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Barriers to Third Mission: organizational and individual antecedents

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Abstract

The fulfillment of the University's Third Mission has led the university to become a key actor for social and economic development in its regions of influence through a much closer linkage with the different agents in its environment. Thus, the literature has highlighted both the benefits derived from the Third University Mission, the difficulties inherent in the process and the existence of various barriers that can hinder its consolidation in the academic environment. Within the framework of these studies, it has been possible to identify three types of barriers to adopting the third mission: process, researcher, and ally or partner. It is worth mentioning that most of the research developed to date has focused on the study of the impact of the barriers on the development of the Third Mission but not on the analysis of the factors that can influence or attenuate the perception of these barriers. This is surprising if one considers that identifying these factors is relevant in designing strategies to promote the University's Third Mission. Therefore, this article aims to identify the factors that influence or attenuate the researcher's perception of different types of barriers to developing Third Mission activities. The study was based on data from a survey applied to a sample of academics categorized in the National System of Science, Technology and Innovation of Colombia and linked to 6 higher education institutions in the Colombian Caribbean region. Binary logistic regression models were established to analyze the data obtained. The results obtained suggest that, in addition to the researcher's previous experience in the external sector, their perception of the existence of processes or support services provided by the university for the promotion of relationships with actors in the socioeconomic environment is important to mitigate the barriers perceived during the development of Third Mission activities, especially when these activities are located in the support for the management and execution of technology transfer activities. In particular, it was found that as the academic's perception of the policies and procedures, support activities, and the university's technology transfer capacity improves, the barriers of both the researcher and those associated with the process are dissipated. This implies that universities should advance in the institutionalization of the third mission and in strengthening the functions of promotion, advice and support, as well as promotion structures and thus be able to mitigate the perceived barriers to the development of the University's Third Mission.

Keywords: Third Mission, Barriers, Organizational aspects, Researcher characteristics, Stokes quadrant

Introduction

In recent years, universities have undergone significant changes in their missionary functions, explained by some authors in terms of the emergence of a new social contract between universities and the society that funds them (Martin, 2002). This new social contract is based on implementing a research agenda that responds to a greater extent to the demands of "society" and a much greater commitment of the university institution to the transfer and socio-economic exploitation of its knowledge and capabilities. Thus, in this context, universities began to strengthen what has been called the University's Third Mission to complement the traditional teaching and research missions.

The Third Mission has had different orientations, from one that focuses on the direct contribution of the university to socioeconomic development, through processes of knowledge transfer to productive actors (Etzkowitz & Leydesdorff, 2000; Jongbloed et al., 2008), to a broader vision that includes the generation, use, application and exploitation of knowledge and other capabilities of the university outside the academic environment (Molas-Gallart & Castro-Martínez, 2007; Tuunainen, 2005). The fulfillment of the Third Mission has led the university to become a key actor for social and economic development in its regions through a much closer linkage with the different agents in its environment (Vega-Jurado & Castro-Martínez, 2011; Wang et al., 2016), and has led to improved competitiveness and wealth creation in the regions where these linkages take place (Barnes et al., 2002; Goddard, 2011).

One of the most visible results of this Third Mission has been the strengthening of University–Enterprise Relationships as a strategy to promote technological innovation processes and, simultaneously, facilitate universities' access to funding sources for developing their research activities. Therefore, it is not surprising that most of the research on the University's Third Mission has focused on studying the nature of university–industry relations, as well as the effects of these relations on both business performance and the scientific productivity of academics (Manjarrés-Henríquez et al., 2009; Meyer-Krahmer & Schmoch, 1998). However, although relevant, this vision leaves out the heterogeneity and specificities of other social agents with which these relationships can/should be established (Castro-Martínez et al., 2016). In this sense, it is necessary, as some authors have pointed out, to approach the analysis of the Third Mission from a much broader perspective, taking into account not only the role of universities in economic development through their articulation with productive actors but also their impact on social development through the relationship with social actors and the government itself (Castro-Martínez et al., 2016; Göransson et al., 2009).

In addition to the above, although the literature has highlighted the benefits derived from the Third University Mission, it has also been recognized that the development of such activities is not an easy process and that several barriers may hinder their consolidation in the academic environment (Bruneel et al., 2010; D'Este & Patel, 2007). These barriers arise because of the difficulties inherent in the articulation process due to cultural and management differences between organizations (universities, companies, foundations, etc.), but they are also associated with the motivations and/or capabilities of the actors directly involved in the relationship, for example, the researcher and the company. Thus, it is possible to identify three types of barriers to the adoption of the third mission: process barriers, researcher barriers, and ally or partner barriers (Arvanitis et al., 2008;

Closs et al., 2012; Jacobson et al., 2004; Lee, 1996). Although these barriers have been documented in previous research, few studies have analyzed the factors that may influence them (Alpizar-Terrero et al., 2017). In this sense, most of the research developed to date has focused on the analysis of the impact of barriers on the development of the Third Mission, but not on the study of the factors that can influence or mitigate the perception of these barriers, which is surprising considering that the identification of these factors is a relevant aspect for the design of policies and strategies aimed at promoting the University's Third Mission.

Considering the above, this article aims to identify the factors that influence the researcher's perception of different types of barriers to developing third-mission activities. The study starts by considering the barriers traditionally recognized in the literature (process, researcher and partner barriers) and includes several elements of interest. First, the analysis is carried out from the researcher's perspective, inquiring directly into the researcher's perception of the obstacles they encounter when developing activities related to the University's Third Mission. This fact is relevant considering that it has been widely recognized that strengthening the University's Third Mission depends greatly on the interest and motivation of the researcher, who, in most cases, decides which external actors to link with and how to do it. On the other hand, this study adopts a broad perspective when analyzing the University's Third Mission, considering not only the relationship with productive actors but also with the government and other social actors (foundations, NGOs). Finally, as possible determinants of the barriers to the third mission, organizational factors are considered, as well as some elements related to the researcher's profile and the orientation of their research work.

