The Role of Academic Entrepreneurship and Spin-Off Companies in the Process of Technology Transfer and Commercialisation

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Abstract

In developed countries, the academic entrepreneurship makes up a very important element of academic environment activities. For some time, the increase in the role of technology transfer and knowledge commercialisation has been also promoted in Poland. Strong connections between the scholarship and the economy (in the future, within the university of the third generation) have a chance to build an economy based on knowledge in our country. The flow of knowledge and the introduction of new solutions (results of scholarly research) in enterprises take place through the intermediary of various methods of transfer and commercialisation paths. Independent of the manner, each fulfils an important role in the public life and economy. This is confirmed by the experience of the States that are recognised as innovation leaders, and presented in the paper as examples of Polish scholars' academic entrepreneurship.

Keywords: academic entrepreneurship, technology transfer, commercialisation, spin-off companies, technological cooperation.

Introduction

Social and economic transformations in the world economy being under way for a few recent dozen years have caused a change in the development paradigm - in the modern theories of economic growth and development, the so-called innovativeness paradigm gained on importance. Following the increase in the share of knowledge and technological progress in production processes, people started to notice that the rate and quality of economic growth in the economy at the turn of the 20th and 21st centuries are determined by the knowledge and human capital, the creation of entrepreneurship with the use of a skilful transformation of research and development results into commercial solutions and the creation of advantageous institutional conditions for the innovation to occur. This can be found at every level of economy in micro–meso–macro scales.

The experience of developed countries, recognised as the leaders of knowledge-based economy (for instance, the Scandinavian countries, Germany, Great Britain,

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USA, Japan, Singapore and others) confirms that the development of contemporary economy and the increase in its competitiveness require a continuous application of technology, innovations and skills to commercialise scholarly knowledge. The scholarly research (basic, applied and development works), the transfer of technology and the cooperation between the university and the economy have become the basis for their achievements (Łącka, 2011). The essence of these connections is the transfer by scholars of technological and organisational knowledge and practical experience related thereto to entrepreneurs and their implementation by companies, so as to achieve economic benefits. New product processing, organisational and even social solutions facilitate an increase in the productivity of enterprises, an improvement in work efficiency and quality. They also foster the creation of new business entities (for instance, the so-called spin-off companies) new work places, new prospects for human business, the launching of new products into the market, the creation of new streams of demand and new markets, discovering new resources and the application of new methods for the use of the existing production factors (Transfer of technology and development 2004).

An efficient connection of scholarly research and business can be seen in enterprises based on knowledge, organised by scholars, which are to commercialise technology, technological knowledge and the skills acquired at their parent entity (university, research centre, or any other scholarly centre). In the countries which rank highest in innovativeness rankings (USA, Finland, Sweden, Japan, Singapore), the academic entrepreneurship and its entities (spin-off companies) are recognised as a very effective mechanism of the flow of scholarly research results into the economy. However, this is not the only way of knowledge and technology in-flow into enterprises. Another channel is created by means of various agreements on cooperation between scholars and entrepreneurs.

The system of technology transfer and knowledge commercialisation

An integral part of a well-functioning innovative system and a process of technological innovation is the technology transfer. It may have an internal character (the flow of knowledge and technology takes place within the State) and an external one (new solutions originate in foreign resources). The basis of economic growth and development of a given State should be its own potential in this field and an efficiently functioning system of technology transfer and commercialisation at the regional level (Matusiak, Guliński, 2010).

The crucial elements of this system are domestic private and public universities, scholarly and research units, research institutes belonging to private and public sectors, independent laboratories. These entities are active, using public and private funds for the research. The effects of their work in the form of scholarly results, patents, know-how and applications for the protection of inventions, become an internal resource of innovation, of which entrepreneurs and the economy may avail themselves.

Beside them, in the system, there are innovative entrepreneurs (they belong primarily to the sector of SME), and new spin-off (spin-out) technological companies. This group of entities handles the transformation of knowledge and new solutions into

market products and services. They adjust the projects of new solutions so as to be implemented in the economic practice.

