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**KNOWLEDGE SPILLOVERS AND
ABSORPTIVE CAPACITY –
INSTITUTIONAL EVIDENCE FROM THE
“GERMAN MITTELSTAND”**

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Knowledge spillovers and absorptive capacity – institutional evidence from the ‘German Mittelstand’

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Abstract: Recent extensions to the knowledge spillover theory of entrepreneurship (KSTE) show that the successful commercialization of new knowledge by incumbents depends on their absorptive capacities. For policy-makers focusing on increasing incumbents’ innovative performance, the systematic reduction of knowledge filter through improved absorptive capacities thus becomes a crucial goal. While the general working mechanisms of knowledge filter have been analyzed within the KSTE framework, few institutional solutions to increase absorptive capacities have been put forth. This study provides an initial case study explaining a specific institutional framework fostering the systematic penetration of knowledge filters by incumbent firms in the case of German SMEs. Using a set of 177 in-depth interviews with firm representatives, the system of interrelated organizations, institutional arrangements, shared values and economic incentives associated with the institutional structures for knowledge spillovers for German SMEs are described. I identify institutional characteristics connected to the dual system of vocational training, regulatory measures and economic incentives mutually enforcing and fostering broad knowledge spillovers. This exploratory approach enables deriving hypotheses for the further study of knowledge filters as well as policy implications for the design of institutions increasing incumbents’ absorptive capacities.

Keywords: entrepreneurship, knowledge filter, knowledge spillover theory of entrepreneurship, networks, small and medium enterprises

JEL-Codes: D21, D82, H41, K23, L14

1. Introduction

Building upon the endogenous growth theory (Romer, 1986, 1994), the knowledge spillover theory of entrepreneurship (KSTE) addresses the issue of knowledge commercialization (Acs et al. 2009a; Audretsch & Keilbach, 2008; Audretsch, 1995), which had remained unconsidered in the original theory. This “missing link” (Braunerhjelm et al., 2010) between knowledge generation by universities, private research institutions and business services and its commercial implementation in firms and (regional) economies has become the central issue studied within the KSTE (see Acs et al., 2013 and Ghio et al., 2015 for extensive reviews of the literature). Among the central results of this line of research is the existence and effectiveness of systematic barriers to knowledge commercialization despite its potential profitability to firms and welfare-enhancing effects for regional economies. These barriers have been denoted as “knowledge filters” and a number of studies have been conducted to determine effective ways of penetrating the various filters hindering the efficient flow of new information (see e.g. Acs et al., 2004; Acs & Plummer, 2005; Mueller, 2006; Carlsson et al., 2009).

The research on knowledge filter has primarily focused on technological start-ups close to universities and research facilities, as well as their effectiveness in commercializing knowledge; thereby, different aspects have been considered, such as the role of geographical characteristics (Acs et al., 2009a; Acs & Plummer, 2005), different national institutions (Stenholm et al., 2013), the age of firms (Acs et al., 2009b; Carlsson et al., 2009) as well as social norms in the respective regions (Guerrero & Urbano, 2014). Overall, the perspective predominant in these studies is that entrepreneurs play the central role in commercializing new knowledge, while incumbent firms often tend to be structurally incapable of penetrating knowledge filter (Acs et al., 2013; Acs et al., 2009a; Audretsch & Keilbach, 2007; Audretsch, 1995).

By contrast, building on Cohen and Levinthal's (1990) and Qian and Acs' (2013) consideration of firms' absorptive capacities, Qian and Jung (2017) emphasize that incumbent firms can constitute a meaningful complement for the effective penetration of knowledge filters. Defining absorptive capacity as “*an ability to recognize the value of new information, assimilate it, and apply it to commercial end*” (Cohen & Levinthal, 1990, p 128), they show that high absorptive capacities of regional incumbents are associated with positive regional development. Based upon this result, Qian and Jung suggest that policy-makers should address the question of how to systematically increase incumbents' absorptive capacities to effectively overcome knowledge filters and thus increase regional innovativeness. This implies a shift of perspective: from improving conditions for entrepreneurs commercializing new knowledge in a specific innovative milieu to considering mechanisms supporting incumbents through designing institutions geared at upholding and increasing absorptive capacities in firms and the overall workforce.

I argue that this shift in perspective has substantial advantages for the design of policies aiming at the effective penetration of knowledge filters by extending the analysis to innovation systems characterized by low entrepreneurial dynamics yet substantial innovative capacities, an aspect scarcely covered in previous cross-national studies of national innovation systems (e.g. Audretsch & Caiazza, 2016; Acs et al., 2016). In those innovation systems, incumbent firms are the central driver of sectoral innovation. More specifically, when building upon the research on comparative institutional advantages - namely the Varieties-of-Capitalism approach

(Soskice & Hall, 2001) - it can be stated that the focus on entrepreneurs commercializing R&D-based innovations tends to disregard the working mechanisms of many innovative processes in ‘coordinated market economies’, i.e. most continental European countries. In these innovation systems, firms are comparably long-lived with a highly specialized workforce, whose fluctuation between firms is impeded, e.g. by high wages and strong employment protection, which fosters firm-specific investments in workers’ qualification. Overall, this system leads to firms, particularly SMEs, pursuing incremental, in-firm innovations, and continuously improving on niche products; properties captured by the term ‘German Mittelstand’ (Massis et al., 2017). Consequently, in coordinated economies, the implementation of new knowledge in many sectors is conducted by incumbents focusing on incremental, low-key innovations, which are developed and implemented in close cooperation with customers and suppliers rather than relying on formal R&D (Thomae, 2017; EFI, 2016; Jensen et al., 2007). To succeed in this specific innovation mode, firms rely on a high degree of absorptive capacities. Therefore, innovation policy in these countries and sectors does not primarily aim at increasing overall entrepreneurship to foster knowledge transfers. Rather, the question for policy-makers is how to build, maintain and improve institutions that succeed in increasing absorptive capacities within incumbents.

This paper’s goal is to describe and analyze institutional mechanisms capable of systematically penetrating knowledge filters and fostering absorptive capacities in firms without direct links to the knowledge production and subsequently identify patterns transferrable to other countries and economic contexts. This research goal resembles and - to some extent - complements Massis et al.’s approach of broadly describing the “German Mittelstand innovation model” and providing transferrable implications for other economic contexts, albeit with a more specific focus on the issue of knowledge transfer. This is achieved by conducting an in-depth investigation into a typical sector of German SMEs characterized by the traits described above and providing a broad description of its institutional setup in terms of knowledge spillovers. Given the holistic nature of the research question, a qualitative approach is chosen, namely the analysis of 177 in-depth interviews with firm representatives. The interview protocols are coded and a quantitative descriptive analysis as well as a qualitative analysis of the institutional mechanisms at play are conducted. Thus, I describe the institutions, entrepreneurial values, regulations, organizations and economic incentives that systematically support knowledge spillovers to incumbents in the ‘German Mittelstand’. Building upon these results, I derive policy implications applicable to other national innovation systems and sectors concerned with implementing incremental innovations and give propositions for the further study of knowledge filters in the context of the KSTE.

The remainder of this paper is structured as follows. In section two, the methodology and interview data are described. Section three presents the quantitative descriptive results (3.1) as well as the qualitative analysis (3.2) and an ensuing discussion with policy implications (3.3), before section four concludes.

