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Jan Fazlagić

### Summary

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**Keywords:** higher education, cooperation between universities and business, innovation, knowledge-based economy, intellectual capital

# Measurement methodology of science-business relations in the reality of Polish higher education

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## Abstract

Cooperation between the world of science (universities, scientists) and the socio-economic environment of the universities has been a subject of many developments and analyses for some time now. As for now, there has been no universal set of tools aimed at measuring effectiveness of science-business relationships (S-B). This paper presents selected expertise results conducted on the behalf of the Foundation for the Development of the Education System (FRSE). It allowed to assess the usefulness of the most popular measures of the science-business relationship. We have identified indicators, which were evaluated in a qualitative study based on a sample of 30 representatives of two universities.

**Keywords:** higher education, cooperation between universities and business, innovation, knowledge-based economy, intellectual capital

## Introduction

The issue of cooperation between universities and business has been present in the literature on innovation management, knowledge-based economy and knowledge management for many years (Lundvall, 1992, p. 10; Dyer et al., 2004, p. 115; Davey et al., 2011, p. 140). Relations between universities and enterprises are often referred to as technology transfer (Friedman, Silberman, 2003, pp. 17–30; Fazlagić

et al., 2014). M. Kwiek mentions financing, the quality of education and research, the relationship between higher education and the labour market as the categories present in international discussions on the future of higher education, and draws attention to the need for universities to seek for “third sources” of financing (Kwiek, 2014). Enterprises and universities are the main elements of the national innovation system (Lundvall, 1992, p. 10; Nelson, 1993, p. 56). Expenditure on research and development carried out at universities constitutes a significant contribution to the technological development and economic growth of private enterprises (Mansfield, 1991, pp. 1–12). On the other hand, the intensity of cooperation between Polish universities and enterprises is low. Almost 80% of Polish R&D potential, measured by the number of scientific and research employees, is located in this sector (80% of “scientific production” is generated outside enterprises). Polish companies do not derive from the achievements of scientific units enough and the share of expenditure on research is too small in relation to expenditure on basic research (Jasiński, 2018). Thus, the intensification of S-B cooperation is a challenge for universities in the reality of the new Act on Higher Education and Science (Act of 20 July 2018. Law on Higher Education and Science, Item 1668).

**The aim of this study is to propose a measurement approach based on a set of indicators and to present the results of own research, which provided conclusions regarding practical aspects of measuring the science-business relationship. The demonstrated research results should not be treated as final but constitute the basis for further in-depth research.** The rest of this study will focus on the preliminary results of an expertise carried out by the author on the behalf of FRSE from October 2017 to March 2018. The presentation of results will be preceded by a literature review.

## The methodology of measurement of the science-business relationship (S-B)

In the early 1980s, the concept of “academic capitalism” and the study of the relationship between universities and business emerged (Slaughter, Rhoades, 2004, p. 11; Kyungi et al., 2016, pp. 223–254; Fazlagić, 2013). Traditionally, the mission of the universities was to teach and train staff for the economy and the state, but in recent years more and more attention has been devoted to the so-called university’s “third mission”, i.e., their involvement in cooperation with the socio-economic environment. The universities are becoming more “entrepreneurial” (Etzkowitz, 2003, pp. 293–337). Many studies have attempted to define ways to measure science-business relationships (see, among others: EC, 2009, pp. 293–337; Holi

et al., 2008; Molas-Gallart et al., 2002, p. 23). On the one hand, these issues are very important for improving the quality of higher education as well as to broadly understood innovativeness of the economy. On the other hand, it is still treated as a set of expectations and postulates (mainly towards universities, neglects or deficits of competence on the businesses' side are noticed to a lesser extent). Cooperation of scientists and entrepreneurs encounters many cultural, legal, institutional and competence barriers (Kyung et al., 2016, pp. 233–254). Usually, different priorities of research units and commercial enterprises mean that the functioning of effective S-B relations is still a phenomenon not very common. An additional barrier to the development of these relationships is the specificity of different countries. Solutions that are proven in one country will not always be effective in another. This, in turn, implies that created conceptual apparatus of measures and guidelines should be adapted to the cultural and institutional realities of a particular country.