Another very important element of the system are innovation centres which include technological parks and incubators, technology transfer centres, pre-incubators, academic incubators, which offer various types of support for the innovative process, and institutions that provide pro-innovative services. Their task is to spread out knowledge and skills amongst the participants of innovative processes. They ensure consultations that consist, among others, in finding out innovative features of a product or technology, a new organisational solution (noticing its innovative potential and market opportunities, carrying out technological audits, working out a development strategy for a company or a scholarly and research unit and their use of technology transfer or knowledge commercialisation). They also offer technical and housing support. This group of entities makes it possible to implement the intentions of the State, related to the support for innovativeness and entrepreneurship of economic entities in Poland (by means of organising system conditions and assistance programmes directed at entrepreneurs and scholars).

The creation and introduction of innovations requires a financial supply, that is why the institutions of financial support for innovations are a very important group of entities in the system of technology transfer, as they prepare an offer of special instruments for financing the innovative undertakings, and are characterised by a high level of risk and uncertainty (because of the specificity unattractive for bank institutions). They include such funds as seed capital, venture capital and business angel.

The system of technology transfer and knowledge commercialisation covers also institutions of market providers of consultation, training and information services. These entities act on commercial principles, calculating their services necessary to implement the process of technology transfer and commercialisation on market principles.

The above-mentioned entities enter into many interactions in the regional system. Among them, there are uni-directional or bi-directional flows - of information, knowledge, technology, skills and financial resources. The intensity of connections between scholarly and research institutions and the economy is conditioned by the operation of national and regional systems of innovation and the pressure of the market demand for new products, services, organisational and marketing solutions (Łącka, 2011).

The essence and stages of technology transfer

The transfer of technology is defined in the literature of the subject in a diversified manner which results, according to Nagrodkiewicz (2010), from the use of the word "technology" to describe the phenomenon whose semantic range is wider than that described by this word. This notion covers the field of technology, dealing with drawing up and carrying out most advantageous processes of manufacturing and raw materials, half-products and products processing in given conditions. This is the knowledge on processing in a purposeful and economic way of natural goods into usable goods (PWN

Encyclopaedia). With this approach, the technology does not refer to all operations related to manufacturing and processing of products, the entirety of technical and organisational innovations. Yet, the phenomenon of knowledge and technology flow has a wider context than putting technical solutions into practice. Similar objections may be noticed in the views of foreign authors, for instance Allen (1984), Rosenberg (1982) and Radosevic (1999).

An approach to the essence of the transfer of technology is the definition published in the paper "Innowacje i transfer technologii. Słownik pojęć" (Innovations and transfer of technology. Dictionary of terms) (Matusiak, 2005, p. 168). It says that: "it is the transfer of information necessary for one subject to be able to copy the operation of another subject. This information appears in two forms - of a technical nature (engineering, scientific knowledge, standards) and procedures (among others, legal procedures, agreements on confidentiality, patents, licences)". Koch understands the transfer of technology in a similar way. He acknowledges that it is: "a purposeful, directed transfer of knowledge and skills to a production process, with the purpose to successfully market the product obtained (Koch 1999). According to the UNCTAD (2001) experts, it is a flow of "systematic knowledge to create a product, apply a process or provide services but it does not cover [the transfer - author's note] of transactions which are limited exclusively to a sale or a lease of goods (following: Jasiński, Ludwicki, 2007, p.28).

The transfer of technology is also defined as a process of adjustment of the results of scholarly research, patents or original ideas to their practical application in manufacturing (Włosiński 2000). If we take into account the fact that innovations may also have a servicing and public nature, then, this notion becomes further widened.

For American experts of the TreMonti Consulting, LLC, the transfer of technology is a process of a formal transfer of the rights to use and commercialise new discoveries and innovations, arising from scholarly research to the other party (Staecker, 2010). In this approach, the process is initiated by the preceding stages which make the transfer of technology possible. They consist in:

- financing research works,
- obtaining research results – inventions,
- protection of intellectual property rights and managing them.

