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Working Paper

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Discussion Papers, Center for European Governance and Economic Development Research, No. 259

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Suggested Citation: Feser, Daniel; Proeger, Till (2015) : Asymmetric information as a barrier to knowledge spillovers in expert markets, Discussion Papers, Center for European Governance and Economic Development Research, No. 259

This Version is available at:
http://hdl.handle.net/10419/121291

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Discussion Papers

Number 259 – October 2015

ASYMMETRIC INFORMATION AS A BARRIER TO KNOWLEDGE SPILLOVERS IN EXPERT MARKETS

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ISSN: 1439-2305

Asymmetric information as a barrier to knowledge spillovers in expert markets

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Abstract: This paper investigates barriers to effective knowledge spillovers for markets in which the product can be characterized as a credence good, i.e. its complexity impedes the evaluation of quality by customers both ex-ante and ex-post. We focus on the German market for energy efficiency consultants, as an emerging and subsidized sector in which the service offered has strong credence good properties. Based upon in-depth interviews with stakeholders, we analyze the determinants and barriers to knowledge spillovers. We find that the incentive to foster spillovers to increase suppliers' knowledge is limited by the difficult commercialization of additional capabilities. The implementation of a public certification scheme has failed to increase the sectoral knowledge spillovers. By contrast, the participation in formal knowledge networks has been more effective in prompting companies to foster knowledge spillovers, which has also led to a higher degree of specialization. We conclude that access to certification schemes should be further restricted to increase market transparency and private networks should be supported to achieve the aim of increasing knowledge spillovers.

Keywords: credence goods, knowledge spillover theory of entrepreneurship, network
JEL-Codes: D21, D82, H41, K23, L14

1. INTRODUCTION

Innovative activities occupy ever-increasing importance for economic growth (Cooke and Leydesdorff, 2006). Knowledge spillovers have been introduced as a core element driving growth within the endogenous growth theory (Romer, 1986, 1994) and have subsequently been emphasized by countless studies. The development of modern knowledge economies has led to substantial global, national and regional competition for the creation of new knowledge, whereby the use of knowledge has become a crucial aspect of entrepreneurial thinking (Aghion et al., 2005; Tang, 2006). This development has increased the relevance of external sources of knowledge to increase firm-specific knowledge to a central strategic question (Howells, 2006). Various knowledge-intensive institutions such as universities, private research institutions and business services have thus been established as channels for knowledge spillovers, challenging companies to improve their internal innovative capacities (Tether and Tajar, 2008; Thomä and Bizer, 2013). Responding to this trend, researchers have investigated the determinants and optimal management of knowledge integration and spillovers as a strategic element within companies.

Initially, the focus was placed upon large enterprises and their innovative capacities leading to knowledge spillovers (Acs and Audretsch, 1988). However, following the seminal work by Audretsch (1995), the knowledge spillover theory of entrepreneurship (KSTE) has substantially broadened the concept of knowledge spillovers to better explain the contributions made by smaller companies to economic growth (Acs et al., 2012; Braunerhjelm et al., 2010; Huggins and Thompson, 2015). Within the KSTE, knowledge spillovers are considered the central driver for companies' success and thus a core element of strategic entrepreneurship (Acs et al., 2012). Knowledge spillovers have been operationalized using e.g. codified knowledge – which can be easily transferred in written form (Acosta et al., 2011; Audretsch et al., 2005) – or tacit knowledge sources, incorporated in human capital (Klepper, 2007). In particular, the case of innovative knowledge disregarded by incumbent companies and research institutions yet turned into entrepreneurial opportunities by newly established competitors has been emphasized (Acs et al., 2013; Audretsch and Keilbach, 2007).[1] The concept of knowledge spillovers thus helps to better understand the long-term success of companies as entrepreneurial opportunities arise from new knowledge and result in competitive advantages (Agarwal et al., 2007).

[1] For recent extensive literature reviews on the results of the KSTE, see Acs et al. (2013) and Ghio et al. (2015).

Overall, the KSTE has established that the knowledge intensity in firms and sectors is the central predicator for the likelihood of knowledge spillovers and thus competitiveness in companies and sectors. However, it can be impeded by knowledge filters, a concept introduced by Acs et al. (2004) after observing regional and sectoral differences in spillover effectiveness. These filters constitute barriers to spillovers from established firms and research institutions (Bonaccorsi et al., 2013; De Silva and McComb, 2012). We suggest that the role of knowledge filters in reducing companies' incentives for increasing their knowledge basis has not been sufficiently investigated and that the focus on knowledge intensity in the KSTE should be extended accordingly. In particular, we hypothesize that, despite high sectoral knowledge intensity, information asymmetries are central knowledge filters preventing an effective transfer of innovative knowledge.