The empirical analysis is based on data derived from the application of a survey to a sample of 211 research professors recognized and categorized by the Ministry of Science, Technology and Innovation of Colombia—Minciencias—linked to 6 universities located in the Colombian Caribbean region and accredited by the National Accreditation Council of Colombia (NAC). The article is structured as follows: “Literature review” section presents the literature review, “Methodology” section describes the methodology and variables analyzed in the study, “Results” section presents the results, and “Conclusions” section draws the conclusions of the study.

Literature review

Barriers to the fulfillment of the University's Third Mission

The university's adoption of the Third Mission has generated important changes not only in the way the institution is organized, but also in the ethos of the academic community. For academics, for example, the fulfillment of the Third Mission leads to greater reflection on the impact of their research activity and a greater commitment to disseminate and transfer the results of their research to different social actors. Similarly, the development of these activities has led to changes in how the professor's work is evaluated, and promotion and prestige are achieved within the institution (Bercovitz & Feldman, 2011; Eom & Lee, 2010; Hertzfeld et al., 2006).

However, given the magnitude of the transformations mentioned above and the fact that the emergence of the Third Mission has been more the result of the changing demands of society and not so much a process of internal development of the university

institution (Martin, 2002), certain obstacles or barriers to its consolidation have become evident (Bruneel et al., 2010; D'Este & Patel, 2007). These barriers are of various types and are related to the difficulties inherent to the relationship process and the characteristics of the actors involved, i.e., the researcher and the partner (companies, foundations, government, etc.). The main barriers identified in the literature are described below.

Process barriers

The development of Third Mission activities implies the implementation of new relationship schemes between the university and non-academic actors that facilitate knowledge-transfer processes, as well as the use of university services and capabilities by the different social actors. These processes can become complex due to the need to guarantee confidentiality conditions and intellectual property rights of the derived results. The negotiations required for the parties to reach a consensus on these points can be complicated and discourage the participation of academics in these activities (Jacobson et al., 2004). Similarly, the administrative procedures related to identifying the partner, signing contracts, and managing the collaboration require significant time and resources that, without support at the institutional level, would be difficult for the academic to assume (Bozeman, 2000).

Researcher barriers

Regarding the researcher, several authors have pointed out that there may be an initial resistance to participate in Third Mission activities because they consider them to be alien to their academic work or think that they do not contribute to their consolidation and recognition as a scientist (Bozeman, 2000; Bruneel et al., 2010). Added to this is the lack of experience in activities that enhance relationships with external actors as well as the lack of business skills, which makes the negotiation process with potential partners more complex (Bozeman, 2000; Bruneel et al., 2010; Gulbrandsen & Smeby, 2005; Jacobson et al., 2004; Mansfield & Lee, 1996; Siegel et al., 2004; Tartari et al., 2012). Additionally, the works of Closs et al., (2012) and Mitton et al., (2007) point out that, in more than a few cases, researchers find it difficult to advance in Third Mission activities due to the time they spend in fulfilling the traditional missions of teaching and research.

Partner barriers

Just as there are factors inherent to the researcher that restrict the development of Third Mission activities, the existence of obstacles inherent to the actors with whom academics interact has also been recognized. Among the most frequently mentioned factors is the scientific-technical capacity of the partner, which can condition the effectiveness of knowledge transfer processes. In this sense, several authors have pointed out that strengthening university–business relations (one of the dimensions of the University's Third Mission) is more complex in contexts where the industrial sector has a low absorption capacity (Vega-Jurado et al., 2020). In these contexts, companies hardly recognize the value that university R&D can have in their innovation processes and do not have the capabilities to assimilate the results of academic research effectively. In line with the above, other aspects pointed out as barriers to the development of the Third Mission are the lack of experience of non-academic actors in relationship processes, making it

difficult to choose a partner and negotiate agreements. Finally, one should not forget the barriers associated with cultural and organizational differences that limit interactions between the scientific community and society (Belkhdja & Landry, 2005; Bruneel et al., 2010; Dasgupta & David, 1994; Hughes & Kitson, 2012). While the scientific community follows principles inspired by the traditional scientific ethos, such as the freedom to publish research results, professional prestige and the prevalence of quality research, the business sector, for example, is inspired by other types of principles, such as confidentiality, cost-effectiveness, the application of research to business strategies and the improvement of the competitive positions of companies (Etzkowitz, 1998).

Factors that influence the barriers perceived by the investigators

The aforementioned aspects have been widely recognized in previous studies related to developing the University's Third Mission. However, most of the research carried out to date describes these barriers from an anecdotal perspective, and few studies have focused on the specific analysis of these barriers and on identifying the factors that may influence their development. Accordingly, and taking as a reference the traditional literature on the determinants of the University's Third Mission, it is possible to propose that the degree to which a researcher perceives the barriers mentioned above as relevant may be conditioned by factors related to the organizational aspects of the institution where they work, as well as by their specific characteristics and researcher profile.

Organizational aspects can be understood as how power and authority are exercised in the institution for the allocation and management of resources and involve the enactment of policies and procedures for decision-making and control in the direction or management of organizations for the effectiveness of processes (Carnegie & Tuck, 2010); it also involves all those structures, processes and activities involved in the planning and direction of institutions and people (Fielden, 2008).

For the development of the Third Mission, universities have made structural and organizational changes aimed at promoting three kinds of activities: (i) communication between knowledge producers and users; (ii) intermediation and negotiation of knowledge transfer agreements; and (iii) knowledge delivery (Jacobson et al., 2004). These changes have resulted not only in the design and implementation of new procedures, but also in the development of support structures aimed at institutionalizing the processes of knowledge transfer and linkage with third parties (Geuna et al., 2009). In the case of European and North American universities, for example, these new organizational forms have names such as: University-Industry Liaison Offices; Technology Licensing Offices; University-Industry Research Centers; Research Alliances; University Spin-Offs and Technology Consulting Firms (Cohen et al., 2002; Link et al., 2007; Rossi, 2010), which began to be the subject of research and reference in the literature.

