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University-Industry Collaboration: Drivers and Barriers for going Online

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Abstract

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Abstract

Extant studies have shown how online communities can promote collaborative and innovative activities in general. Studies on university-industry collaborations have so far focused less on online activities. We therefore set out to examine the individual and organizational drivers and barriers for academics and industrial professionals to contribute to online community-based platforms. We use a mixed method approach using both survey data and in-depth interviews with respondents from the Danish food sector. Findings show that in line with known studies on online innovation communities in general, the main drivers for engagement are organizational and individual learning, and establishing connections, rather than monetary incentives. In contrast to offline studies on university-industry interactions, well-connected academics are less interested in online communities of academics and industry professionals. Finally, the type of knowledge to be exchanged is important. Problems should not be too complex, the locus of knowledge unknown and in the early phase of development, in order for an online form of interaction to be appealing.

1. Introduction

Online communities in general have been studied extensively; we know how difficult it is for such communities to succeed (Dahlander and Piezunka, 2014), why firms rely on online platforms (Boudreau and Lakhani, 2009, Jeppesen and Lakhani, 2010, Bayus, 2013) and why individuals decide to seek out and contribute to such online platforms (von Hippel 1988,

Henkel, 2006, Jeppesen and Frederiksen, 2006).

Previous research has also examined the drivers and barriers for university-industry collaboration, and shown how most collaboration is facilitated through traditional links. Academics and industrial professionals mainly solve problems within existing networks or in some form of offline interactions, e.g. workshops, consulting jobs or common research grants (Cohen et al., 2002, D'Este and Patel, 2007). However, D'Este and Patel point out that "*we know little about the distinctive role of individual characteristics versus institutional characteristics in explaining such heterogeneity of behavior [why academics and industrial professionals interact]*" (2007: 1296). While Perkmann et al. (2011), among others, have shed light on this question in an *offline* context, we aim to answer this question in the framework of an *online* university-industry platform within the Danish food sector. The overall research question driving this paper is what factors influence the likelihood of academics and industrial professionals to engage in online (rather than offline) community-based problem solving efforts. Are the factors the same as in non-academic online settings, or offline university-industry interactions? More specifically, does past experience with online media, existing university-industry collaboration, perceived value for the organization or personal (be it extrinsic or intrinsic) drive the likelihood to participate in such online communities for academics and industry professionals?

The questions driving the present paper thus have a two-fold origin, i.e. examine if a) the same principles that have been uncovered in online platforms (such as Foldit, Zoo Galaxy, Topcoder) aimed at individuals in general and b) factors that influence offline university-industry interactions, are also significant in explaining the likelihood for academics and industrial professionals to engage in online, collaborative interactions.

The empirical data used in this study is based on 335 respondents from the Danish food sector, representing two of the largest industrial food-sector networks in Denmark that consist

of over 30 Danish food-manufacturing companies including Arla, Danisco DuPont, Danish Crown and the five biggest Danish Universities. In additional to survey data, qualitative interviews have been carried out with selected respondents, in order to further validate and illuminate the statistical findings. We chose the Danish food sector as it has a long tradition of university-industry collaboration. Results show that in line with known studies on online innovation platforms in general, the main drivers for engagement are organizational and individual learning, and establishing connections – rather than monetary compensation. Well-connected academics and industry professionals are, for varying reasons, not as interested in such an online university-industry platform. Further qualitative analysis shows how the nature of the problem is vital (cf. (Felin and Zenger, 2014) (Lakhani et al., 2013). If the problem is too complex, the locus of knowledge easily identifiable and the problem is in a competitive, commercial situation, academics and industrial actors prefer to navigate through existing social networks.

Practical implications are argued to be, that platforms should be semi-open, i.e. involve the option to make parts of the dialogue private. Platform owners should be very aware of what kind of problems are to be promoted and pay particular attention to attract young, unconnected academics and relevant large firms, in order to legitimize the platform and generate early interest.

In the following two sections the literature that constitutes the basis of hypotheses is presented. Hereafter specific arguments for hypotheses are given, whereupon the methods and research setting is presented. The next sections contain the analysis of data, followed up by a discussion of the results, and the paper finishes with practical implications and conclusion.

