The impact of the closeness of cooperation on the effectiveness of cooperation in university-industry R&D collaborations

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Abstract

The effectiveness and manageability of collaborations between universities and companies are extremely significant in the period when cooperative R&D projects enjoy increased support. University-corporate relationships may imply a lot of advantages that can yield significant potential added value for all participants. This added value can be translated as contribution to human resource development, access to additional resources, learning impacts, other social gains, or the sum of the synergies of all these benefits. The precondition for the success of these unique business-nonbusiness collaborations is the management of projects implemented within the framework of cooperation, as well as the management of the entire cooperation.

Introduction

Our study focuses on this latter issue. By interpreting the results of empirical research, and by using the tools of relationship marketing we are trying to find the answer to the question whether (governmental, regional, institution or other) programmes designed to enhance the closeness of cooperation improve the effectiveness of university-corporate collaborations in economic terms.

As a starting point of our analysis we conducted a pilot research on the relationship portfolio of the University of Szeged during 2007. During the analysis we applied a dual approach, which means that the relationship between the effectiveness of cooperation and the closeness of cooperation was studied not only from the viewpoint of the corporate, or university party, but from both viewpoints in parallel. In addition to answering this question, this paper pays special attention to the study of the possible gains of university-corporate cooperation, to the components of effective cooperation, as well as to the interpretability of the closeness of cooperation in relation to these two sectors.

1. The characteristics of university-industry R&D collaborations

Similarly to collaborations implemented in other sectors, university-industry collaborations can be described as a rather colourful phenomenon. Although their main significance is in the knowledge flow and the transfer of knowledge, it is worth emphasising that higher education institutions, as the participants of the local society and economy, also maintain corporate and entrepreneurial relationships. In connection with the forms of interactions of the universities, the North American literature highlights the possibility of three-dimensional relationships, cooperation building and development: collaborations that develop or can develop during operation, cooperation possibilities that emerge during the investment activities of the universities, as well as relationships that emerge during the learning process (Habiby 2004; Lengyel 2006). During operation two points of interaction emerge for the institutions: interactions that are established or can be established during the realisation of institutional procurements, or through the presence of the institutions on the labour market. Secondly, during the investment activities of higher education institutions real estate development and enterprise development collaborations can be realised, which manifest or may manifest primarily in the form of service collaborations. Thirdly, learning collaborations may take the shape of workforce development cooperation, as well as consulting, advisory, and R&D collaborations or cooperation possibilities.

In case we focus our analysis on these latter (development) collaborations, we still face a rather heterogeneous area. The contents of these collaborations range from research support to the possibly most complex knowledge transfer collaborations, while in terms of direction one can differentiate horizontal and vertical (upstream and downstream) collaborations. Vertical development collaborations differ from horizontal ones in that while in a horizontal cooperation all participants make investments, and may reap the yield of cooperation proportionate to the investments made, in a vertical cooperation only one party acts as an investor, while the other party is interested in the completion of development as defined. University-industry interactions and R&D projects are mostly characterised by vertical collaborations (upstream alliances), which are mainly induced by the market potentials of the expected results, and these results are mostly private goods (Rothaermel – Deeds 2006; Blum – Müller 2004). In contrast with this, university-industry R&D horizontal collaborations produce knowledge platforms that the participants utilise in accordance with the preliminary agreements.

University-industry R&D collaborations can mostly be characterised with the features of vertical collaborations, wherefore they can be managed by the approach of relationship marketing. Yet, it is worth drawing attention to a few characteristic features:
- Development transactions mostly behave like contracts that turn into cooperation as soon as they include several contracts or a series of projects regulated by contracts (Bercovitcz – Feldman 2007).
- Another feature of vertical university-industry R&D collaborations, which somewhat distinguishes such collaborations from market based buyer-supplier relationships, is their three-dimensional nature. Although in university-industry collaborations as systems of relations the main roles are played by the industrial buyer and the research group performing the ordered task, university management appears as an unavoidable factor (Blum – Müller 2004; Heidrick et al 2005; Barakonyi 2004). The role of university management can vary, however it is primarily interested in the maximisation of resources attracted from the corporate party. To this end it appoints a

regulatory framework, provides internal management services and pursues marketing activities (Barakonyi 2003; Kováts 2005).

- In addition to the above written it must be pointed out that these partnerships can be characterised with a unique business-nonbusiness conflict of interests. The conflicts of interests that emerge in vertical university-industry collaborations as potential sources of conflicts can be captured at three major points: conflicting laws, conflicts of activities and economic conflicts (Resnik – Shamoo 2002; Santoro – Betts 2002; Wu 2000; Slaughter – Leslie 1999).

For the purpose of this study university-industry R&D collaborations include all series of interactions implemented between any university unit and a corporate partner pursuant to a contract, which include a range of development projects, and which can basically be characterised with a unique business-nonbusiness conflict, and the central outcomes of which are private goods that the corporate partner is eligible for, and the relationship and situation of the individual projects are clearly identified in the research coordination regulations of the university.

2. Economic effectiveness of university-industry R&D partnerships in the light of relationship closeness

If we want to scrutinize the economic effectiveness of R&D collaborations, we must face an issue that is difficult to manage. Earlier we conceded that in the course of R&D collaborations (especially in the case of vertical partnerships) the notion of and relationship between the service supplier and the service user can be interpreted, however, in case we wish to interpret these notions in a business-nonbusiness relationship, significantly different interests and expectations can be identified, which make it difficult to evaluate the effectiveness of cooperation.

University-based, academic research traditionally aims at the creation and deepening of basic knowledge, and the integration thereof into the general education programme. The academic sector primarily focuses on new, not yet covered scientific fields that are useful in the provision of long-term perspectives in basic and applied research topics, and serve as a basis for the training of future scientists, experts and researchers (Santoro 2000). On the nonbusiness side the expectations towards cooperation can be summarised as the generation of revenue, the expansion of the political base, prestige maximisation, research and education spillovers, enhancement of reference and reputation, acquisition and enhanced utilisation of human resource capacities, procurement of assets (Slaughter – Leslie 1999; Barakonyi 2004b).

