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**SCIENCE AND BUSINESS COOPERATION.
BARRIERS IN POLAND WITHIN
THE CONTEXT OF SELECTED EUROPEAN
AND NORTH AMERICAN COUNTRIES**



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SCIENCE AND BUSINESS COOPERATION. BARRIERS IN POLAND WITHIN THE CONTEXT OF SELECTED EUROPEAN AND NORTH AMERICAN COUNTRIES

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Summary

This article focuses on the theoretical and empirical analysis of factors affecting the cooperation between science and business. The author will present the results of empirical research conducted in Poland, the Czech Republic, Hungary, France, Norway, the United States of America and Canada. The analysis will indicate how and which factors: structural, systemic, competence or awareness and cultural can be utilised in the commercialisation of knowledge and technologies. The analysis of research outcomes which underpins this study is also set on the following assumptions:

- Every country has different barriers to cooperation between scientists and entrepreneurs;
- Polish scientists and entrepreneurs should rely on proven and significant factors conducive to cooperation between science and business in Poland;
- Academic centres in Poland can benefit from the experience gained by other countries to intensify its model of cooperation with entrepreneurs.

The article will showcase the research results that relate to the identification of selected problems occurring in establishing and maintaining cooperation between Polish scientific research organisations and entrepreneurs in the context of selected countries whose respondents were subject to empirical research.

Keywords: business cooperation, cooperation between science and business, knowledge, marketing, transfer of knowledge and research results, transfer of technology

Cooperation between science and business

— Theoretical aspects

Cooperation between industry and universities results from the need to transfer knowledge and technologies that continue to develop during the commercialisation process of goods and services. The creation of a partnership creates added value both for the enterprise as well as the higher education institution¹. Cooperation between science and business is based, according to Chen and Ye², on the management of relationships between industry and academia and technological initiative. The management of relationships means the handling of agreements and contracts, industry-science consortia, and the transfer of knowledge and technologies. Technological initiatives should be viewed from the point of view of business or science. In the case of business, the activities initiating technological cooperation include undertaking tasks aimed at encouraging innovation and competitiveness of enterprises based on the results of scientific and research works. They can achieve a high standard of their research work by joining their own technological resources and those of scientific research centres. On the other hand, the technological initiative of science (scientific research centres) has its roots in the third generation of scientific research centres. Wissema³, analysing universities referred to as Third Generation, points out that if university centres want to conduct cutting-edge research, they have to reach out for the financial resources of businesses. Globalisation is also an important driving force of cooperation between science and business. The increased mobility of students and researchers means an enhanced global competition for top performers. Hence, cooperation between enterprises and scientific research centres translates into competitiveness of companies and research centres which, competing to attract the best students, have to guarantee access to practical knowledge and the best employers.

Analysing the possibilities of cooperation, explicit reference should be made to the transaction costs of creating the organisation's resources⁴. These are significant when it comes to the transfer of knowledge and technologies that are difficult to value or the results of which are unknown. The conduct of own research projects within an enterprise cuts transaction costs, particularly when a business has access to a highly qualified, young and freshly graduated personnel or employees with extensive experience on the

market. However, cooperation provides access to external expertise. Every scientific research organisation possesses unique intellectual resources or such that can contribute to a unique outcome of R&D work within the framework of collaboration between businesses and scientific education providers. Davies⁵ also argues that the right environment comprised of friendly cooperation between science and business as well as a suitable regional policy covering innovation policies all play an important role in the partnership between science and business. They can contribute greatly to innovation and collaboration between businesses and scientific research centres, reducing the transaction costs for industry mentioned earlier.