2. Method and data

2.1 Research design

To achieve the research goals outlined above, this study describes a particular national structure for knowledge spillover. No systematic inquiry has been undertaken to describe the institutions connected to the German dual training scheme and the networks upheld by professional associations and chambers of craft from a knowledge spillover perspective. Consequently, this study applies an exploratory qualitative research framework to provide initial theoretical insight (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). This approach is able to holistically cover the overarching institutions and the interconnected values and incentives. Developing hypotheses about the working mechanisms of the specific institutional framework opens up opportunities for subsequent empirical studies tackling more specific issues. This study thus builds on the qualitative research frameworks by various authors researching knowledge spillovers (e.g. Schiller & Diez, 2010; Yang & Steensma, 2014; Schmidt, 2015; Feser & Proeger, 2017).

Due to the lack of previous theoretical and empirical work on the institutional structure in question, this study refrains from testing explicit hypotheses and instead centers on three guiding questions:

1. What institutional mechanisms exist for the continual flow of information between producers of knowledge and SMEs?
2. How do these mechanisms work in practice, i.e. what organizational, ethical or monetary incentives are at play? How does competition affect the mechanisms for knowledge spillover?
3. (How) can these institutional mechanisms be transferred to other economic/regional/national contexts?

To answer these questions, interviews with firm representatives from the German craft sector were conducted. Using the logic of theoretical sampling, the interview partners were selected to reflect different subsectors of this sector. This broad choice of firms assures theoretical saturation for the sample and this particular subsection of the broad domain of German SMEs (see Glaser, 1965; Glaser & Strauss, 2008 for the basic methodological contributions). The interview lasted between 5 and 30 minutes, depending on how extensively the entrepreneurs answered. The interviewees were encouraged to explain at length their perspective on the respective matters. The interviewers followed a structured questionnaire, but were encouraged to further inquire into the matter during the interviews. Anonymity was guaranteed to the interviewees and the interviews were recorded, transcribed and codified according to the research questions.

The questionnaire (documented in Appendix A) broadly comprised three parts: first, firm-specific details; second, details on the perception of the firm's market situation; and third, details on the effects of the market specifics on the effectiveness of knowledge spillovers and their outlook on the effects of competition in this system. In most interviews, the brief questionnaire was extended by individual inquiries depending on the entrepreneur's respective answers. Thus, the interviews are not fully identical, but rather aim at producing an extensive explanation of institutional working mechanisms, which a formal questionnaire would have

precluded. Thus, the questions did not aim at testing specific hypotheses from previous studies, but were chosen such that incumbents were encouraged to explain the structures of knowledge spillover faced in their markets.

The interviews were analyzed using the method of content analysis proposed by Mayring (2004). This method reduces the content to the statements relevant for the respective research questions. Thus, initially, open codings were developed and used based upon a reading of the transcripts. Once a set of broad categories had been developed, the open codings were further condensed to more detailed codings and assigned to the categories and sub-categories, which were subsequently used for the subsequent content analysis, upon which the results build.

While this research design is necessarily not representative of German SMEs in general, it can be assumed that theoretical saturation has been achieved as a requirement for the application of the grounded theory (Glaser & Strauss, 2008). This methodological trait implies that no new information is gained for the respective questions in the respective segment of interviewees, even if an infinite number of additional interviews was conducted. The large number of interviewees and the recurring results within the interviews give us confidence that theoretical saturation is indeed fulfilled for the sample. This in turn enables more general statements about the underlying mechanisms of knowledge spillover in the respective sector and deriving policy implications for the design of the respective institutions.

2.2 Firm and market background

For this study, a sample of 177 interviews with German SMEs in the sector of craft products and services is used. This sector constitutes a core domain of the German economy. In 2016, it comprised about one million SMEs with about 5.45 million employees and 360,000 apprentices. This translates to about 12.5% of all German employees and to about 12.5% of all German apprentices. The overall revenue of the German craft sector amounts to about 560 billion Euros for 2016. More specifically, interviews are conducted with entrepreneurs from the building sector, since it is the largest sector within the craft domain with about 60% of all craft SMEs.¹ The craft domain is also chosen since it is the classic example of a sector characterized by SMEs, almost exclusively relying on incremental innovation without formal ties to the systems of knowledge production (Thomae, 2017; Jensen et al., 2007). The interviews are conducted on craft fairs with a focus on building, interior design and renovation in central Germany, at which firms present their products and services to potential customers.²

Choosing the German craft sector as an example of a traditional sector characterized by incremental innovativeness has the additional advantage of featuring two separate markets with specific properties (see Mueller, 2016 and Fredriksen & Runst, 2016 for details):

¹ All numbers on the German craft sector and its economic relevance within the German economy can be obtained from the central craft organization ZDH, see: <https://www.zdh.de/daten-fakten/kennzahlen-des-handwerks/>.

² The interviews were conducted in person by student assistants in March and April 2017 at ten different fairs in different locations in central Germany. Our student assistants have a high degree of knowledge on institutional economics and the economics of the German craft sector, being a research focus of our chair. Consequently, they were highly qualified to conduct the interviews and were qualified discussion partners with entrepreneurs.

(1) The traditional sector, encompassing about half of all craft trades features traditional entry regulations building on acquiring the “*Meister*” certificate (see section 3.2.1), a costly and time-intensive qualification encompassing technical and administrative training along with leadership skills and basic educational knowledge for training apprentices. In those trades, the “*Meisterpflicht*” applies, meaning that only individuals with the respective qualification are allowed to establish and run craft firms. This regulation leads to a situation with higher average quality of products and services yet lower competition by entrepreneurial individuals, making it a good representative of the traits of the German Mittelstand.

(2) In the second sector encompassing the other half of trades, market entry has been deregulated following a European Commission directive in 2004. Thus, the *Meisterpflicht* has ceased to apply and firms can be founded and run without a formal certificate of qualification. This has led to a substantial decrease of participants in formal training, a strong increase in new firms being established and a lower average durability of firms. Consequently, craft firms in these sectors have developed to more closely resemble more competitive, entrepreneurial economies with a substantially higher competitive pressure on SMEs.

Due to this two-part structure of an otherwise similar market, the institutions and incentives connected to knowledge spillovers can very well be discerned in the qualitative analysis. This extends the scope of the results from traditional firms in coordinated economies to firms working under market conditions more similar to those in liberal market economies. In the following, firms in domains with a limited market entry are denoted as being *regulated*, while markets without formal entry requirements are denoted as *deregulated*.

Table 1 provides information on the descriptive statistics of the firms/individual entrepreneurs interviewed for this study. Summing up the basic information on the respondents, it can be stated that firms are generally older incumbents. They are mostly active on regional markets and have rather small numbers of employees, which also explains why mostly high-level staff and the owners themselves attend the craft fairs. About two-thirds are active on the regulated markets and about one-third on deregulated markets, while about half are from former eastern Germany, with the other half coming from western Germany. These basic descriptives point towards regionally-active, smaller, older firms with a strong focus on their reputation for high quality work. The interviews confirm that they are primarily active in market domains with quality competition and refrain from entering direct price competition with lower quality firms. Consequently, a strong emphasis is placed on high levels of technical training and service quality within those firms. This means stimulating and upholding knowledge spillover from various sources.