In contrast with this, market partners are mostly interested in the sale of research outcomes, and the problem solving applications that can maximise profitability and the stakeholders' assets, that can decrease risks, increase market share and sales revenues or that can improve the economy of scales (Katz and Ordover 1990; Hagedorn – Link – Vonortas 2000; Santoro 2000; Barnes – Pashby – Gibbons 2000; Turánszky 1984; Tijssen 2001; Okamuro 2007; Harabi 2002).

This means that the parties have significantly different expectations against each other. These different expectations are accompanied by differing perceptions of the outcomes, which questions the manageability of the cooperation. Yet, despite the above conflicts, there exist numerous successful university-industry collaborative partnerships. It is worth noting here

that 70% of university-industry R&D projects implemented under the Jedlik Ányos Programme – which replaced the National Research and Development Programme, and which supports long-term strategic research projects serving corporate interests – were realised in the framework of cooperation as defined above. In addition, cluster programmes that are widespread in Europe, and are about to start in Hungary, can also be mentioned as examples, since the often cited success of these programmes is the existence of university and corporate partnerships.

Möller and Törrönen (2003) underline the role of relationship closeness as a basic precondition for the success of collaborative projects. They visualise the possible implementation of a vertical relationship along a spectrum. They start out from the fact that the success of a relationship depends on the level of complexity of cooperation. In relationships with extremely low complexity (transaction-oriented relationships) the parties can be characterised with present-orientedness, adaptation in the relationship is minimum, the participants strive for the utilisation of the existing resources and technologies, the focus is on exploitation of the impact of the relationship on exchange activities. As the complexity of the relationship increases, mutual adaptation and relationship specific investments make the cooperation a value generating process. At this level of cooperation the processes of the individual parties start to match, which influences both the exploitation of exchange activities and the development of the relationship portfolio. In the case of extremely complex collaborations the parties approximate their activities to a degree that provides an opportunity for radical innovations.

If we start out from this context, the closeness of a relationship creates a cooperative atmosphere which is accompanied by enhanced cooperative effectiveness. However, in the case of university-corporate R&D collaborative projects this issue is far from being obvious in the light of the literature. Certain studies come to the conclusion that such types of collaborations enhance the productivity of the participating organisations (see for instance Belderbos et al (2004)), while others find that university-firm collaborations clearly deteriorate the economic performance of companies (Okamuro 2007). Others, like Miotti and Sachwald (2003) came to conflicting conclusions in this issue.

This study shows that university-corporate collaborations are not homogeneous: the basic correlations of relationship marketing can and should be applied in this field, too. Despite the significantly different interests, strategically managed partnerships are more effective, and are therefore able to produce economic added value. In other words, university-corporate interactions by themselves – even if the project defined within the framework of such interaction was successfully completed – are not necessarily economically fruitful for the parties. However, by making the relationship closer, the economic effectiveness of these relationships – taken in the broad sense – can be enhanced. Yet, in order to operationalise the problem, it is necessary to define what we mean by the effectiveness and closeness of university-industry R&D collaborations.

3. Operationalisation of the economic effectiveness and closeness of university-industry partnerships

3.1. The economic effectiveness of university-industry R&D partnerships

Several attempts have been made to describe the economic effectiveness of university-industry R&D partnerships, including the initial proposal of Branstetter and Sakakibara

(1998), according to whom the outcome of cooperative R&D can serve as a basis for determining research productivity, which is measured by the number of patents resulting from such collaboration. This performance can first of all be defined as the technological effectiveness of R&D collaborations, which presents only part of the economic benefits gained, however with the help of this scheme certain collaborations or industries become comparable (Branstetter and Sakakibara 2002). This definition is further expanded by the approach of Revilla et al (2000). They argue that during the evaluation of the outcomes of cooperative R&D both the technical and the economic dimensions must be taken into account. Their definition of performance is based on a simple and easily applicable logic: performance is relative, its size largely depends on the initial conditions, on the basis of which the relative size and adequacy of the output can be judged. During the evaluation of outputs both the technological and economic results must be taken into account. In their test model they use three input and three output measures to evaluate performance. The inputs are the total revenue of the partner company, i.e. the "principal", the number of employees and the total R&D budget. As output measures they use the total number of patents from the collaboration, the number of employees employed as a result of the cooperation, as well as the total revenue generated by the cooperation.

This approach is further expanded by the scheme proposed by Miotti and Sachwald (2003). This scheme describes the effectiveness of R&D collaborations also with two variables, with the patent effectiveness and the share of innovative products within the total revenues. When making this definition these authors also start out from the fact that the effectiveness of R&D activities can be described with two factors: technological effectiveness (i.e. the R&D activity yielded an outcome which is regarded as a technological innovation), and (business) success achieved on the market, which is primarily regarded as the success of production and/or marketing, distinguished from the former element. This definition serves as a starting point for Okamuro (2007), too, however, he carries it further by considering technological success as a patentable, or subjectively measurable result, i.e. he evaluates not only the generated patents, but moves towards a value based approach. He defines this business success as a measure of contribution by the cooperative R&D to increased sales.