Considering the above, it is possible to suggest that the researchers' perception of the existence of barriers or obstacles to adopting the Third Mission can be attenuated to the extent that the institution implements processes and/or procedures to support the development of these activities. In this sense, to the extent that the researcher recognizes that there are clear policies within the institution and that there are support services (information, advice, and management) for the development of Third Mission activities, the fewer barriers they will perceive, particularly those barriers associated

with the relationship process. This is based on the fact that individuals' perception of the organization in which they participate is key to understanding their behavior and performance (Alvarez, 2013). Thus, organizational aspects and the internal politics of the university can exert an important effect on the perception of barriers by researchers (Bruneel et al., 2010), imposing limitations or generating specific opportunities for relationships with non-academic actors.

On the other hand, in addition to the factors associated with organizational aspects, it must be recognized that there are factors at the level of the researcher that play an important role in their participation in Third Mission activities, considering that it is they who, to a large extent, have the power to decide on the degree and form of interaction they establish. In this sense, the literature has explored the role exerted by sociodemographic factors (Banal-Estañol et al., 2015); the area of knowledge (Craig Boardman & Ponomarev, 2009; Friedman & Silberman, 2003; Perkmann & Walsh, 2007) and the researcher's previous experience (Bekkers & Bodas Freitas, 2008; D'Este & Patel, 2007) as determinants of the adoption of Third Mission activities. These factors may also influence the scholar's perception of barriers. Thus, for example, the researcher's experience, derived from previous work in the business sector or in the government sector, may attenuate the perception of barriers associated with both the process and the ally due to the relational assets that the latter has built and the knowledge of the interests and motivations of non-academic actors (Molas-Gallart et al., 2016).

Another factor that may mitigate the perception of barriers is the academic research profile. In this line, it has traditionally been pointed out that researchers from disciplines such as engineering are more likely to relate to external actors due to the applied nature of their research compared to academics from the social and human sciences. This idea, however, may be biased because most of the research has approached the analysis of the Third Mission from the perspective of the University–Business relationship, which, as mentioned above, represents only one dimension of it. For this reason, more recently, some authors have taken the distinction provided by Stokes with the so-called Pasteur Quadrant as a theoretical reference for analyzing the role of the academic's research orientation in developing the Third Mission (Stokes, 1997). This author proposes a two-dimensional analysis of research objectives based on the consideration of two axes: a vertical one, representing the search for pure understanding, and a horizontal one, representing the consideration of the use of knowledge. In this way, four distinct quadrants are identified: Pasteur's, Bohr's, Edison's and blank. The Pasteur quadrant refers to scientific fields that are devoted to solving practical problems and progressing with understanding at the same time. Thus, it is recognized that it is possible for significant advances in the store of scientific knowledge to have practical values. Edison's quadrant contemplates applied research inquiring into technological development without pursuing progress in understanding. Such research has some scientific relevance, and the utilization of science occurs with strategic perspectives. The Bohr quadrant, on the other hand, represents basic research without immediate application. There is no commitment to develop any specific product or process. Finally, the blank quadrant is the anti-science quadrant, i.e., it represents societal needs that are not met by the other quadrants.

Stokes' proposal suggests then that, although scientists direct their efforts towards the generation of fundamental knowledge, they face a wide range of degrees of inspiration by the possible considerations of the use of the results of their research, so this may have an impact on their performance in the fulfillment of the Third Mission and their perception of the existence of barriers to the process. Authors such as (Caliari & Chiarini, 2018), for example, point out that researchers in the Bohr quadrant have high scientific competence but little technological capacity, while those located in the Edison quadrant are more focused on technological developments than on scientific activity, which may influence the mechanisms they use for the fulfillment of the Third Mission. Extrapolating these arguments to the analysis of barriers, it could be argued that those academics who develop their research activity considering the potential use of the results derived from it (Edison and Pasteur quadrant) have a greater orientation towards the relationship with external actors, so they tend to perceive fewer barriers for the development of third mission activities.

Methodology

Context of study

This paper uses the Colombian Caribbean region as the study context, a territory with relevant characteristics for the topic under analysis that should be highlighted. First, the Colombian Caribbean region is located in Latin America, a context in which universities have followed an evolutionary process different from that of institutions in the Anglo-Saxon world. Thus, for example, in Latin America, most universities are teaching institutions where research has not yet been consolidated as an academic mission (Schiller & Liefner, 2007). Despite this, since the beginning of the twentieth century and as a product of the Cordoba reform of 1918, Latin American universities incorporated the development of three generic missions in their discourse: Teaching, Research and Extension (Tunnermann, 2010). This particular third mission of the Latin American university ("Extension") was understood mainly as the linkage of the university with the less favored sectors of the population through cultural dissemination and technical assistance and not as a direct participation of the institution in the economic development of the region through a linkage with the productive sector, as was the case in Europe and the United States (Vega-Jurado & Castro-Martinez, 2011). However, starting in the 1990s, a change in science and technology policies materialized in Latin America which, oriented on the approaches derived from the experience of developed countries, promoted in Latin American universities the adoption of the Third Mission under the principles of a closer relationship with industry (Vega-Jurado & Castro-Martinez, 2011). This generated acute tensions within the university, which debated between external stimuli in favor of a form of linkage based on the principles of academic capitalism and internal reluctance, derived from the Latin American tradition, to adopt direct business practices (Vega-Jurado et al., 2007).

Secondly, the context analyzed is a territory that could be called of low absorptive capacity. In Colombia, investment in R&D is 0.24% of GDP, which is low in relation to the average performance of Latin America and the Caribbean (0.64%) and very low compared to cases such as the United States (2.79%). Additionally, the rate of researchers per million inhabitants is 132 and most researchers work in Higher Education Institutions

(95.60%) (Consejo Privado de Competitividad, 2018). Likewise, the absorption of knowledge by companies, associated with the rate of research talent linked to them, is 1.2, a low value compared to the range of 76 in the world innovation indicators (Cornell et al., 2018).

