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THE USE OF UNIVERSITY RESEARCH PRODUCTS IN ENTREPRENEURIAL PRACTICE: SPECIFICS ACCORDING TO SIZE CLASS OF ENTERPRISES AND SECTORS OF ECONOMIC ACTIVITIES[4]

The partnership between universities and businesses, the transfer of research products created in higher education institutions and used in entrepreneurial practice are a source of innovation in a turbulent and highly unpredictable environment. This cooperation provides indisputable benefits not only for scientific and business organisations, but also for the economy and society as a whole. This, as expected, causes significant interest among researchers, as well as national and international institutions. Despite the scientific activity and the emphasized interest, there is a need for additional knowledge regarding the scope and extent of the use of research products created by academia, analysed and evaluated through the prism of entrepreneurs. The aim of this paper is to identify whether enterprises' size and sector affiliation influence the use of university research products in entrepreneurial practice, investigating the companies' perspective. Therefore 904 companies, operating in Bulgaria, were surveyed through a structured questionnaire. The methods for analysing the empirical data combine exploratory data analysis and confirmatory data analysis, in which the tools of diagrammatic images and contingency tables were used. The results show that as the size of enterprises increases, the use of research products does too, while at the same time, entrepreneurs' assessment of the need to establish partnerships with universities has a non-linear relation to the size of the enterprise. In addition, smaller businesses were found to be targeting university research products presented in publicly available forms while bigger ones are looking for interactive ways of knowledge transfer. Along with the size of the enterprises, it was found that their economic sector affiliation affects the intensity of cooperation with the academia highlighting as leading the sectors related to knowledge-based services, contrary to the prevailing perception that manufacturing and ITC sectors occupy leading positions.

Keywords: entrepreneurship; university-business cooperation; research products; knowledge transfer; SMEs
JEL: L14, L25, L26, O33, O36

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1. Introduction

The academia-business knowledge transfer is a source of a number of advantages for the parties involved in this process. The enhanced activity in building and deepening of these relations is a focus of attention not only of higher education institutions (HEIs) and entrepreneurs, but also of a number of institutions and organizations at national and international levels. This is due to many factors, among which are the changes in the characteristics of modern economies, whose major driving forces are scientific knowledge and the innovations based on them.

Over the past few decades, universities have evolved from their traditional roles in education and research to focus on contributing to society through knowledge and technology creation and transfer. Knowledge transfer, as well as its management and use by the business and particularly by SMEs, is considered in studies of many authors, as among the recent are Fitzky, Lang & Baltes (2023), Anand et al (2021), Prihandono et al (2021), Lövsund, Hillemyr, Krikis (2020), Farrukh, Athanassopoulou, Ilevbare (2019), etc. Lately, companies are constantly under pressure to change and innovate, which makes university-industry cooperation an important mechanism for survival and development. There has been a growing number of such relationships, as well as of studies devoted to them.

At the same time, unilateralism in research is observed (Shang, Zhang and Liu, 2021) and it is found that there are not enough studies examining in depth the central role of business organizations in this process (Bercovitz, Feldmann, 2006).

A large number of researchers distinguish enterprises by a number of characteristics, among which the size of the business is leading. Special attention in the studies is given to the group of small businesses (Liao, Barnes, 2015; de Zubielqui et al., 2015; Delfmann, Koster, 2010; Tether, 2002, etc.), due to their dominant share not only in a number of enterprises, but in added value and employment in most sectors of economic activity (Di Bella, Katsinis, Lagüera-González, 2023).

Differentiation in the company size leads to various types of university-business interactions, technology transfer, as well as competitive advantages and other benefits to the enterprises. What all these relations have in common is the drive to innovate, but beyond that, there are some specifics, revealed in a number of scientific investigations. For example, an extensive study on the state of university-business cooperation in Europe, made for the European Commission (Davey et al., 2018), revealed that the size of companies significantly impacts their interactions with HEIs, particularly in education and management cooperation.

The Oslo Manual (OECD, 2018) describes five main types of interaction between companies and HEIs (a significant part of which are universities) and public research institutes: ownership ties, sources of knowledge, transactions, cooperation and people-based interactions. Each major type of interaction corresponds to a set of possible channels for knowledge transfer. The idea underlying this typology is that the five types of interactions can exist independently of each other and reflect both the degree of formality in the relations and the type of knowledge that is the subject of the interaction, depending on its availability (existing and prospective) and embodiment in products (disembodied and embodied).

The question of typologizing the interactions between business and universities is the subject of the study of Ankrah and Al-Tabbaa (2015), in which they group almost all options into six organizational forms: personal informal relationships, personal formal relationships, third party, formal targeted agreements, formal non-targeted agreements, and focused structures.

From the comparison of the two typologies, as well as from the projections of other understandings applied in similar studies, it can be concluded that no restrictions should be placed on the interactions between enterprises and universities, and ultimately, an empirical study should be carried out with the idea that all possible interactions aiming at knowledge transfer should be analysed.

As for the channels of technology transfer (the various research products created by universities and used by businesses), the transfer media systematized by Arenas and Gonzalez (2019) can be mentioned: patents, prototypes, studies, presentations of conferences, publications, as well as mobility of researchers and informal discussions.

Some research papers consider the sector affiliation of companies in knowledge transfer and interaction between business and academia (Nicholls-Nixon et al, 2022; Ezeuduji et al, 2022). As expected, the effectiveness of the partnership between science and business, as well as the benefits and barriers in the process of scientific knowledge transfer to entrepreneurial practice have found their place in the activities of a number of researchers.

The growing interest of researchers in the problems of innovation activity in Bulgarian enterprises in recent decades is expressed in numerous studies and publications, but to a large extent they are either based on available statistical data collected according to established methods (CIS, EIS, NSI), or they focus on individual economic sectors or particular size groups of enterprises, from which it is difficult to assess the overall picture and especially that part of it which refers to the transfer of knowledge from universities to enterprises.