Gardner et al. (2010, pp. 318–327) pointed out that the concept of knowledge transfer in a broader sense concerns the movement of knowledge, ideas, concepts and techniques from a point in which they were established (formative location), usually universities, to all areas of economic and social life. The analysis presented in this study applies only to cooperation with the economic environment, i.e., “business” (but does not apply to cooperation with non-governmental organisations or the public sector). Polt et al. (2001, pp. 247–258) identified the following channels of knowledge transfer between universities and business:

- collaborative research,
- contract research and technology-related consulting,
- movement of employees between universities and business,
- cooperation in education programmes on universities,
- vocational training,
- the use of intellectual property for the needs of spin-offs,
- informal contacts and networks of personal connections.

The measurement methodology should be understood as both selection and definition of indicators and description of the data collection procedure (Holi et al., 2008, p. 30). For the purposes of this study, a “long” list of indicators was first formulated on the basis of literature studies (about 150), which included those indicators that were most often cited by the authors of various types of publications devoted to measuring S-B relations. Same creation of a list of indicators is not a difficult task. The challenge is, however, to select as little indicators as possible that will simultaneously provide the most holistic picture of the studied phenomenon, i.e., they will have “explanatory power” and at the same time the cost of obtaining data will be low: the bureaucratic structures of the university are already overloaded with various types of reporting systems, both for the university’s external and external needs (e.g., parametric

assessment for Ministry of Science and Higher Education). The situation is also complicated by the fact that universities are functioning in two reporting cycles not fully synchronised with each other: calendar year and academic year.

Since the balanced scorecard method has gained great popularity in business (see, among others: Fazlagić, 2002, pp. 4–7; Fazlagić, 2003a, pp. 215–228; Fazlagić, 2003b, pp. 28–32) we observe a systematic increase in popularity of all kinds of measurement methods based on indicators and scorecards. This tendency is visible also in the case of studies on the measurement of S-B relations. Obtaining in-depth knowledge on the quality of science-business relationships requires more empirical studies. Generally speaking, the following methods can be used to serve this purpose:

- a) qualitative,
- b) quantitative.

Qualitative methods can be successfully used in non-commercial organisations and various public institutions. However, if we measure the effectiveness of cooperation between public institutions and non-public institutions, there is a choice to be made. It was considered that the use of quantitative methods would be more adequate.

In the case of researching relations with entrepreneurs, we suggest the use of following research tools:

- a) in-depth interviews,
- b) surveys, preferably in the form of an online survey,
- c) analysis of company documents,
- d) analysis of documents produced at the university level, e.g., reports of the rector, deans, deputies, vice rectors, etc.

On the basis of the project implemented by the Foundation for the Development of the Education System, a set of conclusions and observations regarding the measurement of science-business relations using specially selected indicators was created. Based on the in-depth literature studies, a list of approximately 150 indicators has been created that are used worldwide. The study assessed their usefulness in the higher education in Poland. A great challenge is to develop a set of indicators that simultaneously meet the following criteria:

1. It would fulfil the demand for necessity, i.e., in practice it would be necessary to select/define only such indicators whose measurement would reflect the real and full scale of cooperation between universities and business.
2. Indicators should be cost-effective regarding the cost of their production/acquisition. Administrative staff of Polish universities is already overloaded with various types of administration tasks for internal and external reporting. In large public universities, which sometimes consist of a dozen or so faculties or institutes, with a considerable scope of autonomy, obtaining various types of data is very time consuming.

Therefore, it would be perfect to develop such indicators for which the measurement would not interfere with the functioning of the university, but which would also be a good predictor of science-business cooperation. However, the very specificity of the analysed phenomenon makes it very difficult to fulfil this postulate. The very list of various types of activities that relate to science-business cooperation (see the list below) shows how diverse and numerous indicators should be:

- projects and expertise for business,
- mobility of academic and administrative staff between business and universities,
- didactics focused on business needs,
- scientific development and promotion works of academic teachers synchronised with business needs and expectations,
- knowledge transfer (spin-offs, patents, licenses).

Table 1 lists the populations that may have knowledge about the quality of business relationships. For each of the listed populations, a comment has been added to explain what kind of information on science-business relationships can potentially be obtained from a given target group.