The latter aspect is particularly emphasized because of the potential to commercialise the research results and the necessity to assure the right of priority and the protection of innovations. As to the transfer of technology process, according to the American experts, it covers the following stages:

- evaluation,
- marketing,
- licensing and possibly implementation,
- monitoring.

During the evaluation, the market potential of the new solution is assessed with the help of a technological audit, the strategy for commercialisation is set

out and strong and weak sides of the innovative undertaking are determined. This stage facilitates making a decision on the way the new solution shall be used so as to bring about the largest possible benefits. In this case, the invention shall be treated not only as a scholarly value but also a potential economic benefit. This requires carrying out market and economic analyses which shall allow to compare the potential costs of protection for a given technological solution (for instance, costs of applying for the protection of exclusive rights and costs of its maintenance) with the potential profits that the invention process could generate in the next years. The analysis of this type is not easy to be carried out as it is difficult to evaluate the future benefits - their volume and value are uncertain and burdened with a significant risk. The forecasts are not always confirmed. Sometimes the introduction of the invention and the acquisition of acquirers take longer than it has been forecast. However, one may not give up the evaluation as it is a basis to take up further operations in the process of new solution commercialisation. This stage is also connected with the necessity to get a protection for the invention. The most suitable form of protection, its temporal and territorial range, shall be selected to reserve the exclusive rights.

After the protection application has been lodged, the communication with the market starts by means of marketing operations, together with the promotion of the new solution and the search for potential receivers. At this stage, the information on a given invention is published. The commercialising institute (for instance, Centre of Technology Transfer), attempts to present it in a simple, understandable language, showing the values of the new solution and potentials to use it. This type of information is published in printed promotional materials. Apart from that, other information distribution channels are used for publications (patent databases, technological quotation bases, conferences, exhibitions, shows and fairs, electronic mail, media, etc). A growth in the interest of businesses in the innovations follows, and they try to get in touch both with the commercialising institute and the inventor.

In the subsequent stage, the method of technology transfer shall be selected. In the case of a new solution, the transfer of scholarly research results may take place through licensing, sale, or a spin-off company. At the licensing stage, an agreement is prepared and concluded, allowing for the use of exclusive rights to the invention, utility design, industrial design, and topography of electronic circuit or master work which is the object of the copyright. The owner of the rights may decide to transfer them in return for benefits in the form of licence fees. An alternative for licensing is the sale of intellectual property (patents, material copyrights, know-how, or an independent further development of technology and the introduction of the new solution within the existent or newly created technological (spin-off) company. The variants of commercialisation methods of the results of research development works of university scholars are presented in Figure 1.

The decision on the selection of commercialisation methods of the new solution is conditioned upon several factors. They are, among others: legislation terms in

a given State (among others, those related to the indication who gets the right to the intellectual property), types and features of technology and the degree of its advance, the scope of intellectual property rights protection, the type of target market where it is to be used, financial potential of the subject (entrepreneur, university, institute, scholars), possible potential to get financial support from various sources and the readiness of the owner (a group of owners) of the invention to take up the risk of running business and to engage into running a spin-off company or into entering a joint-venture company (Shane, Cable, 2002; Shane, Stuart, 2002).