The assessment, made on the basis of the literature review below and focusing on some of the outlined unanswered questions, determines the **aim** of this paper: to identify whether enterprises' size and sector affiliation influence the use of university research products in the entrepreneurial practice, investigating the companies' perspective.

Achieving this goal would provide valuable insights into the importance of university research in entrepreneurial practice, a better understanding of entrepreneurs' and managers' perspectives on processes related to knowledge creation and transfer, and last but not least, some ideas that universities and other HEIs would apply in their research activities.

2. Literature Review

Studies dedicated to examining the interactions among universities, industries and governments show that strengthening the capacity of enterprises in R&D, as well as increasing the degree of their internationalization and competitiveness by dynamizing the partnership between the mentioned parties, is an essential prerequisite for the development of *entrepreneurship and innovation* (Shi, Yonezawa, 2012). In fact, knowledge transfer is a

strategic approach that ensures businesses maintain sustainable competitive advantages. Transfer that can take place in different ways – both through hard and soft knowledge delivery mechanisms (Jasimuddin, Zhang, 2009). Research done on the mechanisms of knowledge transfer takes into account the type of knowledge, the way of its transmission and the processing demands of the transfer task (Nokes, 2009).

The adoption and use of knowledge management practices, as evidenced by Alegre et al.'s study (2011) among biotech SMEs, is positively related to innovation performance. Another study (Liao, Barnes, 2015) concluded that, within SMEs, knowledge management practices tend to take place through interaction and collaboration on an informal basis.

University-business collaborations focus not only on the specific *process of knowledge transfer*, but also on the *key factors* for making it successful for the parties involved. Specifically, how different types of organizational climate affect knowledge transfer through the trust built and the commitment demonstrated (Luo, Lee, 2015). Bishop et al. (2011) assert that the outcomes of interactions between firms and universities are influenced by factors like firms' R&D commitments, university research quality, and geographical proximity. More recent quantitative analysis of over 2600 companies related to the "geographical proximity" factor (Østergaard, Drejer, 2022) revealed that nowadays it may facilitate the initiation of a collaboration between a firm and a university, but it does not matter for keeping them together in a persistent partnership.

Through a case study of six networks of Italian SMEs, Massaro et al. (2019) concluded that important factors for productive exchange relationships are both the maintenance and awareness of mutual and balanced interdependence (i.e. cohesion) between exchange partners. This can be facilitated by maintaining open communication channels that enhance perceptions of reciprocity and minimize perceptions of power and dominance among exchange partners. Another case study suggests that collaboration traditions influence the extent to which SMEs are open to external sources of innovation (Radziwon, Bogers, 2019).

Knowledge transfer, in addition to the factors mentioned, depends largely also on other major factors such as *size of the enterprises* and their *sector affiliation.* These factors have been considered in the analyses of Keith Pavitt whose taxonomy of industrial firms according to their sources of innovation (Pavitt, 1984) is well known. Having investigated data on about 2000 significant innovations in Britain in the period 1945-1979, he argued that the sources and purposes of innovation are sector-specific and depend on the company's size. The text presents a classification of companies by size, not comparable to the EU's current classification, dividing them into small (1-999 employees), medium (1000-9999 employees), and large (10000+ employees). Results of his investigation showed that 53.2% of innovations are distributed among large companies, while in the two other groups of enterprises, they are 21.9% (1000-9999) and 24.9% (1-999). Pavitt's taxonomy consists of three categories of industrial companies:

- Supplier-dominated: companies from mainly traditional manufacturing such as agriculture and textiles that rely on sources of innovation external to the firm.
- Production intensive: firms that are either scale-intensive or specialised suppliers.

- Science-based: high-tech firms, which rely on R&D from both in-house sources and university research, including industries such as pharmaceuticals and electronics.

Although Pavitt's taxonomy has been developed only for industrial enterprises and mostly for large companies, it could serve as a basis for distinguishing industrial sectors that are most expected to search for and use university know-how in their activities.

Knowledge transfer is, at the same time, determined by some regulatory, financial, resource and other types of obstacles, which the sustainable cooperation between universities and businesses faces. For example, a study conducted in Australia covering 1226 SMEs, showed that SMEs tend to use "generic" university-industry transfer pathways (e.g. published research results) rather than university-industry links with high "relational" involvement (de Zubielqui et al, 2015). The same study showed that SMEs are more likely to rely on organizations other than universities and related R&D enterprises for knowledge acquisition as clients/customers or suppliers.

In their study, Delfmann and Koster (2010) concluded that sufficient absorptive capacity of SMEs and cognitive proximity are two critical elements for interaction with HEIs, and four variables are important in explaining the likelihood of an organization interacting with HEIs: size of the firm and sector, level of education and year of graduation of the respondent (the entrepreneur). Pinto et al.'s (2013) research found that the use of technological and professional knowledge-intensive business services and university interactions are influenced by customer absorptive capacity related to R&D and innovation, suggesting that innovative firms tend to use all types of external knowledge sources.

Tether (2002) argued that smaller firms have fewer internal resources and need more external knowledge, which means searching for more cooperation partners (including universities). According to Santoro and Chakrabarti (2002), companies could accumulate knowledge and technologies from various external sources, such as customers, competitors, research organisations, government laboratories, industry research associations and universities, the latter being unique in terms of their potential. Tether (2002) also pointed out that since larger companies have more internal resources to engage in knowledge transfer collaborations, they are more likely to be aware of the capabilities of universities.

Rõigas et al. (2018) used data of the Community Innovation Survey (CIS) spanning the period from 2006 to 2008 for 14 European countries, in order to test four propositions concerning the university-company relation, one of which is connected with the firm's size. For this purpose, they previously summarized data from such CIS conducted before 2008 in different European countries, which revealed that the size of the firm has been positively related to the probability of cooperation with universities.