To investigate this hypothesis, we conduct a case study based upon expert interviews within the German energy efficiency consultant (EEC) sector[2], in which homeowners are offered consulting services towards implementing energy efficiency measures. This expert market has grown substantially after several large government programs – including large subsidies – have been put in place to reduce Germany's energy consumption in private residences. The supply side of this consulting market is very heterogeneous: along with customers' inability to evaluate the service quality both before and after the transaction, this leads to a partial market failure due to distrust in expert services (see e.g. Beck et al., 2014; Dulleck et al., 2011; Dulleck and Kerschbamer, 2006). The credence good properties of the service impede experts' ability to signal higher service quality and thus act as a strong knowledge filter precluding spillovers among suppliers. Thus, despite its high sectoral knowledge intensity, the EEC market is rather dysfunctional in terms of an efficient knowledge spillover of new technologies and services. This problem can be traced back to the missing link between suppliers' capabilities and the quality observed by the customer: owing to the complexity of the product, additional firm-specific knowledge in most cases fails to increase revenues. Thus, no structural incentive is provided to actively seek knowledge spillovers within the sector.

We argue that these issues are not limited to the EEC market but rather apply to a large share of service markets to some degree. Thus, understanding the working mechanisms of knowledge filters in markets with information asymmetries can substantially add to our

[2] To our knowledge, EECs have been only analyzed according to their function as an economic policy instrument. The results mainly highlighted the low effectiveness of increasing the rate of retrofit (e.g. Mahapatra et al., 2011; Palmer et al., 2013; Virkki-Hatakka et al., 2013).

understanding of knowledge spillovers in general, as well as enabling more specific policy measures to foster the intra-sectoral flow of knowledge. In our case study, we focus on two specific policy options aiming to reduce the issues associated with the consulting market: first, the effects and shortcomings of a public certification scheme are described and evaluated; second, voluntary knowledge networks are investigated, in which the membership itself can be used to signal higher quality. We find that through establishing informal communication among their participants, these specific networks foster knowledge spillovers to a certain degree, with a focus on commercialization. Both certification and network-building are assessed as policy options in terms of their ability to support knowledge spillover and increase sectoral growth. We can thus contribute to the understanding of knowledge spillovers in expert markets and provide policy implications for decision-makers.

The remainder of this paper is structured as follows. In the second chapter, we review the literature on the KSTE concentrating on the operationalization of knowledge spillover, knowledge filter and the role of networks. Furthermore, we describe our methodology and explain our sample of interviewees in detail. In section four, we present our result, followed by the discussion of economic policy implications in section five. Finally, we conclude in section six.

2. LITERATURE REVIEW

The KSTE literature has furthered our understanding concerning the role of knowledge for companies (Acs et al., 2009a; Audretsch et al., 2006; Audretsch and Keilbach, 2007). It has primarily focused on testing different aspects of the theory empirically (Acs et al., 2009b; Agarwal and Shah, 2014; Audretsch and Keilbach, 2008; Audretsch and Lehmann, 2005), whereby the effective use of knowledge has been identified as the key determinant for sustaining competitive advantages in companies. Following Arrow's (1962) seminal paper on the allocation of knowledge and its role for companies, several difficulties for the effective entrepreneurial management of knowledge have been identified. Since knowledge has the properties of a public good – i.e. by being non-rivalrous and non-excludable in many cases (Audretsch and Stephan, 1999) - companies are aware that their internal knowledge cannot be completely protected from unwanted spillovers. The uncertainty associated with the potential risks of losing competitive advantages determines several difficulties in estimating the outcome of knowledge commercialization. This "knowledge paradox" (Audretsch and Keilbach, 2008) comprises entrepreneurs deciding to use external knowledge, despite being

aware that they will only partially profit from the additional knowledge. Since the value of knowledge is perceived differently among individuals (Acs et al., 2009a), high transaction costs result when initiating knowledge diffusion due to the heterogeneity of the user of knowledge (Braunerhjelm et al., 2010).

Attempting to operationalize the abstract concept of knowledge spillovers, several empirical measures have been adopted. Initially, spillovers were analyzed using codified knowledge, by counting the number of patents and other forms of registered intellectual property rights between companies and sectors (Acs et al., 2002; Plummer and Acs, 2014). Another measure is the change of employees to explain spillovers of tacit knowledge, which can also be extended to small and medium-sized companies that refrain from registering patents (Thomä and Bizer, 2013) but still transfer new-to-the-firm knowledge (Klepper, 2007). Karnani (2013) has criticized an overemphasis on codified knowledge in the literature, which disregards tacit knowledge, particularly in the highly relevant sector of university spin-offs. In this domain, the creation of start-ups using knowledge provided by non-commercial institutions such as universities (Acosta et al., 2011; Audretsch et al., 2005) or research institutions (Cappelli et al., 2014) has been identified as an important source of knowledge spillover. As new employees, university graduates often transfer knowledge to spin-offs in the vicinity (Acosta et al., 2011). Especially in peripheral regions, universities have thus been identified as an important source of innovative knowledge (Pinto et al., 2012; Tether and Tajar, 2008). In this regard, the specialization of academic institutions influences the emergence of knowledge spillovers, whereby applied technological sciences fostering the creation of new firms most effectively (Bonaccorsi et al., 2013). Besides knowledge spillovers from universities, the regional level of competitiveness complementarily supports innovative companies (Audretsch et al., 2012). Two new approaches of operationalizing knowledge spillovers have recently been introduced, measuring entrepreneurial creativity (Audretsch and Belitski, 2013) and the entrepreneurial activities of employees (Stam, 2013), which can help explain the commercialization of new knowledge. Overall, various factors based upon codified and tacit knowledge have been suggested as reasons for knowledge spillovers; however, the quintessential result remains that the degree of knowledge intensity within companies and sectors is the main factor driving the likelihood of knowledge spillovers.

