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# Drivers of Academic Engagement and University–Industry Collaboration in Conditions of Slovakia

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**Abstract:** Universities have been perceived for several decades as an important development factor in the space that shapes the regional environment throughout the generation of new knowledge or technologies and the production of human capital. Our paper focuses on the less researched phenomenon of academic engagement, and thus, the development of university knowledge transfer based on interpersonal links between researchers and application actors from an academic perspective. This empirical study evaluates the results of a nationwide survey of academic researchers devoted to unhiding various aspects of formal and informal cooperation on an interpersonal basis. Using an econometric approach, the study investigates determinants of academic engagement of individual researchers and describes patterns of formal and informal ties between academics and businesses. The results explain which researchers participate in academic engagement activities and elaborate on the motivations and barriers of university–industry cooperation at the level of the individual. We also identified a significant volume of informal dissemination of knowledge of universities in the space via various channels.

**Keywords:** university; academic engagement; university–industry collaboration; knowledge diffusion



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## 1. Introduction

The academic engagement and university–industry relationships can be traced back to the 19th century (Geuna and Muscio 2009). Since the emergence of the concept of "knowledge-based economy" and the following concept of the "third academic revolution", universities have been even more expected to contribute to economic and technology growth (Geuna 1999). Concerning academic research on the topic, the endogenous growth theory (Lucas 1988; Romer 1990; Grossman and Helpman 1991), the "National Systems of Innovation" approach (Freeman 1987; Lundvall 1992; Nelson 1993; Wiyono and Wu 2022), or the introduction of the Tripple-Helix model (Etzkowitz and Leydesdorff 1995; Etzkowitz and Leydesdorff 2000) had discussed the university role in supporting the emergence of innovation in the external (non-academic) environment and established a framework for understanding the role of basic research on economic growth and highlighted the human capital dimension of the technological progress. Coming out of the open innovation paradigm, enterprises are pushed to keep their innovation process open to the external environment in order to be more competitive (Mansfield 1995; Vidal et al. 2022). On the other hand, since the last decades of the 20th century, universities have been pushed to compensate for the shortening of the public financing of the academic sector and proposed to meet the new expectations to contribute to the technology growth in national economies via utilisation of produced knowledge (Veugelers and Del Rey 2014).

At this point, it is necessary to repeatedly state that a university, due to its nature, can be considered as a very open institution binding multiple kinds of potential carriers of academic knowledge (university management, researchers, research groups, students, etc.) which makes results of academic research, as Acs and Plummer (2005) state, inherently

difficult to protect. As knowledge crosses the boundaries of its source, one person can think of something and the other can utilize it (Baptista and Mendonça 2009). The "commercialization" of the knowledge concept involving the patenting and licensing of inventions as well as academic entrepreneurship (Markman et al. 2008), represents the utilisation of formal transfer channels to be relatively complex—explicit knowledge from a university to an external environment while the transfer process is under full control of the university. On the other hand, the concept of so-called "academic engagement" highlights that part of knowledge diffusion from an academic environment (using both the formal and informal transfer channels) happens on the basis of interpersonal linkages between an enterprise and an individual researcher (Cohen et al. 2002).

Even though university–industry collaborations (UIC) have been intensively researched mainly from the point of view of success determinants, organizational factors and from the point of view of applied commercialization models (Koria et al. 2022), we know less about the importance of interpersonal ties between individual researchers and companies for the development of technology transfers and academic businesses (Perkmann et al. 2013). Rothaermel et al. (2007) first mentioned that research on UIC neglected the analysis of individual researchers' involvement in the process. Filippetti and Savona (2017) still state that the individual nature of collaborations and individual determinants of academic entrepreneurship were largely neglected by academics. As uncovered by Perkmann et al. (2013), most of the studies focusing directly on the interaction between researchers and businesses uncovered that academic engagement as an activity, or intention of a researcher is selective and differentiated according to sex, age, seniority and academic standing of the scholar.

Therefore, our intention will be to better understand the ways of academic knowledge dissemination through interpersonal ties. Specifically, given the gaps in knowledge outlined above, we will focus on clarifying the determinants of their emergence, while the individual aspects of the academic will be at the centre of our attention. From a conceptual point of view, we based our research framework on the contribution of Perkmann et al. (2013), who summarized that academic engagement is driven by individual, organizational and institutional factors. Following Filippetti and Savona (2017), however, we will be particularly interested in the, so far, less researched individual factors, mainly concerning the productivity of individuals and their networking, or rooting in the private sector that can also play a vital role in explaining academic engagement due to other studies (Gulbrandsen and Thune 2017). Our data allow us to clarify the practices of academic engagement in a wider context through the assessment of motives and barriers, which complement our analysis of determinants. By describing the channels of knowledge dissemination, we will in turn contribute to a topic that has resonated for decades in the literature without detailed answers. It is the informal dissemination of academic knowledge, whose trajectories and dynamics are difficult to describe, as in the conditions of many universities, that is perceived as an activity "behind the back" of the university (D'Este and Patel 2007). The following research questions arise from the identified gaps:

- What motivates academic researchers to participate in academic engagement activities and what barriers to the development of inter-personal linkages with entrepreneurs do they perceive in the conditions of the country relatively slowly adapting university third mission policies and practices?
- What differences in the frequency of formal and informal ties between academics and enterprises emergence can be identified?
- Are academics' decisions to participate in academic engagement activities influenced by their level of productivity, access to financial resources for science and research, previous experience and networking?

We also argue that the Slovak example of these relationships is excellent for exploring the ways of informal cooperation, given the specific pathway of development of knowledge commercialization in the country. The Slovak legislation in 2017 already defined the possibilities of universities to manage their intellectual property; however, only several

public universities in the country have adopted the rather early third mission policies and established TLOs to support knowledge transfer (Rehák et al. 2019). Slovak universities still miss capacities and internal institutions for the development of the commercialization processes, which opens the ground for research on informal knowledge flows, as "side" activities of academics.

## 2. Conceptual Background

The current literature on the topic can be considered to be extensive but also fragmental and incomprehensive (Perkmann et al. 2013). Several reviews tried to deliver a typology for university–industry collaborations (Dess and Shaw 2001), identify basic aspects and characteristics of universities and enterprises developing cooperation linkages (Agrawal 2001), summarize and compare factors affecting the emergence of commercialization and academic engagement in empirical studies (Perkmann et al. 2013) or investigate the key aspects of university–industry collaboration and find out how these aspects may be related (Ankrah and Al-Tabbaa 2015).

As outlined in the previous chapter, academic engagement refers to the interaction between any actors of the higher education system and actors of different sectors aiming mainly to encourage knowledge and technology exchange (Bekkers and Bodas Freitas 2008) in order to get certain financial or non-financial benefits (Perkmann and Walsh 2009)—e.g., access to rare data, teaching enrichment, joint projects and events (Dess and Shaw 2001). The motivation for engagement crosses the intention to publish research results. It is mostly expected that such cooperation should generate certain benefits or effects on the side of an external partner.

As a first extensive and realistic framework of university–industry collaboration, we consider the contribution of Bonaccorsi and Piccaluga (1994) that summarized six main categories of organizational forms of UIC, namely: personal informal relationships, personal formal relationships, relationships through the third party, formal targeted and formal un-targeted agreements and common focused structures. The majority of newer contribution builds on this framework, and thus, on the assumption that the majority of university–industry collaborations tend to be driven by individuals and pursued on a discretionary basis (Hermanson et al. 2020). Nowadays, it is formally measured in the majority of European countries, how frequently entrepreneurs collaborate with universities, e.g., in terms of the provision of research services, counselling, getting access to unique know-how of researchers, academic technologies or research infrastructure, getting the support with product/service/process development (Rybnicek and Königsgruber 2019). In the case of building the formal or semi-formal relations/partnerships between the academic and non-academic actors, Ankrah and Al-Tabbaa (2015) suggest that UIC formation processes consist of: the identification of potential partners, making contact, partner assessment and selection, partnership negotiation and agreement signing.

