**Urszula Grzelońska[[1]](#footnote-1)**

**The involvement of the science sector in Poland in the transition towards the innovative economy[[2]](#footnote-2)**

1

In 2009 Research Institute for Private Enterprise and Democracy published the results of a study entitled "Conditions of effective cooperation between science and industry", which presented mutual expectations of Polish scientific units and firms[[3]](#footnote-3). On the basis of interviews with entrepreneurs and scientists the authors of this study have determined that 40% of surveyed companies are cooperating with varying intensity with scientific units, and 60% of responding scientific units "received the proposals of cooperation from companies" [A. Poszewicki, 2009, p. 19]. 75% of scientists surveyed said they personally know the owner or the person in charge of a company with which their units are cooperating, and only 10% of scientists said they did not know anyone in the company with which their units were cooperating. Among the firms, almost half (45%) of the participants in the study in question has admitted that they did not know anyone personally among representatives of scientific units, with which they have concluded a cooperation agreement [E. Kulawczuk and P. Kulawczuk, 2009, p.32; P. Bednarz and A. Szcześniak, 2009, p. 61]. As for the subject of cooperation both scientists and entrepreneurs agreed that their cooperation consists of consulting and expertise provided by the scientific units to firms, admitting students for training and internships, scientists’ participation in trainings organized by firms (for employees?) and - much less often - common projects, sometimes specifying that these projects are indeed joint business ventures [E. Kulawczuk and P. Kulawczuk, 2009, p.30; P. Cooper and A. Szcześniak, 2009, p. 60]. In light of these findings, one can ask a question, if the modern economy needs to work with the science or what is the significance of this cooperation and if the above-mentioned ways of the cooperation are indeed the most important ones currently. These are the questions that I’m trying to answer in this paper. After a generalized description of the modern economy in two consecutive stages of its development with emphasis on the importance of knowledge and institutional learning (section 2), I will present the results of the research study indicating at which stage of development is the Polish economy now (section 3).

2

Analyzing the interactions of science and economy here I assume that an economy is represented by firms, and in turn firms’ behavior determines the material condition of individual economies and their abilities to influence their partners, i.e. their competitiveness. I also assume, after Michael Porter, that from the historical perspective the main factors of competitive advantage of firms and individual economies are changing [M. Porter, 1990], and nowadays the most of the world economies, and their buildings blocks i.e. firms, are in various stages of transition from competitiveness based on investments to competitiveness based on innovation [L. Pietrewicz, 2015]. This means that firms have switched in varying degrees from competing with scale and inputs investments, making them more cost-effective, to competing with innovation in products, processes and methods of organization, and that they shape their relationships with the surrounding units and the structure of their production expenditures accordingly. In journalistic jargon the current stage of economic development is called the knowledge-based economy.

This does not mean, however, that even at the investment stage firms do not use and do not benefit from knowledge. In the economy based on investments knowledge needed for the normal functioning of firms is acquired in an almost imperceptible way. In any case, firms do not need to take notice of the entities from the science sector, that produce knowledge and which coexist side by side with them in the economy. Specifically, knowledge needed by firms to run their business, first of all, is brought in by their employees who were previously trained by the scientific units, secondly, knowledge is purchased in the form of patents, licenses or consulting from their business partners, thirdly, it is derived from scientific publications "free" because of the fact that research results are disseminated free of charge as a public good and, finally, fourthly, it is created in the firms themselves, and not only by their dedicated research and development units[[4]](#footnote-4). This knowledge ensures the optimal level of technical reliability of products and of technological processes used in their production, or – to put it differently – this knowledge allows to achieve the planned results with the desired degree of probability when business is run in the conventional manner. The invisibility of the process of acquiring knowledge by firms stems also from the method by which knowledge is being paid. Costs of acquiring knowledge are borne by the various public budgets from which the work of scientific units is being paid. The costs of knowledge acquisition by firms are hidden in wages of specialists employed or in the cost of business services (licenses, consulting, etc.). On the other hand, the knowledge “flowing in” to firms in this way does not have its "fundamental value", which would provide the basis for determining its price. The price firms pay to inventors of patents for new technology, for the design of a new product, is determined solely by the current status of the technology or product / project on the market and in no way is this price a reflection of the social cost of knowledge creation. Firms reasonably expect that they will be always able to find various alternative designs to produce goods, alternative technologies for producing these goods and, finally, alternative markets to sell these manufactured goods.

