BENEFITS AND BARRIERS OF UNIVERSITY INDUSTRY COLLABORATION FROM A RESEARCHER'S PERSPECTIVE – DEVELOPMENT OF FORMATIVE SCALES AND CLUSTER ANALYSIS

Complete Research

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Abstract

This article extends previous empirical research on the benefits and barriers for researchers in the field of Information Systems (IS) to engage in University-Industry Collaboration (UIC), a term that is used to describe the active engagement of a company or government agency in a joint research project with academics. The objectives and motivations of UIC have been discussed widely and controversially in the literature. We were particularly interested in the perceived benefits and barriers that influence an individual researcher to engage (or not engage) in a joint research project. An in-depth literature analysis showed that a very small number of research articles contain empirical data and that there are serious methodological issues. In order to address these issues, we collected primary data from 328 IS researchers with experience in UIC and conducted an explorative study. We developed parsimonious formative measures for the benefits and barriers of UIC and we found that academic and economic benefits positively influence the intention to conduct UIC in the future, while economic barriers negatively influence the intention to engage in UIC. A cluster analysis found five clusters (groups of researchers) that differ in their perception of benefits and barriers and the future intention to conduct UIC. However, the majority of the researchers have a very high intention to conduct UIC in the future.

1 Introduction

There are many facets to the topic of University-Industry Collaboration (UIC), a term that describes the research activity performed by a group of people containing academics *and* practitioners. In the understanding of this paper, the research is carried out together (collaboratively), which in our definition requires an *active engagement* on the part of the industry partner. The collaboration can be carried out with different forms of interaction, e.g. joint basic research, contract research or research-oriented forms of consulting. The research results can be as manifold as the forms, including study reports, design artefacts, or patents and even spin-offs.

Publications in the field of UIC discuss questions such as the "transfer of innovation from academia to industry" (Barker, 2004; Perkmann and Walsh, 2009), "incentive policies" (Lee, 2000), the role of "consulting in IS research" (Simmons and Walker, 2000) and many more.

In this paper we are focussing on our own research discipline, the field of Information Systems (IS). Whilst many researchers in this field feel under pressure to publish in high ranking academic outlets,

some of them also acknowledge the demand of stakeholders who call for more *relevance* in research (Davis et al., 2005). In the context of IS research, relevance is often understood as *relevant to practice* or to practitioners (Schubert and Bjørn-Andersen, 2012, p. 1). This call is echoed by scholars in IS research who acknowledge "that academic research has become less useful for solving practical problems" (Van de Ven and Johnson 2006, p. 802). The key issue, from their perspective, is what they term, the "transfer problem", which is also emphasised by scholars who advocate "Engaged Scholarship", a movement that seeks the revival of collaborative research (e.g. Van der Ven, 2007, Mathiassen and Nielsen, 2008). We believe that the *relationship* between *academia* and *industry* is an important aspect in the discussion around the nature and fundamental understanding of the IS discipline.

However, *empirical studies on UIC* are rare, particularly regarding the question of why some researchers engage in UIC while others do not. The focus of our own study is on the *decision processes* through which researchers choose to engage or not with a company or government agency. Although the literature has identified the barriers and benefits of UIC, no serious *empirical analysis* of these factors has been conducted in the IS research field to the best of our knowledge.

Specifically, despite the high relevance of UIC, little work has been conducted on the perceived *benefits* of participating in UIC and the factors that possibly act as *barriers*, i.e., that hamper the participation in UIC from the individual researchers' perspectives. Therefore, our interest is in exploring what benefits and barriers exist for IS researchers. The analysis from an individual researchers' perspective is indispensable because researchers at universities enjoy great freedom, and they are likely to adopt a personal cost–benefit analysis when choosing their research activity, irrespectively of the wish of their university (Tartari and Breschi, 2012).

This research aims to make the following contributions: Firstly, we critically assess existing empirical studies on benefits and barriers to summarise previous research and to clarify the need of scales that measure benefits and barriers. Secondly, we develop formative measures to operationalise perceived benefits and barriers. Thirdly, we examine the relation of benefits and barriers with the future intention to participate in UIC. Fourthly, we conduct a cluster analysis to segment IS researchers into different groups that differ according to their perception of UIC benefits and barriers and by their intention to engage in future UIC projects. Thereby, it is possible to suggest different instruments to encourage UIC for different groups of IS researchers.

2 Literature Review

There is a rich body of research on UIC with hundreds of studies that analyse the phenomenon from different perspectives. We applied the snowballing methodology in our literature review to identify previous empirical studies that analyse benefits and barriers from the researchers' point of view. We used different databases (JStor, ScienceDirect and Google Scholar) with search terms such as "study", "university and industry", "collaboration", "cooperation" or "joint research" and scanned the abstracts of the articles. This initial process resulted in approximately 50 papers that appeared to analyse benefits and barriers from a researcher's point of view. These articles were reviewed in detail. Additionally, we performed a targeted search for references in these articles that also seemed to match our topic area (snowballing).

We focused our literature search on *empirical studies* because many previous articles are limited to conceptual questions (e.g. Schubert and Fisher, 2009; Bruneel et al., 2010) and our study was intended to be empirical in nature. We found that there are a number of studies that analyse benefits and barriers from an *industry perspective*. For example, Bruneel et al. (2010) identified two major *types of barriers* in their study of over 500 companies; *orientation-related barriers* (e.g. different objectives of universities and industries) and *transaction-related barriers* (e.g. problems with intellectual property). We excluded these studies with an industry perspective as well as studies that merely focus on one barrier for UIC, for example, intellectual property issues (e.g. Jelinek and Markham, 2007). The grow-

ing field addressing university–industry patent collaboration was also excluded (e.g. Guan and Zhao, 2013), as was research on the (regulatory) context of UIC (e.g. Freitas et al., 2013) or the evaluation of large joint research projects (e.g. Marek et al., 2014).