The above approaches concentrate on formulating the "business" effectiveness of university-industry cooperation, however they ignore the problem that arises from the different interests of the parties during the evaluation of the effectiveness of such R&D collaborations. According to Omta and de Leeuw (1997), the outcome in this context is the most efficient combination of resources used by all participants of the supplier network so that it would lead to high quality and cost-efficient buyer-services. This means that university organisations must ensure to provide the buyer with good products/services at the right time and in the right quality. In our opinion the output of university-industry collaborations shows a complex picture. The output of R&D collaborations can basically be divided into two main categories: an output called research performance, which is focused on the scientific community, as well as outputs that are focused on industrial and governmental users and are collectively called user performance. In relation to outputs focused on industrial partners, performance means intellectual values (patents, licences, etc.) that are created as a result of cooperation (innovative performance), as well as economic performance manifested during the cooperation as efficiency, which includes compliance with the pre-determined budget and time-frame, as well as changes triggered in revenues and shares (industrial performance).

University-industry collaborations can be described with two basic factors: the financial effectiveness of cooperation and the technical/technological effectiveness of cooperation. Based on former research, technical/technological effectiveness implies factors that are less

comprehensible in financial terms, yet describe the economic outcomes of the cooperation, such as the achievements of the set objectives, the quality of supplied/used services, as well as the creation of additional outcomes and intangible assets that were either not earmarked in advance, or were not exactly identified.

The financial effectiveness of collaborations is captured by most studies as the volume or cost-efficiency of projects implemented within the framework of cooperation. However, at this point it is worth considering the results of the qualitative research conducted by Vilmányi (2008), who draws attention to the fact that in this context the drop in the relationship building and maintenance costs, as well as the relationship specific equalisation of the parties' cash-flows also appear as financially interpretable outcomes. On this basis the financial effectiveness of cooperation can be described as cash-flow equalisation due to the better plannability of the projects implemented through the partnership, higher cost-efficiency of the projects, the drop in relationship building and maintenance costs due to the fact that interactions become informal, as well as the growth in the volume of orders in parallel with increasing trust (Table 1).

Table 1: Definition of the variables applied for the evaluation of the effectiveness of cooperation

Applied factor	Components describing the factor	Component definition
Financial effectiveness of cooperation	Cash-flow equalisation	Better plannability of scheduled revenues/expenses.
	Cost-efficiency of the projects	Cost-efficiency that is perceived by the service supplier as the reduction of the user's price sensitivity, and by the user as reduced expenditures required for the resolution of the problems that have arisen (which expenditures include the price and the auxiliary costs).
	Relationship building/ maintenance costs	They manifest in the elimination of the partner-seeking costs per project, in the drop of the communication costs of relationships with decreasing frequency, and/or relationships that become informal, as well as in cost savings realised in the development of the legal scheme to be invested for the implementation of a given project.
	Volume	It is designed to indicate the growing number of development projects implemented in the framework of cooperation as a result of cooperation.
Technical/ technological effectiveness of cooperation	Achievement of common objectives	It describes how well the projects implemented in the framework of cooperation fit the pre-defined objectives.
	Quality of services	It presents the service results against the expectations of the different parties.
	Creation of intangible assets for other use	It means a further possibility for development, patent, publication or the generation of the underlying ideas that can be freely used by the partners.

Source: own compilation

3.2. The closeness of university-industry R&D collaborations

During the definition of the closeness of collaborations, the studies of the classic supplier-buyer collaborations by Joseph et al (1995) and the study published by Brinkerhoff on university-corporate collaborations (2002) were used as a starting point. In relation to university-industry R&D collaborations Brinkerhoff (2002) describes the closeness of cooperation by using the term partnership, according to which partnership is a dynamic relationship among diverse actors, based on mutually agreed objectives, pursued through the most rational division of labour based on the respective comparative advantages of each partner. "*Partnership encompasses mutual influence, with a careful balance between synergy*

and respective autonomy, which incorporates mutual respect, equal participation in decision-making, mutual accountability, and transparency" *(Brinkerhoff 2002, page 216).* During the empirical study of the closeness of relationship, Joseph et al came to the conclusion that partnerships are more profitable and have greater management efficiency than other relationships, however it must be noted that they are more management-intensive and time-consuming. In the case of partnerships – as Brinkerhoff (2002) also claims – a higher relationship performance, i.e. higher relationship effectiveness and efficiency can be predicted.

Based on Brinkerhoff's (2002) study, the closeness of cooperation can be modelled with six variables: mutuality and equality in partnership; partner representation and participation in the cooperation; the transparency of partnership; mutual respect; interest in maintaining the partnership; the relationship between cooperation and organisation identity. (The individual variables are presented in detail in Table Table 1)

Table 1: Definition of the variables applied for the evaluation of the closeness of cooperation

Applied variable	Definition of variable
Mutuality and equality in partnership	This variable implies that the activities pursued in cooperation, as well as the processes applied in the partnership are defined and shaped jointly, on the basis of consensus by the parties.
Partner representation and participation in the cooperation	This variable implies the active participation of the parties in the completion of projects implemented within the framework of partnerships, in the regular monitoring thereof, as well as in the formulation of changes.
Transparency of partnership	The partnership is transparent for the parties, as a result of regular and open communication they obtain information about all issues relevant to the partnership.
Mutual respect	The parties to a partnership mutually respect each other's objectives, needs and interests.
Interest in maintaining the relationship	The parties to a partnership view their cooperation in the long perspective, since they are convinced that it significantly determines the quality of their core activities.
The relationship between partnership and organisation identity	The parties to a partnership regard the management of the given partnership as part of the everyday processes; the development of the partnership also determines how the organisation's image of itself changes.

Source: own compilation

4. Presentation of the subjects and methodology of the study

The basic subject of the study, i.e. the relationship between the closeness and effectiveness of university-industry R&D collaborations, can be formulated along two subquestions:
- How do the university and corporate actors perceive the effectiveness of cooperation?
- Is the parties' perception of effectiveness influenced by the closeness of cooperation?

