientation as the organization's ability to actively search for and seize business opportunities. In line with this approach, entrepreneurial orientation becomes a determinant for market operators to undertake and perform the entrepreneurial function (Covin & Lumpkin, 2011). The performance of this function is particularly important for academic spin-off companies (Visintin & Pittino, 2014). They are highly innovative and rely on modern technology in their activities. Thus, the performance of the entrepreneurial function by academic spin-offs is based primarily on building and strengthening a sustainable competitive advantage, spotting and grasping market opportunities including opportunities for commercialisation of research and development results, operating in conditions of uncertainty, consciously taking risks, and building lasting relations with external and internal stakeholders of the home university (Rasmussen & Wright, 2015). These characteristics are particularly significant for building an innovative economy and strengthening the scientific and research potential of the Polish science.

Entrepreneurial orientation of academic spin-offs is shaped by a number of determinants that, according to my understanding, are not fully recognised in the Polish literature. Hence, the further part of the article will present statistical correlations of entrepreneurial orientation of academic spin-offs operating in Poland, on the basis of considerations in related literature and results of my empirical research.

2. Entrepreneurial Orientation

In academic discourse, entrepreneurial orientation determines whether economic operators undertake activities involving the creation of innovation, propensity to take risks, the shaping of market proactiveness, the maintenance of autonomy, and the strengthening of their competitiveness (Anderson, Kreiser, Kuratko, Hornsby, & Eshima, 2015). Ergo, entrepreneurial orientation is a kind of guide for companies (Dyduch, 2008) that is reflected in strategic processes aimed at creating and implementing innovations (Bratnicki & Dyduch, 2016).

Individual elements of entrepreneurial orientation are characteristic, in particular, of academic spin-off companies, whose main task is to bring academic knowledge, technology and R&D to the market. At this point, it should be noted that literature provides no clear definition of academic spin-offs. Accordingly, for the purposes of this article, a definition was adopted whereby an academic spin-off essentially involves company owners (i.e. academics) undertaking to create and use innovative solutions that were developed at the university (Korpysa, 2016).

When analysing individual dimensions of entrepreneurial orientation, it should be stated that innovativeness is associated with Schumpeter's

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creative destruction (van Doorn, Heyden, & Volberda, 2017). It refers to the ability of an entrepreneurial individual to develop new innovative ideas that are materialised thanks to the use of the so-called Kirzner element by the entrepreneur. Under this approach, creative destruction is associated with the organisation's creative strategy that is reflected in the deliberate combination of abstraction with technological innovation (Dyduch, 2018). Bearing in mind the above attributes, it should be stated that, for academic spin-offs, innovativeness determines the need to build and consolidate an innovation culture that enables commercialisation of innovative solutions produced as part of research and development (R&D) at a research centre (Diánez-González, del Carmen Camelo-Ordaz, & Ruiz-Navarro, 2016).

Proactiveness is another important dimension of entrepreneurial orientation. It allows a company to offer products and services that fill a supply gap in a faster manner than other competitors (Wales, 2016). From this perspective, proactiveness is a crucial pillar of entrepreneurial orientation of academic spin-offs. This is mainly because the entrepreneur-researcher should confirm that commercialisation of the results of academic R&D is legitimate (Rasmussen & Wright, 2015). In this respect, it should be borne in mind that due to the volatility and turbulence of the environment, research results oftentimes do not provide the researcher with a clear basis for bringing them to the market. Therefore, in the context of changing needs on the market, the need to verify the obtained results is evident (Walter, Auer, & Ritter, 2006).

The next element of entrepreneurial orientation is the propensity to take risks (Hartsfield, Johansen, & Knight, 2017). In the deliberations, it should be stated that the entrepreneur-researcher also takes personal risk within the process of commercialisation of R&D results, in addition to financial risk. It is worth highlighting that every researcher-entrepreneur working both at a university and at his or her own company takes less financial risk than other entrepreneurs who do not work elsewhere than at their own companies. This is due to the fact that researchers are guaranteed a monthly pay, which may contribute to their being more inclined to take risks associated with the implementation of an innovative project than other competitors. On the other hand, work at a university may condition a lesser propensity to take risks since researchers may not be able to fully engage in their business activity due to numerous teaching and research responsibilities (Walter, Auer, & Ritter, 2006). Furthermore, the risk associated with the development and implementation of new solutions, which is an inherent element of the innovation process, should also be taken into account.