The main interest of our research is to initiate more UIC from universities. Therefore, we believe it is most important to support the initiation of more successful UIC projects. Accordingly, we focus on the establishment of UIC and focus less on the successful management of UIC, whether from the industry or university perspective. Therefore, we excluded the latter research stream that, for example, addresses opportunistic behaviour in UIC (e.g. Jia and Liu, 2010). Additionally, studies that focus on technology transfer offices were not analysed (e.g. Siegel et al., 2004).

Eventually, we found 12 qualitative and quantitative studies that address benefits and barriers from the *researcher's perspective*. The appendix provides an overview of the studies examined and lists all of the benefits and barriers mentioned. The studies in the appendix are organised by empirical approach, i.e. qualitative, quantitative with descriptive analysis, quantitative with multivariate analysis and alphabetically. The studies were published between 1994 and 2014, with the majority of studies (7) published in or after 2011. In the rest of this section we discuss the sample, the methods used, and the benefits and barriers identified in prior research.

One study (Schubert and Bjørn-Anderson, 2012) explicitly focused on international researchers, rather than on researchers from one (or two) country. One study (Lopez-Martinez et al. 1994) focused on Mexican researchers; all of the other studies focused on European or US researchers. The majority of studies focused on researchers from engineering or natural sciences; one study did not indicate the academic background of the researchers (Gomes et al., 2005). The sample size ranges from 9 to 1,544. We found 3 qualitative and 9 quantitative studies. However, three of the quantitative studies only used descriptive statistics such as frequencies or means to analyse their data. The remainder of the quantitative studies used multivariate analytics, such as factor or regression analysis; however, no study used cluster analysis to segment researchers into clusters that differ regarding their perception of the benefits and barriers of UIC. However, a clearer understanding why some researchers do or do not engage in UIC is essential to understand what motivates certain groups of researchers. Accordingly, we argue that a cluster analysis is likely to facilitate a better understanding of UIC and promises deeper theoretical insights because subgroups of researchers can be used to develop new studies that directly target these subgroups.

Some papers in our review analyse both the benefits and barriers of UIC (e.g. Muscio and Vallanti, 2014); other papers analyse *benefits* alone (e.g. Lee, 2000), whereas again others analyse *barriers* alone (e.g. Tartari et al., 2012). However, the wording of the concepts under examination varies; in some studies it is called "advantages" and "disadvantages", "resources" (Meyer-Krahmer and Schmoch, 1998), "motivations" or "incentives" (Lee 2000) and all of these match our understanding of UIC benefits and barriers. All studies focus on benefits and barriers but surprisingly few studies actually *rank* the importance of benefits and barriers from a researcher's perspective. Additionally, some studies use means and frequencies to prioritise benefits and barriers and do not use dependent variables such as the future intention to engage in UIC. Exceptions are the studies by Tartari et al. (2012) and D'Esté and Perkman (2011), which are based on the same data, and Tartari and Breschi (2012). Tartari et al. (2012) found that the effect of *orientation barriers* is stronger than that of *transaction barriers*, whereas D'Esté and Perkman (2011) highlighted *learning* and *funding* as dominant benefits that match academic and economic benefits, which are the factors we suggest below. Tartari and Breschi (2012) determined that access to additional resources and secrecy does not have a significant effect on the intention to engage in UIC. The perceived influence of the threat to academic freedom, however, is very strong.

We believe that there are methodological issues with most of the quantitative studies and that these concerns should be addressed in future research. For example, Tartari et al. (2012) did not report the results of their factor analysis; in other papers, factor solutions are not convincing because very differ-

ent components were aggregated into one factor (e.g. Tartari and Breschi, 2012; Lopez-Martinez et al., 1994). Along the same lines, no empirical aggregation (i.e. factor analysis) of benefits and barriers was conducted for example in the study by Muscio and Vallanti (2014). Furthermore, all papers that reported the results of factor analysis failed to address the possibly formative nature of their measures and treated the measures as reflective. For example, Tartari and Breschi (2012) build a factor that they named "resources" for the items: 1) new ideas for research, 2) availability of instruments and infrastructures, 3) increase in researchers' visibility, and 4) funds for research. In our opinion, all of these items represent very different aspects that need not co-vary with one another, which is a strong indication of a formative measure that combines a number of indicators to form (and not to reflect) a construct.

Overall, benefits and barriers reviewed in the studies were not reliably measured, and their impact on the frequency of collaborations (and success) is not clear and requires further investigation. Therefore, we felt the need to establish scales that measure benefits and barriers more reliably. Accordingly, we decided to conduct our own explorative study to develop new formative measures. Thus, we developed a coding scheme to classify the benefits and barriers identified in the studies (see appendix) to summarise the main findings of our literature review and to be able to create items for our subsequent empirical study.