However, the confusion in drawing the complex picture of academic engagement, even on an institutional level, is caused by the unrecordability of informal cooperation that has no contractual basis (Link et al. 2007). In literature, informal UI collaboration tends to be perceived as even more significant than formal (Siegel et al. 2003; D'Este and Patel 2007). However, from previous research results, there is not much to discuss on the topic so far. Cohen et al. (2002) state that there is a higher probability of informal cooperation in the case of researchers from social rather than life sciences. Schartinger et al. (2002) also suggest that interaction mechanisms and the use of transfer channels also vary across scientific fields. The possibility of the utilization of informally transferred knowledge can be differentiated, mainly based on the intensity and repeatability of contact with an academic researcher (Bekkers and Bodas Freitas 2008), the applicability of research (Bonaccorsi et al. 2014) or absorptive capacity of the enterprise (Cohen and Levinthal 1990).

In this paper, the main focus will be put on the identification of specific individual drivers of scientist willingness to participate in academic engagement. These factors can be grouped into several categories, namely: (1) institutional factors, (2) productivity factors,

(3) access to resources and previous experiences, (4) networking in the application sphere and (5) controls related to common individual traits such as age and sex. In previous research, mostly carried out in conditions of western European countries or the United States, it was mostly the impact of several individual, organisational and institutional factors on academic engagement that was investigated (Perkmann et al. 2013). Concerning the institutional perspective, an affiliation to a scientific discipline strongly affects the collaboration of a scientist with actors of an application sphere. Several empirical studies proved that academics assignable under life and technical sciences (such as ICT, biotechnology, engineering) tend to establish more ties with industry. Scientific affiliation also affects the choice of transfer channels (Bekkers and Bodas Freitas 2008; Bozeman and Gaughan 2007; Martinelli et al. 2008). The relationship or affiliation of an academic with specific entities in a university (like technology centres or centres of excellence) can positively influence cooperation with the application sphere (Bozeman and Gaughan 2007). Less empirical studies focused on the role of TLOs in academic engagement activities, such as TLOs, but would rather support basic commercialization activities such as licencing and spin-off establishments and, indeed, no impact on academic engagement was recorded (Perkmann et al. 2013). In order to examine these realities in our case, we formulated the following hypothesis:

**H1:** *the chance that a researcher will participate in academic engagement increases if he primarily performs applied research.*

**H2:** *there is no relationship between the establishment of TLO (in various forms) in universities and the development of academic engagement.*

Concerning the potential relationship between the productivity of the researcher and his academic engagement activities, we consider these relationships with our prior contribution to the literature gap. Observing this relationship in the conditions of Slovakia is particularly relevant, as the results of research in the conditions of the country point to a barrier to the development of academic engagement in the form of the integration of a wide spectrum of "creative tasks" within the scope of work of a creative employee—mostly, it is teaching, research, project management and administration cooperation with practice synchronously (Buček et al. 2019). In research on the topic, the productivity of the researcher was mostly measured by the number of publications (Lin and Bozeman 2006), while a prevailing part of empirical results found that academics with prior industry exposure produce fewer publications. The quality of scientific research also appears to play a vital role in academic engagement. Collaboration with star scientists drives more success for private enterprises (Zucker and Darby 2007). Several authors measured the "quality" of scientific research by a certain productivity indicator, finding a positive impact of productivity on academic engagement (Bekkers and Bodas Freitas 2008; Haeussler and Colyvas 2011). If the researcher was the originator of intellectual property (mostly measured by patents), they participate more actively in academic engagement (Perkmann et al. 2013). Our intention is to examine this relationship utilizing a broader set of indicators (variable number of A-publications, number of registered patents, dummy for experiences with *mobilities*, average number of hours teaching, number of PhD students) and formulate the following hypotheses:

**H3:** *As the number of A-category researcher publications increases, the chances of participating in academic engagement activities decrease.*

**H4:** *As the researcher's teaching volume increases, the chances of participating in academic engagement activities decrease.*

The question of the availability of grants for the researcher's scientific research activity is also relevant, as it is not only a prerequisite for the creation of new knowledge, but can also support the dissemination of research results in practice (Scandura and Iammarino

2022). Nishimura and Okamuro (2016) found that public funding may create incentives for specific motivations for U–I collaboration. However, we would like to directly address the relationship between the public support of an individual's research and the likelihood of academic engagements, as we miss this discussion in literature. Therefore, we formulate research for another hypothesis:

**H5:** *The probability that a researcher will participate in academic engagement activities increases if he has access to public funding for his own R&D activities.*

In articles that used the seniority variable, a mostly positive effect of academic's experiences was found, as academic engagement activities tend to be a result of existing social capital and networks (Perkmann et al. 2013). The relationship or affiliation of an academic with specific entities in universities (like technology centres, or centres of excellence) can positively influence cooperation with the application sphere (Bozeman and Gaughan 2007).

Finally, we utilize a unique approach to the investigation of the relationship between a researcher running their own business and participation in academic engagement activities at universities. This relationship, however, cannot be discussed with literature due to the fact that in conditions of western countries, it is usually restricted to running businesses in sectors related to the scientific focus of the researcher abroad (Perkmann et al. 2013; Dospinescu and Dospinescu 2020). However, since such activities of university employees are not monitored under the conditions of universities in Slovakia, we formulated the following hypothesis:

**H6:** *The chance that a researcher will participate in academic engagement activities increases if he manages his own business with an activity related to his own scientific discipline.*

From the individual characteristics of the researcher, empirical studies identically confirm that men tend to cooperate with external actors more often than women (Link et al. 2007; Boardman 2008; Giuliani et al. 2010). There is also strong evidence for statistical significance of the age factor; however, the results differ in terms of positive or negative effects on the dynamics of academic engagement (Bekkers and Bodas Freitas 2008; Link et al. 2007; Haeussler and Colyvas 2011; D'Este and Perkmann 2011). The significant impact of national policies on academic engagement was not found in empirical studies (Haeussler and Colyvas 2011; Grimpe and Fier 2010).

## 3. Materials and Methods

The main aim of our research is to investigate individual determinants of academic engagement of individual researchers in Slovak conditions, to evaluate the level of formality to academic engagement processes and to describe motives, expected benefits and barriers of the academic engagement of individual researchers in the case of a country in an early stage of the development of the commercialization of academic knowledge. Thus, our research design can be decomposed on the evaluation of qualitative data from a questionnaire survey that will serve to describe multiple aspects of academic engagement in Slovakia according to individual attitudes of researchers and an econometric analysis of determinants of participation of a researcher on cooperation with a non-academic actor based on a quantification of several questions in the survey.

### *3.1. Survey*

We based our investigation on a questionnaire survey of individual researchers. This approach was adopted due to the fact that secondary data collected by the Ministry of Education, or the Centre of Scientific and Technical Information in Slovakia provide information on indicators of commercialization, rather than academic engagement activities. The only alternative to get information about the dynamics of cooperation between universities

and the application sphere was to investigate mandatory disclosed contracts of individual universities. However, this approach would not allow us to acquire information about informal links between researchers and non-academic entities.