An important component of entrepreneurial orientation is also competitive aggressiveness. It is reflected in companies undertaking activities aimed at improving their market position as compared to their competitors. This is possible, among others, through mechanisms strengthening coopetition with competitors or mechanisms supporting strong competitive aggressiveness

(Jiang, Liu, Fey, & Jiang, 2018). It should be emphasised here that the signs of coopetition among academic spin-offs are exhibited, inter alia, by companies operating in clusters, science and technology parks, business incubators. Thanks to this, academic spin-offs may, together with other operators, carry out R&D activities for the creation and development of innovation (Gorynia & Kasprzyk, 2014). In addition, coopetition can be manifested as strategic alliances between a university and an academic spin-off company, allowing entrepreneurs to share knowledge and acquire new know-know (Hess & Rothaermel, 2011).

The second type of competitive aggressiveness, namely the use of mechanisms supporting competitive aggressiveness, is associated with the application of a strategy targeted, among others, at the achievement of quality, quantity or cost leadership by the company (Jiang et al., 2018).

The last dimension of entrepreneurial orientation is autonomy understood as the ability to independently search for and seize market opportunities. Taking into account academic spin-offs, it should be stated that independent decision-making in the context of business relationships can be shaped by the company's relations with the university, i.e. the home institution (Miranda, Chamorro, & Rubio, 2018). When the university, among others, rents research infrastructure to a spin-off company, grants its licenses, commits university financial and tangible assets to the company's activity, permits researchers to work for the company, then the home institution can influence business decision-making by the spin-off. Consequently, by involving the university in its activity, an academic spin-off may become a less autonomous market operator.

Summing up, it should be noted that the individual dimensions of entrepreneurial orientation merge and overlap, thereby determining the economic performance, innovativeness, and the degree of internationalisation of academic spin-offs (Covin & Miller, 2014). Numerous research findings do not provide consistent results that could form the basis for specifying the impact of particular pillars of entrepreneurial orientation on the activities of academic spin-offs. At this point, it should be borne in mind that some research results show that all dimensions of entrepreneurial orientation, i.e. autonomy, innovativeness, proactiveness, risk-taking and competitive aggressiveness, have a positive effect on the entrepreneurial construct of the organisation (Kwiotkowska, 2017; Walter, Auer, & Ritter, 2006; Tietz, 2013). Other findings, on the other hand, emphasise that only innovativeness, proactiveness and autonomy have a positive influence on the entrepreneurial construct, whereas competitive aggressiveness and risk-taking have a negative or no impact on entrepreneurial orientation of spin-off companies (O'Shea, Allen, Chevalier, & Roche, 2005; Hayter, 2016). In view of the above attributes, it is reasonable to present the results of research on statistical correlations of entrepreneurial orientation of Polish academic spin-offs in the further part of this article.

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3. Statistical Correlations – Research Results

Given the examined population, the adopted empirical research approach used induction of incomplete enumeration aimed at formulating certain laws and conclusions based on the observation of a specific phenomenon occurring in a context that is defined by a time and space dimension. Thus, in order to investigate causal relationships present in spin-off companies, it was decided to use primarily the nomothetic approach. Among research procedures and methods relevant to the analysed approach, a CAWI survey was chosen. This technique was applied because the CAWI method is a good tool in the analysis of a niche of a research area. In Poland such an area undoubtedly is the operation of academic spin-offs. This tool allows a precise definition of examined characteristics and attributes and efficient collection of data by ensuring that respondents feel anonymous and can participate in the interview at a convenient time.