Economic benefits (EBe) describe advantages of UIC from an economic perspective and encompass both benefits for the individual researcher (e.g. personal income) and for his/her research group. Thus, EBe are accompanied with economic resources for the researcher and his research group. Additionally, a researcher's reputation was classified as an EBe, because in the literature reputation is considered to be an intangible asset that represents a competitive advantage (e.g. Walsh and Beatty, 2007). Therefore, academic benefits (Abe) capture academic resources for the researcher, which enable him or her to conduct innovative research and high-quality academic teaching. Economic barriers (EBa) possibly hinder researchers from engaging in UIC due to constraints that concern the researcher and possible partners when a UIC is actually conducted. Specifically, cultural differences between academia and industry lead to high transaction costs when forming collaborations. Industry barriers (IBa) are based on different motivations and procedures from the academic world, whereas personal barriers (PBa) stem from the lack of capabilities of the individual researcher to attract potential partners in industry. Additional categories shown in the appendix but not used in our study are network benefits (e.g. "to be part of a professional network," Peñuela et al., 2014), relevance ("assist university outreach mission," Lee, 2000), academic barriers ("invention not suited for UIC," Geenzhuisen, 2013), and career considerations ("UIC detrimental to career progression", e.g. Muscio and Vallanti, 2014). We did not include these benefits and barriers in our own empirical study because the literature analysis showed that they only appeared sporadically in the existing literature.

3 Empirical Study

3.1 Data Collection

As already motivated in the introduction, the aims of our empirical study are to 1) develop *formative measures* to operationalise *perceived benefits* and *barriers*, 2) to *examine the relation* of benefits and barriers regarding the *future intention of participating* in UIC, and 3) with the help of a cluster analysis *to segment* IS researchers into different groups that differ according to their perception of UIC benefits and barriers and by their intention to engage in future UIC projects. Table 1 provides a description of the sample characteristics.

The first phase of the data collection for our explorative empirical study was conducted on-site at the 2013 International Conference on Information Systems (ICIS 2013), held in Milano, Italy from December 15-18, 2013. ICIS is the major annual meeting of the Association for Information Systems (AIS), which is the most prestigious association in IS research, and represents over 4,000 members

and researchers in over 95 countries. The ICIS 2013 was visited by approximately 1,543 IS academic professionals. The questionnaires were administered during face-to-face interviews by trained graduate students majoring in IS research. Overall, we estimate that approximately 350 researchers were asked to participate in our study, but a number declined using excuses like 'no time' or 'not interested'. From December 15-18, 2013, 268 completed questionnaires were collected, representing a response rate of approximately 76% of those individuals asked to respond, or approximately 17% of all registered conference participants.

		n= 328
Position	Full professor	142 (43.3%)
	Associate Professor	89 (27.1%)
	Assistant Professor	66 (20.1%)
	Senior Lecturer/Lecturer	17 (5.2%)
	Post-doc Researcher	14 (4.3%)
Country of work	Africa	4 (1.2%)
	Asia	39 (11.9%)
	Australia and NZL	37 (11.3%)
	North America	96 (29.3%)
	South America	3 (0.9%)
	Austria, Germany and Switzerland	45 (13.7%)
	Scandinavia	33 (10.1%)
	Benelux	12 (3.7%))
	Portugal and Spain	16 (4.9%)
	UK and Ireland	19 (5.8%)
	Rest of Europe	24 (7.3%)
Size of research group	M (SD)	9.27 (8.140)
	≤ 5	130 (39.6%)
	6-10	115 (35.1%)
	more than 10	83 (25.3%)
Years of experience in IS research	M (SD)	13.90 (9.770)
	≤ 3 years	44 (13.4%)
	4-6 years	38 (11.6%)
	7-10 years	67 (20.4%)
	11-15 years	72 (22.0%)
	16 and more	107 (32.6%)

Table 1. Sample characteristics

The second part of the data collection was initiated by an email to the Association for Information Systems (AIS) world newsletter. This newsletter is regularly sent to all subscribers of the AIS mailing list. With the newsletter's help, we collected 161 additional questionnaires, leading to a total sample of 429 completed questionnaires. There were 35 questionnaires from PhD students and respondents who were not willing to exactly name their position that were excluded from further analysis. For the data collected at the conference, the participants were randomly selected, and we were not able to collect

data to test for non-response bias because of the limited time we had. However, we compared this data set with our second e-mail survey and found no significant differences.

Of the participants, 328 (or 83.2%) affirmed experience with UIC; researchers with no experience (66 or 16.8%) were excluded from further analysis. Thus, our final sample size is n=328, which represents researchers with experience in UIC, who answered all questions as described below. The *questionnaire* was hosted online at unipark.de. It was composed of *five parts*. Firstly, we requested the participants if they personally had *experience with UIC*. Secondly, we asked for their *perceived benefits and problems* associated with UIC. The items are based on the results of our literature analysis and a previous study (Schubert et al., 2015). Seven items were used to measure benefits; six to measure perceived problems of UIC. All items are shown in table 3. The item generation is further described in the following section. Thirdly, we requested the following: research methods used in UIC (e.g. design science research); typical outputs form UIC (e.g. prototypes), typical UIC partners (e.g. private companies) and the typical UIC arrangement (e.g. one university – one company). Fourthly, we requested future plans for UIC with three items. The items are shown in table 2. Finally, we requested demographic information.

3.2 Data Analysis and Discussion

Construction of Formative Measures: To generate formative measures, we used our literature review, where we identified different benefits and barriers for the researchers. We used this groundwork and directly derived indicators or items that capture different themes; we thereby describe and define the constructs and do not reflect these. Thus, our indicators are defining characteristics of the respective measure; the changes in the indicators modify the measure and the indicators need not co-vary with one another (Jarvis, MacKenzie and Podsakoff, 2003). To empirically construct our measures, we adapted the four steps outlined by Diamantopoulos and Winkelhofer (2006): content specification, indicator specification, indicator collinearity, and the presentation of measurement and structural model results (i.e., external validity). We calculated our measures using Smart PLS 2.0.