The statistical population for our querying was 8521 researchers from all public universities in Slovakia that are not exclusively art-oriented (32 public universities in 2018). We excluded 3 art high schools from the survey due to very specific forms of cooperation with the application sphere in the case of such a school that, in our opinion, requires separate investigation. The questionnaire was organized into 33 questions, out of which 19 were closed, 4 can be considered semi-closed and 10 were open. Open questions were included to get broader information about specific attitudes and perceptions of barriers by researchers that generate linkages with non-academic actors. The questionnaire was distributed in electronic form using the Google forms service. We need to note that 395 emails were undeliverable; therefore, we successfully distributed the questionnaire to 8126 researchers. The response rate was 8.69% which represents 776 responses. In order to distribute our questionnaire, it was necessary to create a database of email contacts for all the mentioned 8521 researchers. This database was created manually by processing employee lists or telephone directories at individual faculties. If neither of these sources of contact was available, we had to obtain e-mails through the employee profiles on the websites of individual departments of Slovak universities. The questionnaire was pre-tested. In the case of the chosen university—the Slovak University of Agriculture in Nitra, the questionnaire was first distributed to collect remarks and suggestions towards the research framework and questions set-up, while after processing of these remarks, the questionnaire was re-distributed again to collect data via the updated questionnaire. Up to 61 creative employees of the university (7.9%) took part in pre-testing. Results of pre-testing showed cases of improper or unclear formulation of questions, led to the change of set-up of several questions (open/closed), changes in the set of collected performance indicators of researchers and requested far more precise descriptions and definitions of various aspects of knowledge transfer and academic engagement.

The gained sample is relatively balanced from the perspective of sex and the scientific field of the researcher. In our sample, men accounted for 54.51% of respondents and women for 45.49%. From the perspective of our broadly-conceived scientific fields, 54.25% of respondents fall under life and technical sciences and 45.75% of respondents under social sciences. Up to 60.44% of our respondents achieved the academic degree PhD or equivalent, 25% of respondents were associated professors, 11.47% were professors and 3.22% of respondents achieved the academic degree MA or equivalent. Our structure of the sample by the highest academic honours also approximately follows the distribution in the entire population.

In order to process the information obtained via the survey, we use basic methods of descriptive analysis. As we already mentioned, we gave the academics the opportunity to comment on the perceived attitudes and barriers in the open questions of a voluntary character which allowed them to write extensive answers. Open questions concerning barriers to academic engagement were filled by 139 of the 766 respondents of the survey. To process this data, we used standard methods of content analysis (Given 2008) and text mining (Salloum et al. 2018). To quantify the barriers perceived by researchers we used the open coding technique (Blair 2015) to find common statements. We identified identical barriers in different answers and labelled them by sequential numbers. Subsequently, we subdivided identified barriers into groups by type of actor/organisational level responsible for the barrier occurrence—barriers at the level of individual researchers, at the level of the university, at the level of central policy-making bodies and barriers at the level of non-academic actors.

### 3.2. Data Analysis

Several questions in our questionnaire were formulated in order to carry out quantitative analysis with the aim to explain how various factors influence the decision of an

individual academic to participate in academic engagement activities. A set of indicators has been created to investigate the impact of the chosen individual characteristics of a researcher, on the decision of a researcher to maintain a relationship based on knowledge flow with at least one non-academic actor. The minimum criterion for the "cooperation relationship" was set as a relationship in which there is a direct flow of knowledge to the university to the non-academic actor. Thus, there is at least a relationship based on informal research, service provision or consultancy, respective of formal contract research or counselling. Therefore, it was not a strong enough "tie" for us, e.g., if a researcher just attended a conference with the participation of businesses. Compared to other studies, it is not our intention to delimit cooperation with the "application sphere" to university–industry relations, as university knowledge can generate added value in other sectors as well. By cooperation "with non-academic actor" we understand cooperation with state government entities, self-government entities private actors or even NGOs. The overview of all variables used in model is provided in Table 1.

**Table 1.** Overview of explanatory variables in the model.

| Factor | Description | Type of Variable |
|---|---|---|
| **institutional factors** | | |
| *scientific field* | life and technical/social science affiliation | binary |
| *applied/basic* | orientation on applied/basic research | binary |
| *TLO* | availability of TLO at university | binary |
| **productivity factors** | | |
| *A-publications* | number of A publications * in 2018 | discrete |
| *patents* | total number of researcher's patents | discrete |
| *mobility* | mobility in the previous 3 years | binary |
| *teaching* | number of hours lectured per week in 2018 | continuous |
| *PhD students* | number of PhD. students in 3 previous years | discrete |
| **access to resources and previous experiences** | | |
| *private grants* | access to private research grants | binary |
| *state grants* | access to state research grants | binary |
| *RD infrastructure* | quality of RD infrastructure on department | ordinal |
| *exp. of department* | experiences of colleagues with ac. engagement | ordinal |
| **networking in application sphere** | | |
| *communication* | average number of hours of communication with actors of application sphere per month | continuous |
| *business* | own business of researcher | binary |
| **controls** | **Controls** | **controls** |
| *sex* | *Sex* | *sex* |
| *experiences* | *Experiences* | *experiences* |

* "A" publication—publication classified as A output for purposes of university accreditation (yearly periodic evaluation)—e.g., foreign monography, publications indexed in wos, or scopus databases.

To test our *hypotheses*, we utilized logistic regression. In the logit model, log odds for value 1 are a linear combination of one or more independent variables having binary or continuous characters. The corresponding probability that the observed event will happen (1) may range from 0 to 1 (Cox 1958). The probability that the researcher will keep a tie with the enterprise can be written as follows:

$$p = \frac{b\beta_0 + \beta_1 x_1 + \ldots \beta_k x_k}{b\beta_0 + \beta_1 x_1 + \ldots . \beta_k x_k + 1} + \frac{1}{1 + b - (b\beta_0 + \beta_1 x_1 + \ldots \beta_k x_k)}$$

where:

$\beta_k$ = are coefficients of independent variables
$x_k$ = value of $k$-th determinant of academic engagement

In terms of selected explanatory variables, our theoretical model will look as follows:

$$\text{existence of cooperation link} = \beta_0 + \beta_1 \times \text{sex} + \beta_2 \times \text{experiences} + \beta_3 \times \text{scientific field} + \beta_4 \times \text{applied/basic research} + \beta_5 \times \text{A-publications} + \beta_6 \times \text{patents} + \beta_7 \times \text{mobility} + \beta_8 \times \text{teaching hours} + \beta_9 \times \text{RD infrastructure} + \beta_{10} \times \text{experiences of department} + \beta_{11} \times \text{PhD students} + \beta_{12} \times \text{availability of TLO} + \beta_{13} \times \text{private grants} + \beta_{14} \times \text{state grants} + \beta_{15} \text{ h spent by communication with application sphere} + \beta_{16} \times \text{own business} + \alpha_i + \varepsilon_{it}$$

## 4. Results

### *4.1. Motives, Barriers and Patterns of Knowledge Diffusion via Academic Engagement*

Among the 776 respondents of the survey, 56.06% of these researchers declare the existence of a cooperation link with an actor in the application sphere. While more than half of the respondents cooperated with the practice, we still consider this information to be worrisome. Employees of Slovak universities are most often defined as pedagogical and research employees at the same time while the scope of their work also includes developing cooperation with actors in the external environment. However, as the results of the survey showed, at most, almost half of the university's creative staff was in contact with the application sphere thanks to the collection of data for their scientific research activities.