Statistical correlations of entrepreneurial orientation of academic spin-offs in Poland were studied at the end of 2017. The survey used an online questionnaire developed by me that consisted of 23 substantive questions, questions about respondents' particulars and diagnostic questions. The questionnaire covered closed-ended, semi-open, conjunctive and disjunctive questions. At this point, it should be borne in mind that due to the lack of available data on spin-off companies operating on the market in public registers, e.g. the Polish Central Statistical Office, the Social Insurance Institution, Marshal's, voivodship or municipal offices, an important role in determining the nature of examined companies was played by diagnostic questions. These questions were developed on the basis of the adopted definition of an academic spin-off that was presented in the theoretical part.

Since business registers lack data about the number of Polish academic spin-offs, it was decided to use in the research process the database of companies that was compiled during the implementation of the research project entitled: "Individual entrepreneurship of academic spin-off companies". 809 business owners who were researchers were sent an electronic questionnaire with a request to complete it. 154 questionnaires were received, yet 13 of them were rejected in the qualification procedure. The reason for the rejection was, first and foremost, an incomplete questionnaire.

Based on the collected primary data, the empirical material was analysed. The computer method was applied to calculate and interpret the results. To this end, spreadsheets were designed that were used to enter appropriately coded responses. In order to establish correlations between variables determining entrepreneurial orientation of the surveyed companies, Cramér's V tests of independence were used. According to the assumptions, it was presumed that the closer Cramér's V coefficient was to zero, the weaker the correlation was between the examined characteristics, and the closer it was

to 1, the stronger the correlation. Given a large number of variables, the data were grouped according to statical relationships that could be important for verification of the established research hypotheses. Thereby, significant and insignificant dependences were identified. The whole calculation was performed by means of the Statistica software package.

Taking into consideration the adopted research concept and the main objective of the study, individual subsets were distinguished with account being taken of specific characteristics of companies making up those subsets. Thus, it should be stated that the majority of the owners of academic companies were men (67%), with women constituting 33% of the total population surveyed. In addition, respondents were of different ages. Entrepreneurs between 31 and 45 years of age formed the largest group (62%), and owners under 30 were the fewest (12%).

As regards the academic degree of the surveyed entrepreneurs, it should be noted that two thirds of respondents had a PhD degree (67%), 14% – a master's degree, 15% – a postdoctoral degree, and 4% – a professor's degree. It is also worth mentioning that the vast majority of respondents specialised in technical (52%), economic (21%) and medical (13%) sciences.

Items	Percentage of responses	p	Cramér's V
economic situation	64.06%	0.000000	0.63628
legal regulations (including patent procedures, copyright)	60.57%	0.000000	0.42753
tax system		0.000000	0.46990
degree of competition in the sector	80.45%	0.000000	0.65617
access to infrastructure	61.54%	0.000000	0.56992
science, technology and industrial parks	63.41%	0.000000	0.20044
technology transfer centres	62.96%	0.000253	0.16703
clusters	58.41%	0.010847	0.10575
academic business incubators	58.56%	0.042808	0.08826
science and research centres, universities	57.56%	0.000143	0.14795
venture and loan funds, business angels	69.80%	0.000000	0.25531
banks	53.47%	0.004523	0.11553
Polish Agency for Enterprise Development, National Science Centre, National Centre for Research and Development	64.81%	0.000000	0.20226

Tab. 1. Determinants of innovativeness of academic spin-offs. Source: Prepared by the author on the basis of the survey.

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When assessing statistical dependences in the field of entrepreneurial orientation of academic companies, correlations were first analysed between the innovative activity of companies and individual factors influencing the creation of innovation. In this respect, the structure of responses for the companies that acknowledged having created and implemented innovations in the previous two years (102 companies) was adopted to study the correlations. For each defined determinant, respondents stated its significance in the innovation process. Thereby, significant and very significant factors were adopted to examine the correlation. These factors were diagnosed using the Likert scale (where 1 meant "I strongly disagree with the statement" and 7 "I strongly agree with the statement").