**Table 1. Target groups used to study the science-business relationship**

Target group's name	Example research questions	Suggested research tools
First and second degree students	Do they participate in internships (provided by employers)? Do academic teachers present practical knowledge on their classes? Did practitioners appear in class? Did the students have the opportunity to participate in additional classes at the university with the participation of practitioners?	On-line survey Paper survey (facilitates data collection but requires coding) Focus groups
Third degree students	Are they in contact with business at the time of writing the dissertation? Do they participate in consultations with business practitioners? Whether and how promoters of doctoral dissertations facilitate cooperation with business?	In-depth interviews Focus group
Representatives of the university authorities (rector and vice-rectors, deans)	What activities lead to the intensification of cooperation between science and business? Do they create organisational facilitations and incentives for academic teachers? If so, than which ones? Do they engage themselves in cooperation with business?	In-depth interviews Document analysis Interviews with entrepreneurs regarding their opinions about the university Interviews with university employees about their opinions regarding the university authorities

Target group's name	Example research questions	Suggested research tools
Entrepreneurs cooperating with the university	What benefits does cooperation bring them? What barriers do they face? Do they engage in didactics? Are they involved in academic research at the university? Do they accept interns?	On-line survey Paper survey (facilitates data collection but requires coding) Focus groups
Entrepreneurs not yet cooperating with the university	Do they see cooperation opportunities? What barriers and obstacles do they see on the road to establishing cooperation? What opportunities and possibilities do they see in possible cooperation?	In-depth interviews Analysis of documents describing the company's activities Opinions of other entrepreneurs, e.g., indicating the company's weaknesses
Academic teachers employed at the university who have already been cooperating or cooperated in past in projects with business	What motivates them to commit to the cooperation with business? How they benefit from this?	On-line survey In-depth interviews
Academic teachers employed at the university who have not cooperated in projects with business so far	What are the barriers preventing them from cooperating with business? Do they see the effects of synergy between research and cooperation with business?	On-line survey In-depth interviews

Source: own study

## Research approach

The purpose of this study is to present selected research results on the possibility of measuring the relationship between universities and business (enterprises). There is a rich literature on the importance of this type of relationship for improving the quality of university's functioning, as well as, above all, for improving the economy's innovativeness. There is also available extensive literature on measurement methods. However, a knowledge gap exists due to two facts:

- 1) No standard set of measurement indicators has been developed so far that would even partially make it similar to measurement standards present in, e.g., finance. The authors of publications usually propose their original sets of indicators, often completely different from those proposed by other authors;
- 2) No attempts were made to empirically verify the usefulness/adequacy/relevance of individual indicators present in the literature.

In the further part of the article an attempt was made to, at least partially, solve the problem specified above. The Foundation for the Development of the Education System (FRSE) commissioned in 2017 a two-stage study on the above-developed issues. In the first part of the study, literature studies were conducted on measuring relations between universities and enterprises (in short “science-business”, i.e., S-B). An expertise was prepared, whose main part included a list of 150 indicators identified on the basis of literature studies. In the second part of the study (my original work), an attempt was made to verify empirically the usefulness of these indicators. In-depth interviews with employees of two Polish universities were conducted. One is a private university of economic and social profile located in Warsaw, and the other is one of the state academies of physical education (AWF). The study consisted of collecting opinions on the subject presented to the respondents during in-depth interviews. In the course of the analysis a comparison was made between the theoretical set of indicators developed on the basis of literature studies with the realities of Polish universities. The conducted tests were of qualitative nature. However, the question asked to respondents during a direct interview or when completing the questionnaire (both methods of communication with respondents were used depending on their availability) was as follows: “What do you think about the usefulness of this indicator for measuring S-B relations?”. The research instrument used during the survey was a complete list of indicators, together with the definition of the indicator (if the name of the indicator was not unambiguous) and the code of the indicator. The listed indicators concerned various areas of the university’s operation and for this reason none of the respondents felt competent to provide opinion on all the indicators. When the scope of competence allowed, study participants were asked to express their opinions on indicators that have already been assessed by other respondents. Thanks to this, each indicator was rated by at least three respondents. Opinions of the respondents turned out to be identical or complementary to each other, which facilitated the synthesis and presentation of an aggregated assessment of the indicator. The study involved fifteen employees from each university – representatives of middle and senior management, both academic teachers and administrative employees. The study allowed to create a table containing aggregated, compiled opinions on each of the 150 indicators analysed. A complete study report from one university had a volume of about 60,000 characters. The research approach used in the study can be utilised in further qualitative research (at a larger number of universities). Although the results of the study can be considered as unrepresentative (only two universities), the following facts should be taken into account when assessing results’ representativeness or lack of it:

- 1) the number of universities in Poland in the 2018/2019 academic year equalled 392, which means that two universities constitute about 0.5% of the general population,

- 2) research sample includes one state academy of physical education, which is 1/6 of the general population (there are six physical education universities in Poland, all of them are public and have the rank of academy, although at some other universities there are faculties related to physical education – however from a perspective of university’s management they do not constitute the full equivalent of the above-mentioned six independent schools of physical education (AWFs)),
- 3) technical universities did not participate in the study,
- 4) all universities in Poland operate within the legal framework set by the Legislator, which makes them similar – it reduces the general range of diversity in the population,
- 5) the survey involved 30 respondents – representatives of the academic community, i.e., opinions about one university came from a larger number of respondents,
- 6) no such research has been conducted so far – thus, it is the first Polish empirical study in this field.

Editorial requirements make it impossible to present opinions on all 150 indicators, so their selection had to be made. The criterion for choosing the indicators presented in this article was the cognitive value of respondents’ opinions on a given indicator. At the time of submitting this article for review, FRSE did not agree to the publication of information on the participating universities or the complete list of indicators.

## Research findings

In the further part of this study, the areas of measurement will be discussed and the difficulties and challenges related to the collection and interpretation of information on cooperation between universities and business and measuring the intensity of this cooperation will be presented. Table 2 shows selected indicators with comments. The information presented in the table is intended to show the complexity of the issue of measuring S-B relations, as well as to encourage decision-makers to reflectively and critically perceive the measuring approaches defined in the literature. Based on the obtained research results, indicators were provided with comments and were also divided into two groups:

- a) *GROUP A: Indicators whose application is problematic* – their practical use to measure S-B relations may turn out to be cost-inefficient or the results obtained may not provide the expected value for decision-makers responsible for the evaluation of universities in terms of the effectiveness of their cooperation with business. Critical analysis of indicators from this group may be a kind of signal for decision-makers not to use all the available indicators without a prior reflection. Definition ambiguity, insufficient grasp of subtlety,

in some cases, the high cost of acquisition in relation to the information value and the lack of information collection (reporting) systems are the main reasons for the inadequacy of indicators in this group.

- b) *GROUP B: Indicators with high potential to be used in Polish higher education system.* They are characterised by high information value, relatively low cost of information production and these are the two main reasons why these indicators can be considered more promising.

Table 2 summarises the synthesis of comments collected from study participants. Each field contains a synthesis of statements and opinions collected from at least three respondents.

**Table 2. Analysis of the adequacy of the use of selected indicators to measure the S-B relationship in the context of Polish universities**

Description of the indicator	Commentary
INDICATORS FROM GROUP A: they should be approached with caution, they have many disadvantages and features that impede their implementation	
Total number of individual types of contracts signed in the last year, broken down into: commissioned research contracts and joint research contracts	This indicator can distort the picture of reality because the number of contracts can become an end in itself. Often, cooperation has an informal character. For example, for scientists, a good measure, although difficult to include in the form of an indicator, is the ability to use personal contacts in the following example activities related to conducting research: the ability to attract a business practitioner to his own didactic classes or as a speaker at a scientific conference at the university, the ability to use business practitioners as research participants (respondents, panellists). The number of contracts and the number of actually started processes should be separated. Their values are not always identical. Counting invoices is the best, most reliable measure. "If the university's administration has an appropriate IT system that provides invoices with identifiers, calculating the value of this indicator will be very cheap".
Number of student projects carried out in cooperation with business	Employers often use student projects as a form of recruitment of future students. This draws students away from studying and deepening holistic knowledge. For example, IT companies by hiring 3rd year students in non-challenging IT projects deprive them of the opportunity to deepen their knowledge and gain lasting, universal competitive advantages needed on the labour market. One should take into account the functioning of science clubs in universities. It is also worth considering the activity of scientific circles as a measure of cooperation with business. <b>One should define a "student project". The measurement can be difficult due to the determination of the entity in the university's structures that would register such projects. There may be a risk of double accounting if registering is performed at a department's level.</b>