The emergence of interpersonal cooperation linkages between researchers and non-academic actors in Slovakia does not differ significantly in terms of the affiliation to a scientific area of the researcher. If we classify collaborating academics into the two broadest scientific areas (social sciences, life and technical sciences), we find that while 55.11% of respondents from life and technical disciplines cooperate with the practice, in the case of social sciences, it is up to 57.18% of respondents. In terms of gender, men cooperate with the application sphere more often (51.14% of the sample) than women (44.00% of the sample). Our assumption is that the seniority of researchers influences academic engagement is supported by the result that 51.92% of doctors, 60.31% of associate professors and up to 71.91% of professors in the sample were engaged in cooperation with an external actor.

Figure 1 displays shares of cooperating researchers in our sample that were engaged in chosen sectors that were the subject of our interest. Among the academics that participated on academic engagement, the majority kept cooperating linkage with an actor of the private sector (74.1%), while more than 40% were cooperating with state government bodies and organisations and third sector actors. This information stresses the growing importance of the third sector institutions in regional innovation systems even in conditions of a post-socialistic country.

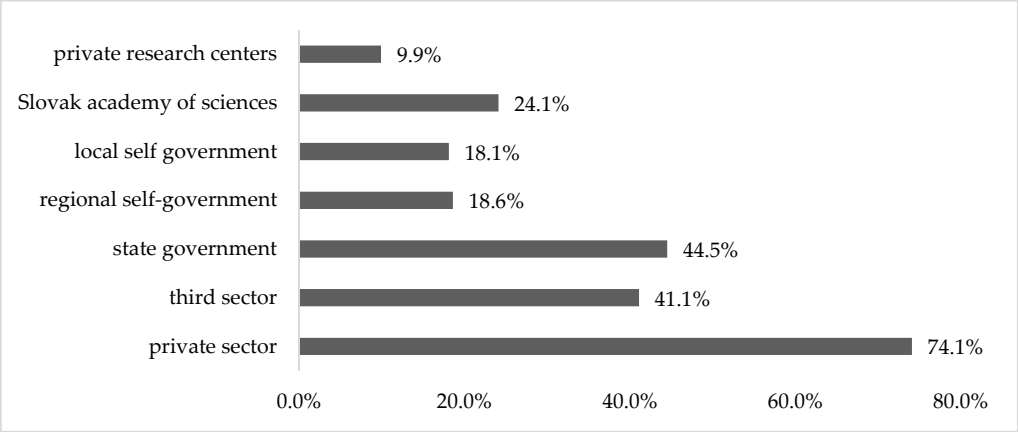


**Figure 1.** Share of academics engaged in application sphere by selected sectors.

Another question of key importance was whether informal linkages influence the dynamics of academic engagement and knowledge transfer based on interpersonal cooper-

ation to a negligible extent. The opposite probably turns out to be a reality. Table 2 shows the proportions of cooperating academics in a sample (those that had at least one case of cooperation with an external actor in 2018) that used listed knowledge transfer channels to shift knowledge/information towards an external partner formally and informally. Academics in our sample provide support to non-academic actors most often through counselling. In 2018, more than a third of cooperating respondents provided counselling to non-academic actors, while 22.4% reported formal counselling (under contract) and 26.5% of respondents declared that they also provided informal counselling. Although this is the only transfer channel where we have seen a higher proportion of academics collaborating more informally than formally, looking at the results for other channels in Figure 2, it is evident that under the conditions of Slovakia, the support for the practice, and therefore, the dissemination of knowledge is also largely facilitated informally. Informal support is provided to non-academic actors in Slovakia also in the case of the production of products or materials (4.1% cooperated formally, 3.7% informally), provision of unique technical equipment of the university (9.1% formal, 6.8% informally) or creation of copyright works (16.4% formal, 7.9% informal). Given the unfinished policies, systems of control of academic activities or support tools at many Slovak universities, a significant share of cooperation with practice is, thus, facilitated informally.

An informal transfer is more preferred by men than by women (44% of men and 34% of women in the sample cooperated with external partners using informal channels). At the same time, it appears that the older the researcher is, the more experiences they have and the more they keep a richer network of partners, the more informal relationships they create (36.46% of doctors, 69% of associate professors and 56.82% of professors used informal transfer channels). It is interesting that only 32% of the total number of respondents in the sample who declared that took part in academic engagement utilized both formal and informal knowledge dissemination channels. This result could lead to the formulation of the hypothesis that formal and informal academic engagement can potentially exclude each other.

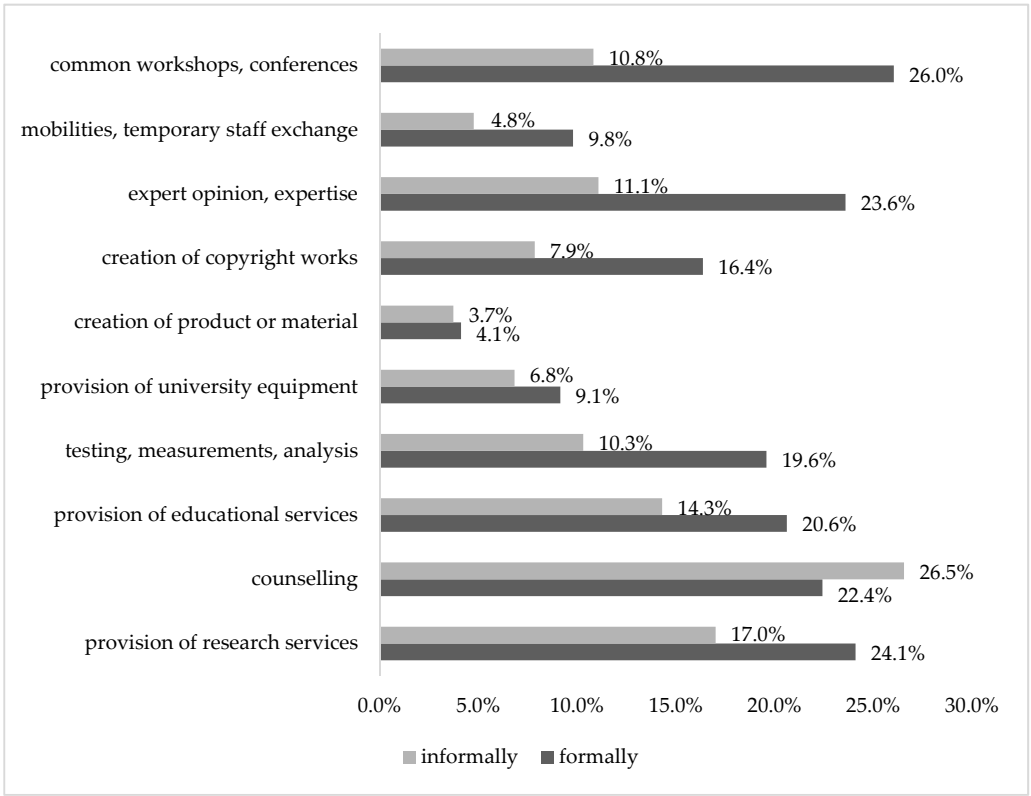


**Figure 2.** Share of academics using selected knowledge transfer channels formally or informally.

We found a certain level of informal academic engagement of Slovak researchers in the application sphere. Based on the supplementary information obtained from the presented survey, we note that the universities in Slovakia are not sufficiently trying to protect knowledge produced by individual researchers, to be transferred into the application sphere formally. The majority of researchers in the survey agree that in conditions of the given university, they are allowed to have side businesses, counselling and research activities in an external environment to a relatively unlimited extent. We recorded that 13.92% of researchers from our sample have a private business while working at the university. Other maintained ties can be also a result of the previous job of researchers in other sectors. Up to 38.53% of researchers in the sample worked in the private sector entities in the past, 32.47% worked in the state administration or self-government, 25.52% worked in non-governmental organisations, 16.37% provide services within scientific park, 3.61% within a business incubator and 3.61% of responded researchers were engaged in industrial unions. The answers to the open-ended questions suggest that many researchers often continue to work for actors in other sectors besides the university.