A 2016-2017 study on the state of university-business cooperation in Europe, made for the European Commission (Davey et al., 2018), also attempted to address the different size groups of enterprises. It has been found out that European academic institutions primarily establish scientific transfer contacts with large and medium-sized enterprises, and less often – with small ones or with entrepreneurs who are in the process of creating and developing their businesses. That is why the executive summary of the study's results not only

emphasizes on the possible mechanisms for intensifying cooperation between universities and businesses, but also offers specific recommendations and mechanisms that would ensure the wider participation of SMEs in these processes (Davey et al., 2018).

The need to introduce research products into entrepreneurial activity is investigated in the literature by looking for dependencies with the sectoral affiliation of the enterprises. Nicholls-Nixon et al (2022) examined the differences in needs between businesses from different sectors regarding the services provided by universities through business incubation. The results showed that *technology-based entrepreneurs* mainly use the physical capital, financial grants, technical and industry-specific knowledge, provided by the incubator. Entrepreneurs from the *creative industries* need physical capital to create products, secure financing for smaller-scale projects, as well as knowledge on fundamental problems arising in business practice (Nicholls-Nixon et al., 2022).

Enterprises from the *tourism* sector are also of interest to researchers in terms of establishing cooperation between them and universities, considering the international context of their activities. The focus was broadened to consider the effect of these partnerships on the students' preparedness and readiness to work in selected six universities, objects of a study conducted in Finland, the UK and South Africa (Ezeuduji et al., 2022).

Vivar-Simon, Errasti and Markuerkiaga (2022) focused on understanding organizational specifics and factors affecting them, considering various opportunities for academic-business cooperation and the growing focus on research and development aspects in partnerships. The objects of their research were 332 SMEs from the manufacturing sector, serving as a basis for analysing the impact of organisational context-related factors (such as general business characteristics, business openness, R&D, innovation, willingness to and support for university-business cooperation) on the activities of the universities related to their educational mission.

Bodas Freitas et al. (2013, p. 444) examined the differences between mature and emerging industries in terms of the process of building technological and innovative capabilities within them, and the role of universities in this process. The innovation environments in mature low- and medium-tech industries and in emerging high-tech industries differ considerably in terms of market and technology turbulence and knowledge input characteristics. Consequently, the strategies for sourcing external innovations, the role of networking, collaborations for innovation development, and the inputs themselves vary. The authors also presented the findings of other researchers, such as Grimpe and Sofka, who argued that firms in high-tech sectors seek technological knowledge from universities and/or suppliers, while firms in mature industries acquire market knowledge from customers or competitors. (Bodas Freitas et al., 2013, p. 445).

Thatcher et al (2016) examined the *benefits* of collaborative research projects for SMEs, universities and graduate students. The internal benefits for SMEs were found to be connected with sharing and/or reducing risk, opportunities for ensuring flexible, effective service; access to specialised research knowledge and enhanced internal capabilities, etc. The external benefits of SMEs' involvement in collaborative research projects with universities were generalized as follows: establishment of more and stronger SMEs and stimulating their

growth; reducing the risk within R&D projects and enhancing collaboration with academia, etc. (Thatcher et al., 2016).

The research of Teixeira, Veiga and Fernandes (2019) also noted the importance of the small business sector's development through its collaboration with academia. The transfer of knowledge leads to *higher innovation intensity* and, ultimately, to *better financial performance* of companies. Their research also revealed that certain factors such as the larger number of workers (respectively the larger size of the company) is connected with a higher number of patent applications.

Dutrénit et al. (2010) shape two types of benefits for firms collaborating with universities: ones related to long-term innovation strategies and others related to short-term production activities. Their study reveals the interesting finding that medium-sized enterprises are relatively least active in their interactions with universities.

Hou, Hong, and Shi (2021) examined the *efficiency* of university-industry collaboration among 71 leading Chinese universities. Their findings revealed that factors determining collaboration efficiency include *university characteristics, government-generated scientific research funds*, and *regional economic status*, in addition to the intensity of partnerships and innovative enterprises.

In connection with the above, it should be noted that the regional economic status is a prerequisite for building and developing successful relations not only from an economic point of view, but also as a level of *awareness* and *desire* (motivation) of universities and businesses to cooperate. Harper and Georghiou (2005) used a "success scenario" approach to develop a shared vision of the future of business-university linkages in the region of Manchester to making it a 'Knowledge Capital' city. Five are the dimensions of this scenario – infrastructure, human resources, inward investment, university missions, and networking.

The impact of the *informal* knowledge transfer mechanisms on the level of innovation performance of enterprises was studied by Abdulai, Murphy and Thomas (2022) among 245 firms. The findings revealed that in order to achieve better innovation performance by informal means, firms need to have a well-coordinated *social system* to get knowledge from all possible university sources.

The barriers that hinder the transfer of knowledge and cooperation between science and enterprises, as well as the implementation of university research products in entrepreneurial practice, are of interest for scientists, practitioners and representatives of various supporting business institutions and organizations. According to Abreu et al. (2009) "it is commonly argued that there are cultural barriers that limit interactions because universities are different to business. For instance, the Lambert Report stated that: 'companies and universities are not natural partners: their cultures and their missions are different'." The authors claim that besides cultural differences, the conventional wisdom is that the conflict over intellectual property (IP) is also an important barrier. Nevertheless, according to them, this is not supported when asking the academicians – the last ones point out the lack of time as the most important constraint.

A major gap in the research practice within the current article's problematic area revealed Shang, Zhang and Liu (2021). They emphasized the *unilateralism* in research done on business-university collaboration, which is why they considered this relationship bilaterally. They examined the relation between knowledge potential matching and innovation performance of university-enterprise cooperation using data over a period of ten years (2010-2020) for the joint patents applied for (Shang, Zhang, Liu, 2021).