The initiative of a scientific research centre aimed at establishing cooperation and concluding a contract generates a "push" strategy — pushing the offer and research results towards the market. Firms, on the other hand, by soliciting scientific partners, employ the "pull" strategy. They "pull" laboratory research results and increase the importance of conducted research⁶. An overview of the research results and legislation related to science and business indicates that firms with average research and development resources are the best partners with which to cooperate⁷. Medium-sized enterprises usually possess the competencies to collaborate with scientific research centres. They also have the financial, market, structural, human, intellectual and social resources⁸ to commission research and implement the results of studies within the firms. Furthermore, the mentioned resources are often insufficient to independently conduct scientific research and implementation works. The legislation in some countries also clearly prefers small and medium enterprises in terms of the cooperation between business and science. One example of this is the US University and Small Business Patent Procedures Act (a.k.a. Bayh-Dole Act), which gives preference to small and medium enterprises in the sale of research results or the granting of licences⁹ by universities. A European country that has implemented extensive changes to facilitate the interaction between universities and industry is Sweden. Its legislation introduced the professor privilege in 1949. Despite the many changes that occurred within the professor privilege, it is considered (similarly to Italy and Great Britain) as an effective instrument supporting cooperation between firms and scientific research centres¹⁰.

Collaboration between business and science also comprises academic entrepreneurship. The incorporation of companies by research and academic staff and students, which are based on knowledge and research outcomes obtained from scientific research centres is an important element of cooperation between universities and small and medium enterprises alike. The mission of establishing university spin-off companies has been aptly described by American professors taking part in Searle studies as the dissemination of research results through academic entrepreneurship, which should be a priority activity for researchers¹¹.

Factors influencing the development of the business-science relationship in scientific literature

Franco and Haase¹², in their considerations on the determinants of cooperation between scientists and the community, indicated two main factors underpinning the forging of a relationship: the motivation of scientists and the interaction channels with the market. Among the factors motivating researchers to collaborate with industry they mentioned: reputation and raising the status of scientists, practical application of research results, acquisition of funding sources and the possibility of publishing research results. Interactive elements included: taking advantage of access channels to the technology market, expert evaluation of research results, access for students to employers and to channels promoting and furthering science, such as seminars and conferences. The factors influencing the development of the science-business relationship will be viewed from the point of view of a scientific research centre and an entrepreneur. Ankrah and Tabbaa¹³ have indicated, based on their analyses, that scientific research centres are clearly creating themselves in cooperation with firms through supply factors and creating businesses through demand factors. The former includes the strategic policy of institutions, increased chances of student employability, access to sources of scientific research funding and an additional source of income for scientists, the use of industrial property by a business, increasing the level of new knowledge in the organisation, the discovery of new theories and their verification when applied in industry, higher citation rates in

scientific publications, public opinion pressure, promotion of innovation, participation in a national and regional innovation strategy and the rendering of services to businesses. The second group of factors inherent to relationships that entrepreneurs are guided by include: Cost reductions, lowering business activity risks, financial benefits derived from placing new products on the market or the commercialisation of knowledge and technologies originating from universities, improved competencies and strengthening of company competitiveness, greater technological capacity, the development of human resources, solving specific problems, as well as access to knowledge and laboratories. Some of the aforementioned factors contributing to this relationship are completely divergent and can be assessed in the words of Dubinskas "When addressing the challenges of the market, realistic entrepreneurs have to deal with dreamers, who try to transform their non-aligned ideas with economic reality into the future capital of companies"¹⁴. An entrepreneur is responsible for managing the company and, contrary to scientists, bears the direct consequences of incorrect theories or unsuccessful implementations. The development of knowledge, new technologies, and new applications is often in contradiction with the pressure exerted on entrepreneurs to generate good, short-term financial results. A factor motivating scientists to enter into collaboration with entrepreneurs is the creation of knowledge and technological solutions which are new, enabling extensive, in-depth knowledge to be gained about the world, driving the further improvement of the world. The main motivating factor for entrepreneurs to cooperate with scientists is the economic value of new solutions or knowledge gained¹⁵.

Muscio and Nardone¹⁶ indicated that the type of collaboration and level of cooperation between the scientific research centre and the firm depends on the size of the company. Large companies are more focused within their cooperation on acquiring human resources and the purchase of results of completed research. Although the intensity of collaboration in the R&D area may depend on the degree of involvement in own R&D, small firms prefer joint projects but with specified sources of funding. Many authors¹⁷ have demonstrated that start-ups are particularly open to cooperation with the academic world. New, small companies possess highly significant features for cooperation: they are flexible, creative, quickly recognising market opportunities and are fast to react to any changes on the market. They also lack

the internal resources to develop new products, nor do they have experienced personnel, experience on the market, marketing skills, social capital, technological equipment or the funds required to develop new technologies. This predisposes them to engage in strategies of establishing strategic alliances, one of the entities of which can be a scientific research centre.