To explain differences in the effectiveness of knowledge spillovers between sectors and companies, Acs et al. (2004) introduced the concept of knowledge filters, thus describing the

barriers of transformation from new to commercialized knowledge. The literature builds upon the observation that companies decide not to commercialize their entire knowledge (Hayter, 2013). Most prominently, the transmission channel of knowledge spillovers between incumbent firms or universities and new companies constitutes the decisive factor potentially blocking the commercialization of knowledge (Mueller, 2006). Knowledge filters have been analyzed with respect to geographical characteristics (Acs et al., 2009a; Acs and Plummer, 2005), institutions (Stenholm et al., 2013) and social norms (Guerrero and Urbano, 2014). Concentrating on the regional level, new companies more successfully cope with knowledge filter than incumbent companies (Acs et al., 2009b). Interpreting the age of companies as a knowledge filter, it has been established that R&D expenses are predominantly conducted by newly established companies (Carlsson et al., 2009), whereby the exploitation of knowledge becomes more difficult for new firms in regions with an already high degree of knowledge commercialization (Acs et al., 2009a). Overall, knowledge filters can explain the regionally and sectorally different exploitation of non-commercialized knowledge.

Knowledge networks can offer an opportunity to reduce the impact of knowledge filters, which has only recently been addressed by a smaller number of studies discussing the role of networks as a transmission channel facilitating knowledge-based entrepreneurship (Hayter, 2013; Huggins et al., 2012; Huggins and Thompson, 2015; Shu et al., 2014). Integrating the role of networks in the KSTE thus offers the opportunity to more comprehensively explain successful entrepreneurial decisions (Hayter, 2013). The initial results are that knowledge spillovers in inter-firm networks improve the overall performance, with mixed effects on the individual firm level (Shu et al., 2014). However, network capital and its spatial distribution – particularly network relations between companies and other knowledge-producing institutions – account for regional differences in innovative capabilities (Huggins and Thompson, 2015). Moreover, a strong positive impact of regional policy has been shown for regions with a low density of networks fostering knowledge spillovers (Huggins et al., 2012).

The literature on KSTE to date has yielded a broad base for further research. In our paper, we add to this literature in two distinct dimensions. First, the KSTE values knowledge and emphasizes its significance for companies' growth. Limitations to the effectiveness of spillovers have been described as resulting from knowledge filters that pose barriers to commercializing. However, markets characteristics – particularly the issue of asymmetric information between buyers and sellers – have not been considered despite their potential role as a filter hindering the commercialization of knowledge from established firms and research

institutions. Therefore, we argue that barriers to knowledge spillovers have not been sufficiently investigated, particularly regarding markets for services that rely on tacit knowledge, which reduces incentives for increasing firms' knowledge basis. We add to the literature by discussing the problems associated with the commercialization of tacit knowledge in markets with asymmetric information. Second, networks and their effect on knowledge spillovers are discussed as an important aspect of the KSTE. Nevertheless, the role of networks as knowledge filters has not been investigated thoroughly in the literature and it has not been shown in detail how knowledge spillovers are affected by different network specifics. Our research can add to this aspect by offering detailed insights into the determinants of and barriers to network-related knowledge spillovers in a market for services with credence good properties. Furthermore, the results from our expert interviews enable us to formulate policy implications for the design of networks that foster knowledge spillovers.

3. DATA AND METHODOLOGY

Since the role of knowledge spillovers in markets with credence characteristics has not been explored to date, a qualitative research framework that analyzes a case study is used to obtain initial theoretical insights (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). This extends the methodological choice in prior studies on knowledge spillovers that have frequently been conducted using qualitative research techniques (Schiller and Diez, 2010; Schmidt, 2015; Yang and Steensma, 2014). Due to the lack of prior empirical and theoretical contributions, we apply our exploratory research design without testing an explicit hypothesis (Edmondson and McManus, 2007).

Following the logic of theoretical sampling, we selected our interviewees to reflect various perspectives regarding the EEC sector, thus assuring theoretical saturation for our sample (Glaser, 1965; Glaser and Strauss, 2008). We conducted the interviews between February and June 2015 in person or via phone. The interviews lasted 40-70 minutes. To preclude sociable desirable responding patterns, anonymity was guaranteed to the interviewees. All interviews – except one[3] – were recorded, transcribed and codified. To assure the quality, the content of this interview was summarized in an extended memo with the relevant content. After the interviews, the reliability of the answer was cross-checked with online publications, press articles and published official company records.

[3] In one case, recording was not possible due to technical problems. Therefore, an extensive memo was written immediately after the interview.

We structured our questionnaire according to common practice in qualitative research, starting with open questions followed by more detailed questions. Our questionnaire comprised three sub-sections. In the first sections, we discussed the definition and characteristics of the EEC market. Subsequently, the interviewees were asked to describe impediments in the EEC market, concentrating on the relevant stakeholder (customer, EECs and policymakers). The interviews concluded with recommendations to overcome barriers to knowledge spillovers in the EEC market.