In an earlier publication, Bercovitz and Feldmann (2006) also emphasized the *unilateralism* of research, pointing out that university-industry technology transfer could not be fully understood if it is not considered also from the firm's perspective. The authors noted that there are unfortunately only a few studies that consider the firm, rather than the university, as the focal actor in these relationships. That is why the present article is aimed at **examining the university-business interactions from the companies' point of view**.

State-of-the-art and practice in Bulgaria

The first study of innovations in Bulgaria in strict compliance with the Eurostat and OECD methodology was conducted in 1997 by the scientists A. Dimitrov, R. Chobanova, P. Ilieva, T. Lekova and R. Kazandzhieva. The results of this study outline alarming trends in the development of innovation in the country and pose questions related to the causes of the negative situation. Among these trends is the declining innovation activity of the business enterprises (Dimitrov et al., 1998). This, to some extent, is explained by the fact that Bulgarian companies have a low innovation culture related to the national economic genotype (Chobanova, 2012a).

In particular, among the first analyses of the influence of the size, structure and branch affiliation of enterprises and institutional interactions and own scientific and technical potential on the level of innovativeness of the Bulgarian economy, are those made by Chobanova (2012b).

Bulgarian enterprises, predominantly micro and small-sized, often face resource shortages or lack of necessary resources for R&D. The data shows that large enterprises are the biggest contributors to the development of technological innovations, but in general, the share of innovative enterprises in Bulgaria is lower compared to the average level for EU countries (Kirova, Zareva, 2021). Despite lagging behind the EU, the SMEs sector in the country has seen a steady trend of increasing innovation activity since 2015. The number of innovative SMEs that offer new and/or improved product innovations and business process innovations is growing (Georgieva, Yalamov, 2021, 2022).

The majority of Bulgarian enterprises do not operate in high-tech sectors, leading to a lack of clear need for R&D product implementation or use, except in cases where specific problems need to be solved (Kirova, Zareva, 2021). This, in turn, determines the degree of interest and the intensity of knowledge transfer and, respectively, the motivation for building and developing partnership relations between enterprises and universities.

A study, aimed at identifying the obstacles in the establishment of cooperation between academia (scientific organizations and universities) and businesses in Bulgaria, found the

following problematic areas: available strategic and regulatory base; public and private sector funding; human capital; capacity of businesses and academia; non-commercial and commercial forms of cooperation and commercialization of innovations and technologies; scientific and technological infrastructure that mediates and facilitates the knowledge and technology transfers (Zareva, Kirova, 2021).

Among the available data characterizing innovation activity in the country as a whole, as well as the use of research products by enterprises, are those obtained within the framework of the Community Innovation Survey (CIS) and the European Innovation Scoreboard (EIS).

CIS for the period 2018-2020 examines the cooperation of innovative enterprises with various external organizations, including with universities and other HEIs. The research covers 14,800 enterprises from Bulgaria of various size classes without micro-enterprises.

The share of identified innovative enterprises[5] in Bulgaria is only 36.2% compared to the EU average of 52.7%, which can be interpreted as a significant lag. Of these, only 1184 cooperate with external organizations (22.1%, at 25.7% for the EU-27), and the cases in which the cooperation is with universities or other HEIs are 212 (4% at 10.5% for EU-27). Of these 212 enterprises, 195 (3.6% vs. 10.2% for EU-27) cooperate with national universities and other HEIs, 33 with those from EU and EFTA countries, and 16 with universities and other HEIs outside the EU and EFTA.

According to the economic activity carried out by enterprises cooperating with universities and other HEIs, the picture is as follows: 90 of them (42%) are from the processing industry, and 76 (36%) – with economic activity 'Creation and dissemination of information and creative products; Telecommunications'. Of the latter, 59 enterprises have economic activities in the field of information technologies (28%). Other economic activities that have more significant shares (over 5%) are: 'Manufacturing of machines and equipment, with general and special purpose' – 19 enterprises, and 'R&D activity' – 14 enterprises.

As for the size of innovative enterprises that cooperate with universities and other HEIs, the picture is as follows: 50% are small, 32% are medium and 18% are large-scaled. When comparing these shares with the shares of the corresponding size classes of enterprises (83%, 15% and 2% of the total without micro-enterprises), it can be seen that as the size of enterprises increases, the share of those who are innovative and cooperate with universities and other HEI.

From the CIS (2018-2020) it is clear that the innovation activity of enterprises from the extractive (mining and quarrying) (B) and manufacturing (C) industries, as well as those whose activity is the production and distribution of electric and thermal energy and gaseous fuels (D), and supply of water, sewage services, waste management and remediation activities (E), is significantly higher than that of enterprises with activities in the service sector, and in relation to the two types of innovations covered by the study – product and

[5] The enterprise is considered as innovative if during the reference period it successfully introduced a product or business process innovation, had ongoing innovation activities, abandoned innovation activities or was engaged in in-house R&D or R&D contracted out.

process. After the industrial sectors are the services covered in sectors H, J, K and sections 46, 71, 72,7 (National Statistical Institute (NSI), 2022a).

An important aspect of CIS research is the knowledge acquisition channels of enterprises. These channels are grouped in the following order:

- Conferences, trade fairs or exhibitions
- Scientific/technical journals or trade publications
- Information from professional or industry associations
- Information from published patents
- Information from standardisation documents or committees
- Social web-based networks or crowd-sourcing
- Open business-to-business platforms or open-source software
- Extracting knowledge or design information from goods or services (reverse engineering)

Unfortunately, in the study for the period 2018-2020, no data were obtained, but it is useful to present the data for the previous study – 2016-2018, which covered 15495 enterprises, of which 4665 (30%) were defined as innovative.