Content Specification: To specify the scope of benefits and barriers, i.e., the domain of content the measures are intended to capture. We conducted an extensive literature review as depicted in our background section, and we specified the domain of benefits and barriers of UIC in the previous section.

Indicator Specification: To ensure that the items used as indicators for our specified measures cover the entire scope of the variables, we included the major aspects that were identified in our literature review. All items were formulated very clearly; they were not lengthy and had no ambiguity or clear directionality in accordance with conventional procedures on item formulation (e.g. Diamantopoulos and Winkelhofer, 2006). We tested the item specification in November 2013 with a panel of 14 researchers that have all worked in UIC projects but have not worked in an IS context. Based on this, pre-test items were rephrased. However, no item was dropped and no item was added. The experts also confirmed the mapping of the items to the manifest variables. In our first two steps, we ensured content validity; thus, our measures represent all facets of UIC benefits and barriers (e.g. Petter, Straub and Rai 2007).

Indicator Collinearity: To ensure the separateness of the distinct influence of the individual items, we tested the items for multicollinearity (e.g. Diamantopoulos and Winkelhofer, 2006). Bollen and Lennox (1991), for example, have noted that, if a particular item correlates too highly with the other items of a formative measure, the scale likely contains redundant information that contradicts its formative nature. Firstly, to test this, we inspected correlations of the items. The analysis of correlation of the items of the three latent variables showed no critical degree of correlation with the highest coefficient of 0.530, which is far below the threshold suggested by Cenfetelli and Bassellier (2009) of 0.9. Secondly, multicollinearity was tested by calculating the variance inflation factor (VIF) among the indicators listed in table 3. With a maximum VIF of 1.61, which is well below the cut-off threshold of 10

(e.g. Kleinbaum, Kupper, and Muller 1988), multicollinearity did not pose a problem. Thus, all items were retained for further analysis.

Measurement results: The results of the measurement model are outlined in table 2 and 3. For the sole reflective latent measure, FI, all loadings are very high, i.e., well over 0.9, the composite reliability (CR) is 0.957 and the average variance extracted (AVE) is 0.8822.

Future Intentions (FI)	Factor Loading
In the next five years…	α =0.933
FI1: I intend to spend more time on UIC	0.920
FI2: I intend to participate in more UIC projects	0.952
FI3: I intend to lead more UIC	0.946

Table 2. Measurement results for FI

Regarding the formative measures (see table 3) for benefits, we found that for EBe, the item EBe3, which measures reputational effects, is dominant with a weight of 0.659. The variable with the highest weight in ABe is ABe2, which measures the access to empirical data. This result corresponds with the finding of Tartari and Breschi (2012) who have noted that, particularly in applied science, research problems from company practice can provide a useful stimulus for sophisticated research. For the constructs measuring UIC barriers, PBa2 (lack of experience) is dominating PBa. EBa and IBa both consist of two items with similar weights. The T-values for seven of the 13 items are significant (with a T-value > 1.96).

	Loading	Stand. Weight (T-Values)
Economic benefits		
EcB1: Personal income	0.5391	0.206 (1,525)
EcB2: More academic staff for my research group	0.5752	0.159 (1,174)
EBe3: Reputation for my research group	0.8746	0.659 (4,401)*
EBe4: Money for my research group	0.7226	0.305 (1,745)
Academic benefits		
ABe1: Access to relevant research problems and questions	0.7383	0.414 (1,898)
ABe2: Access to empirical data of real world phenomena	0.9074	0.716 (3,8437)*
ABe3: Input for teaching	0.3934	0.114 (0,782)
Economic Barriers		
EBa1: Very time consuming to carry and administer the project	0.7605	0.612 (2,123)*
EBa2: Differing research interests or objectives of practitioners and academics	0.8024	0.666(2,315)*
Industry Barriers		
IBa1: Scepticism in industry towards academics	0.7818	0.636 (1,988)*
IBa2: Rigid data protection procedures in companies	0.7853	0.640 (2,007)*
Personal Barriers		
PBa1: Limited access to potential industry partners	0.6573	0.369 (1.087)
PBa2:Lack of experience in setting up a UIC	0.9387	0.807 (2,494)*

*= T-Values significant at p<0.05

Table 3. Measurement results for formative measures

Structural model results and external validity: To examine external validity, we focused on nomological aspects and tested how well the items that measure benefits and barriers relate to another measure, in our case, the FI, to conduct UIC. As previously mentioned, this factor is a reflective measure that captures with three items whether researchers are willing to engage in a UIC in the future.

The Theory of Planned Behavior (TPB) suggests that a behavioural intention is the most dominant predictor of actual behaviour (Ajzen 1991; Sheppard et al. 1988). The proposed relations of barriers and benefits with FI are based on the notion that high barriers inhibit intentions whereas benefits foster intentions. As expected, both measures for benefits are positively and significantly connected to FI: EBe with a path coefficient of 0.292, ABe with 0.184. However, from the barrier constructs, EBa solely behaves as expected with a path coefficient of -0.163. Both coefficients for PBa and IBa are weak, positively (0.041 and 0.044) and not significantly connected to FI. Obviously, for the sample as a whole, PBa and IBa are not important predictors of FI. However, the following cluster analysis hints at an increased importance for certain clusters.

Overall, the structural model has a moderate R-square of 0.167, which is below the threshold value of 0.19 (Chin, 1998), indicating that there are other factors that explain FI to conduct UIC.