The interviews were analyzed according to the content analysis proposed by Mayring (2004), which aims at reducing the content to the relevant statements. In the beginning, we used the open coding technique. Collecting the relevant material, we condensed the open codes with similar coding and ordered it according to categories and sub-categories. Assuring the relevance of the categories, we revised the codes with relevant literature and newly defined codes. We wrote memos for the categories and sub-categories and discussed the codes between the authors to assure the reliability of the collected material (White and Marsh, 2006). The interviewed experts received preliminary results and were given the opportunity to discuss critical aspects.

All experts are stakeholders, thus maintaining an internal perspective of the EEC sector. The EEC sector is a dynamic developing sector that is predominantly influenced by public interventions. The German federal government promotes EECs as advisors in the residential sector to save energy and – ultimately – fulfil international climate goals. EECs offer consulting services for homeowners – mostly for private homeowners living in their own houses – and they act as advisors in undertaking building alterations. Homeowners thus receive support from EECs from the beginning of the planning until the end of the retrofit of their residence.

The interviewees were selected according to gatekeepers from the crafts training institution and the EEC associations. Furthermore, we asked for recommendations from the interviewees to sample relevant stakeholders in the field. Additionally, considering the impact of the public intervention, stakeholders from the innovation support and regulatory authorities participated in the interviews. Our sample thus reflects the heterogeneity of the EEC market, with various relevant private, public and public-private institutions. This enables us to take into consideration the existence of diverse actors within the market to gain insights into the different opinions and perspectives on discussions within the field. The experts had a diverse educational background (technical, legal and administrative). To understand the various

incentives in the market, we used stakeholders from research and education, EECs and political and professional associations to achieve theoretical saturation of the different perspectives (see Table 1), following a similar approach as Muench et al. (2014). Table 1 provides an overview of our sample of expert interviewees. In the following section, the results of the expert interviews are discussed.

Stakeholder Code	Research and Education	EEC	Political and Professional Association	Professional Background
#A	x			Architecture
#B	x			Engineering
#C	x			Crafts
#D	x			State Regulator
#E		x		Crafts
#F		x		Crafts
#G		x		Engineering
#H		x		Architecture
#I		x		Architecture
#J			x	Regional Energy Agency
#K			x	National Energy Agency
#L			x	Innovation support coordination
#M			x	Innovation support bank
#N			x	EEC Journal
#O			x	Architect Professional Association
#P			x	EEC Association
#Q			x	EEC Association
Total	**4**	**5**	**8**	**17**

Table 1. Overview of the sample of experts

4. KNOWLEDGE SPILLOVERS IN AN EXPERT MARKET

4.1 Signaling of knowledge and quality

The German EEC sector has a considerable size of more than 13,000 publicly listed experts and it has developed based upon knowledge spillovers through spin-offs originating in the architectural, engineering and crafts sectors. The demand for retrofit in the residential sector has increased due to the establishment of massive public support programs and the age structure of the German housing stock, since 75% of the residential houses were built before the first German law of 1977 requiring a mandatory thermal insulation and by now require retrofit due to a renovation cycle of 30-50 years (Diefenbach et al., 2010). Thus, the processes of acquiring and implementing knowledge in EEC companies often rely on political decisions regarding the specific design of retrofit subsidies. However, compared to other expert markets, the German EEC market has flexible prices and is hardly regulated. Consequently, unlike other expert professions, the profession of EECs is not protected by the German law. The largest shares of EEC are trained in the fields of architecture, engineering and crafts, whereby the knowledge basis significantly varies along the degree of training by EECs. The level of training ranges from a completed traineeship with additional training on energy efficiency to academic degrees. The term "Energy Efficiency Consultant" (EEC) can be freely used, which has led to substantial heterogeneity in the sector, consequently fostering a negative public image due to quality concerns.

The EEC firms are mostly owner-led micro and small-sized companies. EEC companies have often switched their traditional focus from architectural, engineering and crafts business to EEC services. In the interviews, the entrepreneurial decision to use the companies' knowledge to concentrate on retrofit resulted from the expectation of arbitrage profits. The EECs' decision to enter the market typically starts as a part-time job and subsequently develops into a full-time position with a complete focus on energetic renovation. Overall, the EECs' market has experienced a difficult situation, after a promising sectoral growth has slowed down in the past six years.

The interviewees stated that the commercialization of their service is the main problem for EECs, which results from customers' low willingness to pay. In turn, this is driven by the credence good characteristics of the EEC market, as a company's knowledge intensity is hardly perceptible for customers. This information asymmetry leads to a strong sentiment of uncertainty among customers regarding the actual quality provided by EECs. According to the respondents, the largest share of customers is private homeowners who have only limited

experience with retrofit, which is typically a "once-in-a-lifetime" decision due to 30-50 year refurbishment cycles. Additionally, the outcome of the retrofit and its monetary benefit for the customer depends on various factors. The implementation of the retrofit involves different companies, including EECs, whose behavior can hardly be monitored by the customer. Furthermore, the reduction in energy usage following the retrofit relies upon the customers' behavior. Consequently, the EECs' specific knowledge is hardly perceptible to customers due to the technical complexity and thus it cannot be used as a strong marketing argument.