This stage lasts as long as innovations are being introduced by firms, whenever it fits them, but they are not a necessity to survive in the market. When innovations become the main factor in the competitiveness, and when the economy enters a period of development based on innovation, firms sharply increase their demand for inventions which can be used in commercial applications with high enough likelihood of achieving the expected results that warrant their financing.

The main creators of such inventions during the reign of the economy based on investments were amateur inventors. Those enthusiasts, often operating on the fringe of the economies, transformed the discoveries of science and their own ideas into the design of products, processes or methods of organization, not accounting or the time lost, money spent or chance of success. Few of them have achieved technical and commercial success. As a rule, these inventors were not fully compensated for the costs incurred in the development of their inventions and in preparing them for use in the industrial scale production. In the economy based on innovation amateur inventors are substituted by innovative firms. These are usually small companies, start-ups, incubators of innovation, working on the commercialization of knowledge, that is, on transforming it into forms suitable for industrial use; their job is therefore highly risky. They work quickly, taking into account the corporate regimes, trying to adjust the mode and scale of supply of inventions to meet demand from firms. To finance their activities special highly risky funds are being created in the financial system of the economy – so called venture capital. When the invention is successful it gets sold, or these investors sell themselves to firms seeking new technical or organizational inventions.

Another kind of entities that attract the attention of firms looking for new projects for industrial use are scientific units, that produce new knowledge in a systematic way. This is one of the reasons that at the stage of economic development based on innovation there are direct links between firms and scientific units being formed and that these units enter permanently the sphere of economic activity.

Scientific units discussed here, as I mentioned at the beginning, are synonymously called as universities, and by this term I mean all entities carrying out a systematic scientific research, i.e. discovering regularities that characterize the reality surrounding man. Economists began to be interested in universities when they realized that they may affect, in a non-random way, the manner and pace of economic activity, offering businesses ideas for innovative applications in response to their demand. At the turn of the twentieth and twenty first century economists conducted a series of studies on the modes of operation of universities and they established defining features of universities that fulfill the above mentioned functions; they call such an university a modern university or a university of the third generation[[5]](#footnote-5), as opposed to the traditional university also known as Humboldt’s university [J. Jóźwiak, 2002, 2012; P. Sztompka, 2014; I. Wissema, 2005, pp. 104-105]. Time "reign" of the Humboldt’s university overlaps – generally speaking – with the stage of an economy based on investments, modern university starts to appear only at a time when the economy shifts to the knowledge-based economy, i.e. in the innovation stage of economic development. The main difference between these models of university lies in the fact that only a modern university – alongside traditional functions, i.e. research and education of students – also fulfills the function of providing economic entities in a systematic way with organizational and technical ideas for innovative use and it’s being paid for it. Thus, the university begins to perform these tasks, which in the innovative economy are also performed by innovative companies, becoming a participant in the economy[[6]](#footnote-6). Maintaining regular contacts between universities and firms is no longer a question of good will or personal knowledge of scientists and entrepreneurs, but it becomes a permanent part of operation of scientific units, which in turn determines their recognition and financial situation.

After presenting an overall economic situation, without indicating a specific country, by outlining few stylized facts, I move onto the Polish economy, and I formulate the question of whether and how far the Polish economy is currently in the stage of an innovative economy. My answer (partial) to this question is found by examining the status of direct links between universities and firms, existence of which, as I stated above, is one of the necessary qualities of an economy that is basing its competitiveness on innovation.

3

Based on the research, I mentioned in the introduction, on the mutual expectations of Polish firms and Polish universities (known as scientific units) at the end of the first decade (XXI century), only 11% of the surveyed 203 firms was involved in a joint research project with a scientific unit and only 11% of firms have paid for research and development services of a scientific unit. [Bednarz and Szcześniak, 2009, p. 60]. If you also take into account that in these direct relationships the scientific units predominantly expect from firms to be only a platform for the dissemination of research results (joint conferences, providing training and expertise) and for internships of their students, and that almost half of the direct relationships were based on personal acquaintance, we can say that direct contacts between firms and scientific units are decorative rather than real cooperation. I tried to analyze and determine the scale of the practical business involvement by participating in the studies referred below.