Cluster analysis: We conducted a cluster analysis, which shows that IS researchers are a heterogeneous population in terms of their characteristics, attitudes and motivation for conducting UIC. A cluster analysis is a method for classification with the objective of dividing the data into meaningful subgroups on the basis of their similarity, although the number of possible subgroups or other information regarding the composition is unknown (Fraley and Raftery, 1998; Punj and Stewart, 1983). It is very effective in explorative data mining analysis and enables us to identify patterns in an area, where there are no agreed theoretically well founded taxonomies. To perform the cluster analysis, we aggregated the formative measures according to the relative weight of their items. We employed a two-step clustering procedure consisting of a hierarchical cluster analysis followed by a k-means analysis. Respondents' relative standing on the scales depicted in table 2 and table 3 were used as input variables for clustering.

	Cluster 1: The Self-Assured (n=50)	Cluster 2:The Realistic Optimists (n=108)	Cluster 3: The Disenchanted (n=42)	Cluster 4: The Enthusiasts (n=84)	Cluster 5: The Indifferents (n= 44)
Future Intentions	4.67	6.29	3.12	6.57	4.21
Economic Benefits	4.85	5.25	3.60	4.70	3.87
Academic Benefits	6.38	6.47	6.00	6.43	5.58
Economic Barriers	3.79	5.47	5.81	4.06	4.91
Industry Barriers	3.74	5.56	5.46	3.88	3.59
Personal Barriers	4.06	5.22	4.40	2.59	2.53
Years of experience in IS Research	14.48	11.06	18.02	15.02	14.14

Table 4. Cluster Results

Distances between the clusters were calculated with the Euclidean distance measure and aggregation of clusters was performed with Ward's procedure. To reflect the true structure of the data set, the agglomeration schedule was examined and the elbow criterion used to determine the number of clusters; this resulted in choosing a five-cluster solution as the most appropriate representation of the data. Next, we attempted to demographically profile the clusters to further describe them. However, the country that researchers worked in, the researcher's position and other variables do not differ much for our segments and are therefore not discussed here. The sole variable we report is *prior experience in IS research* (see table 4).

Cluster 1 is slightly enthusiastic regarding its FI for UIC but acknowledges the benefits of UIC. Because barriers are perceived as average, we call this cluster the "Self-Assured". The largest group is

formed by cluster 2, which we call the "Realistic Optimists" because they have a high intention to conduct UIC in the future and perceive both EBe and ABe but also, realistically, EBa, IBa and PBa as relatively high. This cluster has the least experience in IS research. Cluster 3 has the lowest intention to conduct UIC in the future and perceives EBe as below average and the barriers as fairly high. Therefore, we label this cluster as the "Disenchanted". Members of this cluster have the highest experience in IS research of all clusters. Cluster 4 contains the "Enthusiasts", who have the highest FI to conduct UIC in the next five years, perceive barriers as average or below average and acknowledge EBe and, more importantly, ABe. Finally, cluster 5 has the lowest score in benefits; IBa and PBa and scores average in FI. Therefore, we call this cluster the "Indifferents".

4 Discussion and Implications

In this study, we critically assessed previous empirical studies on benefits and barriers and found that no quantitative research approach has yet satisfied basic methodological requirements. Therefore, we conducted an explorative, quantitative study in the IS research domain and developed a parsimonious formative measures to operationalise perceived benefits and barriers.

We tested our scales for nomological validity and found that ABe and EBe are positively and significantly connected to FI with path coefficient of 0.292 and 0.184. This finding emphasises the relevance of additional funds and resources in times when universities struggle with funding issues. However, for the barriers only EBa was negatively related to FI with a path coefficient of -0.163. Both coefficients for PBa and IBa are not significantly connected to FI. Surprisingly, PBa and IBa are not important predictors of FI, which is the most interesting result of this segment of our study.

A limitation of our study is that we only analysed a part of the sample, i.e., researchers that are engaged in UIC and thereby accept selection bias. Consequently, our data is positively biased in favour of UIC and does not represent the attitude of the whole community of IS researchers towards UIC. To contrast our results, future research should investigate the perception of benefits and barriers from the perspective of IS researchers, who are not conducting UIC projects.

The structural model has a moderate R-square of 0.167. However, in this exploratory study, it is unlikely that we accounted for all or most of the factors that foster or inhibit FI to engage in UIC. For example different forms of UIC can have an effect on perceived benefits and barriers. We also did not account for the positive or negative experiences with UIC projects *actually conducted* but focused merely on *motivational variables*. Also, the magnitude and intensity of UIC probably varies with industry and specialization of researchers within IS research which we also did not examine.

Further, future research should also incorporate variables such as institutional support, monetary incentives and other variables from our literature review that we omitted in this explorative study such as academic barriers or relevance. Additionally, motivation for engagement in UIC could originate from peer recognition, the dean or from university presidents. Obviously, this motivation depends on the research approach, which could be either supportive or unsupportive of UIC. Similarly, Penuela et al. (2014) found that a researcher's identity, which is close to the entrepreneurial ideal has a positive effect on engagement in UIC. Therefore, future studies should also include the research approaches that IS researchers prefer and the researcher's identity.

In our cluster analysis, we segmented IS researchers into different groups that differ according to their perception of UIC benefits and barriers and their intention to engage in future UIC projects. Thereby, it is possible to suggest different measures to encourage UIC for different groups of researchers.