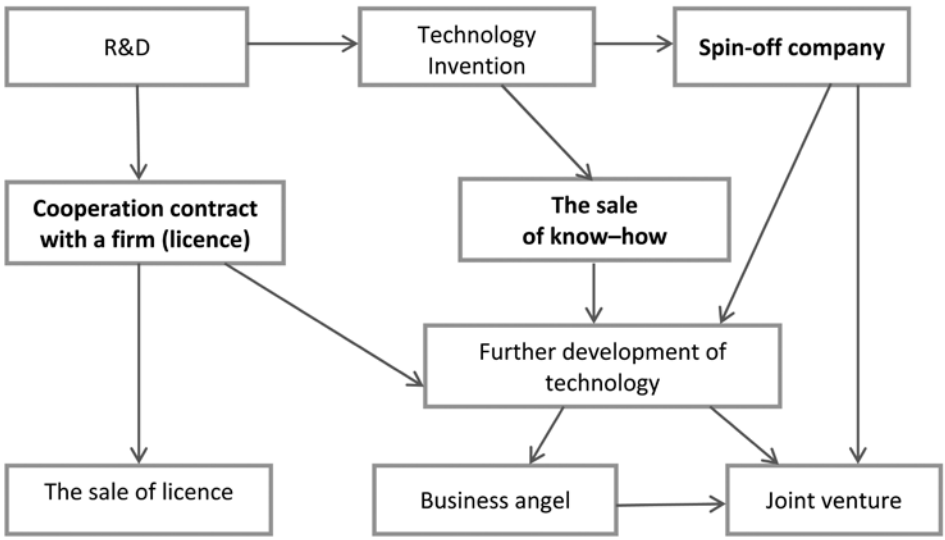

Figure 1. Ways of inventions commercialisation by universities and scholars

Independent of the selected methods of commercialisation, in the end a new solution is introduced in the market, which may be completed by means of acceptance of a given technology, product or service, etc. in the market. If the new solution is accepted by the buyers, then the commercialisation is deemed successful. Its confirmation shall be getting profits from sales, licence fees, revenues from know-how, etc. At this stage, a permanent monitoring of financial benefits gained from the intellectual property rights shall be carried out together with the control of duties being fulfilled by the licences.

American and European understanding of academic entrepreneurship

In recent years, in particular since the reform of the scholarship and research in Poland, a significant interest in the subject of academic entrepreneurship has grown, also with reference to the impact on the functioning of scholarly and research units, the creation of connections between scholars and entrepreneurs, technology transfer and knowledge commercialisation and innovativeness of Polish economy and its

entities (Guliński, Zasiadły, 2005; Tamowicz, 2006, Bąk, Kulawczuk, 2009; Łącka, 2011). This is the result of the discussion on the necessity to have a deep transformation in the model of functioning of Polish universities and scholarly and research institutes, as well as their relation with the economy. The discussion is still on with reference to the introduction of the model of third generation universities in Poland, which is supposed to join three purposes of their operation - education, scholarly research and technology commercialisation (Wissema, 2005).

As indicated by Cieślik (Tomtas, Anders, 2005), this term is used in various sources (expert opinions, scholarly articles, official documents) in an ambiguous manner. In the American approach (Shane, 2004), the academic entrepreneurship is reflected directly in the creation of new enterprises (spin-off companies). This notion designates entities created by the members of the academic community to commercialise and transfer technology which makes up an element of intellectual property, created in the parent academic institution. Such a narrow perception of academic entrepreneurship is characteristic of American literature (Smilor et all, 1990; Radosevich, 1995; Powers, McDougall, 2005). Sometimes this notion is narrowed even more, to the engagement of scholars, with the exclusion of students and graduates) in forming the so-called professors' companies.

Polish experts define the spin-off or spin-out companies in a similar manner (these two terms are frequently used interchangeably) (Matusiak, 2005). This type of enterprises comes into being as a result of an employee/employees of the parent company or a scientific or research institute, institution or research laboratory becoming independent and creating a business, using intellectual, material and organisational resources of the parent institution. A spin-off or spin-out company may have various relations with the parent scholarly institution (no formal connections, licensing agreements, university capital share in the company in return for making the intellectual property rights available).

Yet, in Europe, the academic entrepreneurship is described in much broader terms. The notion is understood as any involvement of scholarly institutions, their academic, auxiliary and administrative employees, students preparing doctor's thesis and students in the economic business and the creation by these entities of any companies (not necessarily using intellectual property). Such an approach to the academic entrepreneurship results from the inclusion of universities into the group of institutions which have an impact on shaping the entrepreneurship (Guliński, Zasiadły, 2005). In this case, the academic entrepreneurship includes any enterprise formed by a person connected in any way to a university, also an enterprise that is not formed for the purpose of technology commercialising.