Location (date) n=177	Dresden (05.03.) 17	Erfurt (09.03.) 17	Halle (17.03.) 28	Ilsenburg (24.02.) 25	Fulda (16.03.) 8	Goettingen (17.02.) 20	Hamburg (26.03.) 15	Minden (19.03.) 15	Münster (25.03.) 14	Wolfsburg (11.03.) 18
Region sum(share)	Eastern Germany 87 (.492)				Western Germany 90 (.508)					
Market scope n (share)	regional 98 (.576)			national 62 (.365)			international 10 (.059)			sum 170
Number of employees n (share)	<5 35 (.201)	6-10 58 (.333)		11-25 37 (.213)		26-50 23 (.132)		>50 21 (.123)		sum 174
Age of firm n (share)	<5 14 (.083)	6-10 8 (.047)		11-25 68 (.402)		26-50 42 (.249)		>50 37 (.219)		sum 169
Market structure n (share)	regulated 103 (.585)			deregulated 56 (.318)			partially / unclear 17 (.097)			sum 177
Position of interviewee n (share)	Owner 54 (.34)	Senior technical staff 24 (.151)		Technical staff 15 (.094)		Manager 38 (.239)		Misc. 28 (.176)		sum 159

Table 1. Basic information on the firms interviewed for this study. Numbers smaller than the total number of interviews (177) imply a missing value, meaning that the interviewee either did not know a plausible answer or refused to answer.³

Firms with these traits are chosen since they are the most promising sources of information on the mechanisms of institutionalized knowledge spillovers for incumbent German SMEs. They are likely to be engaged in knowledge networks and have substantial economic incentives to adopt new knowledge, implement innovative practices and monetize those knowledge spillovers, since their customers are willing to pay for quality improvements. Consequently, they are an interesting subgroup to learn about mechanisms of institutionalized knowledge spillover within the German institutional structure.

³ All firms were from craft domains connected to building, renovating and maintaining houses. The most important sectors were (shares in brackets) carpenters {32 (.181)}, combined home-building crafts {17 (.096)}, plumbing and heating installers {14 (.079)}, metal construction {14 (.079)}, tilers {11 (.062)}, producers of various craft products {9 (.051)}, integrated construction firms {8 (.045)}, chimney construction {6 (.034)}, structural and civil engineering {6 (.034)} and various others {60 (.339)}.

3. Results

3.1 Descriptive results

In the following, the coded results to the main questions are presented and briefly interpreted. Overall, the dataset encompasses 31 variables (i.e. codings), according to which the core results of the 177 interviews can be analyzed quantitatively. Of these variables, the descriptive results of the most important ones are presented below to give an initial idea of overall answering patterns in the interviews. The dataset of respondents is categorized according to their market situation, meaning whether they work in regulated or deregulated domains of the market. This section is followed by an in-depth qualitative analysis in section 3.2 and a discussion with policy implications in section 3.3.

In the initial descriptive section, three domains of results are reported:

- (1) **Vocational training.** Do firms conduct knowledge spillover by participating and what are the effects of competition?
- (2) **Monetization of quality.** Can continuous knowledge spillovers be monetized on the markets?
- (3) **Development of knowledge intensity.** How and has knowledge intensity developed on the markets in past years?

Participation in collective qualification schemes

Looking at the descriptive results in table 3, it can be assessed that eight out of ten firms in regulated markets participate in the qualification schemes, while two-thirds of firms in deregulated markets refrain from doing so. Further, about half of respondents in regulated markets expect that increasing competitive pressure from deregulation would result in fewer participants in the qualification scheme (table 4). Almost no firms expect additional trainees, while some expect no substantial effects. This basic result resonates with those of previous studies on the effects of deregulation on vocational training in Germany (Mueller, 2016).

Participation in collective qualification schemes		
	<i>Yes (share)</i>	<i>No (share)</i>
<i>SMEs in regulated markets (N=101)</i>	79 (.782)	22 (.218)
<i>SMEs in deregulated markets (N=53)</i>	18 (.34)	35 (.66)

Table 2. Share of respondents participating in the collective vocational qualification scheme according to the market structure.

Anticipated change of qualification intensity		
	<i>Anticipated change</i>	<i>n (share)</i>
<i>SMEs in regulated markets</i> Anticipated change in craft training in the case of a deregulation? (N=76)	“Additional training”	2 (.026)
	“Less training”	39 (.513)
	“No effect due to current lack of trainees”	12 (.158)
	“No effect”	10 (.132)
	“Unclear”	13 (.171)

Table 3. Responses to the anticipated change of qualification intensity in case of a deregulation, leading to higher competitive intensity, for firms in regulated markets.

Monetizing knowledge spillover and knowledge intensity

Regarding the aspect of monetization of a higher knowledge intensity in firms, several initial clues can be drawn from the descriptive results.

In regulated markets, firms assume that a higher certification implies a higher level of quality to customers. Firms believe that customers tend to look for and act on different certifications of higher quality when deciding for a firm. Further, most firms assume that customers are able to anticipate the product and service quality, i.e. the firm's qualification prior to the transaction.

In deregulated markets, the picture is less clear. For about half of all respondents, the highest level of certification is accepted as a good indicator of quality by customers. Similarly, about half of all firms assume that customers base their decisions on other quality signals. Consequently, of those respondents who hold the highest degree of certification, a substantial share of respondents do not advertise this certification. Moreover, they acknowledge that this quality signal itself would not lead to a higher willingness to pay for products or services by their customers. Finally, the assessment regarding customers' ability to anticipate product/service quality beforehand is comparable to firms in regulated markets, meaning that a little more than half of all firms assume that customers can judge the quality ex ante.

	Monetizing knowledge spillover				
	<i>Yes (share)</i>	<i>Rather yes (share)</i>	<i>Rather no (share)</i>	<i>No (share)</i>	<i>Unclear</i>
<i>SMEs in regulated markets</i>					
<i>Highest certification of qualification accepted as a signal for higher product quality? (N=99)</i>	60 (.606)	19 (.192)	6 (.061)	10 (.101)	4 (.04)
<i>Customer orientation on signals of higher qualification? (N=57)</i>	22 (.386)	14 (.246)	12 (.211)	7 (.123)	2 (.035)
<i>Can customers anticipate product-/service quality / firm's knowledge intensity ex ante? (N=91)</i>	29 (.319)	25 (.275)	20 (.22)	12 (.132)	5 (.055)
<i>SMEs in deregulated markets</i>					
<i>Highest certification of qualification accepted as a signal for higher product quality? (N=42)</i>	16 (.381)	3 (.071)	8 (.191)	14 (.333)	1 (.238)
<i>Customer orientation on signals of higher qualification? (N=31)</i>	8 (.258)	8 (.258)	10 (.323)	4 (.129)	1 (.032)
<i>Can customers anticipate product-/service quality / firm's knowledge intensity ex ante? (N=37)</i>	13 (.351)	7 (.189)	10 (.27)	5 (.135)	2 (.054)
<i>If available: advertisement of certificates of higher qualification? (N=32)</i>	8 (.25)	-	-	15 (.469)	9 (.281)
<i>If available: do certifications of higher qualification enable higher prices for the respective products/services? (N=44)</i>	11 (.25)	-	-	26 (.591)	7 (.159)

Table 4. Descriptive results on firms' ability to monetize knowledge intensity according to the regulated/deregulated structure of the respective markets.

Regarding the economic incentives for increasing a firm's knowledge intensity, these initial results hint at continuously high incentives in regulated markets. For deregulated markets, this might apply less: while the highest certification serves as a quality signal, most firms do not assume that customers act very strongly on quality signals and therefore refrain from advertising their higher qualification levels. This results yields the (preliminary) interpretation that price competition might not suffice to induce the costly acquisition of a comparably high level of qualification as in markets with mandatory levels of qualification.