Overall, the cluster analysis shows that researchers have different motives to engage in UIC. EBe are, for example, perceived highest for the *Realistic Optimists*. However, it is rather surprising that ABe are very high for all clusters. This result could indicate that there is actually no conflict between academic freedom, high-quality academic output and industry projects. Future research should therefore examine how engagement in UIC influences academic output and how researchers who are not en-

gaged in UIC perceive the ABe of UIC. The clusters identified in this study can be directly targeted in future studies which is obviously imminent for the *Disenchanted* and the *Indifferents*.

D'Este and Perkmann (2011) noted that there is a large difference between two groups of authors. Whereas the first group claims that researchers conduct UIC for economic reasons, the second group emphasises the positive benefits for academic reasons. Notably, our results show that all clusters value ABe highly and that two clusters score below average on EBe.

With the largest clusters, 2 and 4, the majority of the sample is quite enthusiastic towards UIC. For the other groups, the cluster solution can be used as a first step in segmenting target groups to be addressed by technology transfer offices to assist researchers to engage more actively in UIC. For example, the *Realistic Optimists*, who are eager to engage in more UIC projects but have the lowest experience in IS research, could be assisted in bonding with industry by university technology transfer offices. For IS researchers who are not yet engaged in UIC projects, the different clusters identified here can be used as role models to realistically communicate the benefits and barriers of UIC.

References

Ajzen, I. (1991). "The theory of planned behavior." *Organizational Behavior & Human Decision Processes* 50 (2), 179–211.

Barker, D. (2004). "The Scholarship of Engagement. " A Taxonomy of Five Emerging Practices. *Journal of Higher Education Outreach and Engagement*, 9 (2), 123-137.

Bollen, K. and R. Lennox (1991). "Conventional wisdom on measurement: A Structural Equation Perspective." *Psychological Bulletin* 110 (2), 305–314.

Boyer, E. L. (1996). "The scholarship of engagement." *Journal of Public Service and Outreach*, 1 (1), 11–20.

Bruneel, J., D'Este, P. and A. Salter (2010). "Investigating the factors that diminish the barriers to university–industry collaboration." *Research Policy* 39 (7), 858–868.

Cenfetelli, R. T. and G. Bassellier (2009). "Interpretation of formative measurement in information system research." *MIS Quarterly* 33 (4), 689–707.

Chin, W. W. (1998). "The partial least squares approach to structural equation modelling." In: *Modern Methods for Business Research*. Ed. by G. A. Marcoulides. Mahwah, NJ: Lawrence Erlbaum Associates, 295–358.

Coltman, T., Devinney, T.M., Midgley, D.F. and S. Veniak (2008). "Formative versus reflective measurement models: Two applications of formative measurement." *Journal of Business Research* 61 (12), 1250–1262.

Davis, G. B., Massey, A. P. and N. Bjørn-Andersen (2005). "Securing the future of information systems as an academic discipline." In: *Proceedings of the International Conference on Information Systems*. *ICIS 2005 Proceedings.* Paper 83.

D'Este, P. and M. Perkmann (2011). "Why do academics engage with industry? The entrepreneurial university and individual motivations." *Journal of Technology Transfer* 36 (3), 316–339.

Diamantopoulos, A. and H. M. Winklhofer (2001). "Index construction with formative indicators: An alternative to scale development." *Journal of Marketing Research* 38 (2), 269–277.

Fraley, C. and A. E. Raftery (1998). "How many clusters? Which clustering method? Answers via model-based cluster analysis." *The computer journal 41*(8), 578–588.

Freitas, I. M. B., Marquesc, R. A. and E. M. de Paula e Silva (2013). "University–industry collaboration and innovation in emergent and mature industries in new industrialized countries." *Research Policy* 42 (2), 443–453.

Gomes, J. F. S., Hurmelinna, P., Amaral, V. and K. Blomqvist (2005). "Managing relationships of the republic of science and the kingdom of industry." *Journal of Workplace Learning* 17 (1/2), 88–98.

Jarvis, C. B., MacKenzie, S. B. and P. M. Podsakoff (2003). "A critical review of construct indicators and measurement model misspecification in marketing and consumer research." *Journal of Consumer Research* 30 (2), 199–218.

Jelinek, M. and S. Markham (2007). "Industry–university IP relations: integrating perspectives and policy solutions." *IEEE Transactions in Engineering Management* 54(2), 257–267.

Jiancheng, G. and Z. Qingjun (2013). "The impact of university–industry collaboration networks on innovation in nanobiopharmaceuticals." *Technological Forecasting & Social Change* 80 (7), 1271–1286.

Kleinbaum, D. G., L. Kupper, and K. E. Muller (1988). *Applied Regression Analysis and Other Multivariable Methods*. 2d Edition. Boston: PWS-Kent.

Lee, Y. S. (2000). "The sustainability of university-industry research collaboration: an empirical assessment" *Journal of Technology Transfer* 25 (2), 111–133.

López-Martínez, R. E., Medellín, E., Scanlon, A. P. and J. L. Solleiro (1994). "Motivations and obstacles to university industry cooperation (UIC): a Mexican case." *R&D Management* 24 (1), 17–31.

Marek, L. I., Brock;D.-J. P. and S. Jyoti (2014). "Evaluating collaboration for effectiveness: Conceptualization and measurement." *American Journal of Evaluation.* doi: 10.1177/1098214014531068.

Mathiassen, L. and P. A. Nielsen (2008). "Engaged scholarship in IS research." *Scandinavian Journal of Information Systems* 20 (2), 1–18.

Meyer-Krahmer, F. and U. Schmolch (1998). "Science-based technologies: university-industry interactions in four fields." *Research Policy* 1998 (27), 835–851.