The above shows that both universities and the business and social environment in Latin America present certain specificities that can affect the development of the Third Mission. Thus, articulating the Third Mission with the traditional approach to university extensionism that has been present in the work of Latin American universities in the last century can generate greater tensions and barriers both at the level of the researcher and at the level of the process itself. On the other hand, the deficiencies derived from the low absorption capacity of the productive and social sectors may cause the barriers associated with the ally and/or partner to manifest themselves with greater intensity.

In this regard, it is worth noting that much of the empirical evidence on the Third Mission focuses mainly on information on technologically developed contexts, so that extrapolating the results of these investigations to less dynamic contexts as a basis for policy formulation may be a conceptual error (Benneworth & Hospers, 2007; Huggins & Johnston, 2009). All this analyzes the barriers to the adoption of Third Mission practices in the context of the study addressed in this paper even more relevant, considering that given the characteristics mentioned above, it is likely that the results obtained from studies conducted in developed countries are not entirely applicable to the Latin American context.

Data

As mentioned in previous sections, the unit of analysis of this study is the research professor, whose perception of the barriers they evidence when carrying out Third Mission activities as well as the strategies and services that exist in their institution to support the development of these activities are investigated. The information was obtained by applying a survey to a sample of professors-researchers linked to 6 accredited universities located in the main cities of the Colombian Caribbean region (Barranquilla, Cartagena and Santa Marta). The population was defined from the list of professors recognized in the 2017 call for proposals by the Colombian Ministry of Science, Technology and Innovation in one of the four defined categories: Junior Researcher, Associate Researcher, Senior Researcher and Emeritus Researcher. The population size was 872 professors to whom the instrument was sent via email. The instrument's application period was 6 months (December 2017–May 2018), and a response rate of 27% was obtained, equivalent to 235 completed questionnaires. However, after the review, the final sample consisted of 211 surveys with the information required to develop the study.

Dependent variables

The study considers three dependent variables associated with the three types of barriers recognized in the literature and described in previous sections: Process Barriers (*PROCB*), Researcher Barriers (*RESB*) and Partner Barriers (*PARTB*). These variables were built from the answers given by the researchers on the extent to which different factors have been an obstacle to engaging with external actors in the framework of Third Mission activities. The questionnaire listed 16 factors and asked respondents to rate each

Table 1 Factorial analysis of barriers perceived by researcher teachers (Source: Own elaboration (2019))

Barriers	Types of Barriers		
	Factor 1 process	Factor 2 partner	Factor 3 researcher
Its lack of interest in establishing relationships with non-scientific and non-academic entities	— 0.100	0.197	0.769
Lack of recognition as a scientific merit	0.140	0.286	0.746
Lack of time, due to their dedication to other activities	0.334	0.041	0.729
The information available for finding potential users of their research	0.309	0.254	0.668
The lack of interest of other organizations in the research that is conducted	0.207	0.439	0.591
Existing cultural differences	0.092	0.726	0.301
The size and experience of the other organizations	0.338	0.786	0.245
Lack of scientific and technical capacity of other organizations to assimilate their research results	0.302	0.718	0.236
Conditions for the protection of confidentiality and intellectual property rights of result	0.370	0.547	0.338
Lack of external funding for these activities	0.660	0.084	0.356
Marketing and negotiation process	0.515	0.492	0.051
Administrative procedures associated with the execution of the contract	0.744	0.279	0.150
Lack of institutional financial resources for these activities	0.811	0.086	— 0.002
Lack of information during the process	0.746	0.310	0.292
Lack of specialized personnel to support the process	0.728	0.360	0.204
Information and communication barriers during the process	0.636	0.467	0.102
Cronbach's alpha	0.884	0.829	0.802

(Varimax—Rotated Matrix) and internal reliability coefficients (Cronbach's alpha)

on a Likert scale from 1 (None) to 5 (Very much). Based on the results, a factor analysis was carried out and the items were grouped into three factors that were related to the typology of variables indicated above (see Table 1). Factor 1 included aspects related to process barriers (marketing and negotiation, administrative procedures, communication barriers during the process, lack of support, etc.); factor 2 included items associated with partner barriers (cultural differences, scientific and technical capacity of the partner, size and experience of the other organizations, etc.); while factor 3 included items related to the researcher's own barriers (lack of interest, lack of time, lack of recognition as a scientific merit, etc.). According to the results of the factor analysis, the dependent variables were built taking into account the valuation of the items that make up each factor, as follows: the variable takes the value of 1 if the researcher had assigned values between 3 and 5 to any of the items that make up each component, i.e., had indicated that they were of some or great importance; and takes the value of 0 if the researcher had indicated 1 or 2 (little or no importance).

Explanatory variables

As indicated, the objective of this work is to identify the factors that affect or mitigate the perception of different types of barriers for the development of third-mission activities

by the researcher. To this end, and taking into account the literature review carried out, the analysis includes as explanatory variables factors related to organizational and management aspects of the institutions to which the researcher is linked, as well as factors related to the researcher's experience and the investigative profile.

Regarding the dimension associated with the organizational and management aspects of the institutions to which the researcher is linked, the questionnaire included two blocks of questions. The first is related to the academic's perception of the existence of policies, procedures and strategies to support Third Mission activities, while the second is directly related to the frequency with which the university carries out promotion, information, consulting and management activities that support the implementation of the Third Mission. With respect to the first block of questions, the researchers were asked to indicate their degree of agreement with a series of statements using a 5-point Likert scale. A total of 12 items were included and subjected to a factor analysis to reduce the variables. As a result, four factors were identified, which were associated with: (i) policies and procedures (*POL&PROC*); (ii) management capacity (*MANGCap*); (iii) capacity for technology transfer (*TRANSFCap*); and (iv) resource allocation (*RECAII*) (Table 2).

Based on the four factors identified from the factor analysis, four variables were defined (*POL&PROC*; *MANGCap*; *TRANSFCap* and *RECAII*) using the arithmetic average of the scores of the different items that make up each factor.