Two important questions arise when studying the scope and object of a direct relationships between firms and scientific units: whether both sides can and want to maintain such relationships. These questions make sense especially with regard to scientific units whose activities, regardless of the form of ownership, are under regulation in Poland in terms of the sources and use of funds for scientific research [see: The Act of 30 April 2010. Principles of Science Financing].

As for the possibility, all laws governing the operation of research units in Poland allow for the possibility of working for business, at least since 2010. Act on Research Institutes in the chapter on finances of scientific units (art. 16 point 5) states: 'The Institute may, in order to commercialize the results of research and development, participate in technology transfer and dissemination of science and in order to raise funds for statutory activity, with the consent of the supervising Minister, establish corporations and receive shares in such corporations and receive revenues from their activities. " This idea is repeated in the Act governing the operation of research units of all types [see: The Act of 30 April 2009 Polish Academy of Sciences and the Act of 22 July 2005 Law on Higher Education]. For scientific units to want to systematically work with business on the practical application of knowledge created by them you need to change "model" of the university, or at least require adequate incentives, including criteria for assessing scientific units. In the Polish practice, you can put forward an opinion that only the regulations adopted in 2015 (and to be applied from 2017) including the evaluation criteria of scientific units may lead them to take responsibility for the practical application of the knowledge created and direct cooperation with firms. These new regulations allow for dependence of the size of public funds allocated to them on the operation of the unit including the size of their own revenue from "commercialization (selling) the results of their ongoing research and development" and the sale of "products resulting from the implementation of its completed research and development" [see: Regulation of the Minister of Science and Higher Education of 27 October 2015]. They have replaced the previous criteria for assessment of practical activity of scientific units, which rewarded scientific units for taking up applied research regardless of whether someone will buy it or not [see: Regulation of the Minister of Science and Higher Education of 13 July 2012].

In our studies we asked applicants for public assistance from the EU for implementation of innovative activities in 2007-2013 if they are conducting research studies tailored to the economic needs[[7]](#footnote-7). We received responses from 85 firms to our survey which consisted of open and closed questions with suggested answers. Because the surveyed units were asked to indicate whether the suggested situations ever happened or not, the analysis of the information obtained was based on the number of "yes" and "no" responses. If the number of “yes” responses to a particular question does not exceed 15% of the surveyed population of firms we interpret this as not common, or as a border line case. When the number of “yes” responses reached or exceeded 70% of the population surveyed we interpret this that the occurrence of the situation about which we asked, is standard among the surveyed firms, and in the case where the number of “yes” answers was in the range of 15 -75% of firms we interpret this that the situation occurs quite frequently or often. In cases where we the surveyed firms for an assessment of the situation, we asked for ratings points on a scale from 1 to 5; The analysis considered the situation with a rating of 5 and 4 as important for the firm, and the situations of evaluation for 1 irrelevant.

I have analyzed the answers to the following questions:

- with which partners has the firm applied for funding of innovative projects,

- with which partners has the firm worked on innovative ideas,

  - with which partners did the firm have a cooperation agreement in the years 2007 - 2013,

  - where does the firm get the ideas of innovation of all kinds,

  - why does the firm work and why does it not work with scientific units,

  - how does the firm evaluate its partners from the business sector.

In the answers to the first questions above, about partnerships when applying for aid from the EU, total of 24 firms indicated scientific units as such partners (15 indicated research institutes, 9 – R&D units, 2 - universities and 1 - scientific units without closer characteristics; since some firms pointed to a partnership with several types of units, reported numbers do not add up to 24). Other firms as partners were mentioned by only 10 firms. As a partner in the implementation of projects financed by EU total of 67 firms indicated scientific units and research employees (including 52 - indicating universities, 40 – research employees, and 39 - research institutes). It turns out that while the partnership with scientific units when applying for EU aid is quite common among the surveyed firms, the search for partners for the implementation of innovative projects has far exceeded the threshold, and it is a standard procedure. Summary of the answers to the question 1 is discussed in Table 1 below.