Muscio, A. and G. Vallanti (2014). "Perceived obstacles to university-industry collaboration: results from a qualitative survey of Italian academic departments." *Industry and Innovation* 21 (5), 410–429.

Peñuela, J. O., Benneworth, P. and E. Castro-Martinez (2014). "Explaining researchers' readiness to incorporate external stimuli in their research agendas." In: *Ingenio Working Paper Series* N°2014-08.

Perkmann, M., and Walsh, K. (2009). "The two faces of collaboration: impacts of university-industry relations on public research." *Industrial and Corporate Change* 18 (6), 1033-1065.

Petter, S., Straub, D. and A. Rai (2007). "Specifying formative constructs in information systems research." *MIS Quarterly* 31 (4), 623–656.

Punj, G. and D. W. Stewart (1983). "Cluster analysis in marketing research: review and suggestions for application." *Journal of Marketing Research* 20 (2), 134-148.

Schubert, P. and N. Bjørn-Andersen (2012). "University-Industry collaboration in IS research: An investigation of successful collaboration models." *BLED 2012 Proceedings* 29, http://aisel.aisnet.org/bled2012/29 (visited on 11/25/2014).

Schubert, P., Bjørn-Andersen, N. and T. Kilian (2015): "Archetypes for Engaged Scholarship in IS". *International Journal of Information Systems and Management*, 2 (1), 1–21.

Schubert, P. and J. Fisher (2009). "A blueprint for joint research between academia and industry." *BLED 2009 Proceedings 17,* http://aisel.aisnet.org/bled2009/17 (visited on 11/25/2014).

Sheppard, B. H., Hartwick, J. and P. Warshaw (1988). "The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research." *Journal of Consumer Research* 15 (3), 325–343.

Siegel D.S., Waldman, D.A., Atwater, L.E. and A.N. Link (2004). "Toward a model of the effective transfer of scientific knowledge form academicians to practitioners: qualitative evidence from the commercialization of university technologies." *Journal of Engineering & Technology Management* 21, 115–142.

Simmons, P., and Walker, G. (2000). "Contract research as interactive social science." *Science and Public Policy* 27 (3), 193-201.

Tartari, V. and S. Breschi (2012). "Set them free: scientists' evaluations of the benefits and costs of university-industry research collaboration." *Industrial and Corporate Change* 21 (5), 1117–1147.

Tartari, V., Salter, A. and Pablo D'Este (2012). "Crossing the Rubicon: exploring the factors that shape academics' perceptions of the barriers to working with industry." *Cambridge Journal of Economics* 36 (3), 655–677.

Van de Ven, A. H. (2007). *Engaged scholarship: a guide for organizational and social research.* Oxford: Oxford University Press.

Van de Ven, A. H. and P. E. Johnson (2006). "Knowledge for theory and practice." In: *Academy of Management Review*, 31 (4), 802–821.

van Geenhuizen, M. (2013). "From ivory tower to living lab: Accelerating the use of university knowledge." *Environment and Planning C: Government and Policy* 2013 (31), 0–18.

Walsh, G. and S. E. Beatty (2007). "Customer-based corporate reputation of a service firm: Scale development and validation." *Journal of the Academy of Marketing Science* 35 (1), 127–143.

Wei, J. and L. Liran (2010). "Control mechanisms for the opportunistic behavior in industry-university collaborations." In: *Proceedings of the 3rd IEEE International Conference on Broadband Network and Multimedia Technology (IC-BNMT),* 1131–1135.

Welsh, R., Glenna, L., Lacy, W. and B. Biscotti (2008). "Close enough but not too far: Assessing the effects of university-industry research relationships and the rise of academic capitalism." *Research Policy* 37, 1854–1864.

Wen-Hsiang, L. (2011). "Willingness-to-engage in technology transfer in industry–university collaborations." *Journal of Business Research* 64 (11), 1218–1223.