Gallego et al. also pointed to the intensity of activity in the R&D area as the determinant of cooperation.¹⁸ They added that, based on their own research, enterprises more willingly cooperate with scientific research centres if the research receives public funding. This gives rise to a certain inefficiency in the deployment of public funding, particularly when the burden of the funding could be taken on by the enterprise. Companies also clearly show increased activity in the area of science when collaborating with scientific research centres, where the process of commercialisation of new solutions is difficult¹⁹ since it is dependent on highly qualified experts that usually build their intellectual potential over several decades. Such areas include experimental science, applied sciences and engineering²⁰. An example of this are the literature studies of Kato and Adagiri²¹, which point to the significant role of joint research conducted by science and industry in the biotechnology sector in Japan. The cooperation of scientific research centres is naturally more effective for entrepreneurs in the early phases of the technology creation process. As Bravo and Rosende²² pointed out, breakthrough solutions developed in scientific research centres or the outcomes of science and business partnerships are then transformed into innovative products in the firms themselves. Whereas research conducted by academics at the Masaryk University in Brno has shown yet another characteristic feature that confirms that the economy sector not only has an impact on the intensity of the partnership but also on the maximisation of the benefits stemming from such cooperation. According to the studies of Odehnalova and Pirožek²³, the most significant maximisation of benefits resulting from the collaboration between universities and industry occurs in the production sector.

An important factor impeding or supporting collaboration with scientific research centres is the market gap in research results. In the case of cooperation between the world of science and business, it is possible to talk of interactions existing between individual persons and organisations that function in systems that are often very different from each other in terms of their identity, mission and objectives. The market gap in terms of

research results was identified by Hellman²⁴, who referred to them as the "science to market gap." Scientists are often unaware of the different applications of their research findings. Entrepreneurs, on the other hand, often do not know how scientific research conducted in research centres can assist them in their market activity. The science to market gap should be handled by assistance centres.

Cooperation between science and business — methodology and selected empirical research results

Methodology of empirical research

Cooperation between science and business is a topic that has interested many scientists. Some academics study the barriers in cooperation²⁵, while others the effectiveness of the collaboration²⁶. The empirical research conducted from April 2012 to October 2014 by a team supervised by the author of this article concerned models for cooperation between science and business in the process of transferring science. Interviews with the representatives of higher education institutions and enterprises collaborating with universities were conducted within the research project in the following countries: Poland, USA, Canada, Norway, France, Hungary and the Czech Republic. This was accompanied by an on-line questionnaire survey addressed to scientists and entrepreneurs from the above-listed countries. The aim of the empirical research was to analyse the forms of the science-business relationship preferred by universities and enterprises, the identification of bottlenecks, science and business cooperation barriers in the area of research, and the development of recommendations for changes that are necessary at universities with respect to the forging of good relations with enterprises and building a third generation university. A total of 20 higher education establishments took part in non-standard interviews in the first stage of the research. The second stage included 20 interviews conducted at universities in two developed European countries (Norway and France), countries in Europe at a similar stage of knowledge transfer development as Poland (Czech Republic and Hungary), as well as the USA and Canada. A survey based on a questionnaire was also sent out to 12,000

respondents from Poland, four European states, USA and Canada during the period from October 2012 to August 2014. The expert interview method was also employed in the form of a panel of experts from the science and business fields (a meeting of Polish market experts conducted in the form of a seminar) in order to perform a preliminary assessment of the research results. Panels of experts were held in September 2014. Random and purposeful sampling was used at the first and second stage, respectively.