According to the data presented in Table 1, a strong correlation between the distinguished determinants and the creation of innovation by companies exists in the context of the degree of competition in the sector (Cramér's V coefficient of above 0.6). In this regard, more than 80% of companies creating innovations pointed to this factor as a significant determinant. In addition, there is a strong relationship between the economic situation perceived as a significant stimulant of the innovative activity of spin-offs and the creation of innovation. In this case, more than 60% of companies creating innovations regarded this determinant as a key factor. In the course of further verification, it was found that there is a moderate correlation between the creation of innovation and access to university research infrastructure, legal regulations and the tax system (Cramér's V coefficients in the range of 0.4–0.6). Moreover, it is worth noting that companies that created innovations indicated that cooperation with science and technology parks, technology transfer centres, clusters, academic business incubators and science and research centres determined the development of new solutions. In addition, the calculated test of independence ($p < 0.05$) and Cramér's V contingency coefficient confirmed a correlation between the creation of innovation and the impact of R&D institutions on this process. Simultaneously, in the case of cooperation with science, technology and industrial parks, it was found that there is moderate correlation (Cramér's V coefficients of above 0.2). For other statistically significant relationships, a weak relationship was observed since Cramér's V coefficient was below 0.2 in all cases.

While verifying the dependences between innovative activity of spin-offs and the impact of selected market institutions on this process, the correlation for state organisations (Polish Agency for Enterprise Development, National Science Centre, National Centre for Research and Development) was examined. The test of independence ($p < 0.05$) and calculated Cramér's V coefficient showed a moderate relationship.

As concerns the impact of cooperation of academic spin-offs with financial institutions on the creation of innovation, it can be concluded that there are significant correlations. Calculated Cramér's V coefficient

indicated a moderate correlation in the case of cooperation with venture and loan funds and business angels. Thus, almost 70% of companies creating innovations pointed out that cooperation with those organisations determined the creation of innovations. In the case of cooperation with banks, a weak statistical dependence was established. As regards other variables studied, no link was demonstrated.

Another examined aspect of entrepreneurial orientation was proactiveness of academic spin-offs. In the conducted analysis, proactiveness was treated as taking actions allowing entrepreneurs to predict changes and market trends and offer products and services on the market in advance. Thus, the inference was made among those companies that declared that they constantly monitored market trends to offer their product or service to the market (99 companies).

Bearing in mind the above correlation, at the first stage of the assessment of proactiveness, it was decided to analyse variables affecting whether spin-offs did research on customer needs, analysed competitors and assessed their own technological potential. As in the case of the examination of factors related to the creation of innovations, those companies were distinguished that declared that they did research on customer needs, analysed competitors and assessed their own technological potential (112 companies). The particular determinants of proactiveness were defined using a seven-point Likert scale (where 1 meant "I strongly disagree with the statement" and 7 "I strongly agreed with the statement").

In the course of statistical inference, it was established that the company's age and dominant field of science in its activity determine proactiveness of academic spin-offs. This is confirmed by the calculated test of independence ($p < 0.05$), which showed a correlation between variables, and calculated Cramér's V coefficient, which demonstrated a moderate relationship (Cramér's V coefficients in the range of 0.4–0.6).

Company's age	**Customer research**	**Competition research**	**Technological audit**
	Cr V = 0.46804, p = 0.000000	**Cr V = 0.43956, p = 0.000000**	**Cr V = 0.43076, p = 0.000000**
1 year	65.08%	61.11%	25.08%
2 years	65.31%	65.31%	20.53%
3 years	55.93%	63.70%	20.37%
4 years	47.06%	54.12%	18.82%
5 years and more	31.03%	46.22%	6.18%

Tab. 2. Proactiveness and the company's age. Source: Prepared by the author on the basis of the survey.

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When assessing the structure of responses, it can be concluded that the older the academic company, the weaker the inclination to engage in activities that aim to identify new business opportunities. Thus, the percentage of companies conducting technological audit, research on customer needs, assessment of competitors decreases. At the same time, it should be added that the highest percentage of companies looking for business opportunities was among companies operating on the market for up to two years, while the smallest share was among those operating for a minimum of 5 years.