During the study of the first question, the effectiveness of partnerships was the starting point. Although we modified the components to this end, and although their value increases in case they are managed, it is not at all sure that this increase in the perceived effectiveness will be identical for both parties. The parties to the partnership may perceive the effectiveness of the relationship differently. During the consideration of this assumption it is worth taking into account the works by McIntyre et al (2004), as well as Young et al (1996), according to which effectiveness is a perceived phenomenon, and may take different values depending on the original and changing intentions of the individual organisations, and therefore it must be interpreted in the light of the initial figures. Since the parties to a partnership compare

effectiveness against their expectations, effectiveness will be perceived differently by the supplier and the buyer. Starting out from these results we have all the right to assume that

H1: Relationship effectiveness means something different for the service supplier and the service user.

All this means that in case relationship effectiveness can be expressed with different factors for university and corporate actors the above statement can be justified, however if relationship effectiveness can be expressed with identical factors, the above statement can be rejected.

In order to answer the second question we need to study two further subquestions. On the one hand, can increased relationship closeness modify the difference in perception? The question seems logical, since if we start out from Möller's and Törrönen's (2003) chain of thoughts, relationship closeness can be increased through adaptation (matching of processes, relationship specific investments). Adaptation implies the approximation of expectations against and interests in the relationship, which may trigger the convergence of expectations towards the relationship, and hence the convergence of the perception of relationship effectiveness.

H2: As the closeness of cooperation increases, the difference in the perception of effectiveness decreases.

It is worth dissecting this topic from another aspect, too, since the difference in the perception of effectiveness is only one side of the coin. The other side shows the correlation – already concluded by Brinkerhoff, too – whether, independent of the different perception, the outcome perceived by the cooperating partners enhances as the cooperation becomes closer. We assume yes, i.e.:

H3: The greater the closeness of cooperation, the greater the outcome perceived by the actors involved.

This assumption also promises success, since in a closer partnership the parties have a better understanding of each other's possibilities and limitations, as a result of which the expected outcomes of cooperation are more realistic, while conflicts or even the coordination costs decrease. Therefore, if we accept the value generating effect of a relationship based on mutual investments and adaptation, the relationship should lead to better outcomes, too.

The completion of the tasks defined as research objectives required the elaboration of a system of indicators through which the variables of the studied correlations become measurable, and it becomes possible to statistically analyse the behaviour of such variables.

For the development of a system of indicators that would serve as a basis for testing, a questionnaire was compiled for the measurement of the variables of the effectiveness and closeness of relationship. The questionnaire was forwarded to the respondents via e-mail. Data recording lasted from September through November 2007.

The questionnaire contained statements on the relationship effectiveness and relationship closeness variables in the form of tables (matrixes). The respondents who were involved in the research had to form opinion on the given statements on the six-point Likert-scale.

The test population was identified on the basis of the cooperative research contracts and the electronic proposal register of the University of Szeged. In the first step university-industry R&D collaborations were selected from these relationships. We considered all live contracts or series of contracts between a unit of the University of Szeged and a corporate partner that contained at least two projects, one of which had already been closed, and whose starting dates were different. We applied the narrowing method, since during the selection of the population those partnerships were not taken into account in the framework of which no contract based task performance was carried out at the time of the test, or the relationship between the university and the corporate partner was not specified in contract during the cooperation. Narrowing was justifiable, since responses, in the case of which cooperation could not be proven with certainty, could have significantly distorted the test results. As a second step for the identification of the test population, vertical partnerships (45) were selected from the previously mentioned relationships. The questionnaire was sent out to the contact persons of both parties in each of the 45 identified partnerships. Altogether 62 completed questionnaires were returned (as a result of which a responding ration of 69% was achieved). Out of the returned questionnaires 28 were completed by corporate contact persons, and 34 were completed by university contact persons.

In the sample available for analysis, the opinions of the contact persons of collaborations in the field of natural sciences were over-represented, while those of medical and pharmaceutical collaborations were under-represented. In the case of scientific and medical collaborations corporate and university responses had a relatively equal weight, while in the case of pharmaceutical collaborations opinions by the university partners prevailed.

Table 2: Characteristics of the sample available during the analysis

	Questionnaires returned by corporate respondents (as a percentage of the distributed questionnaires)	Questionnaires returned by university respondents (as a percentage of the distributed questionnaires)	Total questionnaires returned (as a percentage of all distributed questionnaires)
In the case of collaborations in the field of natural sciences	80.00%	95.00%	87.50%
In the case of collaborations in the field of medicine	57.89%	47.37%	52.63%
In the case of collaborations in the field of pharmacy	16.67%	100.00%	58.33%
In the case of all surveyed collaborations	62.22%	75.56%	68.89%

Source: own compilation

During the test the methods of main component analysis, correlation calculation and regression analysis were used.

Questions that pertained to the different perception of relationship effectiveness were tested by means of the main component analysis. In case the variable pertaining to relationship effectiveness can be expressed along the same main components, then the perception of effectiveness can be regarded identical, while in the case of discrepancies the mechanism of outcome perception is different. During the application of the main component analysis variables were managed in a standardised form (where the expected value was 0, and scatter was 1), while the threshold value of the information content described by the main components was determined to be 60%.

Correlation calculation was used during testing the correlations between relationship closeness and relationship effectiveness, while regression analysis was used to evaluate the relationship between relationship closeness and relationship effectiveness.

5. Test results

The hypotheses that expressed the research objective were tested in three steps. In the first step it was necessary to test whether the identified factors (such as financial effectiveness, technical/technological effectiveness) really covered the targeted variables. After that the different perceptions of relationship effectiveness were tested, and then the correlation between relationship effectiveness and relationship closeness was clarified.

5.1. Analysis of the characteristics of the factors

Testing of relationship effectiveness was started by studying the financial effectiveness factor. In the first step it was checked whether cash-flow equalisation, the cost-efficiency of projects, the relationship building and maintenance costs, as well as the volume could be expressed with a single factor (main component). The conducted main component analysis showed that although the components were expressed by a single factor, this factor preserved only 57% of the information content of the original variables (Table 4).