An incomplete and unrepresentative sampling frame was built in the third stage according to systematic purposeful and random sampling. Random sampling was used when lists of research staff from the studied universities or enterprises were used. Then, selected entities in the study took part in an empirical study. The returnability of the on-line questionnaire was 5.54%. Analysing the sectorial coverage, the following areas were selected: biotechnology, information technologies, energy and the environment, chemistry, food technology, and new technologies. Within the sectorial selection of enterprises, the experience of the firm in cooperating with research centres and innovation development support centres played the key role. Statistical outputs were used in the empirical analysis with a confidence limit of less than or equal to 0.05.

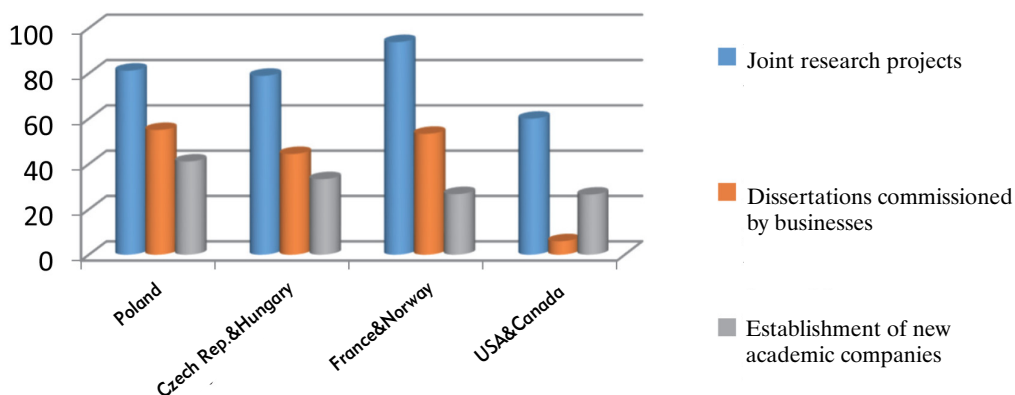
Barriers to cooperation between business and science — empirical analysis

An empirical analysis of the barriers to relationships between business and science will be based on three statistically significant forms of collaboration that were preferred by the respondents. The study sample of respondents from seven countries identified three key areas of cooperation: joint research projects, dissertations requested by businesses and the creation of new academic companies. The fact that joint research projects are the most preferred form of cooperation in all the studied countries remains undisputed. Nine out of ten respondents in France and Norway chose the performance of joint research projects as the preferred form of cooperation between business and research. The lowest percentage of respondents with a preference for cooperation between the science and business sectors was in Canada and USA. However, almost three out of five respondents mentioned joint projects among the forms of collaboration between researchers and

firms (Fig. 1). The second form of cooperation that was important to scientists and entrepreneurs in Poland, the Czech Republic, Hungary, Norway and France were dissertations commissioned by businesses. This form of collaboration is almost unnoticeable in Canada and USA. The author thinks that this is down to the differences in the systems of education. The Bologna system of education applies in Europe, especially the European Union, with a three tiered system of higher education, which contributes to the exchange of students and their work placements in industry. In the USA and Canada, the Bayh & Dole Act has visibly affected relations between businesses and research centres. Student dissertations constitute the basis for the establishment of academic companies in which the university also has rights. In both the former and latter cases, copyrights and proprietary copyrights play a very important role. Students treat their dissertations as their intellectual resource which forms the groundwork for the creation of firms or forms a part of the work of entire research teams represented externally by the universities. The formation of academic companies is the third form of cooperation preferred by all the respondents. Two out of five respondents in Poland pointed to this form of collaboration. In the countries represented by the "old" member states as well as USA and Canada, less than half selected this preference. This disproportion may result from the stabilised situation on the spin-off market in developed countries. In countries like Poland, the Czech Republic and Hungary, academic companies are a relatively new entity on the market and this "novelty" in the entity structure of the economy may affect higher preferences.