Development of knowledge intensity

The third dimension of descriptive results is concerned with the development of knowledge intensity on the two markets. For the analysis, I assume that firms' assessments of the quality development on their markets in recent years is a broad indicator for the degree of knowledge intensity. Thus, evidence can be derived concerning whether the institutional framework at play has fostered knowledge spillovers in the respective markets. Overall, firms in regulated markets are somewhat more optimistic about the average quality in their markets, whereas about the same number of firms in deregulated markets assume that quality has improved compared with those thinking that it has declined. Overall, it can be stated that SMEs in regulated markets tend to view the development of average quality, i.e. knowledge intensity, on their markets more positively than SMEs on deregulated markets.

Development of knowledge intensity in past years						
	<i>Higher (share)</i>	<i>Rather higher (share)</i>	<i>Rather lower (share)</i>	<i>Lower (share)</i>	<i>Unclear</i>	<i>unchanged</i>
<i>SMEs in regulated markets</i>						
<i>Development of overall product/service quality on respective markets (N=94)</i>	34 (.361)	5 (.053)	12 (.128)	16 (.17)	18 (.192)	9 (.095)
<i>SMEs in deregulated markets</i>						
<i>Development of overall product/service quality on respective markets (N=52)</i>	13 (.25)	4 (.077)	8 (.154)	8 (.154)	12 (.231)	7 (.135)

Table 5. Assessment of firms regarding the change in average product/service quality on their market in recent years according to the market structure. Further, firms on deregulated markets are asked whether the deregulation had an influence on the average quality in their opinion.

3.2 Qualitative results

For the qualitative analysis, the full interview protocols are used. For the codings, there are 18 overarching categories with 5-10 sub-categories each. This process provides a structuration of responding patterns by interviewees, which enables deriving evidence for the research questions. Using this methodological approach, three distinct channels fostering knowledge spillovers and increasing entrepreneurs' absorptive capacities can be identified: vocational training, (3.2.1), regulation (3.2.2) and market mechanisms (3.2.3). In the following, these settings are described; in chapter 3.3, the results are summarized and policy implications are presented. For illustrative purposes, representative quotations from the interviews are provided in the footnotes to the respective chapters.

3.2.1 Vocational training

Institutional background

To provide an understanding of the basic channel for knowledge spillovers for German SMEs, the dual training scheme for apprentices is briefly explained. Its structure and working mechanisms apply to the craft sector but also to most other industrial or service sectors in Germany. It can therefore be considered absolute basic knowledge for all interviewees. This system combines theoretical knowledge taught in publicly-financed vocational schools with practical training at the chambers of craft and in firms and is therefore described as a mixed institutional approach to vocational training (for overviews, see e.g. Busemeyer & Schlicht-Schmälzle, 2014; Lassnigg, 2016; Hernandez, 2016).

From a knowledge spillover perspective, this system is quite effective in disseminating the current state of the art in the respective field by combining the spillover of established practical experience-based knowledge from practitioners with newly-created knowledge by industrial and university-based research institutions via the public vocational school system. Publicly-financed vocational teachers are either required to have *Meister*-training and practical experience or are required to study their respective field at technical colleges or universities, whereby many teachers are experienced craftsmen or engineers who start teaching after or during their work in the field. Public schools work closely with the semi-private chambers of crafts to ensure the applicability and relevance of the classes. New knowledge is implemented through new teachers graduating from technical colleges or universities who are taught the current state of technology in their respective fields and within the school system by chambers of crafts who regularly update teaching requirements based upon the current technological developments.

Thus, the German dual system combines extensive in-firm training of apprentices becoming qualified workers ("*Gesellen*") and prospective entrepreneurs ("*Meister*") with a publicly-financed school system and - in recent years - specialized fields of study at universities. Apart from the scale of this system of vocational training, the main difference to other national vocational systems lies in the specific role of chambers of craft, which essentially serve as a knowledge network. It connects the different organizations and firms, which have a mandatory membership. Further, the chambers have a privileged judicial status, allowing them to enforce training requirements for apprentices and Meisters alike.

The curricula followed in schools' and training programs are co-authored by experienced members of the chambers of trade and teachers educated in universities. Both the chambers of

trade and the universities therefore closely coordinate training programs to include basic knowledge but also implement innovations in the field. Consequently, knowledge spillovers normally occur either from institutions of higher education down to firms via the training of apprentices, through additional qualifications offered by the chambers to incumbents or through new entrepreneurs implementing their newly-acquired knowledge from Meisterschools or university studies in their own firms. Similarly, new innovative knowledge is transferred from firms through voluntary work in classes provided within the craft organizations. If field-specific technological innovations have been realized by a firm and tend to constitute a new standard in the field, chambers of craft regularly include these innovations in their various training programs and might also set the respective innovation as a new mandatory product standard that is enforced across firms. Thus, there are both top-down and bottom-up spillover effects. This leads to a situation in which the diffusion of new knowledge happens broadly, as craft firms are often required to conform to the most recent standards and all firms connected to the dual system of training regularly receive new knowledge through the public school system. Thus, not only very innovative firms receive knowledge spillover, but also smaller firms are effectively connected to the domain of knowledge production via the chamber networks. This effect is particularly positive, since knowledge filters are obviously stronger for smaller firms with little or no R&D capabilities, and the institutional framework effectively compensates these disadvantages in terms of knowledge spillovers. While this still does not guarantee an automatic absorption by the firm, it reduces a central barrier to knowledge diffusion and increases firms' absorptive capacities via supportive external institutional structures. In the following, based upon the interview results, the institutional mechanisms that additionally foster participation in this system of vocational training are described.

Craft identity and vocational training

The most traditional channel of knowledge spillover is the entrepreneurs' ethical connection to the vocational training system described above. Established by early German guilds in previous centuries, the ideal of a master-to-apprentice training has prevailed in many of the interviewed modern craft firms. Consequently, a strong emphasis is placed on a high and thorough level of training, i.e. knowledge and skill acquisition by all craftsmen within the firm. As a part of their professional identity, traditional firms are willing to invest in training new apprentices, sending them to vocational schools and receiving training classes from different knowledge providers for their more senior staff.⁴ Interviewees even argue that the strong identity effect on the willingness to initiate knowledge spillovers is independent of the economic risk of training potential competitors and that the ethos is stronger.⁵

⁴ An interviewee puts it such that: "*Such a Meister, a crafts master, still has a vocational ethos. You can say so, for myself even less than for many of my colleagues. There really is a strong vocational ethos and you train apprentices not because, as many might think, they are cheap labor, but you really do train them to pass on your masterly skills, to hand them over to the next generation.*"

⁵ "*Would this decrease your willingness to conduct training? No. Not at all. (I): You would still do it. (R) In any case I would, sure. (I): So you would do it due to your understanding of your vocation, because you think it's right? (R): Yes, of course. Because I see each day how much craft work is messed up if people have no proper qualification [...].*"

Interestingly, the traditional ethos passed on through the craft organizations – while implementing quality-based barriers to market entry – is all but hostile to knowledge spillovers; rather, the passing over of existing knowledge as well as the acquisition of new knowledge is supported by the traditional codes of conduct and supportive of product or process innovation.

When asked about the potential effects of the requirement of higher qualification for creating and running a firm on the degree and quality of apprenticeship training, firms in regulated domains are fairly skeptical. Overall, they assume that professional training will suffer and that the traditional motivation of training apprentices will erode.⁶ Asking firms in the deregulated domains, they will highlight that the traditional mentality can very often no longer be maintained due to competition.⁷ Consequently, increasing competitive pressure might lead to a crowding out of the traditional mentality, as upholding the traditional mentality becomes more difficult from an economic perspective.⁸ This qualitative finding resonates well with the aggregate findings in section 2.1.1, showing that two-thirds of firms in regulated markets train apprentices, compared with only one-third of those in deregulated markets.