Analysing the dominant field of science in the company's activity, it should be stated that research on market needs, assessment of competitors and assessment of its own technological potential were most often undertaken by companies engaged in technical, medical and pharmaceutical sciences. Companies engaged in humanities did so least frequently. These relationships were confirmed by the test of independence ($p < 0.05$), which indicated a correlation between the studied variables, as well as by Cramér's V coefficient showing a moderate relationship (Cramér's V coefficients in the range of 0.2–0.4).

Another significant dimension of entrepreneurship of academic companies was their propensity to take risks. The diagnosis of correlations among the particular variables was based on the structure of responses according to the indication by respondents of the propensity to take risks as an important determinant of innovation creation in the surveyed spin-offs (120 companies). As in the case of innovation and proactiveness, a seven-point Likert scale was used to identify the determinants of propensity to take risks.

In the course of the analysis, it was found that companies that use their own resources to create innovations are more willing to take risks than those that use external sources. Given the obtained data, it should be stated that almost 90% of respondents base their innovative process on their own resources. As regards companies using external resources, the percentage of responses is much smaller and stands at over 10%. Therefore, it can be concluded that academic spin-offs that use their own resources to create innovative solutions may be far more inclined to take risks than companies using external sources. This relationship is confirmed by the calculated test of independence ($p < 0.05$) and Cramér's V coefficient of a value close to that showing a moderate correlation.

An important aspect of the study of entrepreneurial orientation of academic spin-offs was assessing the impact of autonomy of the surveyed companies on the shaping of entrepreneurial activity. At this point, it should be borne in mind that autonomy was examined as a company's ability to function independently, which is reflected in the lack of capital links between the company and other market operators. In order to establish the autonomy of the surveyed companies, respondents' declarations regarding the answer to the question about independence of spin-offs were used. To

diagnose the main determinants of autonomy among companies that defined their operations as independent of other market operators (118 companies), a seven-point Likert scale was used again.

Table 3 presents statistically significant relationships between autonomy of academic spin-offs and their individual entrepreneurial activities.

	Percentage of responses	**p**	**Cramér's V**
Employees' participation in training	66.76%	0.02943	0.20317
Company's participation in scientific and research projects	37.21%	0.00000	0.29535
Research on customer needs	54.13%	0.00005	0.29924
Competition research	50.13%	0.00005	0.26696
Technological audit	9.95%	0.00003	0.24857
Creation of innovations	47.67%	0.00423	0.22034
Propensity to create innovations	57.11%	0.01008	0.24173

Tab. 3. Companies' autonomy and entrepreneurial activities. Source: Prepared by the author on the basis of the survey.

As shown by the data, autonomy of spin-offs may determine employees' participation in training and courses. Furthermore, it can also influence the conduct of research on customer needs, competition analysis and assessment of technological potential. It should also be emphasised that autonomy may affect the creation of innovations and shape the propensity of academic spin-offs to develop new products and services. In the case of all the variables analysed above, the chi-square test of independence revealed statistically significant relationships since $p<0.05$. Subsequently calculated Cramér's V coefficient specifying the strength of a relationship between autonomy and individual variables indicated moderate correlations.

In examining the particular entrepreneurial activities of the surveyed companies, it should be stated that employees participated in training in more than half (66.76%) of companies independent of other market operators. Moreover, most of these companies were inclined to create innovations (57.11%) and conducted research on customer needs (54.13%) and the operations of competitors (50.13%). It is worth adding here that academic spin-offs that were dependent on the home institution participated in research projects (10.21%), were inclined to create innovations (23.14%), did research on customer needs (18.32%) or competitors (21.98%) to a lesser extent than independent ones.

Another important element of entrepreneurial orientation was competitive aggressiveness. In order to identify companies that displayed competitive

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aggressiveness, the results of respondents' answers to the question regarding quality leadership were used. The question was based on: product quality, flexible adaptation of the offer to customer needs, and product innovation. In the case of companies that exhibited quality leadership (111 companies), respondents were asked to specify the significance of individual determinants of competitive aggressiveness on a seven-point Likert scale.