The differences between the European and American approaches result from a lower level of entrepreneurship in Europe and the necessity to support the pro-entrepreneurial attitudes in the European population. Because of this, the academic entrepreneurship is defined in a wide approach as the whole spectrum of procedures with reference to supporting the relations between the scholars and the economy,

pre-incubators and incubators of enterprises, originating from scholarly entities. The variety of spin-off companies phenomenon taken into account, Nicolaou and Birley defined three spin-off groups which differ from one another in terms of the manner in which the owner, the university and intellectual property are involved, (Nicolaou, Birley, 2003). The following types can be distinguished amongst them:

- orthodox type - the enterprise bases its functioning on a scholar-inventor, and the technology transferred,
- hybrid type - the company uses the technology transferred whereas scholars and other persons engaged in the enterprise may be still within the university and in the company they are, for instance, members of scholarly board (consulting function), supervisory board (control function),
- technological type - the spin-off company uses the technology transferred from the university, however, on principle of cooperative technology transfer, and the scholar has no contact with the newly formed company; the inventor may, however, have his shares or offer his consultation services.

The European approach to the academic entrepreneurship and its manifestations is reflected in official documents related to the use of aid resources from the European Union within the Human Capital Operating Programme. These resources are designated to support various projects of academic entrepreneurship (the creation of spin-off companies included). In the case of spin-off companies, they are not only limited to those which use intellectual property generated in the parent university. The only thing which is emphasized is the fact they should commercialize innovative solutions, the knowledge or technology. There is no requirement to use protected knowledge (by a patent or in another manner) which was generated in the scholarly entity. Companies may be founded not only by scholars and Ph.D. students but also students and graduates in the period of 12 months after graduation. In particular, in the case of the latter group, it is difficult to accept that they found companies based on protected technology (Cieślik, 2009).

While trying to get out of this notional chaos and to take into account the specificity of Polish economy (weakly developed entrepreneurship and innovativeness, strong dependency on the European Union's aid for the pro-innovative and entrepreneurial activities) the application of holistic approach to academic entrepreneurship is recommended together with its various manifestations. This means including in this notion various entrepreneurship activities of university scholarly staff and also shaping the entrepreneurial orientation of students and graduates (preparing them to found their own companies based on the knowledge acquired during their studies). Enterprises may be founded by students and graduates during their studies or after graduation. These subjects may start their business related to the knowledge acquired while studying at the university or related to a completely different field. The business of the scholarly staff refers both to the spin-off companies (defined in a narrow sense) and the cooperative forms of technology transfer. These may be contracts related to carrying out research and development works, as commissioned by the industry, joint

launching, joint research with an industrial partner or technological consulting (Cieślik, 2009; Łącka, 2011).

Micro–meso–macro impact of academic entrepreneurship

All forms of so understood academic entrepreneurship lead to knowledge transfer and commercialisation into the economy, although it needs to be the knowledge covered by protective rights. Most phenomena related to the technology transfer and knowledge commercialisation do not have the nature of spin-off companies, even in the developed countries (Guliński, Zasiadły, 2005; Tamowicz, 2006). Moreover, one should not expect a dynamic development of this form of entrepreneurship either in developed countries, or in Poland. The support of academic entrepreneurship may be helpful. However, many other factors determine the readiness of scientists or Ph.D students to undertake their business, particularly charged with such a high risk. Fortunately, the inflow of scholarly research results to the economy also takes place by means of other forms of academic entrepreneurship. Spin-off companies are only one form of their manifestations. Apart from that, the transfer takes place within technological cooperation of scholars and research workers with entrepreneurs (broadly understood as contracts related to scholarly and research cooperation, launching, contract research, licences, patents and know-how sale by universities to businesses, exchange of the staff, consultations, etc).