Continuous qualification of incumbents

Connected to the identity-based incentive to train new apprentices in the crafts, incumbents show a consensus that continuous qualification is a basic requirement in their field. Consequently, firms show an intrinsic willingness to adopt new technologies and invest in the continuous training of their employees. Consequently, the mindset described above is not limited to the training of new employees; rather, essentially all firms acknowledge that continuous qualification is a basic requirement of succeeding on their markets. This mindset is reinforced by traditional values, various regulatory and industrial certification requirements and customers' pressure to implement up-to-date technology. The combination of these factors leads to a mentality that actively seeks knowledge spillovers by working to increase absorptive capacities within firms.⁹ This requirement is not limited to classes organized by the chambers

⁶ A typical answer similarly draws upon the professional understanding of the craft: “Well, it would lead to no more apprentices, it's that simple! Because these things go hand in hand. Those people that really feel connected to their craft, they do their Meister degree, to achieve a certain level of qualification. They deeply care for the continuation of the craft. And that means of course caring for the training of new apprentices [...]” Another respondent explains: “This is a complex mechanism, all that is connected to the Meister requirement, this is quite complex. If someone leads a firm with no quality aspirations, he will do fine with just simple untrained helping worker, and he might even get through with it. At the end, the customers are the ones that suffer.”

⁷ “[...] because an apprentice primarily costs money. You invest in a person, hoping that he will stay in your firm and carries on the quality and skills you taught him. But that doesn't work anymore today, in the areas without the Meister requirement. Because there, you potentially train your future competitor.”

⁸ Says one interviewee from a deregulated domain: “You see, this idealism, no one can afford that anymore. That's a clear and simple thing. I believe that the development in the crafts is getting increasingly harder. Competitive pressure is increasing, working time gets more expensive and also the equipment gets more expensive. Consequently, costs are getting ever higher and you can't afford to just sit there for five minutes, saying, my lord, this is a beautiful piece of work. Vocational trainers and entrepreneurs can no longer afford that and this development, it is sad, but it is real.”

⁹ One interviewee comments: “So, in Meisterschool, you just learn that you have to continue learning etc. So we go to training courses three, four times each year, each time for several days. You just can't afford not to stay on top of things. Who has never made his Meister and hasn't been to school there hasn't learned that this is really necessary.” Another entrepreneur, responding to the question as to whether quality has changed: “Definitely better.”

of craft, but is also fostered by privately-organized knowledge networks¹⁰ or larger firms offering in-house training for their workers.¹¹ Overall, the conviction that continuous vocational training for incumbents is a prerequisite for success on the market is ubiquitous across the interviews and independent of firm size and the regulation/deregulation of the respective domains. Firms thus use various channels to receive knowledge spillovers and continue to build up absorptive capacities.

Proposition 1.

Maintaining a state-wide dual training scheme fosters knowledge spillover.

Proposition 2.

The effectiveness of the dual training scheme hinges on substantial government expenditures and a participatory identity among firms, which might erode in market situations characterized by strong competition.

Proposition 3.

Upholding a mentality of continuous qualification among incumbents, chambers and industrial suppliers stabilizes knowledge spillover.

3.2.2 Regulation

A second separate institutional framework fostering knowledge spillover in the case of German SMEs is extensive public and chamber-based regulations regarding the quality of products and services and the level of training required to continue practicing the crafts. Therefore, regulators systematically determine the degree of knowledge spillovers required from firms, with the option of revoking licenses for market entry if the criteria are not met. While this is obviously a strict measure and strong intervention in the market, it also ensures that innovations can be declared a standard in the field and are therefore implemented by each firm of the respective markets, which again leads to a very broad dissemination of technologies and administrative practices. There are three different layers of regulation and different institutions enforcing standards for the case of German craft SMEs.

Chamber regulation

The initial and most basic regulatory instance is the craft chambers, which require periodic participation in classes for further qualification. Many interviewees refer to their mandatory

[...] *There is far more additional training than earlier on. There are more training classes and we have higher learning requirements.*"

¹⁰ "[...] *there are many carpenters from across the country, fairly big firms that build houses. And with those, there is a continuous further training. That means our Meisters meet within this association of carpenters and exchange their experiences and so improve in the domain of house building. How do new products work? There are always new products on the markets and you always have to figure out how to use them, how do they react, are they ecologically acceptable, how are the physical properties etc. etc.*"

¹¹ "*Quality management to us is primarily a learning process. To always continue learning on the current state. For instance, we have a training academy within our firm, where each worker has the opportunity to learn new things in his special domain. There are various classes each year where each person can decide whether and where to participate. And I can tell you, 99.9 percent of these classes are attended by our employees!*"

classes for the firm's *Meister* as well as for all employees.¹² Consequently, craft organizations are able to impose certain technological and administrative standards to a certain degree by requiring their members to attend classes. While attendees are not always required to implement the respective standards, they are at least informed of all important developments in their field. Consequently, a broad knowledge dissemination is fostered by these requirements, thus penetrating the knowledge filter on a large scale for SMEs. Another regulatory factor is the element of firm-specific control by the chambers of crafts. This institution provides firms with mandatory certifications allowing them to perform specific tasks. The task of renewing certifications allows the chambers to fully access firms' protocols of previous works at any given time, with controls happening regularly. The chamber then tests whether the work has been completed according to the quality standards currently required. If the standards have repeatedly not been met, firms can lose their licenses. This obviously provides a very strong incentive for firms to conform to the current standards in the field and it provides the chambers with an instrument to foster the dissemination of certain quality standards. According to the interviewees, this instrument is used particularly in the domain of ecological regulations, forcing firms to continually screen and adopt the most recent standards in the field. Note again that this is not limited to the most innovative firms or specific subsectors of the craft sector, but rather that it applies to all firms in the regulated domains and - less strictly - to firms in some deregulated sectors.

Proposition 4.

While reducing firms' entrepreneurial scope, vocational chamber requirements are an effective means of continually enforcing knowledge spillovers even to small firms.

National and supranational regulations

A second layer of regulatory requirements is national or EU regulations implementing specific technological standards. According to firms, this process has been especially strict in the field of ecological requirements in recent years. In this domain, the use of eco-friendly building materials, processes and lower energy consumption is fostered. Due to the strict regulatory requirements, there are substantial R&D investments by industrial suppliers and firms are often required to implement the resulting technologies. Otherwise, at best no federal subsidies for home-building or renovation are granted and at worst homeowners and firms have to pay fines. Due to these ever-increasing regulatory requirements, chambers of craft have to ensure that new regulations and the corresponding correct use of new technologies are implemented by their members. This constitutes a substantial incentive to penetrate the knowledge filter in the respective technological fields and uphold absorptive capacities in firms. Interestingly, these strict regulations in certain fields are considered by some to serve as a full compensation for the expected loss of quality due to the deregulation.¹³ Overall, it becomes obvious from the

¹² One typical answer reads: "Well, our craft, particularly chimney sweepers, are required to do periodical mandatory training courses. Myself as the manager and my staff, we regularly have to go to classes. That's required by the law [...]."