2. Online Communities for Innovation

In the past years an abundance of examples and studies have shown the value of communities of individuals. The attempt to freely reveal information and reach out beyond firm boundaries

is not new (Allen, 1983, Dahlander and Gann, 2010) but access to a global Internet has increased such community activities. These communities can either be based on individuals connecting due to common interests or because firms want to reach out to (some) individuals (von Hippel 1988, Lüthje, 2004). Dell's Ideastorm is an example of one firm reaching out to a large community in order to generate ideas in general and feedback to ideas (Bayus, 2013). InnoCentive is an example of a firm acting as a mediator, and thus aims to connect firms with problems to individuals that have unusual skills and ideas that might solve these problems (Jeppesen and Lakhani, 2010). While the open and user innovation literature has showcased many examples of fruitful and profitable online communities (see studies on Threadless (Brabham, 2010), Lego (von Hippel, 2005), Topcoder (Boudreau et al., 2011), InnoCentive (Lakhani and Jeppesen, 2007), Dell (Bayus 2013) a recent important study on thousands of communities by Dahlander & Piezunka (2014) highlights how many attempts to generate an online community fail: 90% generate no activity at all. Nevertheless, such findings merely emphasize the need to better understand when and how online communities might be beneficial to all involved actors.

Since von Hippel's early studies (e.g. 1978) a stream of research has examined why actors engage in communities (von Hippel, 1978). Generally research documents that intrinsic motives are considered more important than extrinsic (e.g., but not exclusively monetary) incentives (Jeppesen and Frederiksen, 2006, Füller, 2006, Frey et al., 2011, von Krogh and von Hippel, 2006). Although also overlapping as e.g. status might be viewed both as extrinsic and intrinsic motives (Boudreau and Lakhani, 2009). In certain special cases users are almost exclusively driven by intrinsic motives. The enjoyment of the innovation task itself can be a strong driver when the user does not perceive the task to be work related (e.g. Wikipedia, cf. Frey et al., 2011). Self-determined tasks that are inherently interesting or intellectually challenging are also strong drivers for contributing users, whose contribution can be even

more substantial when the engaged users perceive themselves as part of a larger cause (e.g. Linux). 'Having fun', intellectual interest, curiosity and the private use of information seem to be very wide-ranging reasons to participate (Füller, 2006, Jeppesen and Frederiksen, 2006, von Krogh and von Hippel, 2006). Activities are thus often rewarding in it self and can lead individuals to contribute to community or other community members even in the absence of financial rewards.

Conversely, merely extrinsic motives to engage in open communities also exist. For individuals, the benefits of engaging might be more long-term oriented as participation can enhance one's reputation in the community, build networks or signal talent to a wide group of other individuals or firms (Frey et al., 2011, Boudreau et al., 2011). This desire to develop and feel affiliated to a certain community occupies a position between ex- and intrinsic motivation. In the case of InnoCentive, the contributors behind the selected ideas receive a financial reward, in addition to the intrinsic benefits (Jeppesen and Lakhani, 2010). Interestingly, it seems like extrinsic rewards in some cases might crowd out intrinsic motives. This kind of shift in motivational basis has been shown to negatively influence the nature of interpersonal interaction and decrease creativity among users (Amabile, 1985, Franke and Shah, 2003). Furthermore, extrinsic rewards might lead individuals to create more non-substantial answers (noise) to challenges and questions than intrinsically framed platforms (Frey et al., 2011). The study also shows that intrinsically oriented individuals produce significantly more substantial solutions to posted issues than extrinsically oriented individuals.

One should emphasize though that most of the above studies are either based on private individuals in general or private users in firms (Henkel, 2006), or are based on firm platforms such as InnoCentive or Dell that pose specific problems or are looking for ideas that specifically relate to their own firm. In the present paper we are interested in communities of

academics and industrial professionals, where both parties can post problems and contribute with knowledge and ideas to problems posed by others. It is thus an open question whether such a framework leads to specific challenges. In order to shed further light on this, the following section examines known literature on university-industry collaboration (UIC).

3. University-Industry Interactions

While the two primary missions of universities are usually considered to be teaching and research, recent years have seen universities focus more on the role in developing local and national economies by commercializing academic knowledge (Perkmann et al., 2013). In order to investigate such commercialization, research often focuses on the transfer of intellectual properties such as patents, licenses and spin-outs, but university-industry interactions are based on many different forms of collaboration. Cohen et al., (2002) show how informal links such as consulting and informal communication and contract or co-operative research are considered the most valuable collaboration links between academics and industry professionals. Patenting and academic entrepreneurship plays a minor role in UI knowledge transfer overall (D'Este and Patel, 2007, Perkmann and Walsh, 2007). Even at MIT only about 10% of all knowledge transfers (although arguably a broader conceptualization than 'collaboration') consist of patenting (D'Este and Patel, 2007).