Description of the indicator	Commentary
	<b>Students can come from various departments and faculties and a given project can be involuntarily or consciously assigned to the achievements of more entities at the university.</b>
Number of citations of articles developed jointly with business representatives	<p>Number of citations of an article does not always mean that it is cited because of an input from business representatives. Rather, the overall portfolio of researcher's citations could be analysed and then assessed how many of his publications were created "in collaboration with business", and how this is reflected in his personal portfolio of citations. So, the unit of analysis should be the portfolio of citations of academic teachers. It should also be taken into account that cooperation with business may have a negative impact on the transparency of research results (trade secrets).</p> <p><b>The indicator is difficult to measure because universities do not test the citation rate of their academic teachers. For example, the value of the Hirsch index is not a standard, obligatory measure used in assessing the achievements of academic teachers at Polish universities.</b></p>
Number of diploma theses written under the joint supervision of a researcher and a business representative	<p>Business representatives do not have the competence or motivation to assess the academic value of diploma theses. One should make a definite distinction between bachelor's and master's theses and doctoral dissertations. In the case of the latter, it is necessary to demonstrate an innovative contribution to the development of science, and there indeed the entrepreneur's contribution could have a dimension related to innovations.</p> <p><b>Universities keep the documentation of diploma theses and one can add to the review sheets the columns assessing whether a business representative was involved when writing the given thesis. The involvement should be graded due to the number of hours, e.g., 0 to 10h; 11 to 50h; over 50h.</b></p>
INDICATORS FROM GROUP B: worth using, have the implementation potential at Polish universities	
The level of entrepreneurs' satisfaction from cooperation with the university*	<p>A very good measure. However, a standard measurement tool (standardised questionnaire used by all universities in Poland) should be developed. It is worth considering the fact that satisfaction has several dimensions (satisfaction from cooperation, satisfaction with the results of cooperation, short-term versus long-term satisfaction). If the university's activity in the field of cooperation increased, one could imagine a situation in which it would be a public information, obligatory provided by universities. The challenge is to "pull" academic teachers away from their main responsibilities. It is best if cooperation with business is synergistically included in the functioning of the university and not an "additional" obligation. This, however, requires the development of new rules for designing the teaching process (service design).</p> <p>For entrepreneurs, in some cases, the mere fact of cooperation with a prestigious public university gives a sufficient and high level of satisfaction. This may apply, for example, to expertise.</p>

Description of the indicator	Commentary
	<p>Currently in Poland many talented scientists and research teams operate in quasi-market realities. Scientists implement very profitable EU projects and have neither financial nor prestigious incentives to engage in classic cooperation with business. Also business sees benefits in cooperation with universities in the EU projects, but in the absence of the EU support, many projects for business could prove unprofitable.</p> <p>The indicator is easy to examine using a telephone survey. In order to optimise the costs, one can commission the study to an external company, which on the basis of the database provided by the universities covered by the study will conduct an analysis based on several survey questions. The problem may be to reach the right people in the company. Opinions of the company's management board and administrative staff can differ significantly. Ignorance of bureaucratic procedures at the university can cause a sense of resentment and frustration in the administrative staff of the company. In turn, the assessment of the final results of the cooperation process may but don't have to be considered satisfactory. One should take into account the effects deferred in time. Investments in R&amp;D, which should be primarily supported when cooperating with universities, are characterised by large time lags and a high level of risk. Entrepreneurs should treat cooperation with universities as high-risk investments which can bring in above – the-average returns. Usually this is not the case: they rather expect a "product" from the university, as if they were ordering it from a store.</p>
The value of sponsorship agreements for the university'	<p>Donations are often a hidden form of obtaining other benefits. Often, reading the provisions in the donation agreement, one can find a record about the allocation of funds for the scientific development of the university. Universities often treat revenues from sources other than ministerial subsidies as general financial means (money streams are not "marked"). Universities' incomes are treated as a general resource, financial surplus, from which other needs are financed, e.g., employee bonuses, repairs, etc. It is also a problem to set the boundaries between funds intended for teams and the criteria for distributing these funds within the university. Sometimes business donations are earmarked for the University's implementation of large congresses, including scientific ones, but not directly resulting in new research results. The indicator is easy to measure, but the results may be of little value/difficult to interpret.</p>
The level of satisfaction of scientists from working at the university for business	<p>Criteria for assessing satisfaction should be developed, e.g., a positive impact on scientific development in cooperation with business should be the main measure taken into account. In general, the essence of cooperation with business should be to look for synergies wherever possible. So, scientists should get the benefits of providing them with the latest knowledge that they use to conduct their own research and teaching.</p>