Figure 3 represents the average scores for the expected benefits from academic engagement identified by the respondents in our sample. In view of the fact that the majority of creative jobs at universities in Slovakia have a mixed scientific-pedagogical character, the most important expectations of cooperation with practice are in the form of non-financial benefits. The highest average significance was recorded in the case of enrichment of the teaching process with practical examples and understanding of the real problems of the application sphere (average importance score 2.75). This is also logically linked to the need to strategically build long-term relationships with key stakeholders (average importance 2.6). Researchers not only need to get inputs into their teaching or scientific activities but often want to test hypothesises in the "real world". Thus, verification of their own scientific results outside the academic sphere reached a still relatively high average score of 2.54.

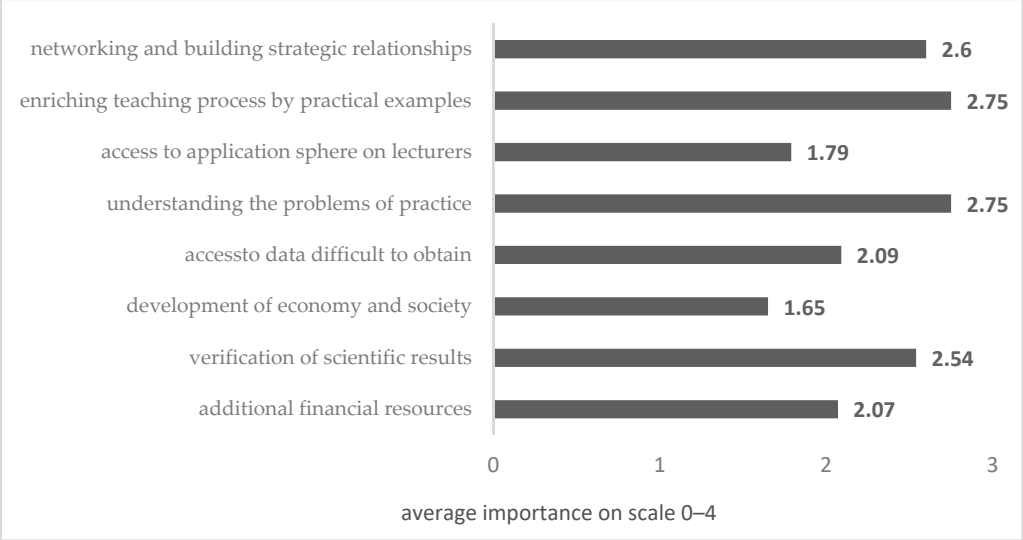


**Figure 3.** Expected benefits from academic engagement.

Expectations of financial profit (whether for themselves, the workplace or the university) gained an average significance of 2.07. Lower scores for financial benefits can be linked to low expectations of personal profit. The results from a different section of our survey, focusing on perceived barriers to academic engagement in Slovakia showed that the majority of surveyed researchers consider personal share of profit from academic engagement activities as inadequate (the majority of this profit is consumed by a university, faculty or department). We would like to compare the average importance of getting financial benefits from cooperation with external actors in the case of researchers from natural/technical and social sciences. While in life and technology sciences, the motivation

in the form of profit is observed to a greater extent (average importance 2.43), academics falling under the social sciences rally on non-financial benefits to a greater extent (average importance 1.66).

**Table 2.** Vertical hierarchy of academics' attitudes towards barriers of academic engagement.

| **Barriers at Level of Researchers** |
| --- |
| lack of time for academic engagement on the part of academics (48) |
| insufficient personal evaluation of academics for the development of cooperation with the application sphere (31) |
| cooperation with practice often takes place in the free time of researchers (17) |
| department/faculty management sees academic engagement as "academic private activities" (15) |
| publishing on topics irrelevant to Slovakia (14) |
| practice is able to communicate and progress much faster than a university (13) |
| incompetence of colleagues—many are "held" at university despite low erudition (11) |
| **Barriers at University Level Perceived by Researchers** |
| missing models of staff remuneration for academic engagement (31) |
| bureaucracy in contract management and approval processes at university (29) |
| universities are too expensive for external partners (14) |
| high shares on contracts divided by university, faculty, departments (12) |
| universities are too slow; lengthy process of project administration for actors of application sphere (8) |
| unfair distribution of personal bonuses to salary at faculties in relation to academic engagement (5) |
| obsolete technical equipment of departments (5) |
| **Barriers at the Level of State Policies** |
| the need to remove the number of student-based subsidy schemes for the academic sector (26) |
| academic engagement is not sufficiently assessed in the methodology of subsidies from the state budget (19) |
| accreditation criteria for universities are too focused on foreign publications (15) |
| national scientific grant schemes do not allow co-financing of/by private partners (14) |
| the lack of a long-term vision for higher education (12) |
| national grant schemes do not push research to be multidisciplinary (9) |

In order to investigate barriers to academic engagement development, we decided to provide the survey respondents with the opportunity to express their specific attitudes concerning perceived barriers to the development of formal academic engagement (contract-based) through open questions in our questionnaire. We come out from an assumption that the understanding of the barriers to formal cooperation with the application sphere can provide us with a better understanding of why informal cooperation appeared in the case of such a proportion of academics. The answers were processed by the open coding method and in Table 2, we present the repeatedly expressed perceived barriers with an indication of how many respondents mentioned them.

At the level of individual academics, it is mainly the lack of time that hampers the development of academic engagement. Academics in Slovak conditions must teach, lead final theses, carry out research, solve multiple research projects of different nature at once (in order to cover lack of financial resources in the department), execute administrative operations connected with research projects, undergo *motilities*, build networks and solve projects in the application sphere, having a low level of administrative, managerial, legal or economic support from the side of the university. Due to these facts, the respondents state that the academic engagement activities take place mainly in "free time". In the case of formal academic engagement via counselling, contractual research and equivalent channels, academics do not feel to be adequately evaluated for this effort "beyond basic responsibilities" from the financial perspective, the perspective of impact on personal growth or from the perspective of recognition of the department in the respective university.

At the level of university management and university-level processes, respondents of the survey state, in several cases, that their university lacks an effective model for staff remuneration for academic engagement and the development of links to the application sphere. As we already indicated, in conditions of several Slovak public universities, academics feel that they are getting a low level of administrative support when organising formal cooperation activities with external partners. It was also stated that universities are, due to the length of contract preparation and multiple levels of contract approval, considerably slower partners for the application sphere than private research institutions and considerably more expensive.

The state policy level of barriers perceived by the responded researchers is mainly from areas of organisation of the public subsidy-based system of financing of higher education in the country and accreditation criteria for evaluation of the university performance. The methodology of the breakdown of state subsidies for higher education is considered by many respondents as overcomplicated and too focused on the number of students admitted to study at a given university. In 2019, there was just a little space to push up state subsidies for a university by academic engagement activities or even by the formal transfer of knowledge via technology licensing or a spin-off establishment. The accreditation (cyclic evaluation of university performance) process in Slovak's higher-education sector is, in recent years, strongly pushing researchers to invest the majority of their time in efforts to publish scientific articles in foreign journals over efforts towards solving domestic problems.