While the above outlines the means of interaction, the following highlights the three main forces that drive collaboration between academics and industrial professionals: 1) Complementarity of research which leads to mutual benefits for both parties, 2) access to additional resources (e.g. testing applicability of new technologies or research funding), 3) firms seek out collaborations with high-quality researchers as they are gatekeepers to high-quality students, emerging technologies and reputation (Bonaccorsi and Piccaluga, 1994, Fontana et al., 2006, Perkmann et al., 2011, D'Este et al., 2005, Hsu and Lim, 2013,

Bergenholtz, 2014).

What form of interaction is preferred seems to depend on the industry, since joint ventures are considered more important in sectors such as pharmaceutics, glass, aerospace whereas other links such as academic consulting is highly used and appreciated in other sectors such as food, medical equipment etc. (Cohen et al., 2002). Furthermore, the rankings of universities (and thus quality of research and access to resources) and tenure of individuals constitute important variables here, since younger individuals and lower ranked departments are involved in more UI interactions (Cohen et al., 2002). All these factors contribute to a basic understanding of why and how academics and industrial professionals aim to collaborate, although these studies focus on offline interactions or online mediums of interactions embedded in existing social networks.

Importantly, the nature of interactions and whom one decides to engage with (strong or weak ties e.g.), has a substantial impact on what kind of information is found and spread. *"Search processes are likely to be socially selective in the sense that they are likely to be influenced by existing inter-personal networks and/or previous inter-organizational collaborations*" (D'Este & Perkmann, 2011: 29). The type of social networks academics and industry professionals engage in thus lead to certain types of knowledge and new problems (Granovetter, 1973, Bergenholtz and Bjerregaard, 2014). Therefore it is important to investigate what drives academics and industrial professionals to engage in online communities, in order to be able to shed light on what kind of problems and type of knowledge can benefit from being at the center of attention of such online sites.

4. Hypotheses

The overall framework for the proposed hypotheses is based on three strands of literature, the literature on online problem-solving communities, literature on university-industry

interactions, and the basic principles concerning attitude formation and behavioral intention under certain conditions.

The first hypotheses will elaborate on the underlying dimensions behind attitudes to University-Industry collaboration using an online platform, explaining factors that lead to the formation of these attitudes. According to D'Este and Patel (2007) prior experience of collaboration is important in explaining the existence of a variety of interaction links. Consequently, we propose the following two hypotheses suggesting that prior behavior (here, experience) positively influences respondents' attitudes to using online communities as an additional university-industry link to facilitate interaction.

H1: *Prior experience with university-industry collaboration positively influences industry professionals and academics' attitude to online UIC.*

While the above hypothesis is based on the former experiences of the involved actors, one can also argue that the perception of the value of such collaboration will influence the likelihood of using a new means of interaction to facilitate university-industry collaboration. D'Este & Patel (2007) argue that prior experience in interacting with the other party has an impact on the variety of interaction links an individual engages in. Similarly, we suggest that the number of different kinds of links to the other party is associated with a more positive attitude towards using new forms of interaction. Respondents with more, existing, university-industry links will have a more positive perception of the organizational benefits obtained by interacting.

H2: *Experience with different types of UIC links, positively influences industry professionals and academics' attitude to online UIC.*

While the above hypotheses is based on the former experiences of the involved actors, we also argue that the perception of the value of such collaboration i.e. organizational motives and incentives will influence the likelihood of using a new online means of interaction to facilitate UIC (Ankrah et al., 2007). If the perceived benefits of UIC are high we expect both

industry and university actors to have positive attitudes towards any means of facilitating this collaboration. We thus expand the original six types of inter-organizational relationships proposed by Oliver (1990) with online university-industry problem solving.

H3: *High perceived value of organizational incentives positively influences industry professionals and academics' attitudes towards online UIC.*

The literature on online media and communities, this will be used to argue for hypotheses 4-7. People who perceive a certain type of media as being useful to perform a certain task, have been argued to be more likely to have a positive attitude towards using that particular media (Chang and Wang, 2008, Shen and Chuang, 2009). Testing this in an interactive whiteboard technology environment, Shen & Chuang (2009) show that users who perceive technology as a useful means of communication are more likely to have a positive attitude towards using it. Based on their findings we propose the following hypotheses:

H4: *Industry professionals and academics with experience in using online media hold a more positive attitude towards using online UIC.*

H5: *Industrial professionals and academics with a positive attitude towards online media hold a more positive attitude towards using it for UIC.*

(Ajzen, 1991) investigated how intentional behavior predicts future actions and argued: *"Attitudes towards the behavior, subject norms with respect to the behavior, and perceived control over the behavior are usually found to predict behavioral intentions with a high degree of accuracy"* (1991: 206). One of the underlying hypotheses behind our model is that attitude can predict behavior (or behavioral intention) (Ajzen, 1991). Thus, we wish to test whether the underlying theoretical expectations from the theory of planned behavior, that attitude predicts behavior, holds for our samples with hypothesis H6 focusing on the relationship between attitudes and behavioral intention.