Table 3: Preservation of the information content during the initial testing of the financial effectiveness factor of the partnership by the collective consideration of the service suppliers' and users' viewpoints

	Preserved information content					
	Own values			Sum of square of loading variables		
Component	**Total**	**As a percentage of variance**	**Cumulated percentage**	**Total**	**As a percentage of variance**	**Cumulated percentage**
1	2.280	56.995	56.995	2.280	56.995	56.995
2	.985	24.634	81.629			
3	.479	11.979	93.608			
4	.256	6.392	100.000			
Applied method: Main component analysis						

Source: own compilation

Table 4: Analysis of communalities during the initial testing of the financial effectiveness factor of the partnership by the collective consideration of the service suppliers' and users' viewpoints

	Communalities	
	Initialised	**Communality**
Cash-flow equalisation	1.000	.810
Cost-efficiency of the projects	1.000	.744
Relationship building and maintenance costs	1.000	.059
Volume	1.000	.667
Applied method: Main component analysis		

Source: own compilation

Since the threshold value for the information preservation requirement was set to be 60%, the applied main component analysis was repeated without taking into consideration the least matching component (changes in the relationship building and maintenance costs) (Table 4). The results so calculated show that the components can still be expressed with a single factor, the factor preserves a very high portion (75%) of the original information content of the variables, and the co-movement of the components and factors is extremely strong (Table 6; Table 8).

Table 5: Preservation of the information content during the repeated test of the financial effectiveness factor of the partnership by the collective consideration of the service suppliers' and users' viewpoints

Component	Preserved information content					
	Own values			Sum of square of loading variables		
	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	2.246	74.855	74.855	2.246	74.855	74.855
2	.490	16.325	91.180			
3	.265	8.820	100.000			
Applied method: Main component analysis						

Source: own compilation

In the next step the technical/technological effectiveness factor of the collaborations was tested. The interaction among the 'service quality', 'creation of intangible assets for other utilisation' and the 'achievement of common objectives' variables was tested in the manner described above, by means of a new main component analysis. The calculated results show that the three variables is expressed by a single factor (by preserving 64% of the original information content), and all initial components of the factor are in close relationship with the factor (Table 7; Table 8).

Table 6: Preservation of the information content during the testing of the technical/technological effectiveness factor of the partnership by the collective consideration of the service suppliers' and users' viewpoints

Component	Preserved information content					
	Own values			Sum of square of loading variables		
	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	1.923	64.104	64.104	1.923	64.104	64.104
2	.633	21.111	85.215			
3	.444	14.785	100.000			
Applied method: Main component analysis						

Source: own compilation

Table 7: Results of the main component analysis of the factors studied from the aspect of outcomes, by the collective consideration of the service suppliers' and users' viewpoints

Co-movement of the components that describe the financial effectiveness of collaborations		Co-movement of the components that describe the technical/technological effectiveness of collaborations	
	Component		Component
	Financial effectiveness of collaborations		Technical/technological effectiveness of collaborations
Cash-flow equalisation	.911	Service quality	.827
Cost-efficiency of projects	.856	Creation of intangible assets for other utilisation	.740
Volume	.826	Achievement of common objectives	.832
Applied method: Main component analysis		Applied method: Main component analysis	

Source: own compilation

In summary it can be concluded that – by the collective consideration of the service suppliers' and the users' viewpoints – relationship effectiveness can be described with two factors, the financial effectiveness of cooperation and the technical/technological effectiveness of cooperation. Furthermore, it can be stated that the impact of relationship building and maintenance costs on the financial effectiveness of cooperation can be disputed, the clarification of this impact requires further testing.

5.2. Testing the different perceptions of the parties to a partnership

In the second stage of the study the focus was shifted to the perception of relationship effectiveness by the service supplier and the user. In other words, we sought the answer to the question whether the effectiveness of cooperation means something different for the service suppliers (university actors) and users (corporate actors). When answering the question we studied whether identical or different factors could be identified when separating the user's and the supplier's sides.

The study was again started by the testing of the financial effectiveness factor, in relation to which corporate and university perceptions differ. While in the case of corporate respondents the variables describing financial effectiveness can be expressed with a single factor (by preserving 71% of the original information content), the same can be expressed already with two factors in the case of university respondents (also by preserving 71% of the original information content) (Table 9; Table 10).

Table 8: Preservation of the information content during testing the financial effectiveness factor of the partnership by the consideration of the users' viewpoints

Preserved information content						
	Own values			Sum of square of loading variables		
Component	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	2.846	71.157	71.157	2.846	71.157	71.157
2	.689	17.229	88.385			
3	.313	7.826	96.212			
4	.152	3.788	100.000			
Applied method: Main component analysis						

Source: own compilation

Table 9: Preservation of the information content during testing the financial effectiveness factor of the partnership by the consideration of the service suppliers' viewpoints

Preserved information content						
	Own values			Sum of square of loading variables		
Component	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	1.860	46.490	46.490	1.860	46.490	46.490
2	1.020	25.495	71.985	1.020	25.495	71.985
3	.733	18.320	90.305			
4	.388	9.695	100.000			
Applied method: Main component analysis						

Source: own compilation

University respondents perceive the cost-efficiency of the projects in a manner very much different from the other variables that describe financial effectiveness, and the perception of relationship building and maintenance costs also shows a contradictory trend (Table 11). On the basis of these results it can be concluded that corporate and university actors perceive the financial effectiveness of cooperation differently.