### *4.2. Model Specification*

At this point, we will move towards our quantitative analysis of determinants influencing the generation of interpersonal linkages between researchers and enterprises. We will work with other not yet presented data obtained from our questionnaire survey for modelling addressed relationships.

First, we would like to briefly describe our explanatory variables. From the institutional factors, the scientific field is a binary variable expressing whether the respondent is a member of a scientific discipline in the field of natural and technical sciences or social sciences. According to several authors, the applicability of academic research is an important prerequisite for the emergence of interpersonal links between researchers and actors of other sectors. Therefore, we have created a binary variable applied/basic research which indicates whether the researcher is mainly focused on basic or applied research. Of the 776 respondents, 8.76% are focused exclusively on applied research, while 40.98% of respondents declared a "predominant" focus on applied research. Purely basic research was carried out by 12.11% of academics in our sample and 38.14% of the respondents focus on basic research predominantly. The relationship between the availability of TLO at universities and a researcher's decision to cooperate with the application sphere is evaluated using dummy variables expressing whether university institutionalized support is in the form of university TLO or not.

Within the productivity category, the impact of the researcher's overload, in terms of the level of productivity on building links with the application sphere, is examined. The *A-publication* variable expresses the number of A-category publications which includes, in particular, the publication of monographs by foreign publishers and contributions in journals impacted in the Web of Science and Scopus. The level of academics' overload from a pedagogical perspective will be measured by the *average number of hours taught per semester* in 2018. Only 4.12% of respondents taught zero hours per week in 2018 (purely carrying out research), 12.37% of respondents taught 1–5 h, 35.95% taught 5–10 h, 43.43% taught 10–20 h and 3.87% of respondents in the obtained sample taught more than 20 h per week (a full-time creative employee of university in Slovakia should teach 10 h). Experience and productivity in the field of commercialization of knowledge is expressed by the variable *patents* (total number in entire career). The binary variable *motilities* express whether the academic has completed mobility within the academic or private sector in the last 3 years. As PhD students can contribute to lowering the overload of research, we formulate

variable *PhD students* that express a number of PhD students led by an associated professor or professor.

Among the access to resources and previous experience-related factors, first, we investigate the relationship between the availability of the *state or private R&D grants* on the emergence of observed interpersonal linkages of researchers. We also formulate variable *RD infrastructure* and *experiences of the department* with academic engagement and commercialization (liqueur scale—own attitude of the researcher) that will test the relationship between the quality of R&D and the poll of experiences and know-how on the level of institution and academic engagement.

The last section—engagement in the application sphere—contains two variables, the *average number of hours invested in communication with actors in the application sphere* per month and the variable *business* that express whether researchers have their own business outside of the academic environment.

We also formulate two *controls*—sex and experiences. Variable experiences express the length of the academic's career in the higher education sector; therefore, it serves as an indicator of seniority.

### 4.3. Results of Model Diagnostics

We execute our LOGIT in the Stata software. First, we proceed with the diagnostics of the model. Having several limits, the linktest can be used to detect specification errors. The idea behind it is that if the model is properly specified, one should not be able to find any additional predictors that are statistically significant except by chance. As linear predictor value _hat is significant, we consider the model to be properly specified. In Table 3. linear predicted value squared _hatsq is not significant; therefore, linktest is not significant. This is signalizing that we face no serious problem of omitting relevant variables and our link function can be considered as correctly specified.

**Table 3.** Results of linktest.

| Number of obs. | 776 | | | | | |
|---|---|---|---|---|---|---|
| LR $chi^2$ (2) | 175.93 | | | | | |
| Prob > $chi^2$ | 0 | | | | | |
| Pseudo $R^2$ | 0.1653 | | | | | |
| cooperation | Coef. | Std. Err. | z | P > \|z\| | [95% Conf. | Interval] |
| _hat | 1.060 | 0.101 | 10.46 | 0.000 | 0.861 | 1.258 |
| _hatsq | −0.079 | 0.053 | −1.5 | 0.134 | −0.182 | 0.024 |
| _cons | 0.057 | 0.091 | 0.63 | 0.531 | −0.122 | 0.236 |

Then we test the proper specification of the model using Hosmer-Lemeshow test of the goodness of fit (Table 4). Hosmer-Lemeshow test suggests regrouping the data by ordering the predicted probabilities and then forming 10 nearly equal-sized groups. Since the test is not significant, we are satisfied with the fit of our model.

**Table 4.** Hosmer-Lemeshow test of model compliance with observations.

| Number of obs. | 776 |
|---|---|
| LR $chi^2$ (16) | 174.09 |
| Prob > $chi^2$ | 0.0000 |
| Hosmer-Lemeshow $chi^2$ (8) | 5.6 |
| Prob > $chi^2$ | 0.6917 |

In Table 5 below, we can see the classification table for our logit model. The overall rate of correct classification is estimated to be 70.62%, with 76.78% of the normal weight group correctly classified (specificity) and 62.76% of the low-weight group correctly classified (sensitivity).

**Table 5.** The classification statistics and classification table.

| | | |
|---|---|---|
| Sensitivity | Pr(+ \| D) | 76.78% |
| Specificity | Pr(− \| ~D) | 62.76% |
| Positive predictive value | Pr(D \| +) | 72.45% |
| Negative predictive value | Pr(~D \| −) | 67.94% |
| False + rate for true ~D | Pr(+ \| ~D) | 37.24% |
| False − rate for true D | Pr(− \| D) | 23.22% |
| False + rate for classified + | Pr(~D \| +) | 27.55% |
| False − rate for classified − | Pr(D \| −) | 32.06% |
| Correctly classified | | 78.80% |

We use the graph of the ROC curve and AUC to check the classification performance of our model, respective of how much is our model capable to distinguish between 0 and 1 classes (Figure 4). When AUC is approximately 0, the model is actually reciprocating the classes. It means that the model is predicting a negative class as a positive class and vice versa. When AUC is approximately 0.5, the model has no discrimination capacity to distinguish between positive class and negative class. The area under the curve of 0.77, in the case of our model, indicates acceptable discrimination for the model.

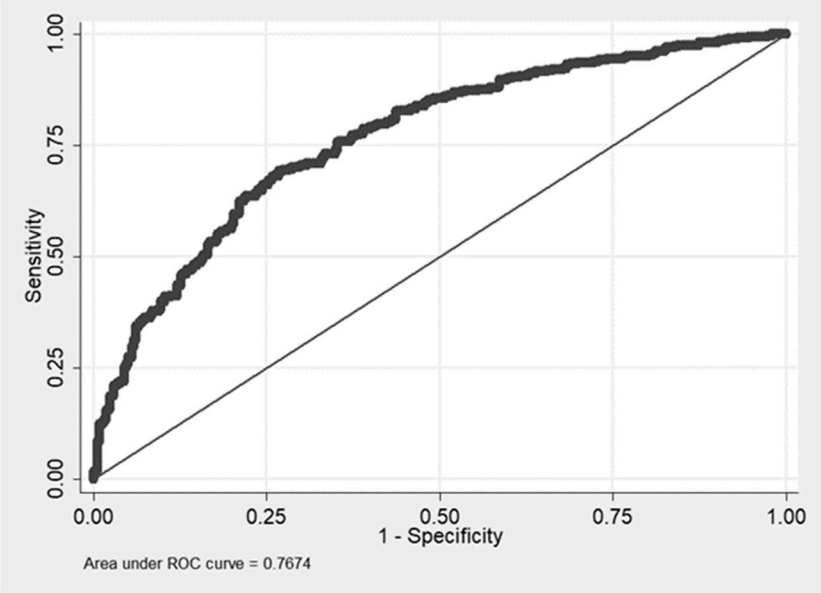


**Figure 4.** The ROC curve and area under it.

### *4.4. Results of Analysis*

In this chapter, we are going to interpret the results of the conducted analysis based on the estimations of the described logit model. First, as far as controls are concerned, only the academic's sex influences whether or not they will be engaged in the application sphere. As we can see in Table 6, if the researcher is male, there is a 1.58 times higher probability that he will cooperate with an entity outside of the academic sector. The model has further shown that the length of an academic career does not affect the probability of a researcher's participation in academic engagement activities.