This issue constitutes a substantial filter for knowledge spillover. Overall, the immediate benefits from creating or acquiring additional knowledge are difficult to evaluate for companies. While up-to-date knowledge is a prerequisite for the technical analysis required for retrofits, the heterogeneity of the market – in combination with the issue of asymmetric information – inhibits the commercialization of knowledge. Therefore, the monetary profits from fostering knowledge spillovers are limited in the EEC sector, since new knowledge cannot be effectively signaled to customers. Thus, the positive correlation between a firm's knowledge intensity and its revenues is weak if non-existent in a service market with credence good properties, as signaling is predominantly dysfunctional.

4.2 Certification and signaling

To counter the issues of information asymmetries and the resulting low-quality offers on the EEC market, the German federal government in 2007 introduced a certification system to improve the quality of EECs, which requires attending training courses on EEC-specific knowledge.[4] EECs are required to have this permission to apply for public funds, which account for more than half of transactions in the EEC market (Prognos et al., 2013). All the interviewees highlighted the relevance of the certification scheme due to the financial incentives and an improved visibility of public quality standards for customers cooperating with EECs. Setting a minimum quality standard, the certificate system regulates the access to the EEC market.

The certificates are used to verify the acquisition of a minimum standard of codified knowledge with a focus on technical aspects of the EEC services, such as building regulations, energy efficiency standards and calculations of energy usage. By contrast, the

[4] Upon receipt of the certificate, the access to subsidies is granted via a public web list. To be included in the web list, a minimum of 70 hours of training and 16 hours of additional training every two years is required (KfW, 2014).

interviewees emphasized the relevance of tacit knowledge, highlighting that the translation of expert to customer knowledge is neglected in the courses. The interviewees thus stated that the certification scheme only has a very limited ability to signal quality to customers and other EECs. The low quality of some courses within the EEC sector is widely acknowledged; consequently, the certificates are assumed to be merely a minimal quality standard. Additionally, the inability to efficiently signal quality and knowledge intensity is driven by the complexity of the certification system, with different certificates for each subsidy program and regular changes to the certification scheme.

Consequently, companies have the sole incentive to attend the courses and receive the certificates to participate in the subsidy programs. Addressing the problem of the low dissemination rate of new knowledge, the state intervention has aimed at improving the knowledge basis of EEC companies to ensure a certain level of quality to customers. It was hoped that knowledge-based competition would incentivize companies to create knowledge spillovers, commercialize the newly acquired knowledge and drive the companies with the lowest knowledge basis out of the market. Nevertheless, the certification system has only had a minor impact on the sectoral knowledge level due to its low standards and the focus on codified knowledge. Additionally, the interviewees emphasized that particularly smaller companies have a low willingness to participate in the training courses due to a lack of capacities for extensive training courses. Nevertheless, training courses are appreciated as networking events that enable informal knowledge exchange among colleagues. Especially market information and marketing strategies are highlighted as positive unintended outcomes of the courses, which can be considered knowledge spillovers among the participants. Nevertheless, the systematic organization of knowledge spillovers through public certification schemes can be considered as having failed. Due to the asymmetric information in the relevant market, no strong incentive exists to foster the broad exchange of innovative knowledge; indeed, the policy intervention has been unable to solve this issue.

4.3 The role of knowledge in networks

EEC companies mostly originate from strictly regulated sectors with existing network structures provided by architectural, engineering and craft chambers. These semi-public organizations assure quality standards for their sector with the training of employees and they define sectoral business rules. Membership is mandatory for all companies in the respective sector and the network structure is partially organized by the members. The EEC sector does

not have such developed network structures at present. There are two professional organizations, which together have organized around 25% of the EECs listed online. The German energy consultant network only accepts university graduates as members, while the EEC Engineering Craft Association has organized mostly companies with crafts background. Both professional organizations confirmed in the interviews that they aim to establish a higher quality standard for their members on a private basis by promoting their members' level of knowledge.

4.3.1 Barriers to entry

Both professional organizations have created barriers to entry for prospective members that assure the quality level of their organization, including a selection process before a company can become a member of the professional organization. In particular, discussions with active members constitute the application process, since other EEC experts are more considered more capable of evaluating the quality of the EECs' services. Thus, a prospective member's knowledge basis with respect to codified and tacit knowledge is checked. According to the interviewees, the barriers to entry limit the network access to EECs with a high-quality knowledge basis. This constitutes the network's attempt to preclude free riding behavior from low-quality experts gaining reputation without contributing to the maintenance of the high quality of the professional organization. The networks aim to establish membership as a quality signal on the EEC market; thus, the barriers to entry are used to level information asymmetries between companies and customers as well as policy-makers.

A strong focus is placed upon learning about a prospective member's qualifications regarding tacit knowledge. Interviewees emphasize that their main concern is the admission of fraudulent experts, which could further worsen the negative public image of EECs and similarly damage the professional organizations' public image. A thorough interview is seen as a partial solution to this issue, whereby the networks try to maintain certain standards since state regulation has not succeeded in ensuring that tacit properties of knowledge are included in the mandatory courses. This barrier to entry ensures the exclusive acceptance of members with a common knowledge basis, which constitutes a prerequisite for a broader exchange of knowledge. Overall, this network structure is considered more stable since low-quality EECs are successfully excluded.