H6: *Industry professionals and academics with a positive attitude towards online UIC will*

have a stronger participation intention.

When investigating personal incentives for voluntarily participating in online knowledge sharing, it has been shown that users are primarily driven by intrinsic motives, rather than extrinsic motives (Boudreau and Lakhani, 2009, Zheng et al., 2011). Consequently, we propose the final two hypotheses to investigate the personal incentive structure:

H7a: *Industry professionals and academics are driven by intrinsic motives when contributing to online knowledge sharing.*

H7b: *Industrial professionals and academics are not driven by extrinsic motives when contributing to online knowledge sharing.*

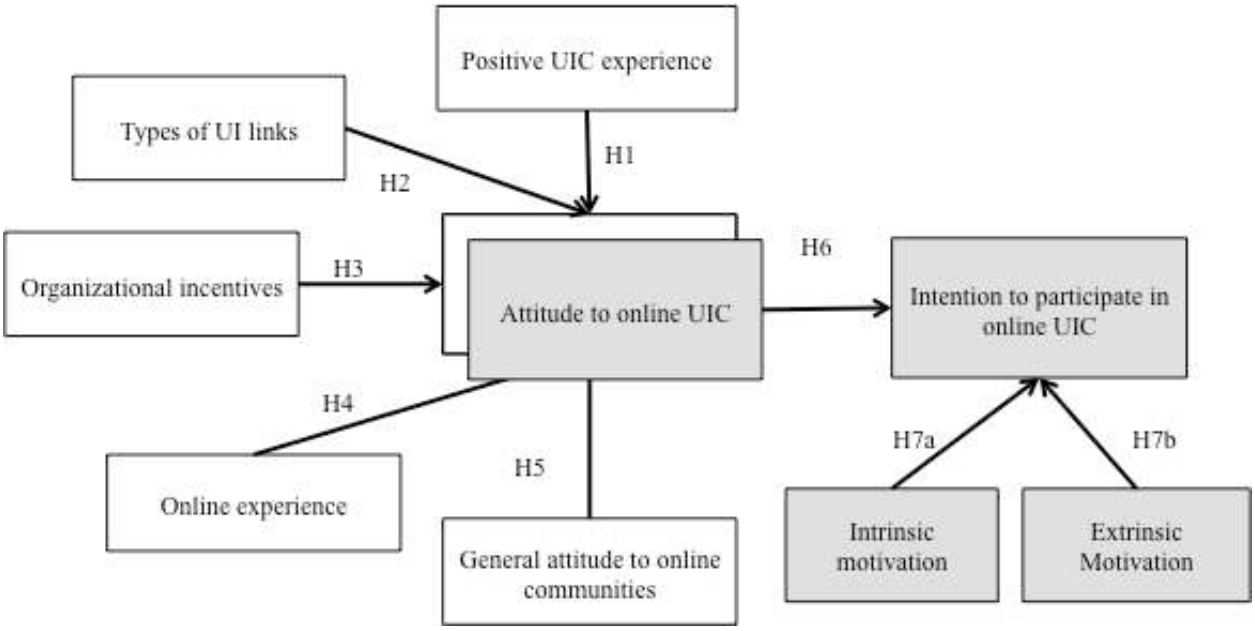

Figure 1. Theoretical model.

5. Method

The paper is based on a mixed method approach first testing the proposed hypotheses quantitatively with survey data and subsequently further investigating the results through a

number of interviews, going more in-depth with the results both with the aim of examining the casual relationships and elaborating on the explanations in the discussion section.

5.1 Quantitative data collection

The quantitative data was gathered through an online survey in May 2013 distributed to 693 companies and researchers within the food industry. Recipients were drawn from databases administered by three Danish food networks: InSPIRe Food, a network of both academics and company representatives interested in food research, The Danish Technological Institute (DTI) network on food and AU Food, a network of researchers within Aarhus University interested in food. Any dublets were eliminated to avoid cross-posting. All recipients have at some point self-selected into these networks, which generates some bias. The large Danish food companies are represented, as are academics from the major Danish universities. Smaller food companies are probably somewhat less well represented.