¹³ "(I): So, what would happen if the *Meisterpflicht* would be abolished? (R): That's a good question. I don't think much would change, since we already have very high mandatory standards due to EU certification. (I): So you could say that this EU certificate in a way has higher than standards than the *Meisterpflicht* and is more

interviews that the ever-increasing regulatory standards force firms to continue training and adapting new technologies by increasing their absorptive capacities.

Proposition 5.

State-wide regulation can trigger knowledge spillovers. Continually enforcing higher standards (e.g. in environmental domains) and connecting market entry to compliance triggers knowledge spillover.

Private certification systems

The third layer of regulation are privately-organized certification systems, which can be acquired by firms to signal their quality commitment. There are various different labels and associations screening firms for certain criteria and offering labels for higher quality in return. These instruments apply in combination with customer demand for high quality and to counter information asymmetries on the markets. Again, the certifications enable external networks to access firms and ensure that a certain current state of the art in terms of service provision and technological standard is met. Often, the certification organizations similarly serve as knowledge networks for member firms, organizing the exchange of ideas and experiences with new technologies.

Finally, apart from national regulations, chamber-based or voluntary certifications, there is another form of supervision by an external institution that provides mandatory quality audits: as a semi-public institution, the German “TÜV” is required to monitor the quality of certain aspects of house building and renovations. It is financially independent on firm membership fees or homeowners and files reports on the correct provision of (among other) craft services. If certain standards are not met, firms are required to re-do the inadequate aspects of their work. According to the interviewees, this external monitoring institution with far-reaching rights to intervene leads to a strong pressure to maintain and increase quality standards that go along and consequently implement new technologies and processes.¹⁴ Again, an external institution is able to impose certain standards – particularly in the field of eco-friendly materials – upon firms and has the right to sanction firms that are unable or unwilling to meet those standards. This provides another channel for the systematic transfer of new knowledge to a very broad base of incumbents. Therefore, while being enforced by different layers of regulation, knowledge transfer might be considerably more effective than through the diffusion of technologies by

demanding and that all would have to get a high standard of knowledge anyways? Yes, a high standard, yes.” Another respondent adds: *“Quality has absolutely improved, because there are so many more legal requirements, they have been adapted by the EU. The technology has a key role, that’s coming more and more. [...] (I): So how can people keep track of these changes, the firms, with these difficult technologies? (R): Difficult. You have to continuously keep training. Further education and never stop, always continue.”*

¹⁴ A respondent answered the question of whether quality has improved as follows: *“Yes, constantly. All the time, continually. Through the current quality controls and through our construction management, the customers demand and of course through the fivefold TÜV audits, we not only have a monitoring of quality, but also an increase in quality. You can’t go there and, I’m exaggerating, build some mess, because this TÜV-audit, checks all this. So this means you cannot hide anything there. And each craftsman knows this at this moment. He knows, someone will come there. And if my works isn’t fine, I’ll have to do it all again. So this wouldn’t make any sense. And so the craftsmen are willing to work accordingly.”*

individual entrepreneurs interested in first-mover advantages and the subsequent imitation by incumbents.

Proposition 6.

Private or semi-private certification institutions foster knowledge spillover with the side-effect of increasing market transparency in situations of asymmetric information.

3.2.4 Market mechanisms

Market mechanisms denote the effects related to the respective market and customer demand on the development of firms' absorptive capacities and – ultimately – knowledge spillover. Four main channels can be identified that determine whether firms aim to increase spillovers: their ability to monetize a higher level of knowledge; customer preference for higher quality goods and services; long-term regional reputation-building by incumbents through high quality and services as well as market pressure to adopt new technologies by industrial suppliers.

Effects of prices

The first and most straightforward motive for increasing knowledge spillovers through training and the implementation of innovations is a firm's ability to charge higher prices for higher quality goods and services resulting from continuous knowledge spillovers. Interviewees stress that their focus on customers with a high quality demand in most cases enables them to realize higher prices for most complex and innovative product solutions, which in turn provides an incentive to pursue the current state of the art in their respective fields. Most respondents agree that their customers monetarily value a high level of training and an effort to implement the current standard of technology, enabling them to charge higher prices due to their higher knowledge intensity.¹⁵ Thus, the continuity and incentive to uphold knowledge spillovers depends on the ability to charge higher prices for higher quality services. In regulated markets, this is less of an issue, since all firms are required to uphold a fairly high level of training, which supports their internal willingness to receive costly knowledge spillovers, as prices do not suffer from these measures.

By contrast, in deregulated markets, knowledge spillovers increasingly depend upon firms' ability to convert them into higher prices through various channels. The effectiveness of these channels in turn depends on customers' ability and willingness to understand qualitative differences and accordingly pay higher prices. Since this criterion is often not met, knowledge spillovers suffer in markets with strong price competition.¹⁶ More generally, this issue is at play in markets characterized by asymmetric information, in which customers are unable to see through quality differences prior to consumption. In the worst case, this leads to a market-for-lemons effect (Akerlof, 1970), in which lower quality products crowd out higher quality

¹⁵ A typical answer to the question of whether higher prices can be charged reads: “Well, I'd say that this is also necessary. I mean, they have invested in their training and can therefore provide a higher quality product and another quality standard. Sure.”

¹⁶ “(I): So you said that quality has generally decreased on your market? (R): Yes. (I) What reasons does this have? Well, I'd say that this has to do with competition, the price pressure. For a certain price, you cannot make an offer with a reasonable quality. The qualification and time is always a big issue here.”

products with lower prices from the respective markets. The interviews provide strong evidence that this process in fact occurs due to the partial abolition of mandatory certification and the market's inability to develop effective private certifications that successfully signal quality to customers. Consequently, customers mostly cannot understand product quality *ex ante*¹⁷, an effect that is aggravated by stronger price competition.¹⁸ This finding is in line with previous case study evidence suggesting that asymmetric information inhibits knowledge spillover on the market for energy efficiency consultants (Feser & Proeger, 2017).

Proposition 7.

Market transparency is a vital prerequisite for strong monetary incentives of increasing knowledge intensity in firms. If quality signaling fails, continuous qualification can become a competitive disadvantage.

Customer preferences for quality

The second market-endogenous mechanism is that of customer preferences for quality and high levels of qualification in SMEs. Overall, despite the troubles associated with signaling quality differences described above, interviewees emphasize that German customers strongly demand high levels of quality and generally have a willingness to pay for such quality products. They ascribe this to specific, culturally-reinforced requirements for quality products in the domain of craft services. Even if they are eager to pay lower prices, customers are described as very uncompromising when it comes to quality and the implementation of the current state of the art in the respective field. This cultural aspect of demand is a strong push factor for firms to initiate knowledge spillovers, as a failure to do so would result in a loss of customer satisfaction and ultimately orders.¹⁹

Thus, as customers are accustomed to firms implementing modern technologies with a high level of quality, firms can draw back on this cultural preference to justify higher prices due to higher qualification. This culturally-determined option thus serves as a corrective force against the issues related to asymmetric information and the crowding out of quality products. If customers were less uncompromising in terms of accepting lower quality, the incentive to uphold knowledge spillovers would certainly be lower for German SMEs. However, since firms can always explain higher prices with their quality commitment and customers overall accept

¹⁷ Responding to the question whether customers understand quality differences, an entrepreneur replies “*That’s difficult. Very difficult for customers. Customers don’t even understand our overall offers and the service we provide. Only if something doesn’t work afterwards, i.e. once there is a damage, then there is a lot of crying around. Then they actually understand quality differences. But otherwise, no, that’s hardly possible in advance. Only if the customers is helped by an expert consultant.*”

¹⁸ “*Customers in general want high quality. But since they aren’t able to tell the difference, there is a lot of fraud going on. [...] Sometimes the firms have no idea of the technology. And they are cheap due to that and sell themselves cheaply. And that does a lot of damage to the crafts in general.*”

¹⁹ One interviewee explains: “*The customer simply demands more, yes. The whole market has become so much more complex. So consulting is more intensive, requirements for obtaining public support has increased, so yes. [...] (I): So the whole craft has become more complex? (R): Yes, definitely. You don’t practice what you’ve learned once. There are some many new things, experience and what you learn from further training etc. You have to do that every day.*”

this connection, the overall level of knowledge spillovers is supported, which has led to quality increases in the regulated domains.²⁰

Proposition 8.