The research data indicates that innovative enterprises use various knowledge sources more intensely than non-innovative ones, with differences more evident in small firms and in more expensive and complex knowledge acquisition channels.

The data does not reveal significant differences between enterprise size classes, but there is a notable increase in the use of accessible sources like conferences, fairs, exhibitions, scientific journals, and trade publications with increasing enterprise size. Larger enterprises use professional and industrial associations, patents, and standardization documents more frequently, while smaller enterprises are more active in social web-based networks and crowdsourcing.

The picture thus presented could serve as a basis on which to highlight explanations related to the use of research results of universities and other HEIs. For example, scientific conferences can attract enterprises by offering well-presented results, while active university participation in fairs and exhibitions can increase the visibility of their scientific findings.

Data from the European Innovation Scoreboard (EIS) survey also provide a good basis for outlining the problems in the use of the research products of universities and other HEIs by enterprises.

From the latest data (2023), the following strengths in the innovation activity of enterprises stand out the high (relative to the average) indexes for EU Design applications (149.2 out of an average of 100) and for EU Trademark applications (118.9 on an average of 100), as well as close to average product innovation index (78.8). The EIS survey also reveal significant progress compared to 2016 in the following areas:

- Product innovation – 67.4% increase;
- Cooperation of innovative SMEs – 51.8% increase;

- Business process innovation – 45.4% increase.

At the same time, the lack of lifelong learning (index 0), extremely low index for state support of company R&D resource productivity (3.2), low resource productivity index (12.3), and low index for innovation costs per employee (15.6) are among the weaknesses stated by EIS.

Although with a far below-average innovation index (46.7), it can be said that there are trends towards increased motivation of SMEs to innovate despite the environmental constraints they face. The question is: to what extent does this motivation direct entrepreneurs' attention to the use of university research results?

According to NSI data, the R&D expenditures incurred by the participants involved in this process (1 074 004 kBGN[6] in total) show that in 2021, business enterprises invested the most funds – 65.8%, followed by the state sector, which allocated 27.1%. HEIs follow – 6.5% and non-commercial organizations – 0.6%. However, the huge share of these funds is for current expenses, not for the acquisition of fixed assets (NSI, 2023a).

There are large territorial disparities in R&D expenditures: 77% were invested only in the Southwest planning region, of which 550 244 kBGN were the expenditures by the enterprises (51.2% of the total or 66.5% of the regional), 239 989 kBGN from the state sector, 33 769 kBGN – from the HEI and 3 262 kBGN from non-commercial organizations. For comparison, the share in the total amount of R&D expenditures in the Northwest region is 4.5%, and in the North-Central region – 3.0% (NSI, 2023b). The reason for these disproportions can be found in the fact that the capital city of Sofia, the economic and educational centre of Bulgaria, is in the Southwest region. The Northwest region is facing the greatest difficulties in its development in the country. The region's insufficient R&D expenditures indicate a lack of current capacity and limited investment activity, which could lead to future disparities.

Disproportions are found not only in terms of the territorial distribution of R&D expenditures, but also in particular scientific fields. The most funds were invested in engineering and technology sciences (51.5%), as well as in medical and health sciences (19.2%). The least R&D funds were spent in social sciences (2.4%) and in humanities and the arts (4.1%) (NSI, 2023c).

Among enterprises, the amount of funds invested in R&D varies significantly according to their economic activity (KID–2008). Enterprises developing activities in the creation and distribution of information and creative products, as well as telecommunications, invested 262 798 kBGN, followed by professional activities and scientific research – 235 595 kBGN and processing industry – 178 943 kBGN. Of the sectors for which information is provided, the lowest activity among enterprises is found in the following sectors: agriculture, forestry and fisheries – 167 kBGN, education – 283 kBGN and administrative and auxiliary activities – 604 kBGN (NSI, 2023d).

Significant differences are found depending on the size of the enterprises regarding the funds spent by them for R&D. Large enterprises (>250 employees) are expected to be the most

[6] kBGN – thousand Bulgarian levs.

active, which share in total expenditures made by business enterprises is 57.4%. With a share of 22.7% are medium-sized (50-249) enterprises, followed by small ones (10-49) with a share of 13.3%, and micro (<9) firms with 6.5% (NSI, 2023e). The data show a directly proportional relationship between the size of enterprises and the expenditures they make in R&D.

In summary, the following limitations of the available research on the state of knowledge transfer from universities and other HEI to enterprises in Bulgaria should be highlighted:

1. CIS overlooks micro-enterprises in Bulgaria, which play a significant economic and social role, providing 30.6% employment and 18.2% added value;
2. CIS focuses on product and process innovation (which of course leads because of their undoubted distinctiveness), but does not examine other types of innovation – among them those defined by Schumpeter, but also some new ones – e.g. green and responsible innovations;
3. Focusing on industrial sectors and excluding micro-enterprises from CIS, the idea emerges that only industrial enterprises can be innovative;
4. Despite the clarity provided by statistical data on universities' and other higher schools' research results in Bulgaria, no studies have been conducted in recent years to track their use by enterprises of all sizes;
5. Cooperation between enterprises and universities (and other HEI) for the purpose of knowledge transfer has been investigated sporadically (as in CIS 2016-2018), and without going into depth about the motivation of enterprises for this cooperation;
6. Despite the availability of data (although not from the latest CIS) on the channels through which knowledge is transferred, it lacks detail on the forms through which knowledge is transferred in the respective channel.

These limitations determine the motivation to conduct an original empirical study, aiming to cover as wide a range of enterprises as possible in terms of size and sectors of economic activity, and with a focus on various types of research results of universities and other HEIs that can be transferred as knowledge and applied in the activities of enterprises.

Based on the literature review, the data of CIS, EIS, the NSI, and authors' expert observations in the current article's problematic field, the following hypotheses have been developed:

Hypothesis 1. The increase in the enterprises' size is positively related to the intensity of established relationships with HEIs in the field of knowledge transfer.