The transfer and commercialisation of knowledge and technology exert a multi-dimensional impact on micro–meso–macroeconomic levels. University employees together with Ph.D students and graduates, make available to third party persons and institutions (primarily entrepreneurs) their knowledge, infrastructure and research results through the intermediary of various forms of knowledge and technology transfer and commercialisation. Their launching into the market (innovations) allows to strengthen the competitive position of the existing companies, to create new enterprises and as to entrepreneurs, scholars and institutes of the research and development sector, to obtain many benefits of economic, organisational and strategic nature (Łącka, 2011).

We should not forget the positive effects of various connections between scholarly and research entities and the companies of the region and the State. In the mesoeconomic aspect, they foster the regional development. They contribute, among others, to an increase in the number of enterprises and innovative companies in the region (the Small and Medium-Size Enterprises included), to the growth of companies' local expenses for development and research works, together with innovations, to a growth in the number of those employed in the existing enterprises and to found new workplaces, as a result of company business diversification, to attract new investors, to increase the proceeds from local taxes, to reduce the migration of residents to other regions.

The macro-economic aspect taken into account, the impact of the academic entrepreneurship, among others: on the development of the domestic scholarship,

directed to the commercialisation of its results, the improvement of the scholarship position in the world rankings, the appropriate allocation of public and private funds, designated to research development and innovative business, the development of the existing industry and services sectors and new fields of economy based on knowledge, the growth in the number of enterprises and employment in the State, the increase in the proceeds from taxes in the budget, the development of modern education system at each of its stages.

Technology transfer and commercialisation within the academic entrepreneurship in Poland - examples

Academic entrepreneurship, technology transfer and knowledge commercialisation through its intermediary are still weakly developed in Poland. It was only recently, following financing from the European Union funds between 2007 and 2013, and after a group of acts reforming the education system[1] entered into force in 2010, that an intensification of actions intended to increase the activity of scholarly community in the field of technology transfer occurred. However, even in this situation, we can find examples of connections between scholars and entrepreneurs which make possible the research results flow to the economy. The research of Łącka (2011) proved that only in a few cases, the technology transfer took place through the intermediary of spin-off companies, founded for this purpose. Most frequently, it was implemented within various cooperation contracts between scholars sand entrepreneurs. This cooperation was started most frequently during the performance of target projects, reported primarily by universities and research institutes (referred to earlier as development and research entities). Their partners in these projects were Small and Medium-Sized Enterprises, and the research results were launched in these enterprises. The limited framework of this paper taken into account, only a few of such examples may be presented.

Technology transfer within the cooperation between technical universities together with research institutes scholars and "PZL-Rzeszów" Wytwórnia Sprzętu Komunikacyjnego S.A.

In 2003, a group of 18 entrepreneurs of the aviation industry in the south-east of Poland (Podkarpacie Region), decided to found an industrial cluster in the aviation industry, named Aviation Valley (Dolina Lotnicza). The Rzeszow University of Technology adhered to this initiative, together with its well-developed Faculty of Machine Construction and Aviation. One of the purposes for this cluster was to cooperate and develop the aviation industry and universities, scholarly and research

1 Act of 15th June 2007 on the National Centre for Research and Development, Journal of Laws of 2007 No. 115, item 789; Act of 30th April 2012 on the guidelines for financing education, Journal of Laws of 2010 No. 96, item 615; Act of 30th April 2010 on the National Centre for Research and Development, Journal of Laws of 2010 No. 96, item 616; Act of 30th April 2010 on the National Science Centre, Journal of Laws of 2010 No. 96, item 617; Act of 30th April 2010 on science institutes, Journal of Laws of 2010 No. 96, item 618; Act of 30th April 2010 on Polish Academy of Sciences, Journal of Laws of 2010 No. 96, item 619.

institutes. They were to carry out research in the field of new concepts for the needs of its members and to develop the research and development sector in the aviation industry. The centre of advanced technologies "AERONET - Aviation Valley (Dolina Lotnicza) - founded in 2004, acting as a consortium was to serve this task. It was founded by the Rzeszow University of Technology (coordinator), Lublin, Łodź, Silesian, Warsaw Universities of Technology, The University of Rzeszow and the Aviation Valley Association. Later, the consortium was also joined by the Aviation Institute of Warsaw, Institute of Fundamental Technological Research Polish Academy of Sciences, The Institute of Fluid-Flow Machinery Polish Academy of Sciences, the Air Force Institute of Technology, and the Czestochowa University of Technology. As a result of this cooperation, the Polish Aeronautical Technology Platform was also organised.