E-mails with a personalized invitation including a link to the survey were sent out as well as two reminders. A total of 341 responses were returned (222 industry responses and 119 university responses). For calculating the response rate 43 respondents are removed due to maternity/paternity leave, vacation, job change etc. resulting in an initial response rate of 52%.

5.2 Measures

Organizational motives for participation in University-Industry collaboration are measures formulated with strong inspiration from (Ankrah et al., 2007). The motives are based on the work of Oliver (1990) who proposes six critical contingencies: necessity, asymmetry, reciprocity, efficiency and stability (Oliver, 1990). For universities nineteen items and for industry seventeen items are formulated, which are subsequently recalculated into the

constructs representing the contingencies based on factor analysis.

Companies' *prior university-industry collaboration experience* is measured by three items created with inspiration from (López-Martínez et al., 1994) and D'Este & Perkmann (2011). The items focus on whether their experience with university collaboration is 'good', 'an important source of new knowledge' and whether universities are 'valuable collaborators'.

The measure for the *number of different university-industry links* is created with inspiration from D'Este & Patel (2007) and Perkmann et al. 2011 (a total of 8 different types of links). The variable is calculated summing the collaboration types for each individual respondent.

Half way through the questionnaire, respondents were given to a short description of a potential online community for collaboration between industry and research within the food sector. The aim was defined as joint problem solving. Subsequently they were asked to answer items on online communities as described below.

Experience with and attitudes towards online communities is measured by ten items with inspiration from Chang & Wang (2008) who investigates user attitudes to online communication tools (Chang and Wang, 2008). Four items are developed to investigate respondents' prior online experience, three for attitudes towards online communities in general and three for attitudes towards university-industry collaboration through online communities.

Motives related to the participation in online/virtual communities are measured with four items on extrinsic motivation and nine items on intrinsic motivation. Items are either drawn directly from or developed with inspiration from Füller et al. (2006). The three items on *Participation intention* are adopted from Zheng et al. (2011).

5.3 Qualitative data collection

For further explanation and understanding of the results in the quantitative study six

qualitative interviews have been conducted. The aim is to obtain a deeper understanding of the phenomenon (Flick, 2009) and the underlying experience, drivers and characteristics explaining their attitude and anticipated behavior related to online university-industry collaboration.

Respondents are selected based on theoretical sampling (Glaser and Strauss, 1967) with the aim of maximizing variation (Patton, 2002). Four respondents have been selected based on their answers in the questionnaire and two more that had not participated in the survey and therefore not biased by the questions and topics revealed through the survey. Two informants from each group (university/industry) were identified one with a positive attitude to the online university-industry collaboration and one negative.

The interviews are semi-structured based on a pre-defined interview guide structured around the topics of the survey. The questions are operationalized to tackle the hypotheses and comprised open, hypotheses-driven and confronting questions. All interviews are recorded and transcribed. As they primarily serve as supportive insights for the survey results only selected quotes will be included in the results and discussion sections.

5.4 Data analysis procedure (quantitative part)

The model in figure 1 has two endogenous variables: 'Attitude to online UIC' and 'Intention to participate in online UIC' and a number of exogenous variables. It would be appealing to model the whole structure as a structural equation model, but such a model does not give an acceptable overall fit. Our hypotheses are not specifically related to the overall model e.g. as a test of theory, but are first of all about potential influences from sets of exogenous variables on each of the endogenous variables. In order to evaluate these hypotheses, we have chosen to estimate one regression model for each of the endogenous variables. Descriptive statistics for each of the variables in the model in figure 1 can be found in the appendix.

Listwise deletion of missing values would lead to 97 complete industry cases out of 160 possible cases and 64 complete university cases out of 94 possible cases. That is a very substantial decrease. In order to keep the information from all cases and not just ignore the possible systematic differences between incomplete and complete cases we have used the multiple imputation approach to missing values. A key assumption for multiple imputation is that the missing data mechanism is at least MAR (Missing At Random). Multiple imputation does not replace missing values with a single value but with a set of plausible values that represent the uncertainty about the right value to impute. We have used the MI procedure in SAS that uses Markov Chain Monte Carlo simulation to estimate missing values in the data set. 10 imputations were performed, with the result being 10 datasets. After imputing the datasets, the regression models were performed and repeated on the 10 imputed datasets. The resulting parameter estimates from the 10 analyses were then averaged and the results for each of the four regression models are shown in table 1. One of the advantages of this approach is that it leads to confidence intervals for each of the estimated parameters that properly reflect the uncertainty due to missing values.

6. Results

Results are presented in two sections, first focusing on the survey results and subsequently the qualitative interviews.