With regard to the development of support activities by the university, five variables were defined that capture the frequency with which the university carries out activities of: a) promotion and communication (*PRO&COM*); b) information (*INF*); c) management (*MANAG*); d) relationship consulting (*RELCONS*) and, e) consulting during and after the relationship (*CDyAREL*). The frequency was rated on a 5-point Likert scale, with 1 being "never" and 5 "always". For the final construction of the variables, a factor analysis was carried out (Table 3) and, subsequently, a variable was defined taking into account the arithmetic average of the scores of the different items that make up each factor.

With regard to the characteristics of the researcher, the analysis included as explanatory variables aspects associated with the orientation of his or her research and previous experience. With regard to the first point, four variables were defined according to the typology proposed by Stokes in his so-called Pasteur quadrant (Stokes, 1997). For this purpose, respondents were asked to rate on a Likert scale of 1 to 5, where 1 = none and 5 = very much, the following items: (i) the extent to which their research activity is inspired by making contributions to the fundamental understanding of phenomena and facts; and (ii) the extent to which their research activity is inspired by the practical use and/or application of knowledge outside the scientific or academic field. The answers given by the researchers to each item were recoded on a binary scale, with value "1 = high" if the researcher had answered "quite a lot = 4" and "a lot = 5", and with value "0 = low" in all other cases. Four binary variables were then constructed, each reflecting the quadrants defined by Stokes (Pasteur, Edison, Bohr, NN) and taking the value of 1 according to the following rules: PASTEUR: high fundamental understanding and high use consideration; EDISON: low fundamental understanding and high use consideration; Bohr: high fundamental

Table 2 Factor analysis of the perception of research professors on organizational aspects of the university (Source: Own elaboration (2019))

	Factor 1: policies and procedures	Factor 2: management capacity	Factor 3: technology transfer capacity	Factor 4: resource allocation
There is a clear institutional orientation and policy towards knowledge transfer	0.822	0.207	0.366	0.008
Adequate procedures are in place for the promotion and management of relations with agents of society	0.710	0.373	0.224	0.313
The policies and procedures defined for the relationship are widely disseminated	0.756	0.271	0.206	0.413
Policies and procedures are articulated to the conditions of the environment	0.688	0.299	0.279	0.392
The institution allocates physical and financial resources to support the development of relationship-building activities	0.355	0.341	0.245	0.716
There is an incentive policy that stimulates the establishment of relationships with different agents of society	0.240	0.495	0.271	0.667
Qualified and experienced support personnel are available to advise on these relationships	0.269	0.827	0.164	0.257
Strategies are implemented to eliminate cultural and informational barriers that impede the relationship process	0.352	0.713	0.320	0.316
Facilitates sufficient and appropriate contacts to find potential partners	0.265	0.778	0.345	0.225
There is an infrastructure for the development of research and technological development processes	0.261	0.336	0.774	0.022
The University has the administrative and management capacity to carry out knowledge transfer activities	0.349	0.232	0.766	0.271
The University has the capacity to manage the protection of industrial or intellectual property	0.194	0.155	0.819	0.284
Cronbach's Alpha	0.920	0.940	0.860	0.800

understanding and low use consideration; NN: low fundamental understanding and low use consideration (Olmos-Peñuela et al., 2014).

Finally, with respect to the researcher's previous experience, two variables are included that, respectively, capture the academic's previous experience in the public sector (*PUBLExp*) and in the private sector (*PRIVExp*). These variables are measured considering the number of years that the academic has worked in the public or private sector, prior to joining the university.

Table 3 Categories of support activities carried out by the university (Cronbach's α) (Source: Own elaboration (2019))

	Promotional activities	Information	Management processes	Consulting during and after the relationship	Relationship consulting
Production of brochures and catalogs	0.934				
Informative e-mails					
Visits					
Meetings and events					
Forums					
Exhibition at fairs					
Trade show attendance					
Information about: actors in the socioeconomic environment		0.883			
Calls and requirements					
Industrial/intellectual property					
Potential partners or allies					
Contract negotiation			0.964		
Administration and execution of contracts and agreements					
Coordination of relations between researchers and funding entities					
Education and training in knowledge transfer					
Valuation and Protection of Intellectual Property					
Control and monitoring of knowledge transfer projects and programs					
Allocation of infrastructure for the development of knowledge transfer projects					
Participation in public and private programs and calls for proposals					0.899
Technical feasibility studies					
Identification of problems					
Financing alternatives and access to resources					
Formulation of proposals					

Table 3 (continued)

	Promotional activities	Information	Management processes	Consulting during and after the relationship	Relationship consulting
Negotiation of proposals and/or projects				0.947	
Legal aspects in the initiation and execution of projects					
Preparation of budgets					
Signing of contracts or agreements					
Design of exploitation plans					
Intellectual / industrial property					

Control variables

In addition to the abovementioned aspects, the study controls for two additional factors. The first is the type of university (*TUni*) to which the academic is linked. In this case, a dichotomous variable is included that takes the value of 1 if the university is public and the value of 2 if the university is private. This distinction is important considering that, given the evolutionary trajectory of the higher education system in Colombia, private universities have been closer to the productive sector, while public universities have been more oriented towards links with other social actors.

The second factor that is controlled for is the type of linkage that the academic has with the university. The literature recognizes that the status of the professor within the organization can impact the development of third mission activities as a result of their trajectory and recognition. In this sense, a categorical variable was defined as follows Professor Status (*PROFStat*) which takes the following values: 1, if the professor is full-time; 2, if full-time occasional; 3, if part-time; 4, if part-time occasional; 5, if tenured; and 6 other type of relationship.

Econometric specification

The relationship between the explanatory variables described above and the barriers to the fulfillment of the Third Mission was studied by estimating binary logistic regression models using the following econometric specification:

$$BARR_i = 0 + \beta_1 POL\&PROC + \beta_2 MANGCap + \beta_3 TRANSFCap + \beta_4 RECALL + \beta_5 PRO\&COM + \beta_6 INF + \beta_7 MANAG + \beta_8 RELCONS + \beta_9 CDyAREL + \beta_{10} CPasteur + \beta_{11} CEdison + \beta_{12} CBohr + \beta_{13} CNN + \beta_{14} PUBLExp + \beta_{15} PRIVExp + \beta_{16} TUni + \beta_{17} PROFStat + \alpha,$$

where i takes values that represent the three types of barriers analyzed in this study. β_j ($j=0, \dots, 14$) are the parameters of the model to be estimated, and α is an-error term.