Currently, the cluster is made up of 72 enterprises, with 21K employees and the sales amounting to over 1 000 000 000 USD per annum. Amongst them, there is the founder - "PZL-Rzeszów" WSK S.A. For many years, this enterprise has been cooperating with universities (long time before the Aviation Valley came into being) which run research works for the needs of the company. The technological partnership with the Warsaw and Silesian Universities of Technology, and the Institute for Ferrous Metallurgy had a significant importance when PZL-Rzeszów WSK was carrying out a job for General Electric, an American company, which produced engines for Embraer, Brazilian aircrafts.

This was connected to the manufacturing of engine turbine blades, as commissioned by the General Electric. It was a very difficult order because of the necessity to manufacture the parts very precisely and to comply with very high quality requirements. Its implementation was possible, owing to the cooperation with experts from both universities and the Institute for Ferrous Metallurgy. The cooperation on the projects took two years. PZL-Rzeszów WSK was manufacturing the blades which were then sent to scholars, to check their operation. After a cycle of tests, they indicated the necessary changes in the technology and together with the enterprise they elaborated methods for acceptance tests of the produced blades. The transfer of knowledge and technology made it possible to generate a product which corresponded to the high requirements of the American contractor. Thus, the commercialisation of a new solution took place.

The positive experience coming from the cooperation with Polish scientists encouraged the company to start up other joint undertakings with scholars. One of them was the project to start up manufacturing of hydraulic conduits, designated for most types of modern aircrafts and helicopters (military and civil ones), for instance (F-16, Boeing 737, Boeing 747, Boeing 757, Mc Donnel Douglas DC-10, Airbus A300, Airbus A310. PZL-Rzeszów WSK became the subcontractor of the American company. They were supposed to be also used by other world companies such as: Pratt & Whitney Canada, R.R. Donnelly, Snecma and General Electric.

The Polish company from Rzeszów needed a scientific and research support that would allow them to satisfy the requirements of the aviation equipment receivers, with

reference to soldering connections, with the use of vacuum soldering and induction soldering technology. For this purpose, it concluded a scientific research cooperation contract with the Production Engineering Plant of the Warsaw University of Technology and with the Institute of Precision Mechanics in Warsaw. The cooperation allowed to develop and implement on a production scale the technologies for hydraulic conduits soldering with various types of connecting union pieces (based on the solders of the Ag-Cu-Ni and Au-Ni types).

Technology transfer and commercialisation within spin-off companies

An example of the use of spin-off companies for technology transfer and commercialisation is Cemat Silicon S.A. It is a classic example of an orthodox spin-off company with the application of technology transferred to the company. It was founded in consequence of a research cooperation of a group of scientists from the ITME Institute of Electronic Materials Technology in Warsaw with "Cemat" Company while producing crystal silica and silica plates (by Czochralski method). These products make up a basis for printed circuits in electronic processors. In 1992, the technological cooperation brought about a spin-off company, in which ITME has 20% of shares. This company exports its whole production and has a leading position in the world market. It still co-operates with ITME in Warsaw, improving the technology and production methods.

Another spin-off company was a result of a lack of interest of domestic entrepreneurs in the possibility to launch a technology prepared by scholars. Employees of the Fertilisers Research Institute in Puławy, within research and development works, invented a modern method of hop extraction and pelleting, for the needs of breweries. The Puławy Institute, within the target project, developed an industrial process of hop pelleting and extraction. Unfortunately, this industry in Poland being taken over by foreign capital groups together with the change in production technology brought about the elimination of Polish hop producers. This caused no possibility to find a company interested in launching the new solution.