Table 10: Results of the main component analysis of the components describing the financial effectiveness from the aspects of the outcomes, by the separate consideration of the service suppliers' and the users' viewpoints

Co-movement of the components describing the financial effectiveness of the cooperation in the case of corporate respondents	Component	Co-movement of the components describing the financial effectiveness of the cooperation in the case of university respondents	Component	
	Financial effectiveness of the cooperation		1	2
Cash-flow equalisation	.875	Cash-flow equalisation	.786	.183
Cost-efficiency of projects	.886	Cost-efficiency of projects	.260	.925
Relationship building and maintenance costs	.731	Relationship building and maintenance costs	-.678	.278
Volume	.873	Volume	.846	-.232
Applied method: Main component analysis		Applied method: Main component analysis		

Source: own compilation

The co-movement of the components that describe the technical/technological effectiveness also shows discrepancies. Although the variables that describe technical/technological effectiveness can be expressed with a single factor in the case of both the corporate and university respondents (Table 12; Table 13), in the case of university respondents this would only allow to preserve 46% of the original information content, which cannot be regarded acceptable. (The same value was 77% in the case of corporate respondents.)

Table 11: Preservation of the information content during testing the financial effectiveness factor of the partnership by the consideration of the users' viewpoints

Preserved information content						
Component	Own values			Sum of square of loading variables		
	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	2.307	76.895	76.895	2.307	76.895	76.895
2	.446	14.862	91.756			
3	.247	8.244	100.000			
Applied method: Main component analysis						

Source: own compilation

Table 12: Preservation of the information content during the initial testing of the financial effectiveness factor of the partnership by the consideration of the service suppliers' viewpoints

Preserved information content						
Component	Own values			Sum of square of loading variables		
	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	1.379	45.962	45.962	1.379	45.962	45.962
2	.888	29.594	75.556			
3	.733	24.444	100.000			
Applied method: Main component analysis						

Source: own compilation

In the case of university respondents the least matching variable (achievement of common objectives) was interpreted independently from this point on (Table 14). At the same time, the 'service quality' and the 'creation of intangible assets for other utilisation' variables could be expressed with a single factor, while preserving 63% of the original information content (Table 15).

Table 13: Analysis of communalities during the initial testing of the technical/technological effectiveness factor of the partnership by the separate consideration of the service suppliers' and users' viewpoints

Communalities		
	Initialised	**Communality**
Service quality	1.000	.506
Creation of intangible assets for other utilisation	1.000	.550
Achievement of common objectives	1.000	.322
Applied method: Main component analysis		

Source: own compilation

Table 14: Preservation of the information content during the repeated testing of the financial effectiveness factor of the partnership by the consideration of the service suppliers' viewpoints

Preserved information content						
Component	**Own values**			**Sum of square of loading variables**		
	Total	**As a percentage of variance**	**Cumulated percentage**	**Total**	**As a percentage of variance**	**Cumulated percentage**
1	1.264	63.175	63.175	1.264	63.175	63.175
2	.736	36.825	100.000			
Applied method: Main component analysis						

Source: own compilation

The results of the conducted main component analyses indicate that while service quality, the creation of intangible assets and the achievement of common objectives are perceived in a relatively homogeneous manner by the companies, university actors perceive the achievement of common objectives differently than the other two variables used for the description of technical/technological effectiveness (Table 16).

Table 15: Results of the main component analysis of the components describing the technical/technological effectiveness from the aspects of the outcomes, by the separate consideration of the service suppliers' and the users' viewpoints

Co-movement of the components describing the technical/technological effectiveness of the partnership in the case of corporate respondents		Co-movement of the components describing the technical/technological effectiveness of the partnership in the case of university respondents		
	Component		**Component**	
	Technical/technological effectiveness of the partnership		**1**	Achievement of common objectives
Service quality	.862	Service quality	.795	
Creation of intangible assets for other utilisation	.849	Creation of intangible assets for other utilisation	.795	
Achievement of common objectives	.918			
Applied method: Main component analysis		Applied method: Main component analysis		

Source: own compilation

In summary it can be concluded that in vertical R&D partnerships both the financial effectiveness and the technical/technological effectiveness of cooperation are perceived differently by the service supplier and the user, wherefore the statement of the first hypothesis can be accepted.

5.3. The correlation between relationship closeness and relationship effectiveness

In the third stage of the study the correlation between relationship closeness and relationship effectiveness was brought into focus. The different perception of relationship effectiveness by the corporate and university actors raised various questions. Since in case we highlight those features of cooperation that yield economic benefits for both parties, how can it be that these benefits are perceived so differently by the parties, especially in a partnership that is shaped by the parties jointly, and in which the parties consciously participate? The correlation of relationship closeness may give an answer to this question. The parties are very much likely to judge the usefulness of partnership similarly, if they view the partnership in the long perspective, if both parties are actively involved in shaping the partnership, while they understand and respect each other's interests, and through all this partnership becomes part of the organisation identity.

Turning this logic into a research question we can ask whether the perception of relationship effectiveness by the participants converges as the closeness of cooperation increases?

In order to study the issue, symmetric relationships, i.e. collaborations in which evaluation by the university and corporate partners alike was recorded, were deleted from the sample analysed during the quantitative research. With this solution a sub-sample consisting of 19 relationships was created. Within this sub-sample we generated the difference between the perception of the characteristics of relationship effectiveness by the university and the corporate partners in an absolute value, where 0 indicates that a feature is perceived identically, and 5 indicates that it is perceived in an extremely different manner. The closeness of partnership was expressed as a sum starting out from the logic that the closer the parties perceive cooperation separately, the closer it will be in reality. Therefore, in order to express the closeness of cooperation a new variable was created for each variable expressing the closeness of cooperation, the value of which ranged on a scale of 2 to 12. The main objective was to clarify the co-movement between the new variables of relationship closeness and the values expressing the different perception of relationship effectiveness. However, during the application of this method a serious problem was caused by the missing values (unresponded questions): if these values are replaced with 0, we face a problem of content, since we assume a perception that did not occur in reality. On the other hand, if we replace this value with the average 3.5 points, it may significantly influence the outcome of the study. For this reason, difference or sum values in the case of which perception by either party could not be identified had to be excluded from the study. We resolved this problem by visualising relationship effectiveness for each relationship with indicators derived from the former values, by taking their mean. The same process was followed in the case of the closeness of cooperation, too. Therefore, if the perception of a value was missing, the difference or sum derived from that value was not taken into account during the calculation of the mean. As a result of this method, we obtained an effectiveness discrepancy indicator and a closeness sum indicator for each (symmetrical) relationship studied.
In order to clarify the correlation between the indicators we applied correlation calculation, the result of which is presented in Table 16.