The close monitoring of the knowledge level among participants leads to a higher level of transparency within the organization concerning the variety of competences. A common

understanding about the purpose and means of the organization constitutes a strong prerequisite for knowledge spillovers. Members can more easily access certain aspects of the professional sectoral knowledge, which leads to the intended and unintended exchange of knowledge. The members' openness to sharing knowledge is higher, as they can expect a certain level of competence among newly admitted members. Overall, the networks successfully provide a common professional platform, which enables high-quality signaling to a certain degree and fosters the sharing of tacit and codified knowledge. It can thus be considered a partial remedy to the market failure due to asymmetric information and the regulatory failure of a common level of training among EECs.

4.3.2 Knowledge sharing activities in networks

Upon entering the networks, companies have access to a variety of offers to increase their knowledge basis. This includes formally organized events comprising lectures, conferences and regional meetings. The courses are taught by internal professionals and external experts teaching about new regulations, technical innovations and customer relationship management. Moreover, informal meetings with other EECs are an important incentive for companies to participate in the networks. The formal platforms are often the basis for an informal exchange of knowledge. Participation in the events is not mandatory for the members, although there is an informal expectation to regularly participate at the network meetings.

In contrast to publicly organized training courses to receive the certificates described above, the content of the network events is oriented towards members' demand, which is necessary given that participation is voluntary. Therefore, the events need to provide knowledge that actually provides additional value to the participants. Receiving updates on close-to-the-market knowledge is important due to the dynamic environment of the EEC sector, with frequent regulatory and technological changes. The courses are thus selected by professionals working in companies in the EEC sector. This internal perspective provided by market participants enables a more accurate anticipation of sectoral problems and future developments than the external perspective provided in the certification courses.

The interviewees attributed a positive impact on the knowledge flow within the EEC sector to the informal contacts established in the networks. Most importantly, the application of technological knowledge concerning retrofit-specific situations is discussed among network members. Additionally, the transmission of tacit knowledge takes place within informal meetings, e.g. detailed market information and prospective developments in the retrofit sector

or customer relationships and dealing with problematic customers. The exchange also includes non-public information about future political trends being disseminated by the members, since the networks are involved first-hand as stakeholders in the policy-making processes.

However, despite these distinct advantages, the interviewees involved in the knowledge networks complain about the low participation of members, since active involvement is very time-consuming. The knowledge transfer of tacit knowledge is characterized as an experience good by the interviewees, i.e. members cannot precisely estimate the potential monetary gains from engaging in knowledge exchange. Only after investing time and energy into the exchange can members estimate whether the engagement has yielded a benefit. In deciding whether to engage in knowledge exchange processes, members regularly weigh the costs as being higher than the uncertain gains and consequently they decide against the time-consuming engagement in network activities. This issue makes it difficult for network officials to motivate companies to participate in network activities.

Despite these difficulties, participation in networks offers entrepreneurs the opportunity to overcome the low knowledge spillover level on markets with credence good characteristics. It supports members in increasing their knowledge basis with codified and tacit knowledge. Knowledge spillovers are fostered due to a better visibility – experts knowing other experts and a higher degree of trust – due to similar interests within the association's goals. Knowledge spillovers regularly take place on an informal level at network meetings and the official propagation of knowledge exchanges fosters the mutual willingness to share knowledge. Nevertheless, the experience good character of networking efforts inhibits the acquisition of new active members and thus limits knowledge spillovers.

4.3.3 Effects of knowledge spillover in networks

The entry barriers of admitting only qualified member increase the knowledge intensity of the networks. Moreover, the knowledge activities of the network offer opportunities for the members to increase their knowledge basis with specific expert knowledge. Taking both aspects into consideration, the networks offer more opportunities for knowledge spillovers when compared to EEC market participants without membership. The interviewees confirmed a high willingness to cooperate with member companies due to the familiarity with the knowledge basis of member experts and the reputation of high quality offered by network partners. In particular, the information barriers regarding the knowledge basis of other

companies are perceived as being lower in comparison to non-network members. Regardless of existing formal forms of cooperation, informal cooperation is predominant in the networks. In particular, flexible and time-saving solutions are assumed to be advantages of cooperation within the network.

This enables an increased inter-firm cooperation, largely driven by the sectoral structure of the EEC market, with a large share of micro and small-sized companies. The flexibility of these companies is limited by their low production capacities. Cooperation with other companies is thus used as a means of conducting additional projects without substantially increasing the staff. This reduces the risk of costly overcapacities that cannot be quickly adjusted according to current demand due to the strong employment protection in Germany. In the EEC market, this is particularly important since alternating phases of fast growth and sectoral recessions have occurred in the past decade. This volatility is caused by the uncertainty caused by inconsistent policy-decisions regarding the volume and specifics of subsidies for energetic renovations, which impede an accurate preparation for future sectoral developments. Therefore, inter-firm cooperation replaces short-term hiring of new staff, which is problematic due to the employment protection and the costs of training new employees in EEC services. A prerequisite of the cooperation is the trust in the cooperating partner, which is – to a certain extent – guaranteed by the network. Especially the reputation of EECs plays a predominant role since the credence characteristics of negative results of the customer relationship can have a large impact, given that the customer can hardly ascertain the reasons for failures.