6.1 Survey results

For each of the two groups (university and industry), two separate regressions are tested, one for each of the dependent variables. The first model is related to the formation of attitudes to online UIC, while the second is concerned with intention to participate in an online UIC problem-solving community. Table 1 shows the regression results.

The regressions for the industry sample show that for **industry professionals'** *attitudes to an online university-industry problem solving community* are mainly formed by general attitudes to communities and organizational incentives related to efficiency. The efficiency incentives for industry professionals are primarily concerned with gaining firm related benefits such as shortening the product life cycle, cost savings and external R&D. Neither prior experience with UIC nor the variation in UI links, are significant in the model. As for the *intention to participate in an online UI community*, attitude to online UIC is a predictor of intention as well as intrinsic motivation, while extrinsic motivation show no significance. Overview of supported and rejected hypotheses can be seen in table 2 below.

Model A: Attitudes to online UIC, Model B: Participation intention

Variables	**Model A - Industry**		**Model B - Industry**		**Model A - University**		**Model B - University**	
Model A - Independent variables	Coeff	Std error	Coeff	Std error	Coeff	Std error	Coeff	Stderror
Prior experience with UIC	- 0.070	0.098			0.168	0.128		
Types of UI links	- 0.113	0.062			- 0.120*	0.066		
Org. incentives (efficiency)	0.300**	0.116						
Org. Incentives (legitimacy)					0.032	0.158		
Org. Incentives (stability)	0.210	0.145			0.153	0.153		
Attitude to communities	0.367***	0.107			0.637***	0.107		
Online experience	- 0.013	0.094			0.021	0.087		
Model B - Independent variables								
Attitude to online UIC			0.391***	0.076			0.395***	0.091
Intrinsic motivation			0.662***	0.114			0.799***	0.116
Extrinsic motivation			0.004	0.093			-0.062	0.104
Model statistics								
Adj R-sq	0.338		0.464		0.686		0.456	
N	160		160		97		97	

* Significant at 0.1% level, ** Significant at 0.05% level, *** Significant at 0.01% level.

Table 1. Results from regression analysis.

The regressions for the **university sample** show a similar pattern for the *intention to participate in an online UI community.* Only intrinsic motives are significant and positive attitude to online UIC is significantly related to intention.

As for *attitudes to an online university-industry problem solving community,* neither of the organizational incentives, nor prior experience are significant in the model, while general attitudes to Internet forums and online communities are the only significant predictor for this sample. Only the variable 'types of UIC links' is tentatively significant with a negative coefficient, indicating that the higher the number of different links university academics have the more negative their attitude is to online UIC.

Hypotheses	**Industry professionals**	**University academics**
H1: Prior UIC experience → Attitude to online UIC	n.s.	n.s.
H2: Types of UIC links → Attitude to online UIC	n.s.	$p < 0.1$
H3: Organizational incentives → Attitude to online UIC	$p < 0.05$	n.s.
H4: Online experience → Attitude to online communities	n.s	n.s
H5: General attitude to online communities → Attitude to online UIC	$p < 0.001$	$p < 0.001$
H6: Attitude to online UIC → Participation intention	$p < 0.001$	$p < 0.001$
H7a: Intrinsic motives → Participation intention	$p < 0.001$	$p < 0.001$
H7b: Extrinsic motives → Participation intention	n.s	n.s

Table 2. Overview of hypotheses.

6.2 Interview results

Felin & Zenger (2014) and Lakhani et al. (2013) in their largely theoretical pieces outline how the nature of problems influences what kind of governance mechanisms are useful for handling (e.g. complex or simple) problems (Felin and Zenger, 2014, Lakhani et al., 2013). Our quantitative data has not captured this, but qualitative interviews support their theoretical framework and show how this angle is vital in order to understand what kind of knowledge

exchanges could take place on such a problem-solving platform.