The first area of analysis that indicates barriers to collaboration between business and research are factors affecting the development of the science-business relationship in an international perspective. Polish respondents are more concerned about the experience of the university in cooperating with enterprises and the business orientation of the higher education establishment. The results of the research conducted by the team headed by the author reveal that entrepreneurs in the studied countries and sectors give particular attention to the presence of incubator centres in the region. The impact of the support institution on the development of collaboration with scientific research institutes is also ranked highly (Fig. 2). More than half of the respondents from Norway, France, USA and Canada stated that technology and business incubators exert a strong influence on cooperation

Figure 1. Preferred forms of cooperation



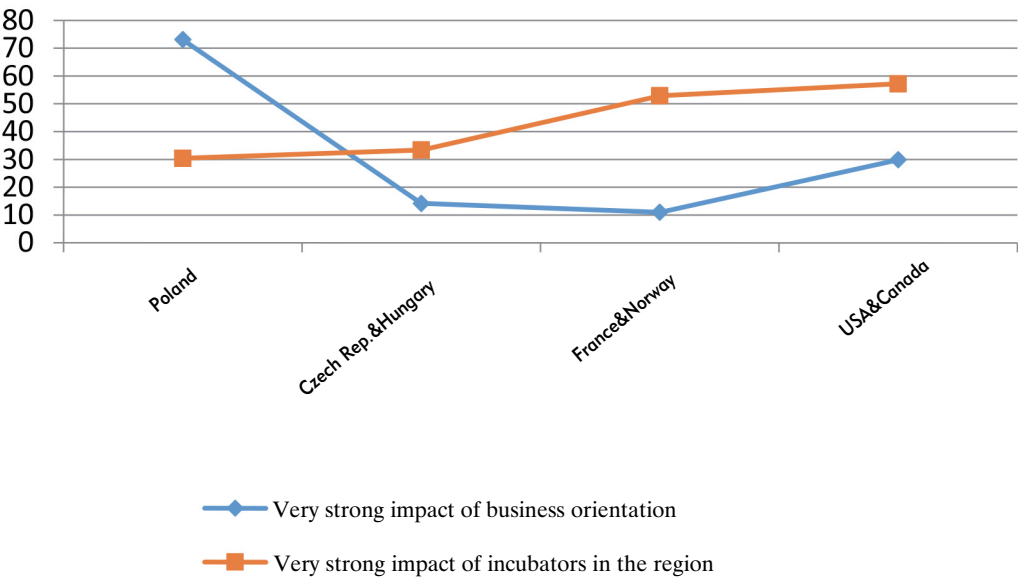
Source: Own study-based data.

between business and science. In Poland, the Czech Republic, and Hungary, every third respondent indicated to the very strong impact of the support institution on the investigated relationship. The features indicated in Figure 2 and the analysis of secondary data²⁷ demonstrates that the late development of technology and business incubators in certain countries is one of the significant barriers to the development of cooperation between researchers and entrepreneurs. Poland, similarly to other countries, has embarked on intensive changes to its unsatisfactory position in the ambit of the creation of supporting institutions at the beginning of the 21st century. Statutory provisions²⁸ concerning intellectual property and the creation of academic business incubators have been implemented in Poland accompanied by EU funding granted for this purpose. The second factor in terms of the creation of barriers or their absence that is statistically significant for the development of good relationships between business and research is the need for a business orientation to be present in scientific research centres. The impact of this factor was mostly visible in Poland. Three out of four respondents pointed to the very strong influence of a business orientation on collaboration within the transfer of knowledge and research results from universities to firms. It is commonly agreed that in the context of an increasing competition on the market, a more market-oriented

approach must be taken in the management of scientific research institutes. Nevertheless, this factor was not highly rated by so many respondents in the remaining study countries. One of the reasons for such significant differences in the responses of the respondents is the fact that research and development (R&D) expenditure is very low in Poland relative to the Gross Domestic Product. Poland has the lowest R&D expenditure compared to the remaining countries, both in terms of public and private expenditure²⁹ analysis.