Customer preferences for firm qualification constitute a major incentive for conducting knowledge spillovers. Customers expecting high-end solutions thus enforce knowledge spillover on a broad scale.

Reputation seeking by regionally oriented firms

As a third market-endogenous mechanism, the interviews yielded the aspect of firms' investments in a high regional reputation. Knowing that most of their customers have a recurring, long-term demand for high-quality products and services, firms aim to establish a strong reputation, which enables them to charge higher prices compared to larger, non-regional firms and build customer loyalty.²¹ Given that this quality reputation can only be achieved by consistently investing in qualification at all levels of a firm's activities to provide satisfactory products and services to quality-interested customers, it provides a long-term incentive for upholding knowledge spillovers.

Reputation is also a classic example as a means of reducing the issues of asymmetrical information by making product specifics visible through transparent long-term quality standards. Consequently, it is a potential remedy to market failures in the domain of craft products and services precluding market-for-lemons developments. Connected with the high quality standards and the effectiveness of word-of-mouth information dissemination, it upholds high quality standards. Consequently, particularly regional firms are forced to uphold the acquisition and implementation of new knowledge. This is achieved by conducting further training for their staff and by participating in the dual training scheme for new apprentices.

Proposition 9.

Reputation-building by regionally-active, long-lived firms can provide an additional stabilization of qualification incentives.

Technological development and craft-industry linkages

A further market mechanism increasing knowledge spillovers is the intense linkage between industrial, R&D-intensive industries providing intermediate products and craft services responsible for adapting and implementing those products at the final customers. While the craft sector fosters very little formal R&D, the large industrial suppliers heavily invest in new technologies and have strong linkages with universities and research institutions. While individual crafts and even chambers cannot sustain innovative cooperation with these

²⁰ A typical answer reads: "Well, I would say that the average quality has increased in the past years, because our customers' demands keep increasing!"

²¹ An interviewee explains: "There are firms that continue to look very closely at high quality, particularly firms that are only active regionally that want to provide high quality, because they are available for customers at all times. [...] Well it's my conviction that that these firms are really committed to providing high quality. Because, you see, if I do bad work in my hometown of about 3,500 inhabitants and I mess up at only one customer, he will tell everybody. People do talk about this. So I have to, if I want to or not, deliver a good quality. Because I live off of word-to-mouth advertisement."

institutions due to size constraints in most cases, the industrial suppliers are able to foster technological developments.

As industrial intermediate products become more complex, versatile and – in recent years – heavily influenced by information technology, the requirements for firms have substantially increased. In order to implement the technological state of the art produced by the suppliers, substantial investment in qualification is necessary, since a failure to do so precludes firms from offering the latest technologies to demanding customers.²² Thus, there is a specific linkage between the market interests of suppliers, who either need to implement increasing regulatory standards or want to gain market advantages over the competitors and the craft firms required to implement the technological standards.

Industrial suppliers have a strong interest in craft firms able to implement their products and therefore try to foster the necessary knowledge spillover, e.g. by financing classes on their products and requiring firms to acquire private quality certifications allowing them to use the respective products. Therefore, market pressure induces penetration of the knowledge filter by larger firms connected to technological innovation in favor of smaller firms.

This specific industry-craft linkage has a certain momentum – fueled by technological innovations, market incentives and regulatory standards – which forces incumbent SMEs to pursue knowledge spillovers.²³

Proposition 10.

Strong linkages to sectors conducting R&D and market pressure from suppliers and customers to implement new technologies helps to penetrate knowledge filters.

²² One respondent explains (responding to the question regarding quality development): “We are far more qualified. About fifteen years ago, many of the technologies were developed and they overstrained many firms. Today, a craftsman needs a broad combination of fields. [...] He’s confronted with technologies he might not have seen in his daily life, so he just has to acquire the qualifications, heat pumps, complex installations, solar technology and so on. So the knowledge that craftsmen need to have nowadays is really much higher than in the past fifteen years. (I): What is the reason for this? [...] (R): It’s because of more informed customers!”

²³ “(R): Quality has improved. (I): Could you explain the reasons? (R): I would say it’s because of the further qualification by craftsmen. (I): Okay, so there are more courses offered? (R): No, because everything becomes more complex, more complicated and you are simply forced to implement it!”

3.3 Discussion and policy implications

This study has so far addressed the institutional mechanisms for the continual flow of information between producers of knowledge and SMEs and how they work in practice. Figure 1 provides a summarization of these results regarding these two research questions.

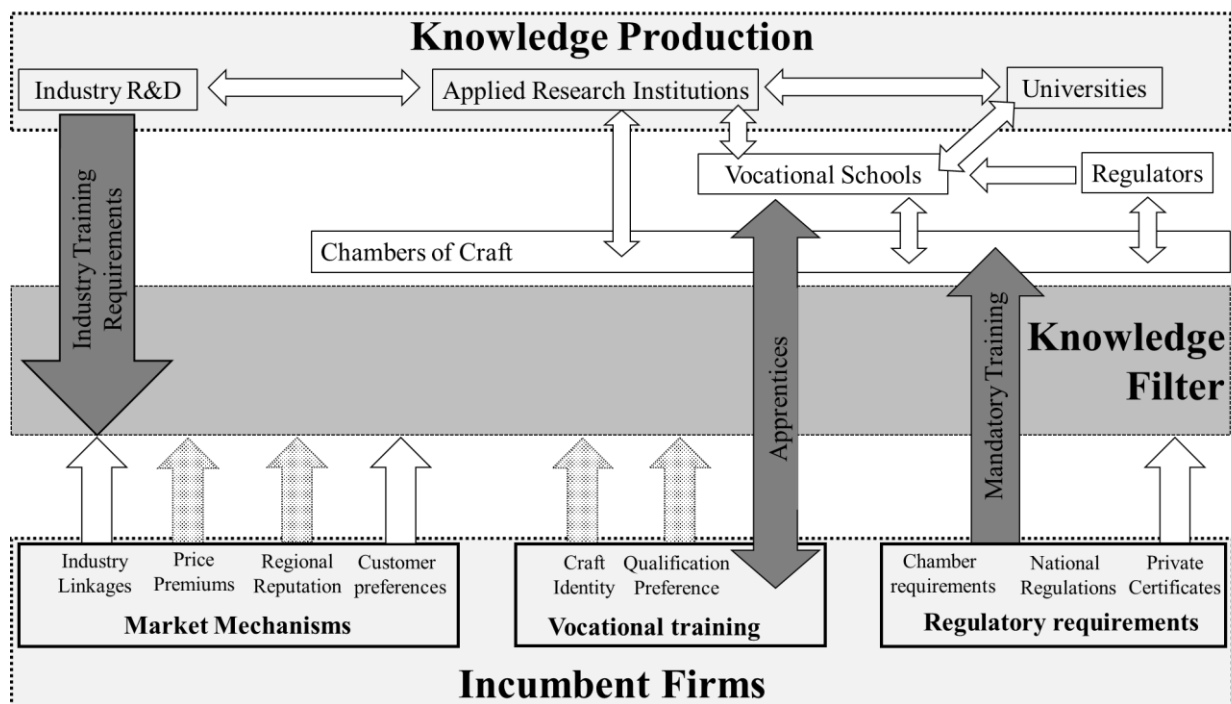


Figure 1. Summary of the institutional framework for knowledge spillover for German craft SMEs. Mechanisms with a dotted structure are weakened or drop out altogether in more competitive markets without entry barriers according to qualification.