Description of the indicator	Commentary
	<p>The study is relatively easy to carry out. One can use the online survey. In the survey, it is also worth asking about the reasons for not cooperating. For the purposes of this study, an example survey questionnaire was developed to examine the level of this indicator</p>
<p>Number of cooperation agreements signed by universities with entrepreneurs</p>	<p>This indicator can distort the picture of reality because the number of contracts can become an end in itself. Often, cooperation has an informal character. For example, for scientists, a good measure, although difficult to include in the form of an indicator, is the ability to use personal contacts in the following example activities related to conducting research: the ability to attract a business practitioner to one's own didactic classes or as a speaker at a scientific conference at the university, the ability to use business practitioners as research participants (respondents, panellists).</p> <p>The number of contracts and the number of actually started processes should be separated. They are not always identical. Counting invoices is the best, most reliable measure. If the university's administration has an appropriate IT system that provides invoices with identifiers, calculating the value of this indicator will be very cheap. Many universities have separate units, e.g., Poznań University of Economics and Business has a special purpose vehicle. Due to legal conditions in Poland, agreements and invoices related to business cooperation with a special purpose vehicle cannot be classified as UEP's achievements, even though in reality it is a classic transfer of knowledge from science to business. Perhaps it would be worth expanding the measurement area to "the university and its subsidiaries whose mission is to transfer knowledge from the university to business".</p>
<p>Number of contracts with local enterprises</p>	<p>The definition of a local company is not very precise, especially in the case of Warsaw, where almost all companies are "local" to universities due to the location of many enterprises in the capital of the country. The reverse indicator, i.e., the share of clients from outside the region in the portfolio of contracts, can well testify of the university's competences. In addition, cooperation with local companies often depends on the decision of the headquarters, which are located far from the headquarters of the university (if we are talking about company branches), the exception are Warsaw universities, which are in a privileged position, e.g., in medium-sized cities there are many factories, branches and warehouses subordinated to the headquarters located far from them. This provides unequal operating conditions in this area. It is worth to diversify the category of companies, e.g., SMEs versus corporations. Cooperation with the public sector cannot be ignored. Also here Warsaw universities have an advantage, whose graduates are employed in central offices, which often means that the first address to which the decision maker turns to is one of the renowned Warsaw universities. Thus, the centralisation of the country puts universities in the country's capital in a privileged position.</p> <p><b>Whether the company is local is largely determined by the company's management strategy. For example, shared services centres are usually cut off from the urban fabric due to their global nature.</b></p>

Description of the indicator	Commentary
Total value of new cooperation agreements signed	<p>The contract value indirectly indicates the level of value of knowledge possessed by the university. If one would clarify the definition of the indicator by its value by "average contract value", this indicator could then also be used to analyse its dynamics over time. Often, entrepreneurs not trusting the competences of the university will want to minimise the risk by commissioning small, trial research. Usually, only the second and subsequent contracts will be for larger amounts of money.</p> <p><b>Easy to measure indicator.</b></p>
Number of persons employed in the implementation of scientific research or development works, including those carried out as a part of a consortium with enterprises	<p>A large number of people employed in the implementation of scientific research for business can cause delays in the implementation of promotion work, which is contrary to the interests of the university. It is better to use percentage units (in relation to the total number of employed).</p>
The number of new technologies, materials, products, methods, procedures, software and types of plants developed for the benefit of enterprises on the basis of contracts concluded by the unit with these entities	<p>Care should be taken to cultivate the unique features of universities not possessed by institutes focused on implementing applied research. It is necessary to add events related to the broadly understood inspiring, determining the direction of development, etc. to the inventory of the products listed here. For example, universities could be more involved in the creation of business strategies. The development of a strategy is in itself a specific project in the area of R&amp;D, in which the university's unique competences may prove to be particularly valuable.</p> <p><b>The indicator is very difficult to measure because the number of achievement categories is very broad and general here. Alternatively, one can consider measuring the working time (in hours) devoted by the university staff to the activities listed in this indicator.</b></p>
Value of contracts concluded by the entity regarding new technologies, materials, products, methods, procedures, software and types of plants, developed for the benefit of enterprises on the basis of contracts concluded by the unit with these entities	<p>A very good indicator. It is only worth noting that the value of contracts may differ from the value of invoices. Sometimes it happens that the contracting authority, after agreeing with the contractor, reduces the value of the contract or (rarely) increases it. Collecting information about paid invoices is a much better measure.</p> <p><b>Easy to measure indicator. It would be best to collect information on the value of invoices. This type of data is easy to collect at the university level.</b></p>