**Table 1.** The frequency of business partnerships with scientific units when applying for financial assistance from the EU and during the implementation of innovative projects

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of firms/ kind of partnerships | R&D units | Research institutes | Universities | Scientific units | Research employees |
| Partnership when applying for financial aid | 9 | 15 | 2 | 1 |  |
| Partnership in the implementation of innovative projects |  | 39 | 52 |  | 40 |

Source: Author’s own calculations based on answers to survey questions.

In the answers to the question about the number of cooperation agreements with scientific units in the years 2007 - 2013 firms have responded separately for the different types of units. Of the 69 firms that responded to the question regarding agreements with universities, 54 of them confirmed the conclusion of a total of 108 contracts which ended in the realization of 126 projects. Of the 33 firms that responded to the question regarding agreements with research institutes, 32 confirmed the conclusion of a total of 76 contracts which ended in the realization of 108 projects. Total of 25 firms reported having agreements with both universities and research institutes. If we assume that firms which did not reply to questions about the agreement with scientific units didn’t have such agreements, we can evaluate the situation, when out of 85 firms responding to the survey 54 have cooperation agreements with universities and 32 firms have such agreements with research institutes, and also taking into account that some of them have agreements with both universities and research institutes, it means that the total of 61 firms have contracts with scientific units and it must be said that the conclusion of contracts by the surveyed firms with scientific units has become a very common occurrence. Maintaining institutionalized contacts between scientific units and firms is slowly becoming the norm (standard - 72% of the population), no matter which party is the one taking the initiative. In reply to some questions concerning the effects of the agreements, firms generally describe the technical characteristics of jointly implemented processes or products, only a few responses characterized these effects more generally, informing about the agreements on the joint patent application, a common right to the invention, or the agreement about employment of some university graduates.

**Table 2.** The number of firms which in the years 2007 - 2013 have concluded agreements with scientific units

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | number of firms responding | number of firms having agreements | number of concluded contracts | number of implemented projects |
| Cooperetion agreements with universities | 69 | 54 | 108 | 126 |
| Cooperation agreements with research institutes | 33 | 32 | 76 | 108 |

Source: Author’s own calculations based on answers to survey questions.

The picture of cooperation between firms and scientific units revealed by the survey looks more pessimistic when looking at the question about the source of innovative projects. The most common answer turned out to be employees, whereby 45 firms indicated them as the source of innovative projects, 28 firms indicated their own R&D as the source of innovative projects. R&D units which are public entities were indicated by 27 firms, and R&D units being commercial entities were indicated by 10 firms. We can therefore be generally generalize that the most common, on the border of being the standard, among the surveyed firms is to seek ideas for innovation among their own staff and their own R&D base (total of 73 firms of the 85 total respondents). Innovative projects suggested by external R&D units (total of 37 responses) were clearly secondary in terms of numbers, although the use of this source was fairly common. In the case of this question firms were also asked to assess the significance of the different sources of the projects. "own sources" meaning their own staff and own R&D units were found as very important by 50 firms (respectively 31 and 19), and as important by 13 firms (respectively 7 and 6) which gives a total assessment of “own sources” as significant by 63 firms. Only two firms found a “own sources” as irrelevant. External R&D units were rated as very important or important source of innovation 19 firms, 16 of these answers related to R&D units which are public entities and only 3 to commercial R&D units, and a total of 6 firms indicated this source as irrelevant. The distribution of these ratings was confirmed in another question, given in a different context, about the significance of various sources of ideas for product innovation and marketing. This question was answered by a total of 79 firms. The responses included evaluation of sources such as own R&D units, domestic R&D centers and foreign R&D centers. The first place was given to own R&D, the employees of own R&D units were very indicated as a very important source by 22 firms, and as an important source by 13 firms, giving a total result of 35 firms. Domestic and foreign R&D centers were evaluated by 17 and 14 firms respectively indicating them as very important source (3 and 4), and as important source (11 and 13) of innovative ideas.