This situation encouraged the employees of the Institute to take up the risk and organise a spin-off company. At its own cost, the company (having incurred a loan) built, equipped and launched the production line. Thus, a new factory was created based on its own modern production technology which manufactures hop extract of the highest quality parameters for Polish breweries and exports it. Its production covers the hop extract demand of Polish breweries completely, and the quality of the products contributes to conquering the foreign markets. The implementation of this undertaking and the decision adopted on founding the spin-off company prevented the collapse of Polish hop farms - our country is the third hop producer in Europe.

A good example of technology transfer from the academic world to the economy is the business of READ-GENE S.A. spin-off company (professors' company) whose president is the Szczecin geneticist, prof. Jan Lubiński. The company was founded in 2005 by scholars of Hereditary Cancer Centre of the Pomeranian Medical Academy

PAM (currently Pomeranian Medical University PUM), directed by prof. J. Lubiński. Since 2009, the company has been noted at the Securities Exchange in Warsaw (the New Connect Market). It handles the methods of detection, prevention and treatment of the most widespread malignant cancers. Since 2011, the company has continued research on the impact of various micro and macro elements and vitamins on cancer affliction and on drawing up new dietary supplements.

From the very beginning, READ-GENE S.A was founded with the target of an international scale business and the selection of the organisational and legal form was to serve this purpose together with the business model. Its basis is the commercialisation of the results of the company's own research and scientific technology generated by the International Hereditary Cancer Centre (MCND) and the Centre of Genetics and Pathomorphology of the Pomeranian Medical University (PUM) in Szczecin. Pursuant to the licence agreement, signed with PAM in December 2005, READ-GENE S.A. company obtained the access to the technology generated within PAM. The licence agreement ensures to the company the exclusivity of technology commercialisation, composed of patents, a base of biological specimens and clinical data of patients registered in MCMD, trading secrets, know-how (Annual report 2012). The university is receiving 20% of the company's proceeds from sales.

Conclusion

The development of the economy based on knowledge in Poland requires a closer cooperation between the scholarship and the economy, as well as an intensive knowledge and technology transfer and the commercialisation of scholarly research results. In this process, an active role of scholars and scholarly and research institutions within academic entrepreneurship is necessary. This can be implemented in the form of technological companies (spin-off, professors' companies) founded by scholars. They decide to run a risky business, using the intellectual property of the university. Another very common manner of technology transfer and commercialisation consists in starting the cooperation between the scholarly and research employees and entrepreneurs in the form of contracts on cooperation with reference to research and development, contract research, licenses, the use of know-how, implementation, consultations, etc.

The academic entrepreneurship has an advantageous impact on the economy in micro–meso–macro scale. The technological cooperation of the scholarly environment with the economy and the direct activity of its representatives for the creation of spin-off companies, contribute to an increase in the innovativeness and entrepreneurship of the economy. This is also confirmed by the examples of technology transfer presented in the paper in various forms of academic entrepreneurship.

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Abstract (in Polish)

Przedsiębiorczość akademicka w krajach wysokorozwiniętych stanowi bardzo ważny element aktywności środowiska naukowego. Od pewnego czasu postuluje się także w Polsce zwiększenie jej roli w transferze technologii i komercjalizacji wiedzy. Silne powiązania nauki i gospodarki (w przyszłości w ramach uniwersytetu trzeciej generacji) mają być szansą na zbudowanie w naszym kraju gospodarki opartej na wiedzy. Przepływ wiedzy i wdrażanie nowych rozwiązań (rezultatów badań naukowych) w przedsiębiorstwach może następować za pośrednictwem różnych metod transferu i ścieżek komercjalizacji. Niezależnie od sposobu, każdy pełni niezaprzeczalnie ważną rolę w życiu społeczeństwa i gospodarki. Potwierdzają to doświadczenia krajów uznawanych za liderów innowacji, ale także przedstawione w opracowaniu przykłady przedsiębiorczości akademickiej polskich naukowców.

Słowa kluczowe: przedsiębiorczość akademicka, transfer technologii, komercjalizacja, spin-off, współpraca technologiczna