**Table 6.** Results of the model.

| Cooperation (1/0) | Coef. | Odds Ratio | z | P > \|z\| |
|---|---|---|---|---|
| sex | 0.457 ** | 1.580 ** | 2.69 | 0.007 |
| | (0.170) | (−0.268) | | |
| experiences | −0.013 | 0.987 | −1.53 | 0.126 |
| | (0.009) | (0.009) | | |
| scientific field | −0.104 | 0.901 | −0.57 | 0.569 |
| | (0.183) | (0.165) | | |
| applied/basic research | 0.793 *** | 2.210 *** | 4.73 | 0.000 |
| | (0.168) | (0.370) | | |
| A-publications | −0.016 | 0.985 | −0.56 | 0.576 |
| | (0.028) | (0.027) | | |
| patents | 0.016 | 1.016 | 1.38 | 0.169 |
| | (0.011) | (0.012) | | |
| mobilities | 0.285 | 1.330 | 1.7 | 0.089 |
| | (0.168) | (0.223) | | |
| teaching | 0.014 | 1.014 | 0.94 | |
| | (0.015) | (0.015) | | |
| RD infrastructure | −0.205 | 0.815 | −1.8 | 0.071 |
| | (0.114) | (0.093) | | |
| experiences of department | 0.386 *** | 1.472 *** | 5.05 | |
| | (0.077) | (0.113) | | |
| PhD students | 0.224 *** | 1.251 *** | 3.77 | 0.000 |
| | (0.059) | (0.074) | | |
| TLO | −0.204 | 0.815 | −1.06 | 0.291 |
| | (0.194) | (0.158) | | |
| private research grants | 0.638 * | 1.892 * | 2.01 | 0.044 |
| | (0.317) | (0.599) | | |
| state research grants | 0.871 *** | 2.390 *** | 4.23 | 0.000 |
| | (0.206) | (0.493) | | |
| communication | 0.028 *** | 1.028 *** | 4.24 | 0.000 |
| | (0.006) | (0.007) | | |
| business | 1.457 ** | 4.293 ** | 2.69 | 0.007 |
| | (0.541) | (2.323) | | |
| _cons | −1.966 *** | 0.140 *** | −5.13 | 0.000 |
| | (0.383) | (0.054) | | |
| Number of obs. | 776 | | | |

statistical significance on levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; standard errors in brackets.

Concerning the observed institutional determinants, the probability of a researcher's interest to collaborate with practice does not depend on the scientific field, respective of whether academic research focus falls under life and technical or social sciences. However, we have found a positive impact on the nature of academic research. If the researcher focuses purely or predominantly on applied research, there is up to a 2.21 times higher probability that he will generate links with actors of the application sphere; thus, we accept Hypothesis 1. We were curious about the results for the availability of TLO at universities, as more than half of Slovak public universities have not established such an institutional unit yet. Several of the existing academic TLOs show fast and positive results from their initial activities, but most of them can be considered as TLOs in seed phase. Several of them provide administrative support also in cases of contract research or provision of services mainly for private sector entities. However, in line with literature, we still found no impact of TLOs on the emergence of cases of academic engagement; thus, we accept Hypothesis 2.

We found no evidence of the relationship between the majority of productivity indicators and the emergence of cases of academic engagement in Slovak conditions. Thus, we must reject both Hypotheses 3 and 4. The experiences and time investments in publishing high-quality publications, testing and registering intellectual property and the completion of motilities are factors which could be, on the one hand, understood as factors of quality of research of surveyed academics but, on the other hand, as the level of researcher's overload

in time investments to activities different from the academic engagement. However, the reality that we found no evidence of teaching overload's impact on cooperation with external actors can be considered striking, as respondents of the survey presented this factor as a barrier to academic engagement in open questions. However, this can be explained by the fact that the declared impact of researchers' workload could not be felt due to a certain volume of "superheroes" among academics who manage to facilitate cooperation with the application sphere even outside working hours. The positive influence of PhD students, in turn, reflects the character of PhD studies in Slovakia. The PhD students are expected to "be a hand" for thesis supervisors, and thus, execute part of the supervisor's responsibilities (teach for him, work on publications, scientific projects, etc.) and reduce their overload.

Within the "access to resources and previous experiences" group of factors, we found evidence of a positive impact of experiences of the department on the emergence of links between academic and non-academic actors. Results of the experiences of the department point to the fact that an accumulation of experiences by colleagues can help to facilitate the researcher's intention to build links and cooperate with external actors. We accept Hypothesis 5, as the availability of both public and also private R&D grants increases the likelihood that the academic will cooperate with the actor of the application sphere. At least in the case of contractual (formal) cooperation, if the research is funded from private sources, the research results flow primarily to the research donor. Therefore, there is, to some extent, a relationship of conditionality in a case, but this does not apply to informal cooperation via selected transfer channels. However, it is more interesting that the availability of state research grants increases the likelihood that the academic will cooperate with external actors to a higher extent—2.23 times. These grants provide the researcher with the opportunity to decide how to disseminate his research results to a certain extent. Considering the proportion of researchers that received financing for their research via state grants (75.26% of respondents), academic research in Slovakia is highly dependent on national sources of funding which was also reflected in the results for this variable.

We found a positive impact of networking factors on the emergence of observed cooperative linkages. The respondents were asked to estimate the number of hours invested in keeping communication with actors in the application sphere. It was found to be the determinant slightly increasing the probability that a collaborative relationship between the researcher and the external partner will emerge. As we already stated in the previous chapters, the evolving system of support for the transfer of knowledge into the application sphere under the conditions of some universities has led to the creation of a tradition of "tolerance" of academics' own business overlapping with their research and development at the university. We found that in the case of academics that have their own business, the probability of cooperation with actors of the application sphere within the academic activities is 4.29 times higher. We can hypothesize that academics who have their own businesses in addition to university jobs facilitate a significant part of informal collaboration between the academic sector and other sectors. Thus, we accept Hypothesis 6.

## 5. Discussion

In this article, we tried to evaluate the current state of the development of academic engagement in the conditions of Slovakia. Our intention was to map out how academic engagement substitutes for formal knowledge transfer in the conditions of a post-socialist country. We contributed to understanding the informal flows of knowledge from the academic environment into practice and, finally, we investigated the impact of diverse factors at the researcher level on the emergence of interpersonal links between academics and the actors in the application sphere.