Regarding the explanatory variables, they are associated with the profile of the researcher and their perception of the organizational aspects of the university for this type of activity. Considering what has been described above, the explanatory variables

Table 4 Descriptive statistics (Source: Own elaboration (2019))

Type of variable	Variable	Min	Max	Mean	Standard deviation
Dependent	<i>BARR1 (Researcher Barriers)</i>	0	1	0.47	0.500
	<i>BARR2 (Partner Barriers)</i>	0	1	0.37	0.485
	<i>BARR3 (Process Barriers)</i>	0	1	0.57	0.496
Explanatory: aspects organizational	<i>POL&PROC</i>	1.0	5.0	3.567	0.9265
	<i>MANGCap</i>	1.0	5.0	3.233	0.9912
	<i>TRANSFCap</i>	1.0	5.0	3.672	0.9693
	<i>RECAII</i>	1.0	5.0	3.295	1.0847
	<i>PRO&COM</i>	1.0	5.0	3.785	0.7222
	<i>INF</i>	1.0	5.0	3.561	0.7653
	<i>RELCONS</i>	1.0	5.0	3.407	0.7760
	<i>CDyAREL</i>	1.0	5.0	3.279	0.8760
Explanatory: research orientation of the research professor	<i>MANAG</i>	1.0	5.0	3.667	0.8263
	<i>CPasteur</i>	0	1	0.46	0.500
	<i>CEdison</i>	0	1	0.14	0.345
	<i>CBohr</i>	0	1	0.36	0.481
	<i>CNN</i>	0	1	0.04	0.191
Explanatory: researcher professor experience	<i>PRIVExp</i>	0	20	1.16	3.76
	<i>PUBLExp</i>	0	43	5.12	7.72
Control	<i>TUni</i>	1	2	1.41	0.493
	<i>PROFStat</i>	1	6	1.89	1.641

taken into account are: Policies and Procedures (*POLE&PROC*); Management Capacity (*MANGCap*); Technology Transfer Capacity (*TRANSFCap*); Allocation of Resources (*ASIGNREC*); Promotion and Communication (*PROYCOM*); Information (*INF*); Relationship Consulting (*APREL*); Consulting During and After the Relationship (*ADyDREL*); Management (*AGEST*); Research Orientation (*CPasteur*; *CEdison*; *CBohr*; *CNN*); Private Sector Experience (*PRIVExp*); and Public Administration Experience (*PUBLExp*). Additionally, it is controlled by: Professor Status (*PROFStat*) and Type of University (*TUni*).

Results

Descriptive results

Table 4 presents the descriptive statistics of the variables used in the analysis. With regard to the dependent variable, as can be seen, of the three types of barriers analyzed, the most relevant for the research professors are the barriers related to the process, followed by the barriers of the researcher and finally, the barriers of the partner. This result suggests that, for research professors, the relationship with external actors is difficult due to the complexity of the process itself, as well as aspects inherent to their academic activity and research profile. Interestingly, their evaluation of the existence of barriers in the partner is the lowest of the three, indicating that, despite the weaknesses of the socioeconomic environment in terms of its absorption capacity, for the researchers, the main obstacles to the Third Mission are in the university environment and in the limitations of the exercise of their work.

In the analysis of the most relevant barriers, the results show that, in the group of barriers to the process, the main obstacles are associated with the difficulty of the administrative procedures required for the management of the agreements, the lack of sources of funding to promote collaboration and the lack of specialized support staff in the universities to support these tasks.¹ On the other hand, as far as the researcher's barriers are concerned, the main obstacles recognized relate to lack of time due to teaching obligations and lack of information on potential partners.² In this regard, previous studies have highlighted that, in the context of Latin America, university academics spend most of their working day developing teaching activities (Abello & Pardo Sánchez, 2014). This fact was pointed out by Closs et al. (2012) as a barrier to the processes of knowledge transfer in the Brazilian context due to the difficulty of the academics to adequately reconcile the time required to interact with external actors and meet their teaching commitments.

Finally, it is worth noting that of the different aspects explored in the survey as potential barriers, the one that received the lowest rating was related to the researcher's lack of interest in developing Third Mission activities. This indicates that the academic community has aligned itself with the new social demands and that, in principle, it is not reluctant to adopt Third Mission practices.

Concerning the explanatory variables, Table 4 shows that the respondents moderately agree with the existence of norms, procedures, policies and structures at the institutional level to support Third Mission activities. This result suggests that, although there is still significant room for improvement from the organizational point of view to support these activities, the respondents consider that their institutions have already begun to take the first steps in this direction and to promote organizational transformations oriented toward the fulfillment of the Third Mission. About the research profile of the academic, 46% of the respondents place themselves in the Pasteur quadrant, 36% in the Bohr quadrant and 14% in the Edison quadrant. These results indicate that, in most cases, researchers guide their activity inspired not only by the fundamental understanding of phenomena but also by the practical utility of their results. In principle, this disposition towards considerations of use (present in the categories of Pasteur and Edison) would imply a greater willingness on the part of academics to link up with external actors who can exploit their results from a social or economic point of view. Interestingly, 4% were placed in the blank quadrant, indicating that their research does not pursue either a fundamental understanding of the phenomena or practical utility. Finally, the results indicate that academics report more previous experience in the public sector—with an average of 5.12 years—compared to the private sector (1.16 years).

Results of the econometric model

Table 5 presents the results of the econometric models for the three types of barriers considered in this analysis. Binary logistic regression is used to estimate the model, given the dichotomous nature of the dependent variables.

¹ These factors were rated as fairly and very important by 57%, 46% and 34% of respondents, respectively.

² These factors were rated as fairly and very important by 59% and 34% of respondents, respectively.