The willingness to cooperate enables companies to specialize since the acquisition of additional technical knowledge is costly and time-consuming. The large number of potential technologies – combined with heterogeneous customers – contributes to the complexity of energy consulting. Cooperating with member companies enables experts to further specialize in specific technologies and services within the market, which reduces competition between EECs and increases profits. The acquisition of specialization knowledge is supported by the network through organizing knowledge transfer meetings and specific courses for niche specialization.

While a higher degree of cooperation has fostered knowledge spillovers thus far, a further specialization could also reduce knowledge spillovers since a higher degree of specialized knowledge makes the commercialization of additional pieces of specialized knowledge more difficult and relevant for fewer companies. Overall, however, the increasing specialization

provides a competitive advantage to network members due to the more efficient exploitation of capacities among cooperating companies.

5. DISCUSSION

Our findings contribute to the KSTE, providing an additional perspective on knowledge commercialization by describing the problems associated with knowledge spillovers on an expert market. The occurrence of knowledge spillovers in the EEC sector strongly hinges on companies' incentives to increase their knowledge basis, which is difficult as signaling higher quality to customers regularly fails. This dilemma leads to a low demand for training courses and other educational programs despite knowledge-intensive requirements for conducting retrofit. This issue is related to the market structure, with asymmetric information precluding a more effective commercialization of knowledge, thus making the retrofit a credence good. Indeed, this conclusion is supported by previous studies investigating problems associated with credence goods in service markets (Schmidt, 2015; Feser and Proeger, 2015; Howden and Pressey, 2008).

Despite the existence of knowledge spillovers for both older and newly established firms, our case study shows that knowledge spillovers in the EEC sector are principally influenced by the credence characteristics of the service. The difficulties in signaling high quality on the market imply a lower incentive for companies to enlarge their own knowledge basis since more knowledge does not necessarily contribute to a better commercialization. This leads to a situation where prices in the EEC sector are not related to the quality and thus cannot provide a quality signal to customers. Therefore, firms have very little incentives to protect their knowledge basis, which enables knowledge spillovers to a certain degree. Nevertheless, knowledge spillovers rarely result in additional profit for other firms since only a small share of the knowledge transferred – mainly specific aspects of tacit knowledge – can effectively be exploited. Overall, the competition with low-qualified experts was characterized by interviewees as a major factor that strongly influenced EEC firms' strategic decisions. The open access to the EEC market was identified as the core problem precluding innovations and knowledge acquisition due to the credence good characteristics of their service. This result is in line with previous studies pointing to a low demand for expert services and market breakdowns due to customers' fear of fraudulent expert behavior in markets with strongly asymmetric information (e.g. Dulleck et al., 2011; Dulleck and Kerschbamer, 2006).

The regulatory intervention as a reaction to the problem of low quality on the EEC market has added an incentive to acquire additional knowledge. To receive the certification enabling the application for subsidies, firms gain a low standard of knowledge. Apart from this function, the newly acquired knowledge can hardly be commercialized and customers correctly assume that the certification is not a quality signal. Thus, overall, the limit to the market through a certification system has only provided a low incentive to improve quality through knowledge spillovers. This result is in line with the literature on certification in the energy sector (Brounen and Kok, 2011; Gram-Hanssen et al., 2007; Stieß and Dunkelberg, 2013). Previous studies have found a low acceptance of certificates among customers due to the complexity of the indirect link between quality and the certificates. Therefore, the knowledge level of companies is maintained to merely fulfil the minimum certificate requirements and no additional resources are invested in knowledge acquisition.

The marginal role of knowledge on the EEC market has changed as networks have introduced a signal of high quality through their selection processes. This has the effect that cooperation between member companies can be realized more easily and that specialization through knowledge spillovers makes the enlargement of the firm's knowledge basis a more profitable strategic decision. Networks thus lower the information asymmetries between suppliers and customers, which can make knowledge spillover and specialization profitable. This result resonates with past discussions about networks that foster knowledge exchange and innovation (e.g. Amara and Landry, 2005; Feldman, 1999; Rogers, 2004). This particularly applies to companies' ability of exchanging internal and external knowledge, which has been characterized as a successful variable to benefit from the use of networks and increase the innovative capability (Vega-Jurado et al., 2008). The mechanism of signaling expert knowledge within an intra-sectoral network produces trust between member companies and is thus a prerequisite for cooperation, which leads to knowledge spillovers.

Overall, we can explain insufficient knowledge spillovers as resulting from information asymmetries in a given market, which thus act as a substantial knowledge filter. This adds to the KSTE by showing that sectoral differences regarding the market structure and product specifics are a relevant category for the efficient working of knowledge spillovers. We argue that the current focus of the literature – which primarily views knowledge intensity as the exclusive driving force for entrepreneurial activity – is incomplete, given that it neglects market specifics. Rather, firms and products in a market may be knowledge-intensive, yet its properties effectively preclude knowledge spillovers and innovative cooperation. Once the

commercialization of new knowledge is complicated by product-, customer- or market specifics, companies no longer have incentives to engage in knowledge exchange. Accordingly, we would argue that knowledge filters such as the ex-ante and ex-post asymmetric distribution of information can significantly contribute to our understanding of knowledge spillovers within the KSTE.