Hypothesis 2. As the size of the enterprises decreases, their orientation towards standard and generally available university research products increases.

Hypothesis 3. The enterprises' sectoral affiliation has an impact on the intensity of the relationships built with HEIs in the field of knowledge transfer.

The empirical study is **limited** to achieving the aim and testing the hypotheses, not investigating some other basic questions having been raised out of the literature review such as types of channels for knowledge transfer, benefits to and better performance of companies using university products, regional and international aspects of university-business cooperation.

3. Research Methodology

904 enterprises operating in the Bulgarian market were surveyed in the period 2020-2021. The survey was carried out within the framework of a research assignment of the Institute of Entrepreneurship of the University of National and World Economy (Sofia, Bulgaria) titled "Strategies and models for using the results of the University Science in Entrepreneurial Activity". Bulgarian universities and companies were surveyed by two different questionnaires. Detection and thorough analysis of the relationship between science and business, as well as the process of implementing research results created in HEIs, from the point of view of businesses, has been pursued by surveying companies within the research assignment.

The survey of firms, results of which are analysed in this paper, was conducted through a standardized online questionnaire. The online form provided a brief introduction to the research assignment, its objectives, the research team and institution, and contact information for respondents. This was done to ensure transparency, public awareness, clarity about the methodology, and the importance of the credibility of the expected answers. In addition, the commitment of the researchers to ensure the confidentiality of the information received from the respondents was stated there.

The questionnaire included several questions that have provided information about: the companies' characteristics and their competitive advantages; the HEIs whose research products or services are used (in the cases of such usage); the types of products or services used by enterprises; the reasons why companies do not use products or services from HEIs in their activities (in the cases of not-usage).

The survey was aimed at reaching as many companies operating on the Bulgarian market as possible and thus covered a wide range of enterprises, initially not having into consideration their size, economic activities carried out, legal status, age, location, etc. Entrepreneurs, managers and key experts/employees were sought as the most suitable persons to fill in the questionnaire, as they could give reliable answers to the formulated questions.

A set of channels was used to reach respondents. The main ones were: a contact database of the members of the team working for the implementation of the research assignment; through assistance from supporting institutions and organizations, including branch chambers, units of the Bulgarian Chamber of Commerce and Industry, business associations and others; through posts in specialized groups in the social media. Support for the conduct of the research was provided by organizations that published information about the research assignment and provided a link to the survey on their websites as well as in their newsletters.

The analysis of the data obtained was done by groups of enterprises (formed by economic sectors and size). The methods used for analysing the empirical data were comparative analyses, exploratory data analysis (EDA) and confirmatory data analysis (CDA), in which the tools of diagrammatic images and contingency tables were also used.

According to their size structure, using the official EU classification, the enterprises in the research sample were represented disproportionately with the increase in their size – micro enterprises (0-9 employees) were 64%, small ones (10-49 employees) – 23%, medium-sized

(50-249 employees) – 9%, and large companies (over 250 employees) – 4%, while their shares in the overall number of Bulgarian enterprises are respectively 92%, 6.6%, 1.2% and 0.2%. Such over-proportionality implies more positive generalizations, but at the same time reduces the risk of misleading conclusions for the enterprises of the higher size classes – especially the large ones.

The Bulgarian national classification of economic activities was used to analyse the sectoral affiliation of enterprises. As expected, enterprises with economic activity "Wholesale and retail trade" (according to the national classifier) have the largest share in the sample (26%), followed by those in the "Manufacturing" (18%) and in "Professional, scientific and technical activities" (14%). With 6% shares are the enterprises sectors "Construction" and "Transportation, storage and posts". With 5% shares are firms in "Accommodation and food service activities", "Information and communication" and "Agriculture, forestry and fishing".

Regarding the extent of using university research results by the companies investigated, out of 901 respondents having answered to this question, 117 (13%) of them stated that they use research services and/or products developed in higher schools/ universities in their activity. The particular HE/universities whose research results the companies are using are various and depending on firms' specialization and needs. Among the most often pointed by the respondents HE/universities are not only industry-focused and specialised ones but also classical universities with a broad range of research areas, etc.

4. Empirical Study Results

4.1. Company size and use of research results

The results of the survey clearly show that with a growth in the enterprise's size, the use of research results also increases – from 10.8% for micro-enterprises, through 12.1% for small enterprises, to 23.8% for medium-sized enterprises and 25.7% for large enterprises. What is striking is the almost double difference in the reported shares between small, on one hand, and medium-sized enterprises, on other, despite the proximity of the two size groups. Obviously, the differences in motivation and opportunities to use research results between micro- and small enterprises are significantly smaller than between small and medium-sized enterprises. The picture outlined in this way can be explained not so much by the motivation to use research results in the activity of the relevant size class of enterprises, as by the increased absorption capacity of the enterprises of the higher size class. Important elements of analyses necessary to clarify the small shares of enterprises using research results in all size classes are the sectors of economic activities, implying different needs for new knowledge, as well as the perceived importance of individual types of competitive advantages used by enterprises.

4.2. Sectors of economic activities and use of research results

The data from the survey shows that among the enterprises in the sectors "Education", "Human health and social work activities", "Agriculture, forestry and fishing" and

"Professional, scientific and technical activities", the shares of those who use scientific results were the highest – respectively 31%, 29%, 24% and 21%. Close to them but with lower shares are the enterprises in the sectors "Information and communication", "Construction" – both with 18% and "Manufacturing" – 15%.

These results, somewhat expectedly, create a different picture of the relationships between the sector of economic activity and the use of university research outputs than that outlined by the CIS. The difference can be explained by the wider range of forms in which these results are presented – not only product and process innovations, but any new knowledge applicable in the activities of enterprises.