The academic sector in Slovakia is a suitable object for comparing academic engagement in the case of the developed and underdeveloped systems of formal technology transfer which can be, for example, demonstrated by lower dynamics of formal transfer (Moravčíková et al. 2017) with its neighbours, Hungary or Czech Republic

(Orazbayeva et al. 2018); however, both countries deal with relatively similar problems. During the last decade, the central government, the Ministry of Education, government agencies and individual universities in Slovakia have taken the first steps towards developing, in particular, the formal transfer of knowledge that universities produce. These steps were mainly in the area of building technology transfer infrastructure, creation of the institutional support (science, technology centres, centres of excellence), creation of TLOs in the form of academic firms or university departments (Buček et al. 2019). However, these new institutional units, built with the support of the European Structural Funds, have not been fully exploited due to the unsuitable conditions in the calls under the Operational Program Research and Innovation (outputs of projects cannot serve commercial purposes for a given time period) due to the lack of skilled human capital, the lack of experiences with knowledge transfer, poor links between private and academic sectors and the often changing policies of university management (Moravčíková et al. 2017).

Our results give a clue that academic engagement in Slovakia is more individualized than institutionalized. The proportion of researchers participating on the academic engagement activities showed to be significantly higher in our survey in comparison to previous studies (Moravčíková et al. 2017). The fact that more than 56% of respondents declared that engagement in the application sphere can be the result of a broadened understanding of academic engagement in this study, even in comparison to foreign authors (see e.g., Abramo et al. 2011; Bilić et al. 2017)—especially in terms of multisectoral approach, focus on non-contractual collaboration and collaborations based on non-financial benefits.

Many authors put forward the question of to what extent and by which channels the knowledge from universities spreads informally (Link et al. 2007; Bonaccorsi et al. 2014; Grimpe and Fier 2010). The academics in Slovak conditions have considerable freedom to enter cooperation with external partners in the name of the respective university department. The insufficiencies in the transfer system, policies, culture and missing institutional support in the Slovak academic sector, together with salary conditions, force the universities to tolerate the own business of their employees and a rampant informal collaboration with the application sphere. Of course, it is worrying that individual researchers produce products and materials and provide services during their working time at the university or, even, provide work on the laboratory equipment of the university informally. On the other hand, the survey results suggest that formal and informal KT can go "hand-in-hand", as the emergence of the formal contract can possibly build on informal collaboration (Link et al. 2007). Considering motives and expectations from collaboration on the side of academics in the case of commercialization activities, one of the main expectations from the collaboration with the application sphere was, in other studies, the expectation of profit (Perkmann et al. 2013). Our survey showed that academics are engaged in the application sphere, especially in order to get non-financial benefits related to obtaining information and data, understanding practical problems and enriching teaching, for which we can find support in studies by other authors (e.g., D'Este and Perkmann 2011; Bodas Freitas and Verspagen 2017) but still look for additional sources of funding.

Several barriers perceived by the respondents of our survey can be considered as conventional also in the conditions of western countries, e.g., the bureaucracy of formal contracts management (Geuna and Muscio 2009) pessimism and resistance to the diversification of academic activities (Van Vugt et al. 2008), the problem of mutual trust and different expectation (Bruneel et al. 2010) and conflicts over public funding of knowledge transferred to application sphere (Reichenfeld 2011). However, as a result of the transformation process from the model of academic research and technology transferring in the socialist era to modern western models, Slovak researchers experience barriers mitigated in western countries several decades ago, e.g., negative attitudes of university management, often changing policies, insufficient time capacity of researchers, remuneration system, the personal assessment system or the impact of academic engagement on career growth. Due to the lengthy administration of contractual relations and the cost of services to external partners, we expect that the academic sector does not have a predominantly good image in

the private sector. Therefore, individual businesses often look for a way to connect with individual professors rather than approaching the university formally.

Our quantitative analysis pointed out several factors that influence the dynamics of academic engagement in Slovakia. From an institutional point of view, we found evidence that scientist affiliation to life and technical scientific discipline raises the potential for academic engagement, in line with Bekkers and Bodas Freitas (2008) or Ponomariov (2008). Networking with actors of other sectors, in terms of investments in communication, is also a prerequisite for the emergence of new links with external partners. Academic engagement is also influenced by the accumulation of the experiences of the department and the degree of support for the development of these activities by the management of the department, which is no longer the case in the US and Western Europe (D'Este and Patel 2007; Ponomariov 2008). It means that individual researchers draw collective know-how at university level, even though they subsequently operate independently to certain extent. The observed impact of the availability of state research funding on academic engagement points out that Slovak researchers supply research results to the application sphere rather than react to demand. Finally, we found a crucial role of social capital and business skills in academic engagement in Slovakia which was suggested by, for example, the results of D'Este and Patel (2007). From individual controls, we similarly to Link et al. (2007), Boardman (2008), Giuliani et al. (2010) found that men tend to more likely to participate in academic engagement while we found no support for the impact of researchers' seniority which means that the age and experiences of the researcher do not play the role in the emergence of collaborative links between universities and external partners.

## 6. Conclusions

In Slovakia, there is considerable scope for formalizing the transfer of knowledge created by academic research for the application sphere, which requires a change in legislation and accreditation criteria at a national level, institutional capacity building, awareness building, setting up effective internal regulations and support models or employee evaluation models at the level of universities. We found that the probability of an individual's participation in academic engagement activities in Slovak conditions grows with a focus on applied research, if the researcher has available both public and private grants to cover his research and development needs or to cover the costs of the opening of collaborative ties, has own PhD students, invests time in building networks in the application sphere or runs a business in addition to employment at the university. Despite the considerable volume of empirical studies, we still cannot compare the importance of formal and informal dissemination of university knowledge to the development of regional economies. Our results suggest that in a post-socialist country, the effects of informal knowledge dissemination could be even more significant.

The results show managerial implications at different levels. As far as national policy is concerned, recommendations could be formulated towards changes in the methodology of the breakdown of subsidies of public universities or the accreditation system. In 2017, these mechanisms do not sufficiently recognize the importance of academic engagement for the development of universities and the region itself and create space for internal policies and internal reward systems that do not sufficiently value academic engagement. It is worth considering how to approach increasing the level of formalization of knowledge transfer into practice, as the current level of informal cooperation combined with less rigid rules can have significant impacts on local and regional development. At the level of universities, it is especially desirable to differentiate job positions according to the academic's narrower specialization in teaching, research or collaboration with industry. In many cases, universities in Slovakia need to build more effective internal tools for motivating academics and decentralize competencies to manage contractual relations with practice.

In future research, it would be interesting to compare the effects of strict formalization of academic engagement with current results. Effects of changes in the law concerning

possibilities of IP rights management by universities and academic entrepreneurship should be a solid ground for further research in post-socialistic countries. We recommend focusing future efforts on investigating the nature of the emergence of the concrete links, their strength and specific flows of knowledge between the researcher and the application sphere actor while responding simultaneously to both sides of the cooperation link. The study shows that elaboration of university–industry networks should be broadened by other spatial actors, while university third-sector knowledge flows appear to be much-omitted topic. In particular, we would like to emphasize the need to evaluate the evolution of U-I collaboration patterns in the conditions of post-socialist countries with an emphasis on evaluating how the economic transition affected the applied models of technology transfer, the adaptation of universities to the third mission and the development of academic entrepreneurship.

Considering the limitations of the study, it is necessary to state that, even in the case of the questionnaire survey with a relatively high responce rate, the results of empirical studies based on questionnaires suffer from dishonest answers or possible understanding and interpretation of questions. This also limits, to a certain extent, the exactness of quantitative analyses carried out on the data from the surveys. The main limit of our analysis is the non-measurement of link intensity. Considering the interpretation of motives and barriers, attitudes of the application sphere are necessary for a comprehensive understanding of why university in Slovak republic appears to be often too expensive, slow and untrustworthy partner.

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