Building upon these basic results, the third research goal can be addressed by providing generalizable results from the German case study.

First, market conditions should be influenced such that the continuous implementation of new technologies leads to a price premium for firms choosing to invest in knowledge spillover. This can be achieved by providing a broad set of certifications and quality labels, whereby effective signaling of quality is crucial in markets for experience and credence goods, in which consumers cannot determine product quality ex ante. If mandatory certifications cannot be implemented, efforts should be made to increase market transparency to foster knowledge acquisition by incumbents. The deregulation in the German case shows that the abolishment of mandatory standards can lead to erosions of quality standards under conditions of asymmetric information. Markets forces might be unable to develop private certifications that credibly signal quality standards compensating the effects of mandatory standards.

Policy implication 1.

Increasing market transparency through voluntary or mandatory quality signals increases the economic incentives for continuous knowledge spillover by incumbents.

Second, the linkages between highly-innovative agents in the supply chains and incumbents should be strengthened to ensure that the implementation of innovations on a broad scale is

pursued by innovating firms and the final customers. If successful, these two factors exert a strong pressure on incumbents to increase absorptive capacities and cooperate closely with innovative suppliers to satisfy customers demand. Firms' inability to uphold their absorptive capacities thus leads to a substantial disadvantage on their markets, which optimally leads to a self-increasing process of knowledge spillovers from highly-innovative sectors to incumbents. These linkages can be created through the continuous increase in product and quality standards by regulators, which essentially force incumbents to uphold their absorptive capacities to avoid fines by the state or judicial claims by consumers.

Policy implication 2.

Regulation implementing the technological state of the art issued by industrial producers as mandatory or publicly-visible voluntary standards can exert pressure on incumbents to increase their absorptive capacities and conduct knowledge spillovers with industrial firms.

Third, substantial public investments in vocation training institutions offering free vocational training is vital to ensure the continuous spillover of knowledge transmitted from university-trained teachers to workers who – at the same time – implement the new knowledge in firms. A broad public training scheme covering the majority of incumbents provides an opportunity for the broad-scale diffusion of new knowledge among the workforce and incumbent firms, which otherwise would not have received the current state of technology. This direct link between knowledge production and incumbents is probably the single most effective means of knowledge spillover, which directly bridges the knowledge filter. In this regard, it might be as effective as entrepreneurs directly implementing innovations, but functions on a much larger scale, as innovations can easily be set as a training standard, thus reaching thousands of apprentices each year and influencing a similar number of firms.

Policy implication 3.

The creation of strong linkages between incumbents, public vocation schools and professional associations through the cooperative training of apprentice can be initiated through maintaining a broad public vocational school system, which continually updates curricula according to the state of technological development.

Overall, this study's policy implication is that a stronger coordination of knowledge producers, networks, professional associations, regulators and incumbents fosters knowledge spillover, while market forces are not generally favorable. This coordination can be achieved through monetary investments in public schools, market transparency measures and the enforcement of regulatory standards. This result generally resonates well with the research on knowledge networks and their positive effect on knowledge spillover (Hayter, 2013; Huggins et al., 2012; Huggins & Thompson, 2015; Shu et al., 2014 and (for the German case) Maennig et al., 2015; Maennig & Oelschlaeger, 2011). While many aspects pointed out in this study might primarily apply to coordinated market economies and incremental, non-R&D innovators, many of their traits can be transferred to other national and regional contexts, particularly to regions or nations characterized by a low entrepreneurial dynamic, little knowledge production yet a large number

of incumbent firms capable of implementing incremental innovation if provided supportive institutions.

4. Conclusion

Extending Qian and Jung (2017) as well as Massis et al. (2017), this study has investigated the ‘German Mittelstand innovation model’, more specifically its means of systematically increasing absorptive capacities in incumbents using the example of a typical German SME sector characterized by low entrepreneurial dynamics, little formal connections to knowledge production and an incremental, non-R&D-based innovative process. Using a set of interviews with SMEs, I have identified the main institutions, mechanisms, values and economic incentives driving knowledge spillovers in this sector despite its considerable disadvantages when compared to high-technology, knowledge-intensive entrepreneurial sectors. Overall, it can be shown that industry-SME linkages, differentiated regulation and – most prominently – the dual training system are effective mechanisms for broad knowledge spillovers to most firms in the sector. This coordinated system effectively and continuously penetrates knowledge filters, leading to a situation in which the dissemination of new knowledge does not exclusively hinge on the existence of entrepreneurial individuals disseminating innovations through market processes. Instead, incremental innovations are continuously disseminated across incumbents in a combination of voluntary and mandatory technology adaption, mainly through the institutions connected to the chambers of craft, which effectively support firms’ absorptive capacities. I suggest that the further study of knowledge filters can profit from a practical institutional perspective, describing in greater detail the mechanisms and structures supporting incumbents’ absorptive capacities. Investigating institutions and their working mechanisms thus supports the derivation of applied policy implications for an increase in absorptive capacities fostering broader knowledge spillover.

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Appendix A. Guiding questions for the interviews

Please note that the overall number of questions asked to interviewees was higher. Only the questions relevant for the analysis in this paper are documented in this appendix. Overall, 21 questions were discussed with respondents (apart from the initial 8 questions on firm specifics), of which only the 14 questions documented below are related to knowledge spillovers. Note, further, that the guiding questions were often discussed in further detail with respondents. Thus, the questions documented below in many cases only constitute the starting points of a brief discussion of the respective content.

Guiding questions	
What's your firm's zip code?	
To which craft domain does your firm belong?	
Are you active on a regional or national market?	
What is your position in your firm?	
How many employees does your firm have?	
When was your firm founded?	
Does your firm train apprentices?	
Does the Meisterpflicht apply to your domain?	
Only Meisterpflicht firms	Non-Meisterpflicht firms
Would the abolishment of the Meisterpflicht lead to fewer trainees in your craft domain?	Has the abolishment of the Meisterpflicht led to fewer trainees in your craft domain?
Is the Meisterbrief accepted as a signal for higher product quality in your craft domain?	Is the Meisterbrief a signal for higher product / service quality in your craft domain?
Do Customers orient towards signals of higher quality in your craft domain?	Do Customers orient towards signals of higher quality in your craft domain?
Can customers anticipate the quality of goods / services from the certifications of higher qualification?	Can customers anticipate the quality of goods / services from the certifications of higher qualification?
	Do you advertise your certification of higher qualification (Meisterbrief) if available?
	Do the certifications of higher qualification (Meisterbrief) enable you to charge higher prices?
How has the average quality of goods / services developed in the past 15 years in your craft domain?	How has the average quality of goods / services developed in the past 15 years in your craft domain?
	Has the deregulation of market entry influenced product/service quality in your craft domain?
	If yes, for the better or for the worse?