Table 5 Binary logistic regression model results (Source: Own elaboration (2019))

Explanatory variables	BARR1 Researcher barriers	BARR2 Partner barriers	BARR3 Process barriers
<i>POL&PROC</i>	0.034	0.038	-0.991***
<i>MANGCap</i>	- 0.363	0.145	0.096
<i>TRANSFCap</i>	- 0.406*	- 0.247	- 0.581**
<i>RECAII</i>	0.111	0.093	0.132
<i>PRO&COM</i>	- 0.106	- 0.272	- 0.357
<i>INF</i>	- 0.135	- 0.363	- 1.195***
<i>RELCONS</i>	- 0.108	0.220	0.870**
<i>CDyAREL</i>	- 0.054	- 0.356	- 0.803***
<i>MANAG</i>	- 0.038	- 0.135	0.626
<i>CPasteur(1)</i>	0.033	- 0.090	0.062
<i>CEdison(1)</i>	- 0.184	- 0.278	0.820
<i>CNN(1)</i>	- 1.808**	- 0.481	- 0.771
<i>PRIVExp</i>	- 0.072*	- 0.018	- 0.041
<i>PUBLExp</i>	0.065***	0.054***	0.107***
<i>TUni</i>	- 0.647*	- 0.565	- 1.402***
<i>PROFStat</i>			
<i>PROFStat 1</i>	- 0.998	- 0.204	- 1.324
<i>PROFStat 2</i>	- 0.487	0.732	- 1.202
<i>PROFStat 3</i>	- 1.723*	- 0.502	- 4.252***
<i>PROFStat 4</i>	- 2.284	- 0.715	- 2.606
<i>PROFStat 5</i>	- 1.510*	0.140	- 1.059
Constant	6.550	3.558	9.792
Omnibus testing			
Chi-square	40.257.688	24.954	85.556.265
p-value	0.004633	0.203	0
Pseudo-R ²			
Logarithm of the likelihood -2	247.610.584	251.257	197.850.79
Nagelkerke	0.235	0.153821	0.453
Hosmer and Lemeshow test			
Chi-square	5.564	3.844.099	4.634
p-value	0.695992	0.870908	0.796
Predictive capacity of the models			
Accuracy (IC 95%)	72%	66%	76%

The results show that the models with the greatest explanatory power are those related to process and researcher barriers. In these two cases, evidence was found of a significant effect (in some cases positive, in others negative) of both the organizational aspects and the academic characteristics.

Beginning with the organizational aspects, evidence was shown in favor of the effect of adopting policies, procedures and practices to support knowledge transfer, as strategies to reduce the perception of barriers related to the Third Mission process. In this line, the variables *POL&PROC* y *TRANSFCap* showed a significant and negative effect. These results support the findings of authors such as Geuna et al. (2009) and Jacobson et al. (2004), who emphasize the importance of designing and implementing new procedures and support structures in universities aimed at institutionalizing

the processes of knowledge transfer and linkage with third parties as a key element to ensure the transition towards the adoption of the Third Mission. Due to the inherent complexities of these new activities, universities must create an enabling environment for them, defining new policies, recognition and incentive schemes, but also facilitating the management of these activities through support structures with specialized personnel. It is also worth noting that, of the organizational factors considered in the analysis, the variable *TRANSFCap* also showed a significant and negative effect on the perception of researcher barriers. In other words, the strengthening of transfer capacities at the organizational level not only attenuates the perception of barriers related to the relationship process itself, but also reduces the barriers that the researcher perceives at the personal level. This may be because, to the extent that the researcher finds support in the organizational instances for the development of transfer activities, their perception of aspects such as lack of time or difficulty in identifying partners decreases.

With regard to the implementation of support activities, the results indicate that information activities are the most important ones (*INF*) and consulting activities during the relationship (*CDyAREL*) also decrease the perception of barriers in the process. This result is in line with what was expected and indicates that to the extent that the university implements actions to facilitate the identification of partners, the negotiation of contracts and/or the negotiation of intellectual property aspects, the development of Third Mission activities is perceived less problematic by the academic.

Considering the above results, it could be stated that the university's management in fulfilling the third mission may impose constraints and opportunities for researchers (Halilem et al., 2011). Thus, the university must be able to understand its true dynamics in these processes and develop alternatives that go hand in hand with the way in which professors carry out certain activities of the third mission. The lack of flexibility at the institutional level can make the process of engaging with external actors cumbersome for academics and discourage them from collaborating, in addition to the fact that research professors are particularly sensitive to the characteristics of the operating environment in which they work (Tartari & Breschi, 2012).

Turning to the effect of the academic characteristics, the results show that those associated with the researcher's previous experience are the most significant of the variables considered in the analysis. In this sense, the results show that previous experience in the public sector increases the perception of the three types of barriers analyzed, while previous experience in the private sector decreases the perception of barriers associated with the researcher. Based on the fact that previous experience was included in the analysis as a proxy for the academic's relational capital, these results reveal an interesting pattern. Previous involvement with governmental entities makes the researcher more cautious in relation to the development of Third Mission activities and identifies greater barriers in the process, in the partner and in themselves. This result may be due to the highly bureaucratic nature of public institutions in Latin America, which hinders negotiation and contracting processes. Thus, researchers who have previously worked in the public sector and have first-hand knowledge of these elements may find it more difficult to establish relationships with

such organizations, both because of the lack of interest they may have in the results of academic research and because of the difficulty of managing the collaboration process.

On the other hand, researchers with more experience in the private sector perceive barriers to establishing Third Mission actions with less intensity. In this case, prior knowledge of the logic and organizational climate of the companies reduces the researcher's reservations regarding the development of transfer activities and relationships with external actors. This result is in line with the findings of authors such as Arvanitis et al., 2008; Craig Boardman & Ponomariov, 2009; Landry et al., 2010; who consider that the participation of academics in Third Mission activities with industry is largely related to the experience they develop thanks to the idiosyncratic resources located in their environment and not so much to the generic resources and services to which they have access through their university technology transfer office, unlike the previous experience in the public sector in which the recognition of the bureaucratic processes associated with them may affect the imaginary that this work from the university implies.