These results enable us to derive policy implications that can help to improve innovation policy aiming at increasing knowledge spillovers in sectors with credence good characteristics. We have found that the core problem of a low knowledge spillover rate is the lack of an additional competitive advantage and corresponding monetary benefits from gaining additional knowledge. Accordingly, regulators need to establish a situation in which customers demand and perceive higher quality services, which can only be achieved by increasing market transparency. In a more transparent market, companies' investments in knowledge intensity are more likely to lead to increased profits, which in turn would foster the competition for quality among firms. Countering asymmetric information on a regulatory basis can be achieved by intensifying the requirements for the certification of firms. Accordingly, access to the supply side of the market would need to be strongly restricted, excluding all firms that fail to meet a certain knowledge standard. While this measure would not reduce information asymmetries per se, customers' trust in the quality of the service could be improved. While restricting the market would naturally have a trade-off with higher prices charged by the remaining firms, it would likely stimulate the further specialization and increases in knowledge intensity by the firms remaining on the market. In the specific case of the EEC market in Germany, regulators have avoided this measure thus far, in order to protect smaller companies unable to afford the costs for additional training. Instead, the certification approach is to be extended over a longer period, slowly improving the requirements and quality of mandatory training. From a political perspective, this approach appears reasonable and suitable to – at least slowly – improve knowledge intensity in this sector.

Networks constitute a second-best solution to the issues associated with asymmetrical information. They can establish quality signals on a voluntary basis for knowledge-intensive businesses and thus establish and maintain a certain level of trust among customers and participants. In turn, this increases the incentive to foster knowledge spillovers, specialize and cooperate with other trusted members. While these positive effects are provided by voluntary private cooperation, policy-makers could contribute to these knowledge networks. Potential ways of supporting private networks include providing additional funding for improved

training among members or fostering a closer cooperation between the public institutions offering training and know-how and the private networks. Particularly an exchange of training personnel and materials could improve knowledge spillover and thus improve the sectoral knowledge intensity in the medium run. More thorough public support to the private network initiatives could also increase their attractiveness to other firms in the sector by increasing the value of their quality signal, which might permanently increase incentives for firms with a low knowledge intensity to acquire the network's quality standard.

6. CONCLUSION

Generating innovations is increasingly vital to maintain national, regional and sectoral competitiveness. In this development, companies are required to use external knowledge to improve their knowledge intensity and succeed in global markets. The KSTE describes and analyzes the influence of knowledge spillovers, particularly regarding newly established companies using non-commercialized knowledge. While knowledge intensity is generally considered the main determinant of knowledge spillovers between firms, we suggest that properties of the markets should be drawn upon to explain the lack of spillovers. Understanding market properties as a knowledge filter can explain discrepancies in knowledge spillovers between different sectors. Apart from gaining another perspective of the dynamics and barriers to knowledge spillovers, identifying and analyzing market specifics enables more precise policy implications that can alleviate barriers to knowledge sharing. To illustrate this point, we presented a case study of the German EEC sector, which is a knowledge-intensive expert market with asymmetrical information between customers and firms, in which the services have credence good characteristics. We argue that the specific problems and solutions identified for this sector are applicable to other markets with similar characteristics, in which knowledge spillovers are sub-optimal.

In this regard, we pointed to asymmetrical information as the central problem precluding knowledge spillovers. We showed that companies hesitate to invest in acquiring additional knowledge, since they know that it cannot be commercialized at present. Customers distrust service providers, since they cannot effectively evaluate the quality of the services due to the lack of signals of high quality. Given that customers do not demand higher quality, the existing firms engage little effort to specialize and improve their knowledge basis. Regulators have tried to solve this problem by introducing a mandatory minimum training; however, since the requirements are fairly basic, the ensuing certification does not serve as a quality

signal that could foster quality competition. Private knowledge networks with a mandatory testing before granting membership have provided a partial remedy to the problems associated with asymmetric information. Membership in these organizations can be used to signal quality to a certain degree; additionally, knowledge events – both formal and informal – contribute to additional knowledge spillovers, a higher willingness to cooperate with other member firms and an ensuing specialization. However, despite these positive effects, the general problem of a market with heterogeneous qualities that are non-transparent to customers is not solved by private networks, given that customers' inability to correctly perceive knowledge-intensive providers with high-quality services still precludes strong incentives for knowledge spillovers. We suggest that regulatory efforts to increase market transparency and a step-wise increase of mandatory quality standards are indispensable to foster quality competition and knowledge spillovers.

We argue that knowledge spillovers are problematic in non-transparent markets with credence good properties, based upon a case study on a specific German sector. Obviously, while we are convinced that this is a valid point, additional evidence – both qualitative and quantitative – is required to support this result. Further research should thus focus on other expert markets that face similar problems of asymmetrical information hindering the efficient spillover of new information. Furthermore, the sector explored here is rather new and with few formal network structures, when compared to established markets for expert services. For this reason, studies on more traditional sectors with well-established professional networks could further our understanding of barriers to knowledge spillover. For instance, studying the medical sector – which is a classical credence good market run by knowledge-intensive experts - could help us to understand how to better overcome the structural issues in these markets to foster knowledge spillovers most efficiently.

ACKNOWLEDGEMENTS

Financial support for conducting the interviews from the iENG project (grant number 03EK3517A), funded by the Federal Ministry of Education and Research, is gratefully acknowledged.

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