On the basis of statistical inference, it was found that there are dependences between factors determining competitive aggressiveness of academic spin-offs and the following variables: the company's age and dominant field of science in its activity.

	Innovativeness	**Product quality**	**Flexible adaptation of the offer to customers**
Company's age (in years)	**p = 0.00000 Cr V = 0.26424**	**p = 0.00000 Cr V = 0.21081**	**p = 0.00000 Cr V = 0.26581**
1	35.71%	76.98%	73.81%
2	57.14%	77.56%	77.56%
3	70.74%	78.89%	79.63%
4	75.30%	81.94%	82.35%
5 and more	76.82%	82.38%	82.38%
dominant field of science	**p = 0.00000 Cr V = 0.27583**	**p = 0.00000 Cr V = 0.32785**	**p = 0.00000 Cr V = 0.25173**
biological sciences	31.70%	65.86%	58.54%
chemical sciences	73.68%	100.00%	89.47%
economic sciences	47.09%	69.84%	79.36%
technical sciences	58.16%	82.15%	87.69%
medical and pharmaceutical sciences	31.86%	79.12%	65.94%
agricultural sciences	23.81%	73.81%	66.66%

Tab. 4. Competitive aggressiveness of academic spin-offs. Source: Prepared by the author on the basis of the survey.

When assessing the obtained results, it should be noted that as academic micro-companies operate longer, the importance of product quality, flexible adaptation of the offer to customer needs and innovativeness may increase. In addition, according to the test of independence, there is a moderate correlation between the company's age and individual factors of competitive advantage.

Taking into account the dominant field of science in their activity, it should be stated that all the determinants of quality leadership are significant for the majority of companies active in technical, chemical and economic sciences. For companies active in biological, medical, pharmaceutical and agricultural sciences, the most significant determinants of competitiveness include: product quality and flexible adaptation to customer needs. In the case of all variables determining competitiveness, the chi-square test of independence showed statistically significant relationships. At the same time, as follows from the statistical inference and calculated Cramér's V coefficient, the dominant field of science in the company's activity is the strongest factor affecting determinants of competitiveness in all cases.

4. Conclusion

Summing up, statistical inference reveals that the issues discussed may be important for the commercialisation of academic knowledge and technologies. In the course of the inference, it was found that all elements of entrepreneurial orientation affect the entrepreneurial construct of the organisation. Thus, it has been diagnosed that innovative processes of academic spin-offs may be most strongly determined by the degree of competition in the sector, the economic situation, the tax system and access to economic infrastructure. R&D entities and financial institutions may influence these processes to a lesser extent. Furthermore, it has been demonstrated that proactiveness and competitive aggressiveness of the surveyed companies may be most affected by the company's age and dominant field of science in its activity. It has also been diagnosed that the company's autonomy may be conditioned by innovation creation, research on competitors, research on customer needs, and participation in scientific and research projects. In addition, it has been found that the propensity to take risks may depend on the company's own resources that can be used in operations.

In the context of this discussion, it should also be stated that entrepreneurial orientation is shaped by a number of exogenous and endogenous factors. In this respect, it has been diagnosed that it is endogenous factors that primarily shape orientation of the surveyed companies. Thus, the owners of academic spin-offs may be expected to exploit endogenous factors to a greater extent than external factors in the future decision-making process and actions, which may contribute to strengthened competitiveness of the academic companies sector in Poland and faster transition of the Polish economy to economy 4.0.

Taking into account the above results, it should be stated that although the objective of the study has been attained, the issues concerned certainly have not been exhausted. In this respect, however, it is important to emphasise significant limitations of the research ensuing from a small sample and an

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assessment of only opinions of company owners. The research certainly needs to be continued to include broader quantitative analyses of a larger sample. In spite of this imperfection, the most important statistic correlations of entrepreneurial orientation of academic spin-offs have been identified and these may be helpful in the establishment and development of academic spin-offs in Poland.

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