Appendix: Literature review

	Author and year	Sample	Benefits/ Barriers		
Qualitative approaches	van Geenhuizen 2013	25 Dutch researchers from engineering and natural sciences	- Invention not suited for UIC (ABa) - Financial factors (EBa)	- Value system, needs, and routines at university (IBa)	- University–business conflicts (EBa)
	Gomes et al. 2005	22 Portuguese and Finish researchers (without academic background)	- Access to funding (EBe) - Access to information (ABe) - Access to knowledge (ABe) - Access to resources (EBe) - Actualization/competitiveness (ABe) - Employment opportunities (ABe) - Education with meaning (ABe) - Image (EBe)	- Outsourcing R&D (ABe) - Individual gains (EBe) - Quality of human resources (ABe) - Attitudes (EBa) - Bureaucracy (EBa) - Confidentiality (IBa) - Culture (EBa) - Different language/mental worlds (EBa)	- Different needs and objectives (EBa) - Fear of challenging mindsets (EBa) - Lack of knowledge/experience (PBa) - Lack of practical knowledge in universities (EBa) - Previous bad experiences (PBa) - Time horizons (EBa)
	Schubert and Anderson 2012	9 IS researchers from different countries	- Access to empirical data (ABe) - More staff (EBe) - Contribution for society (R) - More funds (EBe)	- Access to relevant research questions (ABe) - Lack of recognition from colleagues/deans (CC) - Acquisition cost (EBa) - Difficulties in obtaining funding (PBa)	- Scepticism in industry towards academics (IBa) - Negative reputation of UIC (CC) - Lack of access to industry partners (PBa)
Quantitative Approaches - Descriptives	Lopez-Martinez et al. 1994	31 Mexican researchers from natural science and engineering	Not classified: Benefits - Accomplishment of social function of the university - Update and corroboration of knowledge - (Specific request of a firm) - Expansion of professional perspectives, maintain the researcher up dated and increase in individual prestige - Increase in institutional prestige, contribution to diffusion of knowledge	Not classified: Barriers - Additional income for researcher - Access to laboratory equipment and financial resources - Instability of public universities - Technological gap, lack of participation by firms in project definition - Disagreement in research costs, confidentiality and industrial property rights - Academics live in ivory tower	- Lack of financial resources and entrepreneurial mentality - Insufficient recognition for applied research - Excess of university bureaucracy - Not-invented-here syndrome - Culture gap, lack of communication, incompatibilities, mutual distrust of capacity of human resources and of institutional responsiveness of objectives
	Meyer-Krahmer and Schmoch 1998	433 German researchers from engineering, computer and natural sciences	- Additional funds (EBe) - Knowledge exchange (ABe) - Flexibility of industrial funds (EBe) - Additional facilities (EBe)	- References for public projects (EBe) - Short-term orientation (IBa) - Limited industrial basis (PBa) - Restrictions to publications (IBa)	- Less interesting topics (ABa) - Administrative problems (EBa) - Unfair terms of contract (IBa)
	Muscio and Vallanti 2014	197 Italian directors of departments from engineering and physical sciences	- Creation of long-term relationships with industry (N) - Application of research outside academia (R) - Source of income for department (EBe) - Solving problems faced by industry (R) - Testing applicability of research in industry (R) - Advancement of research in industrial context (ABe) - Research funding (EBe) - Opportunity to develop IP (EBe)	- Low-cost access to resources/data (EBe) - Access to industrial competencies (ABe) - Access to laboratories/facilities (EBe) - Source of income for professors (EBe) - Difficulty to find innovative companies (PBa) - Lack of government funding (EBa) - Difficulty to get in contact with individuals from industry (PBa) - Short-term orientation of Industry research (EBa) - Lack of understanding on expectations (EBa) - No established process for UIC in universities (EBa) - Differing research interests/needs (EBa)	- Rules set by university or government-funding schemes (EBa) - Delay of research outcomes by industry (IBa) - Conflict with teaching/research duties (ABa) - Professional research networks include few/no companies (PBa) - High personnel turnover in industry (IBa) - UIC detrimental to career progression (CC) - Potential patent conflicts (IBa)

	Author and year	Sample	Benefits/ Barriers		
Quantitative Approaches - Multivariate	D'Este and Perkmann 2011	1,528 British researchers in Engineering and Physical Sciences	Commercialization: – Source of personal income (EBe) – Seeking IPRs (EBe) Learning: – Information on industry problems (ABe)	– Feedback from industry (ABe)Information on industry research (ABe) – Applicability of research (R) – Becoming part of a network (N) – Access to in-kind resources:	– Access to materials (ABe) – Access to research expertise (ABe) – Access to equipment (EBe) Access to funding: – Research income from industry (EBe) – Research income from Gov (EBe)
	Lee 2000	427 US researchers from natural science and engineering	Motivation for academic research support: – Secure funds for research assistants & equipment (EBe) – Supplement funds for one's own research (EBe)	– Gain insight into one's own research (ABe) Motivation for teaching function: – Gain knowledge useful for teaching (ABe) – Create student jobs and internships (ABe) – Assist university outreach mission (R)	Motivation for entrepreneurship : – Test practical application of theory (ABe) – Look for business opportunity (EBe)
	Peñuela et al. 2014	1583 Spanish researchers from engineering and natural sciences	– Additional funds (EBe) – To be part of a professional network (N)	– Access to experience of non-academic professionals (ABe)	– Access to equipment or infrastructure (EBe) – Grants and job opportunities for students (ABe)
	Tartari and Breschi 2012	657 Italian researchers from engineering, medicine and natural sciences	Resources: – New ideas for research (ABe) – Availability of instruments and infrastructures (EBe) – Increase in researchers' visibility (EBe) – Funds for research (EBe)	– Placement opportunities for students (ABe) Freedom: – Endangers basic research (ABa) – Limits the choice of research topics (ABa) – Not interesting enough for academic researcher (ABa)	Secrecy: – Secrecy over research results (IBa) – Ownership of research results (IBa) – Limits in communication of research results (IBa)
	Tartari et al. 2012	1,544 British researchers in Engineering and Physical Sciences	Orientation barriers: – Short-term orientation of industry research (EBa) – Difficulty in finding companies (PBa) – Lack of continuity in companies' research strategies (EBa) – Differing research interests or needs (EBa)	– Lack of understanding (EBa) – Delays in dissemination of research outcomes (IBa) Transactional barriers: – Regulations imposed by university or funding agencies (EBa) – Policies adopted by university's technology transfer office (EBa)	– Potential conflicts with industry regarding intellectual property rights (IBa) – Absence of established procedures for collaboration with industry (EBa) – Low profile of University's technology transfer offices (PBa)
	Welsch et al. 2008	84 US researchers from biology	Productivity enhancing: – Increases access to new knowledge (ABe) – Accelerates product development (ABe) – Increases access to new research tools (ABe)	Scientific interaction: – Provides contact with a wider network of scientists (N) – Restricts scientific communication among university researchers (N)	Industry support: – Provides new research funds (EBe) – Provides new support for graduate students/postdocs (EBe)

ABe= Academic benefits, EBe= Economic benefits, R= Relevance, N= Network benefits, ABa= Academic barrier, CC= Career considerations, IBa= Industry Barriers, PBa= Personal Barriers