**Table 3.** Sources of innovation ideas among the surveyed firms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Numer of firms responding | Importance rating of **5** | Importance rating of **4** | Significant source  (ratings **5 + 4**) | Insignificant source  (ratings **1 + 2**) |
| Own employees | 45 | 31 | 7 | 38 | 1 |
| Own R&D units | 28 | 19 | 6 | 25 | 1 |
| Public R&D units | 27 | 5 | 11 | 16 | 2 |
| Commercial R&D units | 16 | 2 | 4 | 3 | 4 |

Source: Author’s own calculations based on answers to survey questions.

More generally, not necessarily in connection with the use of financial assistance from the EU, relations between economic and scientific are highlighted by the answers to the question about why firms use the services of external R&D units. The survey included several suggested responses or asked to report their own answers. The response that the services of external R&D units are cheaper (than the services of their own facilities or than using their own services) was given by 35 firms and 37 firms admitted that it is easier to settle the costs, when you use the external services. The response that outsourced services are more professional and technically easier to assimilate and that outsourced services are easier to assimilate from the legal point of view was indicated by 40 and 35 firm respectively. When asked about the evaluation of these arguments as very important and important when using the services of external R&D units the cheapness of services of foreign R&D units was indicated by 3 firms, the argument about easier costs settlement by 11 firms, the argument about easier technical assimilation by 16 firms and finally the argument about easier legal assimilation by 6 firms. Responses of firms that were not suggested in the survey show their pragmatic orientation when dealing with scientific units. Two of them indicated as very important that they use the services of external R&D units to help them developing new projects, one firm indicated that in that way it doesn’t have to maintain its own facilities, one firm said that in this way it obtained an access to specialized equipment. The latter topic was also reflected in the answers that you can’t otherwise benefit from specialized services (4 firms indicated this argument as very important), or that one's own R&D unit does not do such research (2 firms indicated this argument as very important) and finally one answer that firm must demonstrate an independent evaluation of its project (probably required by the funding body).

More firms answered why they don’t use (than why they use) services of external R&D units. This means, inter alia, that in the sample 85 respondents there are more firms that don’t use them than those that do. Among the suggested answers 51 firms indicated that "there is no such need", beside this there were single indications that "we have our own staff and their own abilities," that " R&D units don’t understand the needs of business", that "the firm is disappointed" and finally that "universities produce the titles (scientific)”. Total of 44 firms don’t use the services of external R&D units as the estimate that they represent "an insufficient level of competence", and 49 firms don’t use them because "they didn’t get such an offer." Total of 47 firms said “it’s difficult to overcome bureaucratic barriers", 49 firms indicated suggested in the survey answer, that there are legal barriers in using the services of R&D units, 47 firms indicated service of these units as "too expensive". As to the significance of the responses indicated by firms, it was clear a clear assessment, as total of 30 (20 very important and 10 important) firms indicated that "there is no need for that". Other arguments, both in the answers about the reasons for the use or the reasons for the lack of use of such services, were rated as very important or important by about ¼ of the respondents

How does the situation among respondents actually look like in terms of doing their own R&D or commissioning such services? We can learn it in the context of examining the issue of investment in research and development, by analyzing the answers to questions about the situation in this area in 2010 and 2013. The surveyed firms reported that in 2010 8 of them conducted research and development, but in 2013 there were already 21 such firms. Also, in 2010 5 firms were commissioning R&D and in 2013 this number increased to 14.

**Table 4.** The number of companies doing their own research or commissioning the R & D services

|  |  |  |
| --- | --- | --- |
| Number of firms | Year 2010 | Year 2013 |
| Own R&D | 8 | 23 |
| Commisioning R&D services | 5 | 14 |

Source: Author’s own calculations based on answers to survey questions.

Among their own, and not suggested, answers about what should be changed in the institutional setting in order to eliminate the most onerous barriers to innovation and what would help increase business expenditures on research and development the most interesting from the point of view of relations between firms and scientific units are the statements in the second area described here. It is quite understandable that firms seek solutions not on their side, but on the side of potential partners, and that they order their answers as first, second and third in terms of importance. The most general, not to say vague, answers were ranked as first. I will point out two postulates: "access to knowledge and information of potential partners" and "alignment of higher education programs." Suggestions reported as second and third in importance are characterized by greater concreteness and relate to the structural reconstruction of the sphere of research, changing the nature of the relationship between science and business, and financial matters.