Table 17: The correlation among the closeness of cooperation, the performance of cooperation and the network effect

		Effectiveness discrepancy indicator	Closeness sum indicator
Effectiveness discrepancy indicator	Correlation coefficient	1	-.568(*)
	Significance (bilateral)		.022
	N	19	16
Closeness sum indicator	Correlation coefficient	-.568(*)	1
	Significance (bilateral)	.022	
	N	16	16
** Correlation at a significant, 1% significance level (bilateral)			
* Correlation at a significant, 0.5% significance level (bilateral)			

Source: own compilation

It can be understood from the correlation calculation that the closeness of cooperation and relationship effectiveness have negative significant correlation. All this means that the closer the cooperation, the lower the difference between university and corporate perception of the variables of these viewpoints. At the same time it also means that the closer the cooperation between the participants of university-industry R&D partnerships, the truer it is that the parties will perceive the effectiveness of the relationship along the same factors. Based on the above, the second hypothesis specified by the study also turned out to be correct.

Based on the results, the difference of the perception of cooperation closeness and relationship effectiveness is in inverse relation. However, during the study of the closeness of cooperation another question was raised: does the closeness of cooperation influence the perceived level of relationship effectiveness? The problem raises an exciting issue, since if we can answer yes to the question, in the case of higher-level relationship closeness not only the economic effectiveness from cooperation will be perceived at a relatively equal level, but effectiveness will also be valued higher.

The test aiming to answer this question was carried out on a joint sample, by the collective consideration of the users' and service suppliers' viewpoints, since in this case the subject of the test was not the difference in the perception of relationship effectiveness or relationship closeness, but rather the correlation between these two characteristic features of university-industry R&D collaborations. In order to answer the question, in the first step we performed another correlation calculation, the results of which are presented in Table 18.

Table 19: The correlation between the closeness of cooperation and the performance of cooperation by the collective consideration of the users' and service suppliers' viewpoints

		Mutuality and equality in cooperation	Partners' participation in the cooperation	Transparency of cooperation	Mutual respect	Interest in maintaining the relationship	The relationship between cooperation and organisation identity
Financial effectiveness of cooperation	Correlation coefficient	.550(**)	.509(**)	.594(**)	.611(**)	.710(**)	.493(**)
	Significance (bilateral)	.000	.000	.000	.000	.000	.000
	N	62	62	62	62	62	62
Technical/technological effectiveness of cooperation	Correlation coefficient	.492(**)	.631(**)	.716(**)	.626(**)	.698(**)	.365(**)
	Significance (bilateral)	.000	.000	.000	.000	.000	.003
	N	62	62	62	62	62	62
** Correlation at a significant, 1% significance level (bilateral)							
* Correlation at a significant, 0.5% significance level (bilateral)							

Source: own compilation

It can be concluded from the analysis that there is positive and significant correlation among all variables of the closeness of cooperation and the factors of relationship effectiveness, which indicates the verification of the third hypothesis by itself. On the other hand, though, the clarification of the relationship between the closeness and effectiveness of cooperation requires the conduct of a regression analysis.

For the unanimous expression of the closeness of cooperation we described the individual components with a single factor. For this operation we resorted to the previously applied main component analysis. The conducted main component analysis showed that the components applied for the description of relationship closeness can be expressed with a single main component as a factor. The factor preserves nearly 63% of the original information content of the variables (which we find acceptable on the basis of the applied criterion), and the co-movement of the components and the factor is extremely strong (Table 19; Table 20).

Table 19: Preservation of the information content during the testing of the closeness of cooperation factor by the collective consideration of the service supplier's viewpoints

	Preserved information content					
	Own values			Sum of square of loading variables		
Component	Total	As a percentage of variance	Cumulated percentage	Total	As a percentage of variance	Cumulated percentage
1	3.764	62.737	62.737	3.764	62.737	62.737
2	.744	12.406	75.144			
3	.621	10.351	85.494			
4	.396	6.596	92.090			
5	.304	5.062	97.152			
6	.171	2.848	100.000			
Applied method: Main component analysis						

Source: own compilation

Table 20: Results of the main component analysis of the components describing the closeness of cooperation, by the separate consideration of the service suppliers' and the users' viewpoints

Co-movement of the components describing the closeness of cooperation	
	Component
	Closeness of cooperation
Mutuality and equality in cooperation	.718
Partners' participation in the cooperation	.842
Transparency of cooperation	.838
Mutual respect	.843
Interest in maintaining the relationship	.854
The relationship between partnership and organisation identity	.628
Applied method: Main component analysis	

After expressing relationship closeness in this manner, we studied the regression relationship between the closeness and effectiveness of cooperation by studying separately the relationship between the two factors expressing the effectiveness of cooperation and the 'closeness of cooperation' factor. The test results indicate that relationship closeness significantly influences both the financial effectiveness of cooperation (R=0,731; R²=0,534), and the technical/technological effectiveness of cooperation (R=0,756; R²=0,571) (Table 21; Table 22).