Relatively small are the shares of enterprises using research results in the sectors "Financial and insurance activities" (9%), "Wholesale and retail trade", "Accommodation and food service activities", "Administrative and support service activities" (all with 8%). No enterprises from the other sectors have stated that they use results from scientific research.

The obtained results can be a confirmation of the assumption that sectors with higher shares of enterprises that are using results from scientific research have a greater need for new scientific knowledge in order to build competitive opportunities and develop in the long term. On the other hand, the absence of such enterprises in the "Transporting and storage" sector, in which 6% of all surveyed enterprises operate, is somewhat puzzling. The explanation for the other sectors, in which there are no enterprises using research results, is in the single cases or in the small number of enterprises covered by the study.

4.3. Types of research products and their use by size classes of enterprises

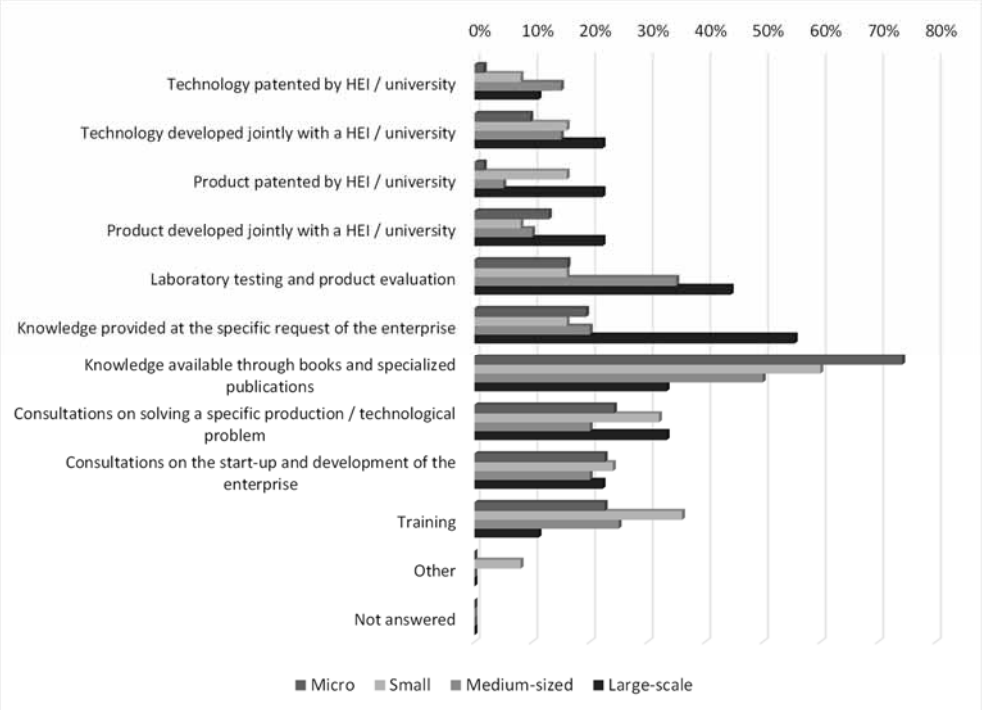
It is known that the results of the research activities of the universities can be offered in different forms and with different degrees of accessibility to the enterprises interested in their use. In the study, the different types of outcomes were distinguished in the manner presented in Figure 1.

When distinguishing the individual forms of research results, both their classification according to CIS, Oslo Manual (OECD, 2018), but also the systematization of transfer media proposed by Arenas and González (2019) were considered.

An impression is made by the strong predominance of knowledge as a form of research product in the given answers. Is it generally available (used by enterprises without it being considered in the universities) or is it presented to the enterprises by request? In both cases, it is a matter of scientific production, which is anyway developed in the universities (mostly without taking into consideration its usefulness for the business), while its adoption into the practice is initiated by the businesses. The state with the products and technologies, patented by HEIs and afterwards used by businesses, is similar. In this case, however, it can be expected that by working on these research products, universities are taking into consideration the eventual interest from the business.

The results from the analysis revealed an interesting picture, showing substantial variations between the enterprises of different size classes regarding the research products they most commonly use (Figure 1).

Figure 1. Most commonly used research products by enterprises of different size classes



Source: Own analysis.

The most popular research products are those that are most accessible, including in terms of price, such as – the knowledge presented in books and specialized journal publications. It is noticeable that when using these types of products there is a decrease in their utilization as the size of the enterprise increases – from over 74% in microenterprises to 33% in large enterprises. This decrease is compensated for by using knowledge provided upon specific requests by companies, with utilization reaching 56% in large enterprises. However, in micro, small, and medium-sized enterprises, the utilization is relatively modest – 19%, 16%, and 20%, respectively. The data shows that small enterprises more frequently rely on consultations and training as a means of acquiring new knowledge, as well as jointly developed technologies and products patented by universities. Laboratory testing and product evaluations are more commonly utilized by medium and large enterprises.

It appears that technologies and products patented by universities are scarcely used by microenterprises (only single cases) but at the same time, this size of enterprises does utilize jointly developed technologies and products (10% and 13% of the cases).

In summary, the results of the empirical study confirm the assumption that the utilization of universities' research products is influenced by both the accessibility of these products and their correspondence with the specific needs of the respective enterprise. In this context, it can be argued that larger enterprises are more likely to engage in more expensive forms of acquiring and using research products, including those obtained through collaborative activities. A picture which to different extents was proven from previous studies – de Zubielqui et al. (2015), Delfmann and Koster (2010), Pinto et al. (2013), Tether (2002), and Rõigas et al. (2018).

4.4. Reasons for non-use of research products

The results of the conducted empirical survey do contradict the generalizations and conclusions made on the problem, and the resulting assumptions about the relatively scare knowledge about this issue in Bulgaria. Nevertheless, a major problem in the national context remains the high percentage of enterprises that do not use the research products of HEIs (as it is also proofed by CIS). This high percentage (87% in the present survey) directs attention to the investigation of the reasons underlying it. Despite established opinions on reasons like low absorptive capacity and lack of resources, it's crucial to learn from entrepreneurs' or managers' explanations.