Three different aspects stand out in the interviews; I) complexity of knowledge, II) locus of knowledge and III) what point in the product development process the knowledge is affiliated to (early or late stages). See table in the Appendix for illustrative quotes from the interviews related to these aspects. I) If knowledge is too complex, i.e. either too decomposable and inter-dependent, it is not suitable for online collaboration. It would be too complicated to describe all the relevant issues and the conversation can hardly get started. In particular firm-based respondents conveyed this view. II) If the locus of knowledge is already known, it is much easier go directly to this particular source, rather than broadcasting the message on an open site. III) If a firm has questions about a product that has progressed far in the development process, an online forum is also not suitable, since the firm would have to broadcast their intellectual property – in contrast to how InnoCentive works, where the problem is anonymized and the focal firm pays for possible solutions (Lakhani and Jeppesen, 2007). This means that the proposed type of open online community for university-industry collaboration in this study is more suitable if the locus of knowledge is unknown, the problem is not too complex, and the issue at hand deals with fairly basic science in a fairly pre-competitive situation. In this way both firms and academics can broadcast (Jeppesen & Lakhani, 2010; Felin & Zenger, 2014) to a very specific, and relevant target group. In practice this furthermore entails that such an online community is more likely to be used as a site that connects various social and technical worlds, that research has documented is difficult to bridge (Rosenkopf and Nerkar, 2001, Jeppesen and Lakhani, 2010). This means that such a site can answer questions by actors that go beyond their own social and technological world. This might entail that the knowledge required is simple but just distant, but could also involve more radical learning.

One final factor that came out in the interviews was an indication that larger established firms

feel they more likely to know (or at least think they know) where relevant knowledge is located. According to prior research larger firms are likely to have better absorptive capacity (Cohen and Levinthal, 1990), which may be linked to this phenomenon.

7. Discussion and practical implications

As expected and in line with former open innovation studies, clear-cut extrinsic motives do not influence an intention to participate in online communities (Jeppesen and Frederiksen, 2006, Boudreau and Lakhani, 2009). The survey results in our study show that potential access to financial resources are not important for academics' nor industry professionals' intention to participate in online university-industry collaboration, which is in contrast to university-industry relations in general (Perkmann et al., 2011). While intrinsic motivations are strongly significant for both academics and industry professionals, the construct is partially created by different items in each sector. Both academics and industry professionals are motivated by the opportunity to work with new ideas and knowledge, while only industry professionals are driven by the opportunity to showcase their ideas and test own abilities. In an interview, one young academic e.g. highlights how she really enjoys seeing how her knowledge of basic science can help industry professionals with practical problems. One could argue that similar to Boudreau & Lakhani (2009) our data on potential online university-industry interactions reveals a motivation that is primarily intrinsic, but also overlapping with extrinsic incentives; the aim of showcasing ones (commercial) ideas is arguably linked to an extrinsic interest in promoting a profit-seeking interests. The different ways the intrinsic constructs are created is thus very much in line with the different institutional logics of a disinterested academia and profit-driven industry cf. (Merton, 1973, Perkmann and Walsh, 2009). Generally, we can support the type of incentive structure that studies in other fields have revealed.

Most former studies on university-industry collaboration have focused on offline interactions (Cohen et al., 2002, D'Este and Patel, 2007, Perkmann and Walsh, 2009, Bergenholtz and Bjerregaard, 2014). We present data focused on online interactions, and our study reveals evidence which partially conflicts with D'Este & Patel's 2007 finding, that prior experience with university-industry collaboration is an important, positive factor to explain the likelihood of a researcher engaging in a greater variety of interaction links in the future. For academics, the number of existing different types of university-industry links actually seems to play a negative role for their interest in online communities. In contrast, any positive prior experience with industrial links has no direct impact on attitudes towards online university-industry communities. Academics thus seem to become saturated, if they already are involved in a wide variety of interactions with industry (in contrast to D'Este & Patel 2007). Qualitative evidence supports this claim since interviews indicate that younger and less connected academics are more likely to be interested in online communities as they do not yet have as many links to industry (in line with D'Este & Patel's finding on age and types of offline interactions). In terms of industry professionals, the number of different types of university-industry links plays no significant role.

Attitudes to communities in general is the strongest predictor for the formation of attitude to online UIC both for industry professionals and university academics, indicating that at this point in time where there are only few opportunities for doing online UIC (for a recent initiative in the packaging and food area see: www.letsopenup.se) attitudes to online UIC are more based on beliefs and knowledge about internet forums and online communities than prior UIC experience and incentives. Only the industry sample shows that organizational incentives related to efficiency are relevant. For industry professionals, a high focus on efficiency in the collaboration with universities (i.e. competitive advantage through the shortening of product life cycles, cost savings and external R&D work) as described in

Ankrah et al (2007) adds to positive attitudes towards online UIC. We can thus argue, that industry professionals see online platforms as a way of streamlining the collaboration with universities, making e.g. the identification of relevant actors for collaboration.

Overall, our study expands former theoretical knowledge on with whom and how academics and industry professionals would like to interact, since most existing research has focused on university-industry relations in general, or offline in particular (Cohen et al., 2002; D'Este and Patel, 2007; Perkmann and Walsh, 2007). Our data on online communities for interaction thus sheds new light on how the internet might facilitate new types of links or occupy a need that is not catered for by existing offline collaboration forms such as young researchers solving simple or decomposable problems for SMEs.