Regarding the research profile, no evidence was found that the researcher's orientation (Pasteur, Bohr or Edison) significantly determines the perceived barriers. In principle, it was expected that a greater orientation of the investigative processes towards the conditions of use would decrease the perception of barriers on the investigator's part, compared to the orientation towards the achievement of the fundamental understanding of the phenomena. Along these lines, although the coefficients of the Edison variable were negative, their effect was not significant. In this sense, it seems that regardless of the orientation that the researcher has in terms of the principles that guide their research activity, the development of Third Mission activities is something assumed as necessary in the academic community and its development is more or less facilitated by factors of an organizational nature or aspects related to the specific experience of the researcher in fields other than academia.

Finally, concerning the control variables, the significant effect of the type of university the researcher is linked to stands out. Specifically, the results indicate that if the researcher belongs to a private university, their perception of the barriers related to the process and to the researcher decreases. One possible explanation for this result is to be found in the tradition of the Colombian university. As pointed out in "[Context of study](#)" section, public universities were traditionally distanced from the productive sector and their links with the social sector were structured around the development of activities oriented to a large extent to make up for the deficiencies of an inefficient state. On the other hand, private universities were founded in several cases to respond to the needs of the productive sector itself and developed more flexible processes to manage commercial agreements and negotiations with third parties. This may support the conclusions of Morales-Rubiano et al. (2014), who state that, in Colombia, in the case of national public institutions with the possibility of contracting and managing salaries and budgets with money from the State, they are subject to gaps in the regulations that prevent them from establishing long-term relationships with the environment. These gaps become more evident when these universities try to adopt Third Mission activities because the efforts made from within the university for capacity building, such as diversifying the sources of

resources available for R&D, guiding innovators to patent their inventions, and actively relating to the environment, encounter serious complications derived from the legislation that governs them.

Conclusions

This article aimed to determine the factors influencing the research professor's perception of different barriers to fulfilling the University's Third Mission. The analysis took into account the organizational aspects of the university, as well as factors related to the characteristics and research profile of the academic.

The first aspect that emerges from the analysis is that, of the three types of barriers considered, the most relevant are those directly associated with the process of relating with external actors and the barriers inherent to the academic. To a lesser extent, the professors identified the barriers associated with the potential partner and/or ally as relevant. This fact is interesting insofar as it reflects that, from the researcher's perspective, the main obstacles to strengthening the Third Mission are found in the academic environment and, therefore, there is ample room for maneuvering in the universities themselves for the design of policies and strategies that promote the consolidation of this new Mission. Aspects such as the difficulty of the procedures related to negotiating agreements and/or contracts and the lack of financial resources and specialized support personnel to support these activities were the main obstacles identified in the relationship process. On the other hand, lack of time due to teaching obligations was the aspect identified as the main barrier at the academic level. All these obstacles can be addressed by designing institutional strategies and represent areas of intervention of interest for designing university policies.

Following the above, the results show that to the extent universities have implemented actions to adapt their institutional structure, policy, and procedural framework, the barriers mentioned above are attenuated. In fact, some of the variables included in the study as proxies for organizational aspects showed a significant and negative effect on both process and academic barriers. Researchers who perceive that their institutions have improved their transfer capacity and have implemented policies and procedures favorable to the Third Mission and information and advisory services for its development perceive, to a lesser extent, the existence of barriers in the process. This demonstrates the importance at the university level of implementing actions to institutionalize the Third Mission, recognizing the challenges involved in developing new linkage schemes with the actors in their socioeconomic environment.

Concerning the characteristics of the teacher, the aspect that shows to have the greatest impact on the perception of barriers to the Third Mission is the researcher's previous experience in non-academic sectors. In this regard, the results point to an interesting pattern: previous experience in the public sector increases the valuation of barriers, while previous experience in the private sector decreases them, particularly the researcher's own barriers. In general terms, the literature has pointed out that the previous experience of the academic is a factor that can attenuate barriers to the extent that it facilitates the understanding of institutional frameworks other than the university, as well as the identification of common points and interests in the negotiation processes. In this sense, it has been pointed out that, if there is prior knowledge of the interests and

characteristics of potential partners, the relationship process becomes easier. According to the results obtained, this logic holds true in the case of previous experience in the productive sector, but does not apply to the public sector. This result may be related to the characteristics of the context analyzed, where, in general, public institutions are recognized as highly bureaucratic organizations with little flexibility to adapt to new collaboration schemes.

On the other hand, no significant difference was found in the perception of barriers between teachers classified in the Pasteur and Edison quadrants concerning those classified in the Bohr quadrant. In this sense, the perception of barriers to the development of Third Mission activities seems not to be determined by the specific orientation adopted by the teacher in his or her research work, and regardless of the orientation towards practical results or the search for a better understanding of phenomena, the barriers are present.

The nature (public or private) of the institution where the researcher works was also a key variable in reducing the perception of barriers to the Third Mission. Specifically, researchers belonging to private universities tend to perceive fewer barriers than those working in public institutions. This last result, added to the aspects mentioned above, shows that in the context analyzed, the strengthening of the University's Third Mission depends to a large extent on the adaptation of institutional frameworks to the requirements of this "new social contract" of the university with society and the design of policies, procedures, strategies and structures to support the development of these new linkage schemes. Researchers seem to be clear about the new demands and have accepted the implications derived from a greater linkage with the productive sector and society in general, but they demand greater support from the institution on those fronts where they are not strong (contract negotiation, intellectual property, search for partners) and greater flexibility to combine the development of these new activities with their classic missions of teaching and research.

Finally, it is important to point out some limitations of the present study that become possible lines of future research. First, the analysis is based on cross-sectional data, taken at a specific time, which imposes certain restrictions when finding causal relationships between variables is desired. Secondly, the analysis is based on the perception of academics, who, although they are a key actor, are not the only protagonists in these processes. Future studies can complete the analysis of barriers to the Third Mission by exploring the perspective of non-academic actors (companies, public sector entities, etc.) in relation to the obstacles they encounter both in the process and in the university itself.

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Author contributions

JV and LM analyzed and interpreted the data. GN was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Declarations

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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