The most frequently cited reason in the study is that "The company does not need research services/products created by HEIs" – from 54% for micro-enterprises to 29% for large enterprises. The survey shows that as the size of the enterprise increases, the frequency of citing this reason decreases.

The reason cited in the second place is the inconsistency of the HEIs' research products with the needs of the enterprise. An interesting fact regarding this reason is that it is more prevalent among small and large enterprises, while it is less common among micro and medium-sized. The explanation of this non-linear relationship between enterprise size and the perceived inconsistency of research products offered and needs should be sought in further research.

Thirdly (but relatively less often), the inconsistency between the perceived need for the use of research products and the need for a corresponding capacity for this use is cited as a reason. This reason is more often mentioned by micro and medium-sized enterprises, and less frequently by small and large ones, which raises the question: why do small enterprises not fit into the assumption that their capacity to use research products increases with the size of the enterprise?

In addition, a number of responses were received for inadequate attitude from HEIs in cases when businesses look for their products and services. This indicates the need for Bulgarian universities and other HEI to take corrective actions in this regard.

5. Hypothesis Testing

An important component of the analysis, necessary for proving hypotheses 1 and 3, is the adoption of a measure of the intensity of relationships between enterprises and universities and other HEI. In this case, the combination of two elements is considered as such a measure: the frequency of enterprises using research products and the mechanism (form) through which the creation and transfer of research products are realized.

Regarding the first element, the data unambiguously show that as the size of the enterprises increases, the proportion of enterprises in the respective size class using research products also increases. The performed Chi-Square test proves that the relationship is statistically significant, but at the same time weak in strength (Cramer's V – 0,124).

Concerning the second element, however, the analysis of the data reveals a non-linear dependency among the lower-size classes. At the same time, it can be observed that the relationships between large enterprises and HEI exhibit higher intensity compared to the general sample of SMEs.

Thus, with the assumption that it is difficult to point out a significant difference in intensity between small, on one hand, and medium-sized enterprises, on the other, hypothesis 1 can be accepted. Supporting the acceptance of the hypothesis are also the answers clarifying the reasons for not using research products – it is evident that with the increase in enterprise size, the assessment of the necessity to establish relationships with HEI also changes – large enterprises are more demanding in their search of the right research product compared the medium, and small enterprises too compared to micro-enterprises.

As for hypothesis 2, it is undoubtedly proven by the data on the types of research products used by different size classes of enterprises. The hypothesis was tested using the Chi-Square test, applied to the individual types of research products used by the respective class of enterprises. It is important to note, however, that as the size of the enterprise increases, the reduction in the use of research results in generally available forms is replaced by the use of results provided on a specific request, but not from fundamentally more expensive and complex forms for knowledge transfer (Confirmed by Chi-Square test).

Hypothesis 3 can also be accepted on the condition that the sectoral affiliation suggests not only specific needs for research products but also a specific size structure of enterprises. The existence of some inconsistency between the sectoral composition in the research sample and that in the total population of Bulgarian enterprises requires additional sector-specific studies to definitively prove the hypothesis.

The results of the empirical study conducted, which can be claimed to add new understandings to existing knowledge, are:

1. The identification of sectors of economic activity classified as services, for which the assumption that they would have an interest in the use of university research products is rare due to the dominant understanding that the main users are manufacturing and ICT enterprises;

2. The disclosure of a non-linear relationship between the size of the investigated enterprises and the assessment of the compliance of the research products offered by universities with the needs of the enterprise;
3. Each size class of enterprises, although to a different degree, is interested in the use of knowledge (research products) of universities and other higher schools, but the form of presentation and transfer of this knowledge determines the degree of its use. Among the main characteristics of the forms of presentation and transfer are the costs and the correspondence of knowledge to specific problems of enterprises.

6. Policy Implications

Policymakers should differentiate specific programme measures for intensifying knowledge transfer from universities and HEIs to enterprises based on their size class. This includes reducing barriers to transfer, such as costs and human resources engagement. Supporting micro-enterprises should focus on university policies and practices while encouraging bigger enterprises to build their own absorption capacity and implement joint projects with universities.

The limitations of the conducted empirical study do not allow for particularly detailed policy recommendations to promote the use of university research results in entrepreneurial activity, but they provide the basis for the following recommendations for further research on the topic:

- Deepening research in sectors of economic activities in which neglect of the need for the use of research products is registered – mostly traditional services that are affected by recent technological development and new knowledge.
- Expansion of research in the direction of identifying the most common problems in individual economic sectors, for the resolution of which the creation and transfer of knowledge from universities is critical.
- The identification and modelling of cooperation mechanisms between enterprises and universities, which ensure mutual interest and, together with this, protect the public interest in spending public funds for R&D.

7. Conclusions

The proof, albeit with certain conventions, of the hypotheses formulated based on the literature review, emphasizes the need for the development of specific policies and programmes to encourage the establishment of effective relationships between enterprises of different size classes and HEIs to facilitate the processes of creation and transfer of research results into the practice of these enterprises.

Objects of special support should be the micro and small enterprises operating in sectors of economic activity often considered as non-typical users of university research products – mostly providing traditional services and being pressed by other economic sectors to achieve higher productivity in order to survive and develop further. This support should primarily be directed towards providing entrepreneurs with knowledge of the benefits that research products could bring to their businesses, and secondly, towards developing the absorptive capacity of the enterprises they manage.

Finally, referring to some of the arguments for the non-use of research products by enterprises, in-depth analyses of the processes for creating such products in HEIs should be conducted, with a focus on the motivation for research activities and the alignment of these activities with the current and strategic needs of each economic sector.

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