In terms of practical implications, one cannot expect academics to continuously being interested in new forms of interactions, in contrast to industry professionals. This indicates that being able to attract (young) academics is particular important for the potential success of such a platform. The platforms should allow for a semi-open interaction, i.e. facilitate the connection of different social and technical worlds, where future collaboration is likely to be taken offline for intellectual property rights reasons. In this way connective, online social networks are more likely to succeed than open university-industry problem-solving communities. Finally the problems and potential knowledge exchange need to be framed properly.

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Appendix

Industry sample: Descriptive statistics and correlations among study variables

Variables	N	Min	Max	Mean	St.dev	1	2	3	4	5	6	7	8	9
1. Attitude to online OIC	139	1	7	5.21	1.30	1								
2. Intention to participate	123	1	7	4.87	1.35	0.637**	1							
3. Prior experience with UIC	131	1.33	7	5.44	1.31	0.026	0.122	1						
4. Types of UI links	159	0	8	1.24	1.69	-0.157	0.115	0.315**	1					
5. Org. incentives (efficiency)	97	1.20	7	4.38	1.05	0.409**	0.301**	0.119	0.167	1				
6. Org. incentives (stability)	139	2	7	5.75	0.89	0.292**	0.201*	0.368**	0.198*	0.418**	1			
7. Attitude to communities	151	1	7	5.17	1.41	0.547**	0.515**	0.045	-0.041	0.236*	0.216*	1		
8. Online experience	159	1	7	3.97	1.63	0.267**	0.380**	0.081	0.142	0.167	-0.006	0.562**	1	
9. Intrinsic motivation	135	1.71	7	5.68	0.98	0.356**	0.347**	0.120	0.013	0.239*	-0.083	0.201*	0.287**	1
10. Extrinsic motivation	123	1	6.8	3.81	1.16	0.545**	0.644**	0.158	0.068	0.232*	0.296**	0.447**	0.191*	0.432**

* Significant at 0.05% level

** Significant at 0.01% level

Appendix

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* Significant at 0.05% level

** Significant at 0.01% level

Overview of illustrative quotes from the qualitative interviews

	Complexity of knowledge	**Locus of knowledge**	**Stage of the development process (early/late)**
Industry respondents	*"A great deal of our work requires a massive knowledge base before it makes sense to discuss as it is of a very technical nature… That is why a lot of challenges are not suitable to post online, basically because people have no clue about the content." (Development engineer, large firm)*	*"X and Y (business areas) is after all a small business so we know all the people around the world who know something." (Development engineer, large firm)*	*"What we mainly want to accomplish is the creation of some basic building blocks to what we are doing. We are not getting a new product developed at the universities, but rather insights and new techniques that can make our product development faster and more efficient." (Development engineer, large firm)*
	"As a company you don't care how the results are inferred… It is all about getting the knowledge transferred into commercial application. (Head of innovation, large firm)	*"Yes – we do have a large network, but we have a tendency to couple up with the usual suspects… It someone with a different background ask some questions or issues then it could really move something." (Innovation manager, large firm)*	*"When we are collaborating about something pre-competitive then we can easily work together, but as soon as it gets related to specific products hen it becomes too commercial." (Innovation manager, large firm)*
	If the right people use the forum I do believe it would be useful but it will quickly end up with people calling each other as the problems are too complicated" (Development engineer, large firm)		*"We get a lot of fundamental questions answered and our manpower boosted in some projects. I am capable of developing new methods of measurement, but I don't have the time. It is often basic knowledge that can help us in development projects." (Innovation manager, large firm)*
University respondents	*"In a science context what we do takes time and it is more distant from the product. Therefore, the problems also become more difficult to describe, and it is difficult to get in contact with anyone about it." (Senior researcher)*	*"We know where to ask... I know most people within the business… I would typically start discussing it with my colleagues… then we find out who probably knows the answer." (Senior researcher)*	*"A platform like this needs to deal with pre-competitive issues! Otherwise people will close themselves around it (ref to secrecy)." (Senior researcher)*
		I think it is difficult to see the justification for at player like X (large firm). The people from X know how to get in, who to approach and how to maneuver around. Smaller companies who are not already engaged in UIC are those I believe we could catch with a platform like this." (Leader of research unit)	
		"Young researchers do not have that much contact to industry and their natural way of finding solutions to issues is through the internet." (Post.doc. researcher)	