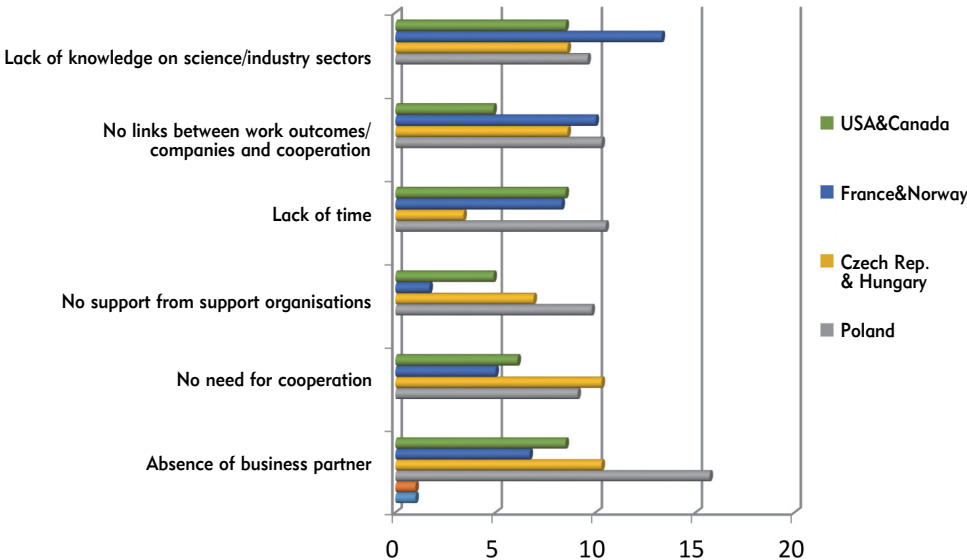
The empirical analysis will be completed by listing the statistically significant barriers to cooperation between research centres and businesses that were specified by respondents from the seven countries represented in the empirical study. The following were among the key barriers: lack of knowledge on science or industry, no links between the work of firms and the collaboration, lack of time for cooperation, no assistance from support organisations, no need for cooperation, absence of a business partner for scientific research centres (Fig. 3). Based on the replies of the respondents, it can be concluded that the following barriers are prevalent in Poland: absence of a business partner, lack of time, no links between the work of the company and the collaboration, no assistance from support organisations. Respondents from the Czech Republic and Hungary mainly pointed to the absence of a business partner and the lack of a need for cooperation as the main obstacles to cooperation between scientific research organisation and businesses. The group of respondents from France and Norway, however, indicated the following as being significant: lack of knowledge about scientific research and industry sectors and the absence of a connection between the results of company work and cooperation. The last study group, respondents from USA and Canada, recognised the following barriers: lack of knowledge about the sectors of science and industry, lack of time and absence of business partners. The absence of a business partner (on the research side) was always the most significant barrier (except in France and Norway). Thus, it can be derived from this that the very powerful effect of the market orientation on cooperation between businesses and science is completely logical. The market orientation of scientific research centres will considerably facilitate finding a business partner for joint research and development work.

Figure 2. Factors influencing the development of the business-science relationship — an international perspective



Source: Own data based on empirical research in 2013–2014.

Figure 3. Main barriers to cooperation between businesses and research centres according to respondent countries of origin



Source: Own data based on empirical research in 2013–2014.

Conclusion

Collaboration between businesses and research centres in the age of R&D products is indicated by many researchers as crucial for generating and implementing innovations in enterprises. Their role differs depending on the size of the company, whether it is a large, medium or small enterprise. A similar statement may be made to market sectors. Wherever the process of transfer of knowledge and technologies is complicated and drawn-out (e.g. the biotechnology and pharmaceutical sectors), cooperation between research centres and businesses is given greater preference. The results of the research team under the leadership of the author of this article also point to a different hierarchy of significant barriers to cooperation between researchers and entrepreneurs. Of the study countries, five out of the seven of them indicated the absence of a business partner as the key impediment to the science and business relationship. The factors stimulating collaboration include the performance of joint research projects, student dissertations commissioned by businesses, establishment of academic companies, regional technology and business incubators as well as the business orientation of scientific research centres. Despite the results of the research presented in this article being fragmented and unrepresentative, they do enable, accompanied by an analysis of literature on the subject, the main obstacles to the transfer of knowledge and technologies from scientific research centres to businesses to be identified. The reference of results gathered in Poland to those obtained in the questionnaire survey and from expert interviews conducted in other countries may be a premise for seeking good practices in order to avoid the problems in cooperation between the research centres and businesses of Polish scientists and entrepreneurs.

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