Description of the indicator	Commentary
Expenditure received from enterprises (amount) on R&D	<p>The indicator refers to flows from enterprises to universities. This type of activity can be confused with sponsorship. Some corporations, under generally formulated agreements, wanting to build their image in the scientific and student environment make various types of donations that can be classified by universities within this indicator (contrary to the intentions of the authors).</p> <p><b>Easy to measure indicator. One only needs to enter the appropriate tags in the accounting system.</b></p>
Share of publications with business in the total publications of the unit	<p>A very important indicator showing the intensity of science-business cooperation. The university can easily register publishing activity by noting the attributes of individual publications, such as levels of business representatives' involvement in establishing a business (e.g., consultations, joint research, joint analysis of results, review of finished work and others).</p>
Number of publications resulting from joint research and development projects	<p>A very good indicator. Different levels of entrepreneurs' involvement in the publication creation should be taken into account.</p> <p><b>The voluntary and declarative nature of the information collected should be taken into account. In the database which collects information from academic teachers, the field "whether the publication was the result of a joint research project with an entrepreneur" can be added. If there was a risk that the academic teachers would give false information, it could be verified by asking the respondent to provide the entrepreneur's data.</b></p>
Number of graduates who have obtained the title/academic degree on the basis of works created in cooperation between the university and business	<p>It should be determined what is the value of such a work compared to the others. The applicative nature of work is often in the academic community either unrecognised or recognised and treated as its weakness. The interests of individual graduates may be in conflict with the strategic objective contained in this indicator. Innovative master's or doctoral dissertations can owe their innovativeness precisely to the fact that they abstract from current business goals and priorities. The indicator is very easy to measure – one only needs to define the parameters and register them in the documentation of theses at the dean's office level.</p>
Number of academic teachers employed in business	<p>For entrepreneurs, people with an academic career are of low value. Scientists who want to find fulfilment in business according to the description of the indicator formulated in such a way will probably start their own company or go to work in business, giving up their academic career.</p> <p><b>Multi-time employment was finally almost abolished in 2013 because from that moment the rectors have the right to prohibit their employees from having another full-time employment and they very often use this right. The suggestion contained in this indicator suggests the exact opposite phenomenon.</b></p>

Description of the indicator	Commentary
Number of university employees who went into business	<p>The high value of this indicator from the university's perspective is definitely a negative phenomenon. It can be interpreted as, e.g., a) the inability of universities to create favourable conditions for scientific promotions; b) the university's recruitment system accepts people without scientific passion.</p> <p><b>Information on this subject can be collected only on the basis of data obtained informally. There is no obligation to inform the employer about further professional plans. Those scientists who "go to business" often set up or develop consulting companies and become self-employed.</b></p>

\* For the purposes of this study, an example survey questionnaire was developed to examine the level of this indicator, but the maximum volume of the text does not allow to include it in the paper.

Source: own study.

## Conclusions

This study presents the results of the author's empirical research consisting in reflective analysis of indicators used to measure S-B relations. The aim of the study was to examine the usefulness and adequacy of a wide set of indicators (about 150) to describe and measure the intensity of science-business relationships. The considerations contained in this study should be treated as a form of in-depth reflection and an incentive for further discussion and research on the issue of knowledge transfer from universities to business in Poland. As an argument for improving the quality of S-B relations measuring instruments, it should be pointed out that incorrectly developed measuring tools give a false picture of the transfer from the perspective of MNiSZW, which in turn results in the fact that then, based on an incorrect diagnosis, MNiSZW tries to "fix" the situation in areas that do not require intervention at all. This study brings a new quality to the current public debate in Poland, i.e., it shifts the focus from seeking answers to the following questions:

- What is science-business cooperation about?
- Why is science-business cooperation needed and serves both sides?

towards the problem: "How to effectively and accurately measure the intensity of this cooperation?". The debate on measuring the intensity of cooperation between science and business is obviously a part of the wider context of measuring social phenomena, especially those related to economics and business. We certainly need a good reporting system regarding the implementation of the "third mission" by Polish universities.

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