Table 21: Regression parameters during the testing of the correlation between the financial effectiveness and closeness of cooperation

Regression parameters								
Model		**Non-standardised parameters**		**Standardised parameters**	**t**	**Sig.**	**Tolerance**	**VIF**
		B	**Scatter**	**Beta**				
1	Constant	-.024	.091		-.258	.797		
	Closeness of cooperation	.742	.092	.731	8.081	.000	.731	.731
Dependent variable: financial effectiveness of cooperation								

Source: own compilation

Table 22: Regression parameters during the testing of the correlation between the technical/technological effectiveness and closeness of cooperation

Regression parameters								
Model		**Non-standardised parameters**		**Standardised parameters**	**t**	**Sig.**	**Tolerance**	**VIF**
		B	**Scatter**	**Beta**				
1	Constant	-.027	.088		-.304	.762		
	Closeness of cooperation	.769	.088	.756	8.707	.000	.756	.756
Dependent variable: technical/technological effectiveness of cooperation								

Source: own compilation

Based on the above, the third hypothesis can be considered verified, too, since by increasing the closeness of cooperation both the perceived financial effectiveness and the perceived technical/technological effectiveness change in the positive direction.

6. The limitations of the test

Although the test results confirmed our expectations, we must emphasise the limitations of our pilot research project, which emerge due to the complexity of the correlations addressed, the explanatory power of the presented regression relationships, the small size of the sample used in the research, and the time series used.

The discovered correlations can be rightly criticised for the fact that apart from relationship closeness they did not involve parameters such as trust, satisfaction or commitment that would probably significantly influence relationship effectiveness. The correlations detected between relationship closeness and the effectiveness of cooperation let us conclude that the classic factors of relationship marketing have an influencing power here, too. This is also confirmed by the regression relationship discovered between the two correlations addressed, the explanatory power of which indicates that relationship closeness is only partly responsible for relationship effectiveness. However, at this stage the analysis of these missing correlations was beyond the objectives of our study. As referred to in the section that presented the subject of our study, at the current stage our primary objective was to reveal whether in these nonbusiness-business interactions, which are laden with significant conflicts of interests and often conflicts of approaches, relationship behaviour produces added value for the parties, or not. Our results show that it does produce added value, on the basis of which relationship-specific behaviour is unanimously recommended for the parties to such partnerships.

However, at this point we must draw attention to the pilot nature of the study, the limitations of which suggest prudence in the generalisation of the results. Although the concluded results are promising, testing of the revealed correlations on a larger sample represents a further task.

In addition to involving further factors and enlarging the sample, the research conducted can also be expanded by performing longitudinal tests, which allow for studying the depth of the correlations among the not yet fully explored characteristics of this field.

7. Summary

In this study we examined the correlations between the economic effectiveness and closeness of university-industry R&D collaborations. The actuality of the topic is underlined by the fact that in the past decades these partnerships have become the focus of interest of both the economic development actors and the knowledge-based industries, and the successful management of the partnerships has become a central issue for these sectors. On the other hand, though, the successful management of university-industry partnerships is far from being evident, since the actors' expectations towards these business-nonbusiness relationships are so different that they can radically undermine the success of these partnerships.

In the course of our study we started out from the correlation according to which in closer collaborations the relationship-specific investments made by the parties, and the approximation of the processes yield common interests and expectations, as a result of which the parties' perception of the effectiveness of cooperation can be converged.

In order to explore the problem, we studied three fundamental questions: how can the effectiveness of university-industry R&D collaborations be described; how is this effectiveness perceived by the parties involved in the relationship; how can the perceived relationship effectiveness be influenced by the closeness of cooperation?

Our research concluded that the economic effectiveness of university-industry R&D collaborations can be expressed in terms of financial effectiveness on one hand, and technical/technological effectiveness on the other. Financial effectiveness means all those financially interpretable benefits that the parties gain by cooperating with each other, while technical/technological effectiveness includes all those economic benefits that the parties gain during or as a result of cooperation, which cannot or can only hardly be expressed financially. Through the detailed study of the financial and technical/technological effectiveness we concluded that it is perceived differently by the buyer (corporate partner) and the supplier (university partner). At the same time we proved that the closer the relationship, the greater the perceived relationship effectiveness, and closer cooperation also induces similar perception of the relationship effectiveness by the parties.

Our research can be regarded a pilot project – primarily due to the size of the sample tested – and the promising correlations revealed in the research project encourage us to repeat the test on a larger sample.

Annex

1. Questions addressing the financial effectiveness of cooperation

- The plannability of expenditures of projects implemented through, or in the framework of cooperation is excellent.
- The cost-efficiency of projects implemented through, or in the framework of cooperation is excellent.
- Through cooperation, the relationship building and maintenance costs of the projects are showing a downward trend (e.g. partner-seeking costs, communication costs, travel costs, project management costs, legal costs, etc.)
- New projects are defined through or in the framework of cooperation.

2. Questions addressing the technical/technological adequacy of cooperation

- The quality of development service used in projects implemented through, or in the framework of cooperation is high.
- Projects implemented through, or in the framework of cooperation yielded several extremely valuable intangible assets (exploration of the possibility for further development, patent, publication or basic idea thereof), which the partners utilised within their own respective scopes.
- The common objectives are achieved in all cases through cooperation.

3. Questions addressing the closeness of cooperation

- The activities and procedures to be pursued in the framework of cooperation are determined jointly, and the viewpoints of the parties are taken into account.
- The progress of the projects implemented in the framework of cooperation, and the completion of the tasks undertaken by the parties are regularly evaluated on the basis of criteria determined jointly in advance.
- Within the framework of cooperation information exchanges and dialogues take place regularly by means of the pre-determined communication channels; we regularly receive fair responses even in relation to relevant information beyond the scope of the contract.

– We mutually respect each other's needs, interests and limitations.
– Continuous cooperation has a positive impact on the quality of our core activity.
– Cooperation with our partner contributes to the shaping of the image of ourselves.

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