Structural remodeling of science sphere relate to such proposals, reported as second and third in importance, as "a change in the promotion rules of scientists," “promotion of scientists for implementation, not for publications and titles", "elimination of habilitation", "proposals from universities and research centers”, “availability of external funds for this purpose”. Regarding the changing nature of the relationship between science and the economy respondents formulated the following postulates "wider dissemination of innovative solutions by research and development sector" "facilitating access to institutions offering R&D services”, "institutional linkages between university staff and students and firms", "cooperation between businesses and universities." Regarding issues related to financing innovation respondents suggested "putting emphasis on the development of specialized venture capital" and " facilitating the commercialization of R&D”. All the mentioned above suggestions might not be expressed in the best way, but they are definitely consistent with the developments in the most innovative economies in the world.

XXX

I wrote this paper about the involvement of science sector in building an innovative economy (in Poland) with conviction - justified in theory - that without such involvement innovative economy, also known as knowledge-based economy, will not arise. I based the evaluation of the real economy in the second decade of the twenty first century on evaluations, expectations and the actual activities of Polish firms with regard to scientific units. It turns out, what I have expected and what was already confirmed in an earlier research, that firms do not see the Polish scientific units as cooperation partners when it comes to selection of products, technologies or methods of organization, that’s how they evaluate them and verbally formulate their expectations from them. However this is not the whole picture, which can be seen by the number of cooperation agreements in the implementation of business projects concluded between the surveyed firms and scientific units and by the number of innovative projects funded by the aid from the EU. Based on this we can cautiously believe that the Polish economy is somewhere on the road to reach the stage of an innovative economy. One of the obstacles is the current situation of research units. These units are in principle regulated, they are in a schizophrenic situation regarding their motivation, and above all, we can’t say that they have began to systematically integrate into their objectives the idea to supply the economy with innovative ideas suitable for practical use.

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1. Institute of Economics, Polish Academy of Sciences, professor [↑](#footnote-ref-1)
2. This paper is a revised version of my chapter six written by me, “The role of the science sector in the transition toward the innovative economy”, which is the part of the book edited by Joanna Kotowicz Jawor "Innovation of the Polish economy in the transitional phase of development", Warsaw in 2016. This version of the paper was prepared for presentation at the Bilateral Polish –Hungarian conference „Development pattern of CEE countries after 2007-2009 crisis, on the example of Poland and Hungary”, organized by the Institute of Economics, Polish Academy of Sciences on 29 September 2016 in Warsaw [↑](#footnote-ref-2)
3. It is a collective work "The conditions for effective cooperation between science and industry", ed. by M. Bąk and P. Kulawczuk, which presents mutual expectations of Polish firms and scientific units based on the interviews with 202 firms and 213 researchers. [↑](#footnote-ref-3)
4. The importance and role of research and development branches of in industrial firms was studied in detail by Stanislaw Gomulka in [Gomulka, 1998, s.35-41]. The author draws attention to the fact that, after a period of growth of the relative importance of these branches in the second half of the twentieth century, their importance measured by the percentage of employees working in these branches in the total number of employees in the company as well as the value of property in these branches in the total value of property in the company has began to decline. [↑](#footnote-ref-4)
5. In the literature it is assumed that in the history of modern universities modern university (third generation) was preceded by a so called Humboldt’s university (second generation) and before that by medieval university (first generation). [↑](#footnote-ref-5)
6. There are sometimes concerns raised that the third function of the university makes it vulnerable to the corporate regime, which threatens the loss of some features of universities, such as the freedom to choose the subject and the mode of scientific research necessary for the effective implementation of the first two functions of universities and thus may lead to the loss of their identity [Sztompka, 2014]. Here I don’t assess as to whether the features of the new model of university are good or bad for its traditional functions. I only note some trends in the roles of current and emerging participants in the economy. [↑](#footnote-ref-6)
7. These studies were conducted in 2015 by Institute of Economic Sciences within the framework of the project entitled "The paradigm of development and the effectiveness of pro-innovation structural aid from the EU", under which the book mentioned at the beginning of this paper "Innovation of the Polish economy in the transitional phase of development" has been prepared. [↑](#footnote-ref-7)